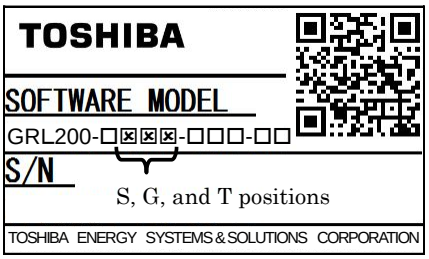
TOSHIBA

INSTRUCTION MANUAL

Line differential Protection IED

GR200 series (GRL200)

TOSHIBA ENERGY SYSTEMS & SOLUTIONS CORPORATION



Notice: GRL200 manual is issued for '010', '011', '013', '019', or '022' software code, which you can identify at 'S, G, and T positions 'on Software nameplate.

Safety Precautions

Before using this equipment, please read this chapter carefully.

This chapter describes the safety precautions recommended when using the GR equipment. Before installing and using the equipment, this chapter must be thoroughly read and understood.

Explanation of symbols used

Signal words such as DANGER, WARNING, and CAUTION, will be followed by important safety information that must be carefully reviewed.

⚠ DANGER	Indicates an imminently hazardous situation which will result in death or serious injury if you do not follow the instructions.
⚠WARNING	Indicates a potentially hazardous situation which could result in death or serious injury if you do not follow the instructions.
⚠CAUTION	Indicates a potentially hazardous situation which if not avoided, may result in minor injury or moderate injury or property damage.

⚠ DANGER

•Current transformer circuit

Never allow the current transformer (CT) secondary circuit connected to this equipment to be opened while the primary system is live. Opening the CT circuit will produce a dangerously high voltage.

⚠WARNING

•Exposed terminals

Do not touch the terminals of this equipment while the power is on, as the high voltage generated is dangerous.

•Residual voltage

Hazardous voltage can be present in the DC circuit just after switching off the DC power supply. It takes approximately 30 seconds for the voltage to discharge.

•Fiber optic

CLASS 1 LASER PRODUCT.

⚠CAUTION

•Earth

The earthing terminal of the equipment must be securely earthed.

⚠CAUTION

•Operating environment

The equipment must only be used within the range of ambient temperature, humidity and dust detailed in the specification and in an environment free of abnormal vibration.

•Ratings

Before applying AC voltage and current or the DC power supply to the equipment, check that they conform to the equipment ratings.

•Printed circuit board

Do not attach and remove printed circuit boards when the DC power to the equipment is on, as this may cause the equipment to malfunction.

•External circuit

When connecting the output contacts of the equipment to an external circuit, carefully check the supply voltage used in order to prevent the connected circuit from overheating.

•Connection cable

Carefully handle the connection cable without applying excessive force.

•Modification

Do not modify this equipment, as this may cause the equipment to malfunction.

•Short-wire (Short-bar)

Do not remove the short-wire/short-bar(s) connected to the frame earth (FG) at the terminal block on the rear of cases.

•Electric wire between #35 - #37 on the power-supply terminal block

Make sure the wire is connected.

(Exception: This wire needs to be detached for performing the dielectric voltage test.)

•Disposal

This equipment contains neither expendable supplies nor parts that can be recycled. When disposing of this equipment, the customer must contact an operator responsible for industrial waste disposal, and request that the operator dispose of this equipment in accordance with the local waste disposal regulations; otherwise the person who disposes of this equipment may be punished under local regulations. When disposing of this equipment is practiced by the customer acting on their own behalf, it must be done so in a safe manner according to local regulations. For further information in terms of the disposal, the customer shall contact to a local dealer and sales staff at Toshiba Energy Systems & Solutions Corporation (Toshiba ESS, Japan).

This equipment contains neither expendable supplies nor recyclables.

•Plastics material

This equipment contains the following plastics material.

- ABS, Polycarbonate, Acrylic resins, Nylon 66, and others.

Equipment installation and operation

•Equipment installation

Never remove cables at frame ground terminals (FGs) while the AC/DC power supplies.

•Equipment operation

The user shall have responsibilities to use and install the equipment where the specifications are designated by the manufacture. Never operate the equipment on the condition where the manufacture cannot intend. Otherwise, the safety function furnished into the equipment may not be operated properly.

•Symbols

Symbol	Description
	**Protective conductor terminal**
	**Caution, risk of electric shock**

Liability, copyright and others

•Disclaimer of liability

We have checked the description of this manual against the hardware and software described, but we cannot guarantee that all deviations have been eliminated from the description completely; hence, no liability can be accepted for any errors or omissions contained in the information given. We review the information in this manual regularly and there will be some corrections in subsequent editions. We reserve the right to make technical improvements without notice.

•Copyright

© Toshiba Energy Systems & Solutions Corporation 2020.
All rights reserved.

•Registered Trademarks

Product/Equipment names (mentioned herein) may be trademarks of their respective companies.

Contents

1 Introduction 1
1.1 Protection functions 2
1.1.1 Purposes of the protection 2
1.1.2 Requirements in the protection functions 2
1.1.3 Behavior of backup protections 4
1.1.4 Concepts of current differential protection (DIF) function 6
1.1.5 Concepts of distance protection (ZS/ZG) function 6
1.1.6 Concepts of carrier command protection (DISCAR/DEFCAR) function 10
1.1.7 Tripping CB by the protection functions 10
1.1.8 Autoreclosing CB (ARC) after the operation of the protection functions 11
1.1.9 Conventional applications 11
1.2 Control 12
1.3 Monitoring and metering functions 12
1.4 Hardware overview 13
1.5 Symbols used in logical diagrams 14
1.6 Abbreviation 18
1.7 Function Block (FB), Function ID, Signal number (Data ID) 20
2 Relay application 22
2.1 Current differential protection for the line 23
2.2 Segregated-phase current differential protection function (DIFL) 24
2.2.1 Differential protection characteristics (DIFL) 24
2.2.2 Check relays characteristics (OCs and UVs) 30
2.2.3 CT circuit-failure detection (DIFL-CTF) 32
2.2.4 Charging-current compensation (DIFL-Ic) 33
2.2.5 Differential current monitor (DIFL-IDSV) 34
2.2.6 Setting 36
2.2.7 Data ID 37
2.2.8 Setting DIFL accounting for CT ratio/rating and fault currents 40
2.3 Zero-sequence current differential protection (DIFGL) 44
2.3.1 Differential protection characteristics (DIFGL) 44
2.3.2 Check relay characteristic (EFD) 47
2.3.3 CT circuit-failure detection (DIFGL-CTF) 48
2.3.4 Charging-current compensation (DIFGL-Ic) 48
2.3.5 Setting 50
2.3.6 Data ID 51
2.3.7 Remote different trip 52
2.3.8 Setting 60
2.3.9 Data ID 61

2.4 Distance protection (ZS/ZG) 62
2.4.1 Principle of distance measurement 63
2.4.2 Element characteristic in distance relay 67
2.4.3 Common application for ZS and ZG 80
2.4.4 Carrier command protection feature 86
2.4.5 Extended application 91
2.4.6 Scheme logic 93
2.4.7 Setting tips for main/remote backup relays using distance zones 96
2.4.8 Setting tips for multi-terminal lines using distance zones 98
2.4.9 ZS/ZG test 100
2.4.10 Setting 101
2.4.11 Data ID 113
2.5 Direct transfer trip (DTT) 121
2.5.1 Setting for the operation 122
2.5.2 Scheme logic 123
2.5.3 Setting 124
2.5.4 Data ID 125
2.6 Distance carrier command protection (DISCAR) 126
2.6.1 Permissive underreach protection (PUP) 127
2.6.2 Permissive overreach protection (POP) 128
2.6.3 Unblocking overreach protection (UOP) 131
2.6.4 Blocking overreach protection (BOP) 133
2.6.5 Protection for week infeed terminal 136
2.6.6 Countermeasure for current reversal 138
2.6.7 Programing DISCAR using PLC function 140
2.6.8 Setting 141
2.6.9 Data ID 142
2.7 Directional earth fault command protection (DEFCAR) 144
2.7.1 Permissive overreach protection (POP) 145
2.7.2 Unblocking overreach protection (UOP) 148
2.7.3 Blocking overreach protection (BOP) 148
2.7.4 Coordination with DISCAR protection 150
2.7.5 Programing DEFCAR using PLC function 151
2.7.6 Setting 152
2.7.7 Data ID 153
2.8 Switch on to fault (SOTF-OC) 155
2.8.1 Scheme logic 156
2.8.2 Setting 158
2.8.3 Data ID 158

2.9 Overcurrent protection (OC) 159
2.9.1 Relay polarity 160
2.9.2 Inverse definite mean time and definite time characteristic 163
2.9.3 Threshold value for operation 168
2.9.4 Reset Ratio 168
2.9.5 Miscellaneous functions 168
2.9.6 Scheme logic 170
2.9.7 Setting 172
2.9.8 Data ID 175
2.10 Earth fault protection (EF) 177
2.10.1 Relay polarity 178
2.10.2 Inverse time and definite time delay characteristic 181
2.10.3 Threshold level for operation 187
2.10.4 Reset Ratio 187
2.10.5 Miscellaneous functions 187
2.10.6 Scheme logic 188
2.10.7 Setting 190
2.10.8 Data ID 194
2.11 Negative sequence overcurrent protection (OCN) 195
2.11.1 Relay polarity 196
2.11.2 Inverse time and definite time delay characteristic 198
2.11.3 Threshold value 203
2.11.4 Reset Ratio 203
2.11.5 Miscellaneous functions 203
2.11.6 Scheme logic 204
2.11.7 Setting 206
2.11.8 Data ID 208
2.12 Thermal overload function (THM) 209
2.12.1 Thermal state determination 210
2.12.2 Thermal characteristic 211
2.12.3 Scheme logic 212
2.12.4 Setting 213
2.12.5 Data ID 213
2.13 Broken conductor protection (BCD) 214
2.13.1 Equivalent circuit for a one-phase series fault 215
2.13.2 Characteristic and setting 217
2.13.3 Miscellaneous functions 217
2.13.4 Scheme logic 218
2.13.5 Setting 218

2.13.6 Data ID 219
2.14 Circuit breaker fail protection (CBF) 220
2.14.1 CBF operation and its elements 221
2.14.2 Re-trip feature 221
2.14.3 Backup feature 222
2.14.4 Scheme logic 223
2.14.5 Operation timing 225
2.14.6 Setting 226
2.14.7 Data ID 227
2.15 Overvoltage protection for phase-to-neutral (OV) 229
2.15.1 Drop-off and pickup characteristic 230
2.15.2 Delay for the operation of the OV element 230
2.15.3 Time characteristic 230
2.15.4 Miscellaneous functions 233
2.15.5 Scheme logic 233
2.15.6 Setting list 235
2.15.7 Data ID 236
2.16 Overvoltage protection for phase-to-phase (OVS) 237
2.16.1 Drop-off and pickup setting 238
2.16.2 Delay for the operation of the OVS element 238
2.16.3 Time characteristic 238
2.16.4 Miscellaneous functions 240
2.16.5 Scheme logic 241
2.16.6 Setting list 243
2.16.7 Data ID 244
2.17 Phase under-voltage protection (UV) 245
2.17.1 Drop-off and pick-up characteristic 246
2.17.2 Time characteristic 246
2.17.3 Miscellaneous functions 249
2.17.4 Scheme logic 249
2.17.5 Setting 251
2.17.6 Data ID 252
2.18 Phase-to-phase under-voltage protection (UVS) 253
2.18.1 Drop-off and pick-up characteristic 254
2.18.2 Time characteristic 254
2.18.3 Miscellaneous functions 257
2.18.4 Scheme logic 257
2.18.5 Setting 259
2.18.6 Data ID 260

2.19 Frequency protection (FRQ/DFRQ) 261
2.19.1 FRQ features and characteristics 262
2.19.2 DFRQ features and characteristics 264
2.19.3 Setting 266
2.19.4 Data ID 268
2.20 Out of step tripping by voltage (OSTV) 270
2.20.1 Operation characteristic 271
2.20.2 Scheme logic and settings 273
2.20.3 Setting 274
2.20.4 Data ID 275
2.21 Inrush current detection function (ICD) 276
2.21.1 Operation and characteristic 277
2.21.2 Scheme logic 277
2.21.3 Setting 278
2.21.4 Data ID 278
2.22 Fail safe (FS) 279
2.22.1 Overcurrent element (OCFS) 280
2.22.2 Phase current change detector element (OCDFS) 280
2.22.3 Earth fault current element (EFFS) 280
2.22.4 Multi-level overcurrent elements (OCMFS) 281
2.22.5 Under-voltage element for phase-to-earth (UVFS) 282
2.22.6 Under-voltage element for phase-to-phase (UVSFS) 282
2.22.7 Under-voltage change detection element (UVDFS) 282
2.22.8 Scheme logic 283
2.22.9 Setting 285
2.22.10 Data ID list 286
2.23 VT failure detection (VTF) 287
2.23.1 VTF features 288
2.23.2 Operation for the VTF function 288
2.23.3 VTF Logic 289
2.23.4 Setting 291
2.23.5 Data ID 292
2.24 CT failure detection (CTF) 293
2.24.1 CTF features 294
2.24.2 Operation for the CTF function 294
2.24.3 Scheme logic 294
2.24.4 Setting 296
2.24.5 Data ID 297
2.25 Multi-end fault locator (FL-A and FL-Z) 298

2.25.1 FL calculation with data at a local-terminal and remote-terminals 299
2.25.2 FL calculation with data at a local-terminal only 306
2.25.3 Selection of calculation results 312
2.25.4 Screen of FL output 313
2.25.5 Preparation and consideration of setting 316
2.25.6 Setting procedure 318
2.25.7 Setting 322
2.25.8 Data ID 325
2.26 Trip circuit (TRC) 326
2.26.1 Command for tripping CB and signal to block reclosing CB#1/CB#2 329
2.26.2 Recording identifiers for respective fault types 332
2.26.3 Scheme logic 333
2.26.4 Setting 338
2.26.5 Data ID 339
2.27 Autoreclose (ARC) 341
2.27.1 Overview 342
2.27.2 Terminology 347
2.27.3 Function block diagram 352
2.27.4 Timing diagram 361
2.27.5 Autoreclosing logics 364
2.27.6 Setting 388
2.27.7 Data ID 389
2.28 Voltage check for autoreclose (VCHK) 393
2.28.1 VCHK1 for 1CB system 394
2.28.2 VCHK1 and VCHK2 for 1.5CB system 395
2.28.3 Scheme for synchronism 396
2.28.4 VCHK1 setting for 1CB system 401
2.28.5 VCHK1 and VCHK2 settings for 1.5CB system 405
2.28.6 Scheme and activation 407
2.28.7 Setting 409
2.28.8 Data ID 411
2.29 Transmission control function (DIF_COMM with three terminals) 412
2.29.1 Data communication interface 413
2.29.2 Synchronization control 414
2.29.3 Topology of telecommunication 421
2.29.4 Communication setup 422
2.29.5 Setting 424
2.30 Communication application (COMM_APPL) 425
2.30.1 Relay-address configuration 426

2.30.2 Sub-communication channel for 1CB arrangement 427
2.30.3 Sub-communication channel for 1.5CB arrangement 429
2.30.4 Integral communication bits 430
2.30.5 Communication bits for OSTV 431
2.30.6 Usage of sub-communication channel 431
2.30.7 Setting of open terminal detection 431
2.30.8 Communication test 432
2.30.9 Setting 433
2.30.10 Data ID 434
2.31 Protection common (PROT_COMMON) 451
2.31.1 Selection of breaker system 452
2.31.2 Decision of CB open/close status 452
2.31.3 Decision of DS open/close status 455
2.31.4 Dead line detection 456
2.31.5 Detection of current change (OCD) 457
2.31.6 Setting 458
2.31.7 Data ID 459
3 General control function 461
3.1 Control scheme 462
3.2 Control mode 465
3.2.1 Select-before-operation mode (SBO) 465
3.2.2 Direct-operation mode (DIR) 466
3.3 Common controls (CMNCTRL) 468
3.3.1 PLC_BIT/UNIT/BOOL signal 469
3.3.2 Provision of selected status 470
3.3.3 Miscellaneous settings 470
3.3.4 Setting 472
3.3.5 Signal 473
3.4 Local, remote and PLC control 475
3.4.1 Local control 476
3.4.2 Remote control 476
3.4.3 Programmable logic control (PLC) 476
3.4.4 Signal for Local/Remote control 477
3.5 LED reset function (LEDR) 478
3.5.1 Select logic for resetting LEDs 479
3.5.2 Cancel logic in SBO mode 481
3.5.3 Operate logic for SBO/DIR mode 482
3.5.4 Settings in LED logics 483
3.5.5 Mapping for IEC61850 communication 485

3.5.6 Setting 489
3.5.7 Signal 490
3.6 Counter function for the general (GCNT) 491
3.6.1 Counter setting for a signal 492
3.6.1 Select logics for SBO/DIR modes 494
3.6.2 Cancel logic for SBO mode 500
3.6.3 Operate logic for SBO/DIR modes 502
3.6.4 Mapping for IEC61850 communication 506
3.6.5 Setting 510
3.6.6 Signal 511
3.7 Mode control function (MDCTRL) 520
3.7.1 Function 521
3.7.2 Mapping for IEC61850 communication 522
3.7.3 Setting 526
3.7.4 Signal 527
4 Control and monitoring application 529
4.1 Single position device function (SPOS) 530
4.1.1 Selection logic for SBO/DIR modes 531
4.1.2 Cancel logic for SBO mode 546
4.1.3 Operate logic for SBO/DIR modes 550
4.1.4 Setup for BIO module 566
4.1.5 Mapping for IEC 61850 communication 574
4.1.6 Setting 579
4.1.7 Signal 580
4.2 Double position controller with synchronizing-checking (DPSY) 582
4.2.1 Select logic for SBO/DIR modes 583
4.2.2 Cancel logic for SBO mode 597
4.2.3 Operate logic for SBO/DIR modes 601
4.2.4 Operation counter 617
4.2.5 Measurement of operation intervals 621
4.2.6 Setup for BIO module 623
4.2.7 Mapping for IEC 61850 communication 634
4.2.8 Setting 638
4.2.9 Signal 640
4.3 Software switch controller function (SOFTSW) 645
4.3.1 SOFTSW controlling 646
4.3.2 Control logics for SBO/DIR modes 649
4.3.3 Cancel logic for SBO mode 658
4.3.4 Operate logic for SBO/DIR modes 658

4.3.5 Mapping for IEC 61850 communication 665
4.3.6 Setting 669
4.3.7 Signal 670
4.4 Operation time reset function (OPTIMRSTCTRL) 681
4.4.1 Select logic for SBO/DIR modes 683
4.4.2 Cancel logic in SBO mode 686
4.4.3 Operate logic for SBO/DIR modes 687
4.4.4 Mapping for IEC61850 communication 689
4.4.5 Setting 693
4.4.6 Signal 694
4.5 Total time measurement function (TOTALTIM) 695
4.5.1 Operation feature 696
4.5.2 Preparation for operation 698
4.5.3 Mapping for IEC 61850 communication 699
4.5.4 Setting 703
4.5.5 Signal 704
4.6 Synchronizing check for different network (SYNDIF) 707
4.6.1 Relays to check line-outage 708
4.6.2 Synchronization check relays 710
4.6.3 Line-outage check 715
4.6.4 Synchronization check 720
4.6.5 Relay selection for checking synchronization 724
4.6.6 Voltage selection for line arrangement 726
4.6.7 Setting 728
4.6.8 Signal 730
5 Technical Description 734
5.1 IED case and module slot 737
5.1.1 1/1 Case 737
5.1.2 3/4 case 739
5.1.3 1/2 case 741
5.2 Transformer module for AC analog input (VCT) 743
5.2.1 VCT11B 744
5.2.2 VCT12B 745
5.2.3 Constitution of VCT 746
5.2.4 Setting VCT ratio 747
5.2.5 Check of rated current 748
5.3 Signal processing and communication module (CPU) 750
5.3.1 Processing module 750
5.3.2 Communication modules 752

5.3.3 Location of communication modules 755
5.4 Binary IO module (BI, BO, and BIO) 756
5.4.1 Binary input feature 757
5.4.2 Binary input circuit 758
5.4.3 Binary output feature 767
5.4.4 Binary output circuit 769
5.4.5 Structure of binary IO Module 775
5.4.6 Settings of binary input circuits 781
5.4.7 Signals (Data ID) of binary input circuits 783
5.4.8 Settings of binary output circuits 786
5.4.9 Signals (Data ID) of binary output circuits 788
5.5 Power supply module (PWS) 790
5.6 Human Machine Interface (HMI) 793
5.6.1 Outlook 793
5.6.2 LED Indicators 794
5.6.3 Function keys with LEDs 799
5.6.4 Monitoring jacks 804
5.6.5 Operation keys 806
5.7 Clock function 807
5.7.1 Clock setting 807
5.7.2 Selection of date and time formats 807
5.7.3 Time Synchronization 808
5.7.4 Setting time zone 812
5.7.5 DST setting (Summer time setting) 813
5.7.6 Setting 815
6 Engineering tool 816
6.1 Overview of GR-TIEMS 817
6.2 Connection 818
6.3 Common tools 818
6.4 Monitoring tools 819
6.5 Record tools 819
6.6 Generic configuration tools 819
6.7 IEC 61850 configuration tool 820
6.8 IEC 60870-5-103 configuration tool 820
6.9 MIMIC configuration tool 820
7 PLC function 821
7.1 Overview of PLC function 822
7.2 PLC data error 822
7.3 PLC driver 823

8 Recording function 827
8.1 Fault recorder 828
8.1.1 Types of recording information 828
8.1.2 Screen information 830
8.1.3 Setup for the fault recorder 831
8.1.4 Scheme logic 834
8.1.5 Setting 835
8.1.6 Signal (Data ID) 835
8.2 Event recorder 836
8.2.1 Trigger signals 836
8.2.2 Trigger modes 841
8.2.3 Screen information 842
8.2.4 Setup for the event recorder 842
8.2.5 Setting 843
8.2.6 Signal (Data ID) 843
8.3 Disturbance recorder 844
8.3.1 Recording time and amount 844
8.3.2 Relays within disturbance recorder 844
8.3.3 Maximum number for recording disturbance phenomena 845
8.3.4 Number of analog quantities and logical signals for disturbance recorder 845
8.3.5 Trigger settings for PLC programming 848
8.3.6 Screen information 848
8.3.7 Setting 850
8.3.8 Signal (Data ID) 851
9 Monitoring function 852
9.1 Outline 853
9.2 Metering data (Metering group) 854
9.2.1 Metering information on the screen 855
9.2.2 Setting for measurements 855
9.2.3 Diminishing a very small value to display zero 856
9.2.4 Flow settings for active/reactive/apparent powers 856
9.3 Statistics data (Power value group) 858
9.3.1 Power information on the screen 858
9.3.2 Setting for power values 858
9.3.3 Regulation of power values 858
9.4 Statistics data (Demand value group) 859
9.4.1 Demand information on the screen 859
9.4.2 Max/Min/Averaged information about the demand feature 860
9.4.3 Demand cycle 860

9.4.4 Resetting data in demand features 860
9.5 Statistics data (Peak-demand value group) 862
9.5.1 Max/Min/Averaged information about the peak-demand feature 862
9.5.2 Resetting data of peak-demand features 862
9.6 Statistics data (Counter group) 863
9.6.1 Count information on the screen 863
9.6.2 Report setting for GCNT (Dead band feature) 863
9.7 Statistics data (Total time group) 864
9.7.1 Time information on the screen 864
9.7.2 Report setting for TOTALTIM (Dead band feature) 864
9.8 Statistics data (Accumulated time) 864
9.9 Monitoring for miscellaneous functions 866
9.10 Setting 867
9.11 Data ID 868
10 Automatic supervision 873
10.1 Outline of automatic supervision 874
10.2 Generic supervision tasks 877
10.2.1 Mismatch between ROM and RAM (ROM/RAM error) 879
10.2.2 Check-sum error (SUM error) 880
10.2.3 Supervision of RAM (RAM error) 881
10.2.4 Supervision of ECC on memory (ECC error) 882
10.2.5 Supervision of MRAM (MRAM) 883
10.2.6 Supervision of program codes (CPU error) 884
10.2.7 Supervision of DPRAM on sub-CPU (DPRAM error) 885
10.2.8 Supervision of DPRAM on external-CPU (DPRAM error) 886
10.2.9 Detecting non-maskable interrupt (NMI error) 887
10.2.10 Supervision of sampling period (SMP error) 888
10.2.11 Detection of sub-CPU not operated (Stopped error) 889
10.2.12 Detection of external-CPU not operated (Stopped error) 890
10.2.13 Supervision of setting data (Setting error) 891
10.2.14 Supervision of real-time clock (RTC error) 892
10.2.15 Supervision of analog input data on VCTs (AI ACC error) 893
10.2.16 Abnormal current flowing in CT (CT error) 894
10.2.17 Current transformer failure (CT fail) 895
10.2.18 Supervision of current in zero-sequence (I0 error) 896
10.2.19 Supervision of voltage in negative-sequence (V2 error) 897
10.2.20 Supervision of voltage in zero-sequence (VZ error) 898
10.2.21 Supervision of binary IO module#1 (BIO#1 error) 899
10.2.22 Supervision of binary IO module#2 (BIO#2 error) 900

10.2.23 Supervision of binary IO module#3 (BIO#3 error) 901
10.2.24 Supervision of binary IO module#4 (BIO#4 error) 902
10.2.25 Supervision of binary IO module#5 (BIO#5 error) 903
10.2.26 Supervision of binary IO module#6 (BIO#6 error) 904
10.2.27 Supervision of binary IO module#7 (BIO#7 error) 905
10.2.28 Supervision of binary IO module#8 (BIO#8 error) 906
10.2.29 Supervision of human machine interface (HMI error) 907
10.2.30 Supervision of power supply module (Power error) 908
10.2.31 Supervision of data in PLC function (PLC data error) 909
10.2.32 Voltage transformer failure (VT fail) 910
10.2.33 Supervision of circuit breaker contacts (CB1/CB2 fail) 911
10.2.34 Supervision of disconnector contacts (DS fail) 912
10.2.35 Supervision of response for pinging (Ping error) 913
10.2.36 Supervision of data in 61850 settings (Commslv error) 914
10.2.37 Supervision of GOOSE publishing (LAN(GOOSE)error) 915
10.2.38 Aux. contacts monitoring (DPSY faulty and undefined) 916
10.2.39 Setting 918
10.2.40 Signal (Data ID) 922
10.3 Device-dependent supervision tasks 927
10.3.1 Error detection of differential current in DIF (Id) 928
10.3.2 Current transformer failure detected with DIF (DIF-CT) 929
10.3.3 Synchronizing and sampling error (Com sync fail) 930
10.3.4 Communication failure (Com fail) 931
10.3.5 Error signal level for sending (TX level) 932
10.3.6 Error signal level for receiving (RX level) 933
10.3.7 Propagation delay error (Com Td) 934
10.3.8 Error terminal configuration (Term ID) 935
10.3.9 Monitoring ready state at the remote (Term rdy) 936
10.3.10 Transmission error (Com fail-R) 937
10.3.11 Master-slave monitoring (MSCHK) 938
10.3.12 Supervision of Relay ID (RYID) 939
10.3.13 Setting 940
10.3.14 Signal (Data ID) 943
11 Communication protocol 946
11.1 LAN communication 947
11.1.1 Setup 947
11.1.2 Auto reset function 955
11.1.3 Monitoring LAN communication 956
11.1.4 Settings 957

11.1.5 Data ID 959
11.2 IEC 61850 communication 961
11.2.1 About protocol 963
11.2.2 Communication service 965
11.2.3 How to manage engineering work 968
11.2.4 Setting for IED 984
11.2.5 How to supervise in 61850 communications 986
11.2.6 Quality signal in 61850 communication 987
11.2.7 Goose monitoring status in 61850 communication 988
11.2.8 Setting 990
11.2.9 Data ID 990
11.3 IEC 60870-5-103 communication 999
11.3.1 Overview 1000
11.3.2 Requirements in the Master station 1002
11.3.3 Interoperability 1003
11.3.4 Communication interface in the IEC 60870-5-103 standard 1004
11.3.5 Editing data of the configuration 1005
11.3.6 Protocol selection 1024
11.3.7 Tips for settings 1025
11.3.8 Setting 1026
11.4 USB communication 1027
12 User interface 1028
12.1 Outline 1029
12.2 HMI operation 1033
12.3 Record sub-menu 1036
12.4 Monitoring sub-menu 1043
12.5 Setting sub-menu 1051
12.6 I/O setting sub-menu 1064
12.7 Time sub-menu 1071
12.8 Test sub-menu 1079
12.9 Information sub-menu 1085
12.10 Security setting sub-menu 1087
12.11 Control sub-menu 1088
13 Installation 1090
13.1 Caution for storage 1091
13.2 Handling precautions 1091
13.3 Unpack and inspection of hardware and software 1092
13.4 PWS alarm threshold setting 1096
13.5 Removing and installation of an inside module 1097

13.6 Rack mounting 1103
13.7 Wiring work 1107
13.8 Guide for optic cable work 1111
14 Commissioning and maintenance 1113
14.1 Cautions 1115
14.2 Preparations 1115
14.3 Test operations 1117
14.3.1 Test for communication 1117
14.3.2 Test for relay application 1118
14.3.3 Test for control application 1120
14.3.4 Test for BI and BO circuits 1120
14.3.5 Test for mode change (MDCTRL) 1120
14.3.6 Signal monitor 1120
14.3.7 LED light test 1120
Appendix 1 Signal list for common function 1121
Appendix 2 Case outline 1129
Appendix 3 Typical external connection 1136
Appendix 4 IEC61850 MICS, PICS, PIXIT, and TICS 1141
Appendix 5 IEC60870-5-103 interoperability 1205
Appendix 6 Ordering 1220
Appendix 7 Technical data 1235
Appendix 8 Manufacture setting 1251
Appendix 9 Matrix between VCT terminals and relay applications 1253
Appendix 10 Rack mounting 1258
Appendix 11 Input dummy for relay application 1262
Appendix 12 Notes for the dielectric voltage test 1270

1 Introduction

GRL200 line differential protection has been designed to provide phase-segregated current differential protection with digital telecommunications, together with control applications. The GRL200—intelligent electronic device (IED)—provides you with the flexibility to meet their application and engineering requirements in addition to offering excellent performance, the high quality and reliability.

1.1 Protection functions

The IED has a number of protection functions and these functions are being optimized for transmission or distribution systems. The followings functions incorporated and programmed with the user's settings using the menus on the IED or in the engineering tools can operate well with mutual linkage between protection functions.

1.1.1 Purposes of the protection

In order to secure the stability in the power system, the protection function provides three significant fundamentals for the protection in response to various faults:

(1) Prevention of power supply interruption is to clear the faults and recover the faulted power transmission as soon as possible.

(2) Prevention of damage to equipment is serviced not to damage the primary device even if faults occur successively. For example, destruction of insulators, rupture of lines, burning of transformers, and others may result in severe damages in devices in the power system. The protection function can serve the device not be vulnerable severely for such damages.

(3) Prevention of system instability is to clear faults in the power system speedy by the operation in the protection functions. Otherwise, a generator will be in out-of-step if a fault does not clear speedy.

1.1.2 Requirements in the protection functions

Several essences shall be considered for the operation within the relays:

(i) Selectivity

If any fault occurs in the power system, it shall be cleared. At the same time, we should consider that the unfaulted segments of the power system must be isolated from the faulted segment in which the fault may clear. Figure 1.1-1 illustrates the protection areas constructed with two different protection schemes; the two schemes are overlapped so that the entire areas are protected.

Figure 1.1-2 illustrates the locations of a circuit breaker (CB) and a current transformer (CT) connected with the relays. In Figure 1.1-2(a), for example, two CTs locates on the both sides of the $CB^{(N)}$: a CT is connected with the relay $Ry^{(S)}$ seeing into the line and another CT is connected with the relay $Ry^{(X)}$ seeing to the busbar; the zones protected by the two relays are overlapped.

Figure 1.1-2(b) exemplifies that both the forward line and the busbar are protected using a CT. Once a fault occurs between the CT and the CB(N), the relay Ry(S) for the forward line can operate, but the relay Ry(X) for the busbar may fail to operate to clear the fault. That is, we should keep in mind that a blind spot never exits in the power system for designing the protection.

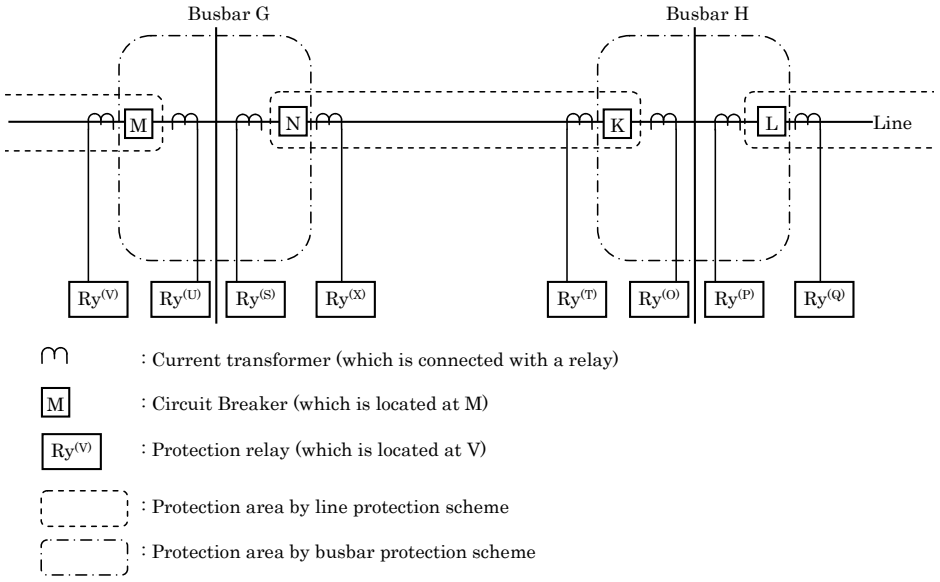


Figure 1.1-1 Two protection schemes for line and busbar

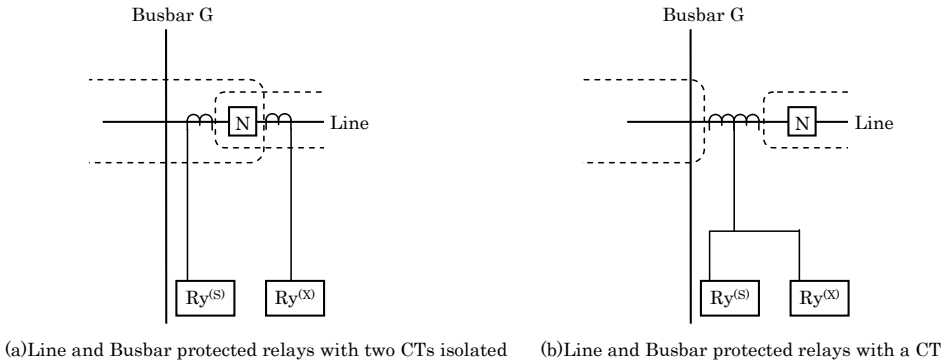


Figure 1.1-2 Protection schemes and the location of the CB

(ii) Speediness

As mentioned earlier, shortening the fault duration is realized by the speedy operation of the relay; it is achieved by the high speed signal processing module. However, we have to note that the operating time of the CB is slower comparted with the one of the processing module. Additionally, the propagation delay of the communion should also be considered when the carrier command protection function is considered for the protection.

(iii) Reliability

The relay is in a quiescent state normally, but the relay shall respond to a fault instantly once it occurs on the power system. Hence, the operation availability shall be checked whenever the line is energized in unfaulted state. Additionally, to improve the operation reliability, the protection scheme is checked externally by fail-safe function (FS). That is, the relay operations are checked not to issue a trip command mistakenly by the FS relay; consequently, erroneous tripping can be prevented dramatically if the prime (main) relay operates mistakenly. The check results of the FS relay are combined together with the operation results of the prime relay at the last stage (i.e., AND logics runs on the trip circuit).

1.1.3 Behavior of backup protections

Faults shall be securely cleared and clearing the faults shall be made as soon as possible, or the power system may result in the outage. As to protect the power system, as a rule, a main (primary) relay operates along with a number of backup relays. A protection function represents the main (primary) relay, whereas the other protection functions operate as the backup relays. Accordingly, faults could be clear if the main (primary) relay were in the failure to operate.

(i) Protection for the line

The element† in the current differential protection function (DIF) is designed to operate for the main relay. However, we shall note that the main protection cannot operate perfectly at any time. For example, the DIF protection function cannot operate correctly once the telecommunication incident or others occur. Thus, we shall design that clearing the faults could be performed by the operation in backup relays in any case. Note that we should figure the capability for clearing the faults being dependent on the system integrity. The conventional relays (such as distance relay and others) are serviced as the backup protections, which we discuss successively.

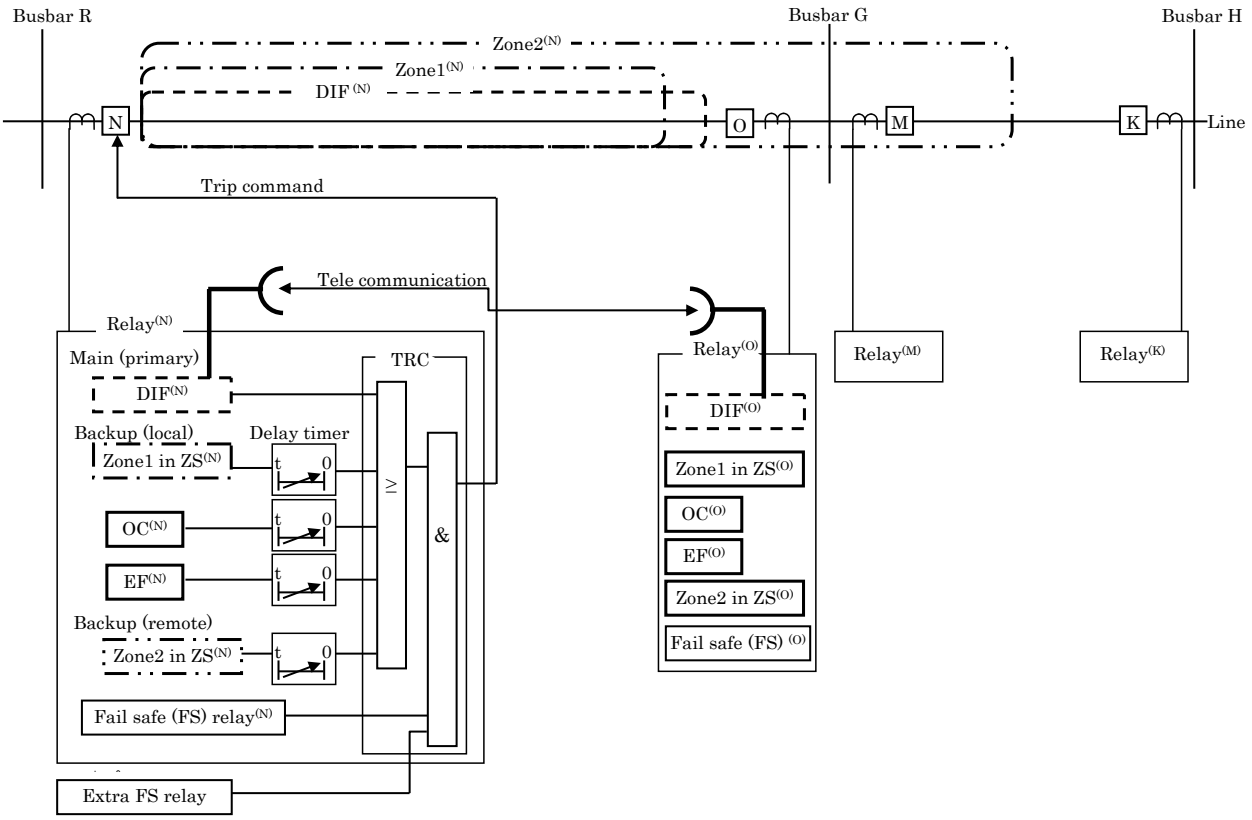


Figure 1.1-3 Protection zones provided by the main relay and backup relays

†Note: When the carrier command protection function (DISCAR or DEFCAR) is available, the function can also service as a local backup protection. We shall also note that the function cannot operate in the device failure in the telecommunication.

(ii) Coordination between the main and the backup protections

The operation of the backup protection is realized by retarding the operation of the backup protection rather than the main protection; retarding is made with setting the delay timer of the backup protection. We shall note that the setting value for the delay timer should be chosen so that the coordination between the main protection and the backup protection is realized. The degree for retarding the backup protection is determined by the consideration of operating and reset time margins:

- Operating time of the main protection
- Reset time of backup protections
- Operating time of the circuit breaker

(iii) Types of the backup protections

The backup protections are grouped into two: 1.backup protections serviced from the remote end far from the location of the main protection and 2.backup protections serviced locally as same as the main protection.

(iii)-1 Remote backup protection (Retarded backup protection)

Due to practical problems such as the incidents of power supply and others, there is possibility to fail to operate the main protection. Therefore, providing a backup protection from the remote end is essential so that the main protection is backed up remotely. For the ZS/ZG protection, the zone2 and zone3 for the relaying elements can be serviced as the remote backup protections.

(iii)-2 Local backup protection (High-speed backup protection):

If the circuit breaker has failed to trip by the commands of the main protection, the CB could be tripped by the commands of the backup protections located beside the main protection. For the DIF function, the zone1 element of the ZS/ZG function and others are serviced as the local backup protection.

1.1.4 Concepts of current differential protection (DIF) function

Current differential protection compares the currents flowing into and out of the protected line. The difference of the currents, that is, the differential current, is almost zero when a fault is external or there is no fault, and is equal to the fault current when the fault is internal. The differential protection operates when the difference of the currents exceeds a set value.
The DIF function in the GR200 series relay located at the ends of the line can examines the entering and outgoing currents in every 7.5 electrical degrees; they are transmitted to the other terminals in every four samples using the telecommunication. As the DIF function can obtain the current data at all remote-ends using the telecommunication, the DIF function at any locations can perform as the master.

As synchronized sampling can be performed at all terminals, the current data are the instantaneous values, which are sampled simultaneously at each terminal. Therefore, by using the identical sampling address, the value of the differential currents can be obtained straightforward by summing current data at the local and the remote. Thus, compensation of transmission delay time is not required in the DIF function.

The GR200 series relay takes respective three-phase currents and a residual current in so that performing segregated-phase and zero-phase current differential protection are achieved.

1.1.5 Concepts of distance protection (ZS/ZG) function

In the distance protection function, the line protection is grouped into four [or five] zones; the zones are protected with four [for five] measuring elements: zone1(Z1), zone1X(Z1X), zone2(Z2), and zone3(Z3)[zone4(Z4)]. Figure 1.1-4 illustrates the six elements in the Mho characteristic.

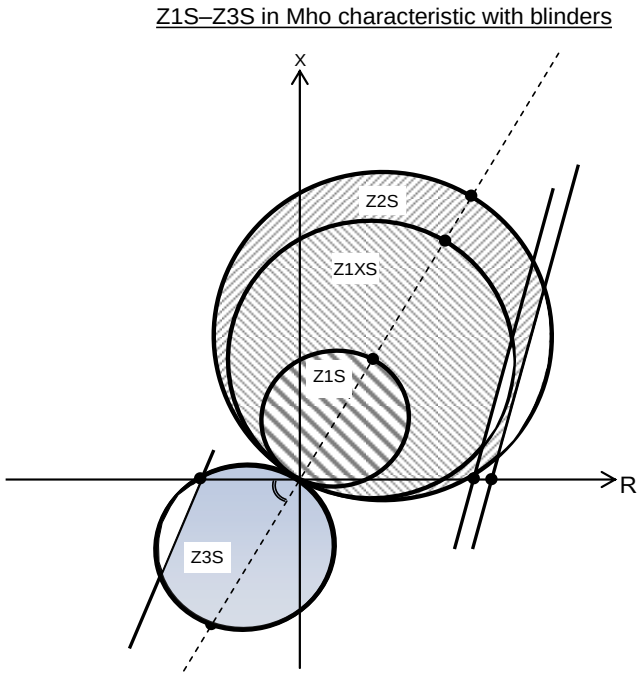


Figure 1.1-4 Four zones in Mho characteristic

(i) The reach of the zone1 element

The user shall notice that the reach of the zone1 element is usually set to approximately 80 to 90% of the length of the line (the reach of the zone1 should not include the busbar at the remote end. That is, the zone1 element shall not operate for a fault occurring beyond the remote busbar). Accordingly, if a fault occurs out of the zone1 and lies behind the remote busbar, the zone2 element starts to operate to clear the fault, but its operation will be retarded by the comparison of the operation of the zone1 element†.

†Note:Operation of the carrier command protection function (DISCAR or DEFCAR) is practical when the user wishes to clear instantly the fault that occurs in that area.

(ii) Measuring error and its influence

In the case of a fault with resistance, the reactance component seen by the relay at the terminal sending power is smaller than the actual value and it tends to overreach. On the contrary, the reactance component seen by the relay at the terminal receiving power is greater than the actual value and it tends to underreach. The line impedance has different values in different phases. When its average value is used for the relay setting, underreaching will occur in a phase with greater impedance than the average value. In the case of fault resistance, its impedance is greater for earth faults where the fault is grounded via a steel tower or tree rather than a phase fault consisting of arc resistance only. Therefore, measuring errors about the earth fault relay are generally greater than the errors about the phase fault relay. The fault arc is considered to be almost equivalent to pure resistance. But if the phase of a current

that flows into a fault point from the remote end is different from the phase of the local current, the voltage at the fault will have a phase angle difference with respect to the local current, producing a measuring error in the distance relay with the principle of measuring the reactance component. The existence of a zero-sequence current on the protected line and adjacent line can also cause errors in the earth fault relay. The zero-sequence current normally acts in the direction of relay underreaching due to the effect of the induced voltage. The compensation method will be described in detail in the next section. The earth fault relay contains more errors than the phase fault relays even with these compensation methods. Therefore, the earth fault relays are usually set with a greater margin than the phase fault relays.

Regarding measuring errors in the relay, it is also necessary to consider hardware errors in the relay itself, errors introduced by coupling capacitor voltage transformers (CCVT), and transient overreach errors caused by the DC component of the fault current. For the GR200 series relays, the errors are defined to be less than 5%.

(iii) Detection of power swing and out-of-step

Power swings occur when the output voltages of generators at different points in the power system slip relative to each other, which result in system instabilities that may be caused by sudden changes in load magnitude or direction, or by power system faults and their subsequent clearance. During the course of such a power swing, the impedance seen by a distance relay may move (relatively slowly) from the load area into the operating characteristic of the distance protection. In fact, this phenomenon appears to the distance protection measuring elements like a three phase fault condition and may result in tripping if no countermeasure is applied. Most power swings are transient conditions from which the power system can recover after a short interval, and distance protection tripping is therefore highly undesirable in such cases. GR200 series relay provides the block function for power swing (PSB) so that preventing unwanted tripping is possible during the power swing. Figure 1.1-5 illustrates the typical impedance locus as seen by the distance relay during the transient power swing.

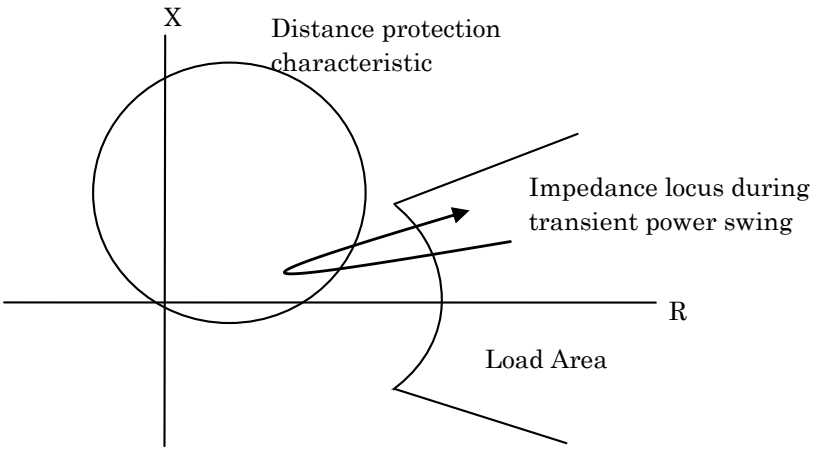


Figure 1.1-5 Impedance locus during transient power swing

A special case of the power swing condition occurs when the power system disturbance is so severe that generators lose synchronism with each other and are said to be out-of-step. During an out-of-step condition the phase angle between generators continues to increase and pass through 180°, at which point a distance relay measures an impedance equal to that for a three phase fault at the center of the power system. The impedance locus typically describes an arc passing through the electrical center, as shown in Figure 1.1-6.

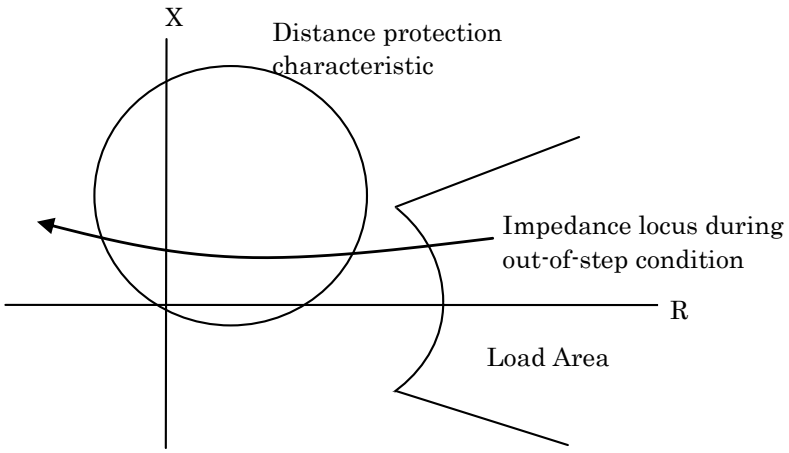


Figure 1.1-6 Impedance locus during out-of-step condition

In the case of a full out-of-step condition (as opposed to a transient power swing), it is desirable to separate the system in the vicinity of the center of the out-of-step condition. GR200 series can provide an out-of-step detection element (OST) which can provide tripping in these circumstances.

Although the power swing and out-of-step conditions are very closely related (in fact one is simply the most severe form of the other), completely different actions are required from the protection relay. The PSB function must ensure stability of the distance protection during

transient power system conditions, while the OST element initiates system separation by tripping in the event that a severe power swing results in potentially irrecoverable loss of stability in the power system. The PSB and OST elements are therefore completely separate functions within the relay, with different characteristics, separate scheme logic and different settings.

1.1.6 Concepts of carrier command protection (DISCAR/DEFCAR) function

(i) DISCAR Command protection by the distance (ZS/ZG) protection

If information picked up in the distance protection (ZS/ZG) function located at the ends of the protected line are exchanged mutually by means of the telecommunication, it is possible to determine accurately whether a fault occurs within the protecting zone or not. Consequently, at each ends, the trip command can be issued faster. The GR200 series can provide the following carrier command schemes using the elements of the ZS/ZG function.

- Permissive underreach protection (PUP)
- Permissive overreach protection (POP)
- Unblocking overreach protection (UOP)
- Blocking overreach protection (BOP)

(ii) DEFCAR command protection by the earth fault (EF) protection

Like in the DISCAR function, the DEFCAR function is designed to operate using the directional characteristic of the earth fault protection (EF) function. The DEFCAR function can provide the following carrier command schemes:

- Permissive overreach protection (POP)
- Unblocking overreach protection (UOP)
- Blocking overreach protection (BOP)

(iii) Operation with autoreclosing (ARC)

The user should notice that the operation in respective command protections initiate the operation of the autoreclose (ARC) for the circuit breaker very fast.

1.1.7 Tripping CB by the protection functions

After issuing the trip commands by the protection functions, the trip commands are grouped within the trip circuit (TRC) function; then, the TRC function drives the binary output circuits within the relay for transferring the trip commands to the CB. The TRC function can operate for tripping single-pole or multi-poles. Before the protection functions is reset, the auxiliary contacts of the CB must be derived to open; this is because, the protection function cannot interrupt straightforward the current flowing on the tripping coil circuit of the CB.

1.1.8 Autoreclosing CB (ARC) after the operation of the protection functions

Most faults that occur on high voltage or extra-high voltage overhead lines are transient faults caused by lightning. Once a transient fault occurs, the circuit breaker (CB) is tripped to clear the fault; reclosing the CB is performed after the confirmation of the de-ionized gases in the CB. The time between clearing the fault and reclosing the CB should be made as short as possible to keep the power system stable. Given the de-ionization generated by the fault arc, we should take enough time for the de-ionization, which commences once the CBs at all terminals are tripped. However, we can take the time in minimum if all CBs at the terminals are tripped at the same time.

1.1.9 Conventional applications

[OC] Directional/non-directional phase over current protection

The OC function provides some relay elements. The OC function includes inverse time and definite time characteristics.

[EF] Directional/Non-directional phase earth fault protection

The EF function provides some relay elements. The choice of characteristic is selectable between inverse time, and definite time.

[SOTF-OC] Switch on to fault protection

In order to quickly remove a fault which may occur when a faulted line or bus-bar is energized, the SOTF protection will be operational for a certain period after the circuit breaker closes.

[FS] Fail-safe protection

The IED is provided with Fail-safe elements which function as a check relay and enhance security against a fault a power system with week infeed, or prevent a false tripping due to a signal failure in the protection system.

[VTF] VT failure detection function

When a fault occurs in the secondary circuit of a voltage transformer (VT), voltage dependent measuring elements may operate incorrectly. Thereby when the VTF function detects a failure in the VT, the VTF function blocks the voltage dependent relay.

[CTF] CT failure detection function

When a fault occurs in the secondary circuit of a current transformer (CT), current dependent measuring elements may operate incorrectly. Thereby when the CTF function detects a failure in the CT, the CTF function blocks the current dependent relay.

[FL-AZ] Fault locator with communication

When a fault is detected, such function, which communicates with a far end IED, determines fault location with data in the IEDs between. Were to the IED to fail to communicate with the far end IED, another fault locator function, which is cited below, would be used as a substitute for this function.

[VCHK] Voltage check for auto-re-close function

This function is used in corporation with the function of auto-re-close (ARC). The VCHK checks voltage and frequency differences between a Bus-bar and Lines, and permits the ARC the operation.

1.2 Control

The control functions are provided for circuit breakers and isolators, other switchgear and transformers. The user can operate the functions using the human machine interface; the functions are able to operate together with such as automatic sequence control, interlocking safeguard function and manual overridden function.

[GCNT] General pulse counter function

This function can observe a signal, for example the output of a PLC function and counts the number of pulses for the signal. The total number of pulses counted is recorded.

[MDCTRL] Mode control function

This function enables an interface for test function block (TSET-FB). With this interface, a mode change command is made within the IED for the TEST-FB.

[LRST] LED reset function

The LRST function can turn off a LED when the LED is lit by tripping.

1.3 Monitoring and metering functions

Using the HMI, the monitoring and metering functions can display status, settings, data and others. The user can also see information using "GR-series Toshiba IED Engineering and Monitoring Software (GR-TIEMS)" both at local and remote end.

Monitoring function:

This function supervises status of protection functions, and displays power system quantities. It also shows failure information in the CT and VT.

Fault record function:

Such function records the state of a fault when the trip command is issued. It also memorizes the fault data. The user can see, with the IED screen, these data with additional information: date & time, fault phase, tripping phase, tripping mode, fault location, operating mode and power system quantities.

Event record function:

The function provides recording feature that memorizes any event occurred in the IED.

Disturbance record function:

Disturbance record is triggered by fault detection. The user can see the waveform recorded by this function using GR-TIEMS.

1.4 Hardware overview

The IED has human machine interface (HMI), which is made of LCD screen, indication lights, operation and function keys, monitoring jacks, and a USB connector. Voltage, current input terminals, and binary input and output circuits are provided on the rear..

HMI features:

- Menu-driven human interfaces for settings or viewing of stored data.
- A standard LCD or a large LCD (MIMIC) screen, LEDs, function keys and operation keys

Communication features:

- USB for GR-TIEMS
- 100BASE-TX(or FX) for SAS in the IEC 61850 protocol
- RS485 or the fiber optic I/F in the IEC 60870-5-103 protocol

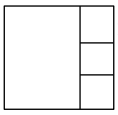
Module circuits and others:

- Binary input circuits and binary output circuits with configurable features
- AC inputs
- Programmable logic for I/O configuration, alarms, indications, recording and others
- Automatic supervision

1.5 Symbols used in logical diagrams

Symbols used in the scheme logic and their meanings are as follows:

(i) Relay element, signal-monitoring point, PLC connection point, and Mapping point

1. **Marked with**  : Relay elements

2. **Marked with**  : Signal-monitoring point designated by Element ID number

Note that the symbol can be connected with what follows:

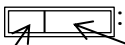
A binary output (BO) circuit

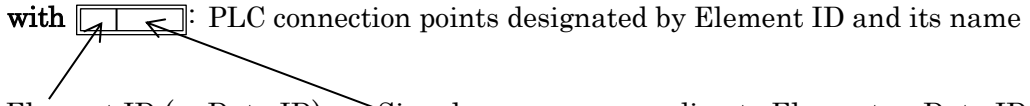
A LED circuit

Like in the BO and LED circuits, it can also be connected or mapped to what follows:

A PLC connection point

The IEC 61850 logical node (LN) to send a signal for the SAS

3. **Marked with**  : PLC connection points designated by Element ID and its name

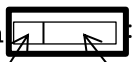


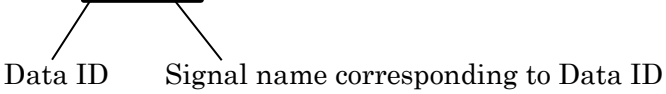
Note that the symbol can be used for the reception point coming from the output of PLC logics.

Note that the user does not apply a PLC connection point straightforward when functions (relays/control and monitoring) are operated on sub-CPU rather than main-CPU. Thereby, an alternative connection point (PLC driver[1]/Input dummy[2]) is provided in place of the PLC connection point. The user shall notice that the provision of the alternative connection point is dependent upon the selection of the model.

[1]PLC driver is discussed in Chapter *PLC function*.

[2]Input dummy can be discussed in Appendix *Input dummy for relay application*.

4. **Marked with**  : Mapping points designated by Data ID and its name

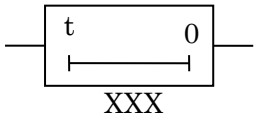


[1]Note that the symbol can be used as a signal reception-point coming from the SAS. The reception point is mapped to the LN of the IEC61850.

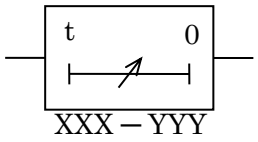
(ii) Timer symbol

- Delay timer

Delayed pick-up timer

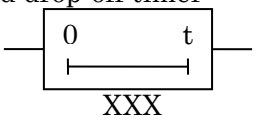


Fixed timer (XXX: Set time)

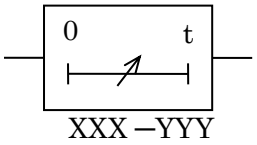


Variable timer (XXX ─ YYY: Setting range)

Delayed drop-off timer

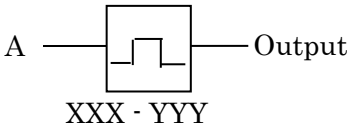


Fixed timer (XXX: Set time)

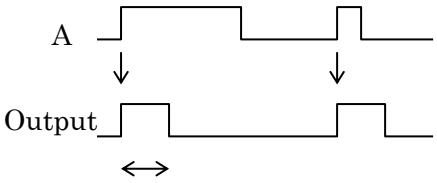


Variable timer (XXX ─ YYY: Setting range)

- One-shot timer

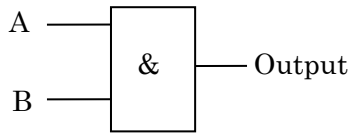


XXX - YYY: Setting range



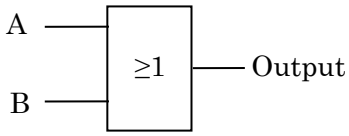
(iii) Logic symbol

- AND gate



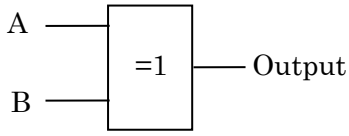
A	B	Output
1	1	1
1	0	0
0	1	0
0	0	0

- OR gate



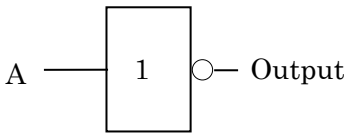
A	B	Output
1	1	1
1	0	1
0	1	1
0	0	0

- XOR gate



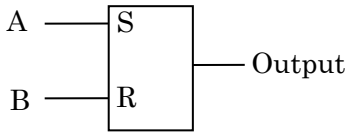
A	B	Output
1	1	0
1	0	1
0	1	1
0	0	0

- Signal inversion



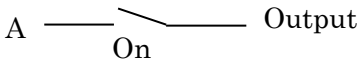
A	Output
0	1
1	0

(iv) Flip-flop symbol

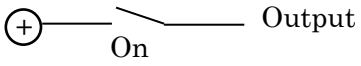


A	B	Output
0	0	No change
1	0	1
0	1	0
1	1	0

(v) Scheme switch



A	Switch	Output
1	On	1
1	Off	0



Switch	Output
On	1
Off	0

1.6 Abbreviation

Abbreviation	Description
ADC	Analog to digital converter
BCU	Bay Control Unit
BCPU	Bay Control and Protection Unit
BI	Binary Input module or circuit
BO	Binary Output module or circuit
BIO	Binary Input and Output module or circuit
CB	Circuit Breaker
CPU	Signal processing and communication module
CT	Current Transformer
DS	Disconnecting Switch
EF	Earth Fault
ES	Earthing Switch
EWS	Engineering Workstation in the substation
GPS	Global Positioning System
GR-TIEMS	GR-series Toshiba IED Engineering and Monitoring Software
GUI	Graphical User Interface
HMI	Human Machine Interface
IED	Intelligent Electronic Device
IDMT	Inverse Definite Minimum Time
LCD	Liquid Crystal Display for IED screen (standard LCD screen)
LCP	Local Panel for Controlling
LED	Light Emitting Diode
MIMIC	Touchscreen operation configured by user's program to operate control application
NA	Not Applicable
NGR	Neutral Grounding Resistance
N/C	Normally Closed
N/O	Normally Open
OWS	Operator Workstation in the substation
PC	Personal Computer for maintenance
PCB	Printed circuit board
PLC	Programmable Logic Controller
RCC	Remote Control Centre
SAS	Substation Automation System
SC	Station Computer
SCMS	Substation Control and Monitoring System
TCP/IP	Transmission Control Protocol/ Internet Protocol

Abbreviation	Description
UTC	Coordinated Universal Time
SyncSrc	Synchronization Source
VT	Voltage Transformer
VCT	Transformer module including VTs and CTs
43	Selector device or selector switch

1.7 Function Block (FB), Function ID, Signal number (Data ID)

(i) Signal symbols

Function Block (FB) is the software module and GR-series IED implements FBs for protections, controls and communications. The function ID is unique ID described by six digits in hexadecimal; each function ID represents each FB. Signal number (or Data ID) is the logical address of the input and output data of the FB. The signal number (Data ID) consists of a function ID and an element ID. The function ID is common within the FB; accordingly the element ID will be shown to make description simple. The element ID is 10 hexadecimal and it has the element ID name for easy to read. Figure 1.7-1 exemplifies the symbols, the function ID, and the element ID. The table below shows the structure of the signal.

	Function ID	Element ID	Note
Format (Hex)	FFFFFF	XXXXXXXXXX	Content
Signal example	123456	80000xxxx0	XX relay in phase-A is operated.

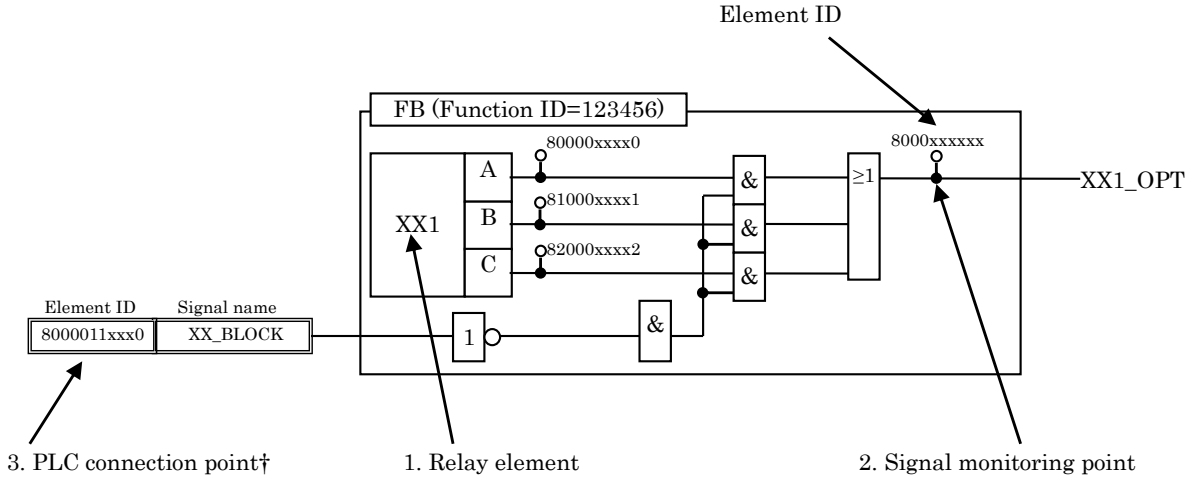


Figure 1.7-1 Example of symbols and others

†Note that a PLC connection point can be shown with the function ID (123456) plus element ID (8000011xxx0) expressed in 16 delights in hexadecimal, in some scheme logics. The 'PLC connection point' could be found to search the letter '**E**' of element ID (i.e., '8000011**E**xx0').

(ii) Data length (bit length of Data ID)

The user can read data length of a Data ID by seeing the seventh and eighth number of the Data ID. Table 1.7-1 shows examples of 1~32-bits data.

Table 1.7-1 How to identify a Data length by seeing Element ID

Data length	Example Function ID	Example Element ID	Identifier texts	Note
1-bit	400001	**8**000001B6F	**8** (the beginning # of Element ID)	
8-bits	400001	**20**00001B6F	**20** (First and second # of Element ID)	
8-bits	400001	**30**00001B6F	**30** (First and second # of Element ID)	
16-bits	400001	**21**00001B6F	**21** (First and second # of Element ID)	

Data length	Example Function ID	Example Element ID	Identifier texts	Note
16-bits	400001	**31**00001B6F	**31** (First and second # of Element ID)	
32-bits	400001	**22**00001B6F	**22** (First and second # of Element ID)	
32-bits	400001	**32**00001B6F	**32** (First and second # of Element ID)	
32-bits	400001	**42**00001B6F	**42** (First and second # of Element ID)	Float 32
64-bits	400001	**23**00001B6F	**23** (First and second # of Element ID)	
64-bits	400001	**33**00001B6F	**33** (First and second # of Element ID)	
64-bits	400001	**43**00001B6F	**43** (First and second # of Element ID)	Float 64

2 Relay application

2.1 Current differential protection for the line

Current differential protection function (DIF) at local-terminal and remote-terminal can operate by comparing the currents flow in and out in the line. The value of the current-difference is close to zero when a fault does not occur (i.e., No fault). The DIF function consists of a current segregated current differential protection (DIFL) and a zero-sequence current differential protection (DIFG); they can detect phase-to-phase fault, phase-to-ground fault, and a phase-to-ground fault. The DIFL and DIFGL functions can operate for on the three-terminal line; remote differential trip (RDIF) function can substitute the operation of the DIFL and DIFGL functions when an error occurs on the communication channel.

Note: Several IED models do not have some features in the DIF protection. To determine whether their features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.1-1 Comparative table in respective ordering numbers

Section	Relay function	Ordering No. at "G&T"				
		10	11	13	19	22
2.2	Current differential (87) (DIFL)	✓	✓	✓	✓	✓
2.2.2	Check relay OC (50FS) (DIFLFS-OC)	✓	✓	✓	✓	✓
2.2.2	Check relay UV (27FS) (DIFLFS-UV)	✓	✓	✓	✓	✓
2.2.2	CT failure detection by Id (DIFL-CTF)	✓	✓	✓	✓	✓
2.2.4	Charging current compensation (CCC) (DIFL-ICC)	✓	✓	✓	✓	✓
2.3.1	Zero sequence current differential (87N) (DIFGL)	✓	✓	✓	✓	✓
2.3.2	Check relay EF (50N/FS) (DIFGL-FS)	✓	✓	✓	✓	✓
2.3.4	Charging current compensation (CCC) (DIFGL-ICC)	✓	✓	✓	✓	✓
2.3.7	Remote differential trip (DIFGL-RDIF)	✓	✓	✓	✓	✓

✓: Applicable NA: Not applicable

2.2 Segregated-phase current differential protection function (DIFL)

The principle of current differential protection (DIFL) function is to compare the currents flowing into and out of the transmission line; the differential current is obtained by the comparison between two currents in the DIFL function. In the DIFL function the value of the differential current is almost zero when a fault occurs out of the protection zone (i.e., external fault). Conversely the value of the differential current is nearly equal to the fault current when the fault occurs in the protection zone (i.e., internal fault) The DIFL function can issue a trip signal when the value of differential current is beyond to the DIFL settings.

The DIFL function can calculate the differential current when current data of two-terminal line are obtained. That is, the relays at local-terminal and remote-terminal should be connected by the communication. If a failure occurs on the communication, the DIFL function may be affected by the error data due to the failure. Therefore, five check relays are provided and are used to prevent the spurious operation in the DIFL function.

When a failure occurs on the CT circuit, the DIFL function cannot operate correctly. Therefore, CT circuit failure-detection function is available in the DIFL function. Monitoring function for differential current (DIFL-IDSV) is also provided so that the spuriousness of the differential current can be detected during the CT circuit failure

Countermeasure features for through-fault-current and stub area are also available in the DIFL function. These features are useful for the protection of the close-up external fault and the stub-area fault.

The user can use the DIFL function for lines connected via a one-and-a-half breaker busbar system; the DIFL function can sense stub faults and through fault currents.

2.2.1 Differential protection characteristics (DIFL)

(i) Characteristic of differential (Id) and restraint (Ir) current plane

The DIFL element has dual percentage-restraint characteristics. Figure 2.2-1 shows two characteristics on the plane between differential current (Id) axis and restraining current (Ir) axis. The Id is referred as a vector sum of the phase currents at all terminals. The Ir is referred as a scalar sum of the phase currents at all terminals. The DIFL function is operated if a cross point between the Id and the Ir moves into the hatched area of Figure 2.2-1. The DIFL function can removes charging phase-current using the function of charging current compensation (See section 2.2.1(vi))

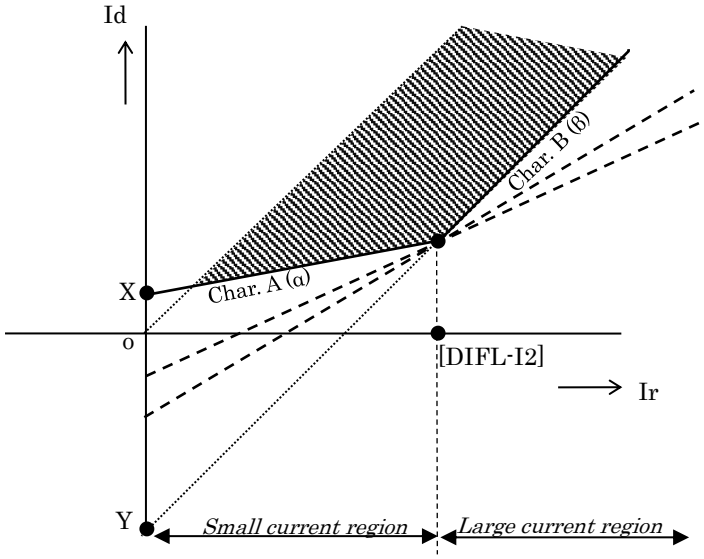


Figure 2.2-1 DIFL element on Ir-Id plane

The characteristic A shows weaker restraint; this characteristic ensures sensitivity against low-level faults. Conversely, the characteristic B has stronger restraint. That is, the DIFL characteristic varies its sensitivity depending on the Ir.

Suppose that a fault occurs out of a line and the CT is saturated by the external fault. The DIFL function can be operated falsely because the differential current due to the increases erroneously. This is because either by the CT saturation or the CT transient error. Accordingly, the slope of the characteristic B is steeper than the slope of the characteristic A; as a result, the increasing Id current does not give rise to the erroneous DIFL operation owing to the CT saturation or the CT transient error.

However, the DIFL operation in the characteristic B can block this false operation although the DIFL operation depends on the magnitude of restraining current in the characteristic B.

The characteristic A and B both are expressed using the following equations:

$$I_d \geq \alpha \times I_r + \mathrm{X} \qquad (2.2\text{-}1)$$

$$I_d \geq \beta \times I_r - \mathrm{Y} \qquad (2.2\text{-}2)$$

$$\mathrm{X} = (1-\alpha) \times \text{setting}[\textbf{DIFL-I1}] \qquad (2.2\text{-}3)$$

$$\mathrm{Y} = (\beta-\alpha) \times \text{setting}[\textbf{DIFL-I2}] - (1-\alpha) \times \text{setting}[\textbf{DIFL-I1}] \qquad (2.2\text{-}4)$$

$$\alpha = \frac{\text{setting}[\textbf{DIFL-Slope1}]}{100} \quad (2.2\text{-}5)$$

$$\beta = \frac{\text{setting}[\textbf{DIFL-Slope2}]}{100} \quad (2.2\text{-}6)$$

Equation (2.2-1) and (2.2-2) shows the characteristic A and B, respectively. The user can set minimum internal fault current using setting [**DIFL-I1**]. The user can set the knee, which is referred as crossing point characteristic A and B, using setting [**DIFL-I2**]. Restraint settings of the characteristic A and B in percentage are available using settings [**DIFL-Slope1**] and [**DIFL-Slope2**].

(ii) Characteristic of Inflowing and Outflowing currents plane

Figure 2.2-2 provides another expression corresponding to the Figure 2.2-1; the characteristic is expressed on the plane between the outflowing current (I_{out}) axis and inflowing current (I_{in}) axis. Regarding to the I_{out}–I_{in} plain, the DIF operation is performed in the hatched area of this figure.

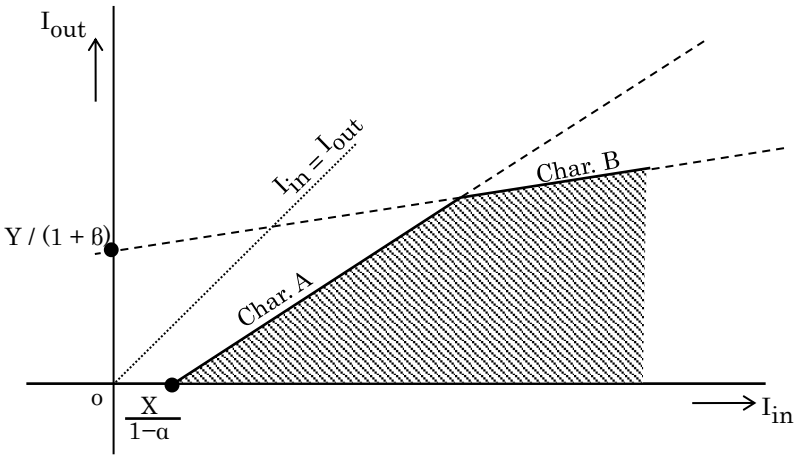


Figure 2.2-2 Segregated-phase current differential element (I_{in}-I_{out} Plane)

The I_{in}–I_{out} plane also has characteristic A and characteristic B; hence, the A and B both are described in the following equations:

$$I_{out} \leq \frac{1-\alpha}{1+\alpha} \times I_{in} - \frac{X}{1+\alpha} \quad (2.2\text{-}7)$$

$$I_{out} \leq \frac{1-\beta}{1+\beta} \times I_{in} + \frac{Y}{1+\beta} \quad (2.2\text{-}8)$$

Equations (2.2-7) and (2.2-8) show the characteristic A and B, respectively. Figure 2.2-2

shows that the characteristic B. It defines the maximum outflowing current when an internal fault occurs so that the internal fault can be detected by the characteristic B. The outflowing current can be very much significant for the double-circuit line having three terminals or the line having three terminals accompanying an outer loop circuit. A part of the fault current flows out at one terminal and the other part of the fault current flows into at another terminal depending on the fault location. The fault current flow is discussed later.

(iii) Trip delay timer in main logic

The DIFL function has a delay timer to issue a trip signal so that the DIFL function and the other protection relays can be well organized. The delay timer, made of definite time type with setting [**TDIFL**], can delay to issue a trip signal for the TRC function†. The delay timer is illustrated in Figure 2.2-3.

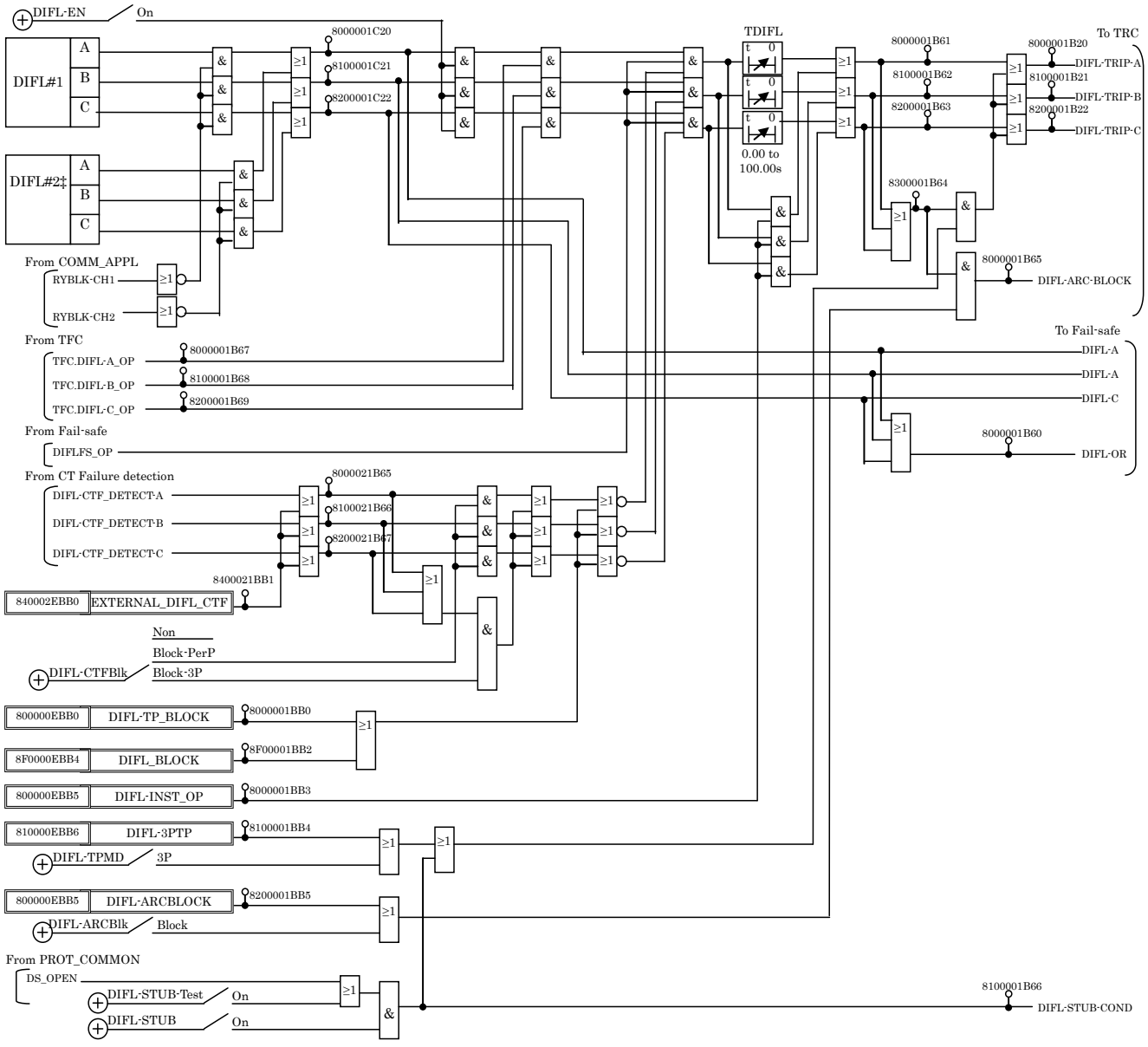


Figure 2.2-3 Generation of trip signals in the DIFL function

†Note:The TRC function is discussed separately. See *Chapter Relay application: Trip circuit*.

‡Note: The DIFL#2 relay is only applicable when the relays run in the dual mode. For more information of the mode, see chapter *Relay application: Transmission control function*.

(iv) Trip mode

To issue a trip signal the user can select either a three-phase trip (**3P**) mode or a single-phase trip (**1P**) mode using scheme switch [**DIFL-TPMD**].

The trip mode is influenced by the operation in CT circuit-failure detection function (CTF-DIFL†). The user can select a block mode in response to the CT circuit-failure using scheme switch [**DIFL-CTFBlk**]. If blocking a trip signal upon occurrence of the CT circuit-failure is not required, the user should set **Non** for scheme switch [**DIFL-CTFBlk**]. If the failed phase is only required to blocked on occurrence of the CT circuit-failure, the user should set **Block-PerP** for the scheme switch [**DIFL-CTFBlk**]. On the other hand, if required is to block a trip signal to all three phases upon occurrence of the CT circuit-failure, the user has to set **Block-3P** for the scheme switch [**DIFL-CTFBlk**].

†Note: The operation and the logic of the CTF-DIFL function is discussed in section 2.2.3.

(v) Switch for DIFL operation

The user should set **On** for scheme switch [**DIFL-EN**] prior to the DIFL operation, as illustrated in Figure 2.2-3. The DIFL#1 element and the DIFL#2 element can be operated per phase basis; thus the DIFL function can issue respective trip signals "DIFL-TRIP-A, -B, and -C". Note both DIFL elements run in parallel; the DILF elements are not designed to operate in hot-standby mode.

(vi) Setting for autoreclose function

Autoreclose (ARC) function is to re-close the CB again to restore service after tripping the CB. If the user wishes to operate the ARC function, the user should set **Non** for scheme switch [**DIFL-ARCBlk**]. If the user wishes to not to operate the ARC function on the DIFL operation, set **Block** for the scheme switch [**DIFL-ARCBlk**] so that signal "DIFL-ARC-BLOCK" is injected not to operate the autoreclose function (ARC). The ARC function is discussed separately. (See Chapter *Relay application: Autoreclose function*)

(vii) Blocking trip issuing by communication failure supervision

The trip signals are blocked when communication failure is detected†. Communication

application function (DIF_COMM) can monitor data error, sampling synchronism and reception from the remote terminal.

Communication failure is monitored for each channel and is combined with the results of such as self-supervision, sampling synchronism and CRC. It is assigned to each signal (RELAY BLOCK #1 and #2, which are used to block the output of DIFL#1 and #2 elements instantaneously to avoid unwanted tripping while the communication failure is detected.

†Note: For more information, see Chapter *Relay application: Communication application function.* The chapter tabulates relevant communication failure monitoring points in Data ID list.

‡Note: See device dependent features in Chapter *Automatic supervision: Supervision tasks*.

(viii) Blocking trip issuing by by PLC connection

When the user wishes the DIFL function not to issue a trip signal, the user can use PLC connection point "DIFL_BLOCK" so that the DIFL function cannot issue a trip signal, as seen in Figure 2.2-3. The PLC connection point is useful when the user wishes to program no to operate the DIFL function externally.

2.2.2 Check relays characteristics (OCs and UVs)

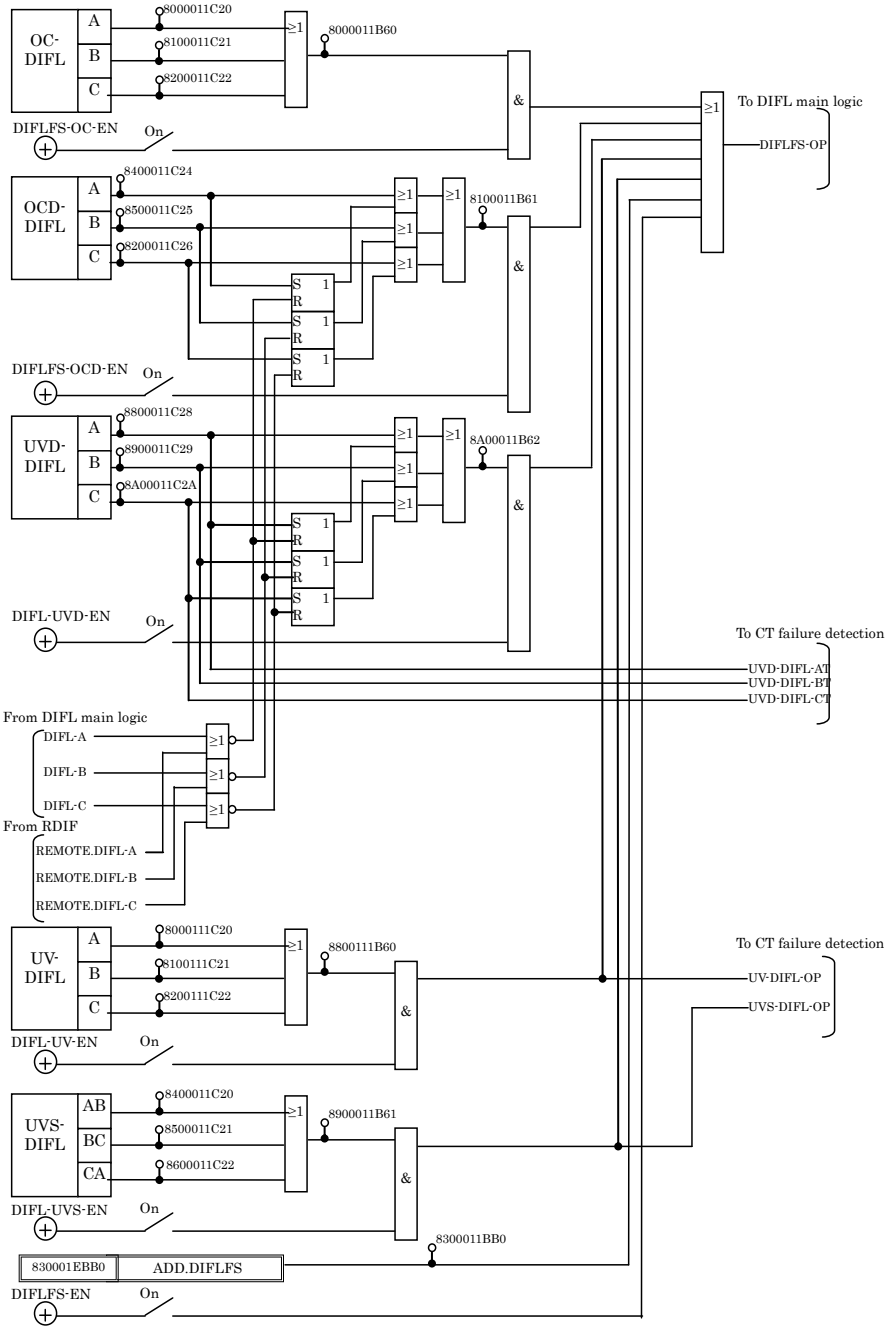


Figure 2.2-4 Check relays logic

Note: The user should set **Off** for the scheme switch [**DIFLFS-EN**] when the operation of check relays is not required.

To remove unnecessary operations in the DIFL function, check relays are introduced and the DIFL function is allowed to operate during the check relays being in operation. The check relays consists of five relay elements, a signal aggregated with the five relay elements is injected into the DIFL logic, as shown in Figure 2.2-4. The user should set **On** for scheme switch [**DIFLFS-EN**] when the operation of the check relays is required to operate for the DIFL function.

(i) Current change detection element (OCD-DIFL)

Figure 2.2-5 shows a current vector (I_M) measured at the present and a pre-current vector (I_N) measured at one sampling cycle† ago. When the magnitude of difference between (I_S) is larger than a setting, the OCD-DIFL element is operated. The OCD-DIFL element is expressed by the following equation:

$$|I_M - I_N| > I_S \qquad (2.2\text{-}9)$$

where I_S is referred in order to determine the operation of the OCD-DIFL element; the user can set the value using setting [**OCD-DIFL**], which is applied to adjust the decision point for the operation. The user can set the value among 0.05 to 0.20A when 1A rating‡ is applied for the VCT module. When 5A rating‡ is applied for the VCT module, the setting value is chosen among 0.25 to 1.00A.

The quiescent load current does not affect the sensitivity of the OCD-DIFL element; thus, the OCD-DIFL element can detect a fault current sensitively.

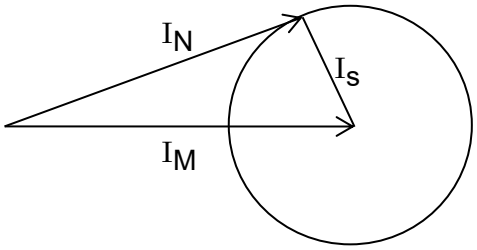


Figure 2.2-5 Current change I_S detected by I_M and I_N

†Note:We define a sampling cycle as 7.5 electrical degrees.

‡Note:For the rating and the VCT module, see Chapter *Technical description: Transformer module for AC analog input*.

(ii) Over-current detection (OC-DIFL)

For OC-DIFL relay element the user can set the sensitivity using setting [**OC-DIFL**]. When 1A rating, **OC-DIFL** value is selected from 0.05 to 50.00A. When 5A rating, the setting value is placed from 0.10 to 250.00A.

(iii) Under-voltage element (UV-DIFL)

For UV-DIFL relay element the user can set the sensitivity using setting [**UV-DIFL**]. The value is selected from 5.0 to 130.0 V.

(iv) Under-voltage element for phase-to-phase (UVS-DIFL)

For UVS-DIFL relay element the user can set the sensitivity using setting [**UVS-DIFL**]. The

setting value is selected from 5.0 to 130.0V.

(v) Under-voltage change detection element (UVD-DIFL)

Suppose there is a difference between the voltage vector at present (V_M) and the pre-voltage vector measured one sampling cycle ago (V_N). When the magnitude of the difference between is larger than setting [**UVD-DIFL**], the UVD-DIFL relay element is operated. The setting value is chosen among 1 to 20V.

(vi) Check relays activation

The user can set **On** for respective scheme switches [**DIFLFS-OCD-EN**], [**DIFLFS-OC-EN**], [**DIFLFS-UV-EN**], [**DIFLFS-UVS-EN**], and [**DIFLFS-UVD-EN**] so that the user can select the operation of the respective check relays.

2.2.3 CT circuit-failure detection (DIFL-CTF)

The CT circuit-failure-detection function (DIFL-CTF) is to detection of the breaking wire in the CT circuit. Signals of the check relays are injected into the below logic so that a trip signal is not issued upon occurrence of CT failure.

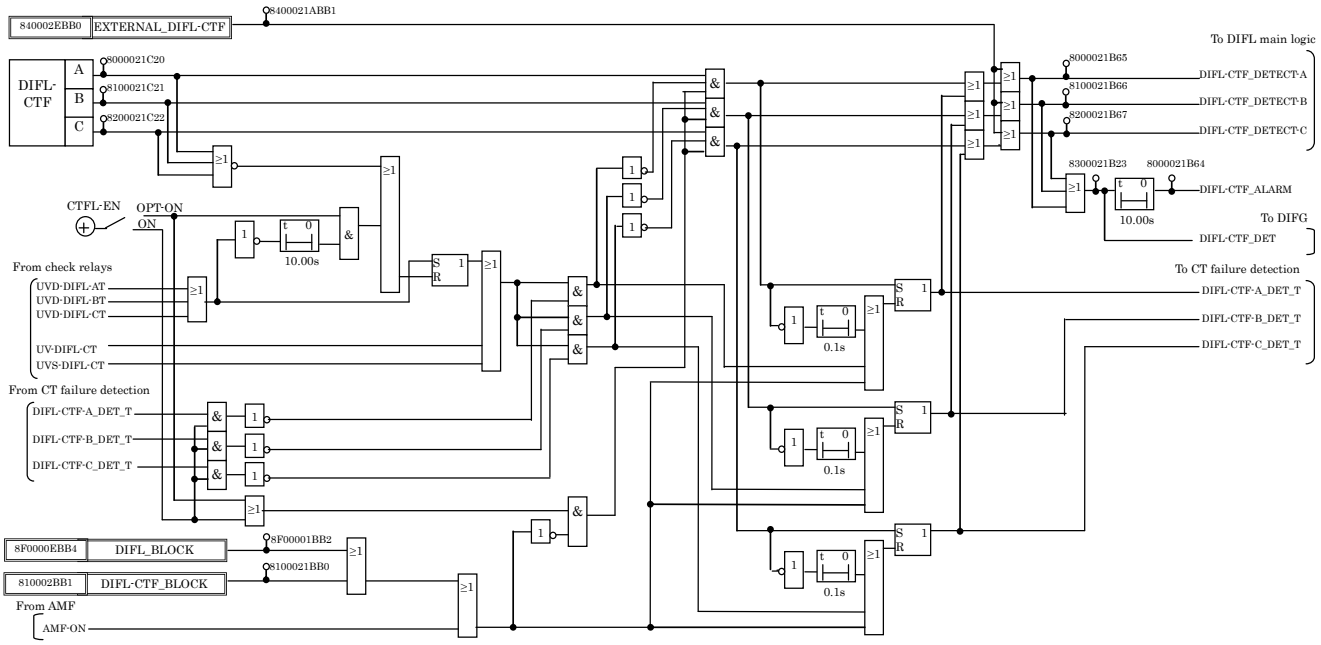


Figure 2.2-6 CT failure detection logic

The user can select the detection type for the CT circuit-failure using setting [**DIFL-CTF**]. If the user wishes to reset the DIFL-CTF operation after the breaking wire is removed, the user should set **On** for scheme switch [**CTFL-EN**]. If the user wishes to reset the DIFL-CTF operation after any operation of the UVD-DIFL relays, the user should set **OPT-On** for the scheme switch [**CTFL-EN**]. On the other hand, if the user wishes not to operate the DIFL-CTF function, set **Off** for the scheme switch.

If the failure in the CT circuit lasts for 10sec or longer, signal "DIFL-CTF-ALARM" is also provided‡. The user can use an external CT circuit-failure function, provided the user wishes to use the external function in place of the DIFL-CTF function; a PLC connection point "EXTERNAL-DIFL-CTF" is provided for this purpose.

If the CT circuit-failure detection function is required not to operate, the user can remove the operation using PLC connection point "DIFL-CTF_BLOCK". The CT circuit-failure detection function can also be stopped when the AMF-ON signal is injected.

†Note:AMF feature is used for the test. To generate the AMF signal for the test, see chapter *User interface: Test sub-menu*.

‡Note:They are transferred to the automatic supervision function, which we shall discuss separately.

2.2.4 Charging-current compensation (DIFL-Ic)

As illustrated in Figure 2.2-7, when the DIFL function is used for underground cables or long overhead transmission lines, charging-current flows due to the influence of the line capacitance. The changing-current may be observed as an erroneous differential current.

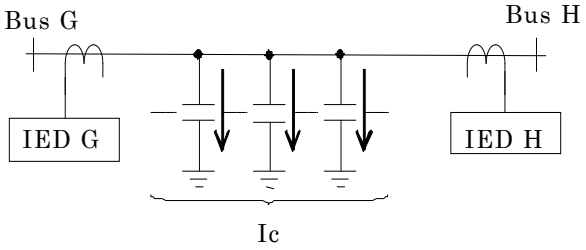


Figure 2.2-7 Phenomenon of charging current

The DIFL sensitivity can be compensated using the charging current, but its compensation can be performed at the expense of reduced sensitivity to internal faults. In addition, the charging current can vary strongly in response to the running line-voltage. Thus, the user should take into account it for the setting.

The DIFL function provides a charging current compensation function in order to avoid the effect of the charging current so that the DIFL sensitivity is maintained. The compensation function keeps calculating the charging current in response to the running line-voltage provided by the VT on the line. As a result, the DIFL function can compensate for the charging current.

To apply the compensation into the DIFL function, the user should set line charging

current for setting [**DIFL-IcC**] and rated-line voltage for setting [**DIFL-Vn**]. The line capacitance is computed between the relays at local and remote-terminals using the settings. That is, the line capacitance is divided by two when the number of the IEDs is two. On the other hand, the line capacitance is divided by three when the number of the relays is three†.

†Note: If one of the three relays is not operated during testing, the line capacitance is divided by two.

For the provision of the line voltage, the relays can keep calculating the sharing charging current per sample-by-sample basis. The equation is denoted as follows:

$$\mathrm{Ic} = \mathrm{C}\frac{dV}{dt} \qquad (2.2\text{-}10)$$

where,

Ic = line charging current

C = line capacitance calculated using the settings [**DIFL-IcC**] and [**DIFL-Vn**]

V = line voltage measured

By using the Ic, the DIFL function can calculate a line current compensated per a sample-by-sample basis as follows:

$$\mathrm{I} = \mathrm{I}' - \mathrm{Ic} \qquad (2.2\text{-}11)$$

where,

I = compensated current

I' = actual measured current

All necessary phase information has to be taken account basically. This is because the DIFL function calculates both the charging current and the compensated line current per sample-by-sample basis.

2.2.5 Differential current monitor (DIFL-IDSV)

Monitoring function for differential current (DIFL-IDSV) is provided so that detecting spuriousness in the differential current is feasible during the CT circuit failure. The user can adjust the removal period for issuing using setting [**TIDL-SV**]. To operate the DIFL-IDSV function, the user should set scheme switch [**DIFL-IDSV-EN**] **On**; setting [**DIFL-IdSV**] is also provided to set the monitoring level. As shown in Figure 2.2-8, the results of the monitoring function are provided at PLC connection point "DIFL-IDSV"; they are transferred to the automatic supervision function, which we shall discuss separately.

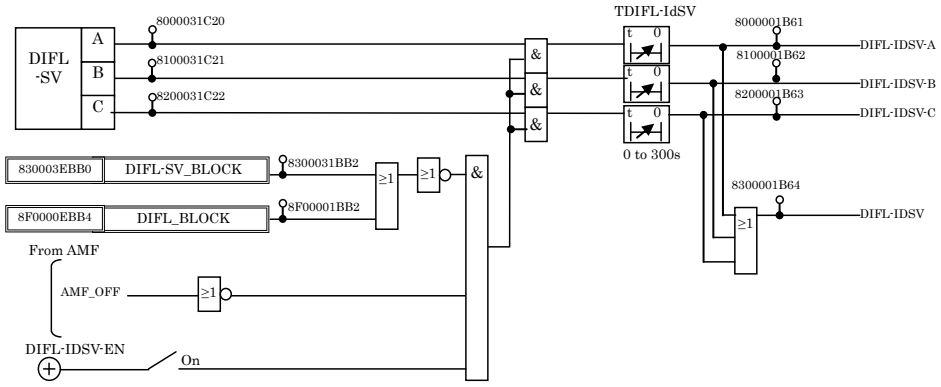


Figure 2.2-8 Differential current monitor logic

If the monitoring function is required, the user can remove the operation using PLC connection point "DIFL-SV_BLOCK". The monitoring function can also be stopped when the signal of AMF† is injected.

†Note:AMF feature is used for the test. To generate the AMF signal for the test, see chapter *User interface: Test sub-menu*.

2.2.6 Setting

Setting of DIFL (Function ID: 410001)

Setting device		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
DIFL-LP	DIFL-EN	Off / On		-	DIFL protection enable	On		
	DIFL-I1	0.10 - 2.00	0.50 - 10.00	A	Minimum operating value	1.00	5.00	
	DIFL-I2	0.6 - 60.0	3.0 - 300.0	A	Knee point of large current region	8.2	41.0	
	DIFL-Slope1	10 - 50		%	Small current range percent slope of Id-Ir characteristic	17		
	DIFL-Slope2	50 - 100		%	Large current range percent slope of Id-Ir characteristic	100		
	DIFL-IcC	0.00 - 1.00	0.00 - 5.00	A	DIFL charging current compensation	0.00	0.00	
	DIFL-Vn	100 - 120		V	DIFL rated voltage	110		
	TDIFL	0.00 - 100.00		s	DIFL trip delay time	0.00		
	DIFL-CTFBlk	Non / Block-3P / Block-PerP		-	DIFL operation block by CTF	Non		
	DIFL-TPMD	1P / 3P		-	DIFL trip mode, phase segregated trip or 3-phase trip	1P		
	DIFL-ARCBlk	Non / Block		-	Autoreclose execution block by DIFL-trip	Non		
Fail Safe	DIFLFS-EN	Off / On		-	Check relay enable	Off		
	DIFLFS-OC-EN	Off / On		-	Check relay OC-DIFLFS enable	On		
	DIFLFS-OCD-EN	Off / On		-	Check relay OCD-DIFLFS enable	On		
	DIFL-UV-EN	Off / On		-	Check relay UV-DIFL enable	On		
	DIFL-UVS-EN	Off / On		-	Check relay UVS-DIFL enable	On		
	DIFL-UVD-EN	Off / On		-	Check relay UVD-DIFL enable	On		
	CTFL-EN	Off / On / OPT-On		-	CTF detection enable	On		
	DIFL-CTF	0.05 - 2.00	0.25 - 10.00	A	DIF relay for CTF detection, operating value	0.10	0.50	
	OC-DIFL	0.02 - 50.00	0.10 - 250.00	A	OC relay for check, operating value	1.00	5.00	
	OCD-DIFL	0.05 - 0.20	0.25 - 1.00	A	OCD for check relay, operating value	0.10	0.50	
	UV-DIFL	5.0 - 130.0		V	UV relay for check and CTF blocking, operating value	46.0		
	UVS-DIFL	5.0 - 130.0		V	UVS relay for check and CTF blocking, operating value	80.0		
	UVD-DIFL	1 - 20		V	UVD relay for check and CTF blocking, operating value	5		
Id-SV	DIFL-IdSV-EN	Off / On		-	Differential current monitoring enable	Off		
	DIFL-IdSV	0.05 - 2.00	0.25 - 10.00	A	DIF relay for Id-SV, operating value	0.10	0.50	
	TDIFL-IdSV	0 - 300		s	Differential current monitoring, detection time	10		

2.2.7 Data ID

◆ Signal monitoring point

DIFL (Function ID: 410001)

Element ID	Name	Description
8000001C20	DIFL-A	DIFL relay element operated (phase-A)
8100001C21	DIFL-B	DIFL relay element operated (phase-B)
8200001C22	DIFL-C	DIFL relay element operated (phase-C)
8000001B60	DIFL-OR	DIFL relay element operated (3-phases OR)
8000001B61	DIFL-OPT-A	DIF-L protection operated (phase-A)
8100001B62	DIFL-OPT-B	DIF-L protection operated (phase-B)
8200001B63	DIFL-OPT-C	DIF-L protection operated (phase-C)
8300001B64	DIFL-OPT	DIF-L protection operated
8000001B20	DIFL-TRIP-A	Trip signal by DIF-L protection operation (phase-A)
8100001B21	DIFL-TRIP-B	Trip signal by DIF-L protection operation (phase-B)
8200001B22	DIFL-TRIP-C	Trip signal by DIF-L protection operation (phase-C)
8000001B65	DIFL-ARC-BLOCK	Autoreclose block signal by DIF-L protection operation
8000011C20	OC-DIFL-A	OC-DIFL relay element operated (phase-A)
8100011C21	OC-DIFL-B	OC-DIFL relay element operated (phase-B)
8200011C22	OC-DIFL-C	OC-DIFL relay element operated (phase-C)
8000011B60	OC-DIFL	Check relay permitted by OC
8400011C24	OCD-DIFL-A	OCD-DIFL relay element operated (phase-A)
8500011C25	OCD-DIFL-B	OCD-DIFL relay element operated (phase-B)
8600011C26	OCD-DIFL-C	OCD-DIFL relay element operated (phase-C)
8100011B61	OCD-DIFL	Check relay permitted by OCD
8800011C28	UVD-DIFL-A	UVD-DIFL relay element operated (phase-A)
8900011C29	UVD-DIFL-B	UVD-DIFL relay element operated (phase-B)
8A00011C2A	UVD-DIFL-C	UVD-DIFL relay element operated (phase-C)
8A00011B62	UVD-DIFL	Check relay permitted by UVD
8F00011B23	DIFLFS_OP	Check relay for DIF-L trip
8000111C20	UV-DIFL-A	UV-DIFL relay element operated (phase-A)
8100111C21	UV-DIFL-B	UV-DIFL relay element operated (phase-B)
8200111C22	UV-DIFL-C	UV-DIFL relay element operated (phase-C)
8800111B60	UV-DIFL	Check relay permitted by UV
8400111C24	UVS-DIFL-AB	UVS-DIFL relay element operated (phase-AB)
8500111C25	UVS-DIFL-BC	UVS-DIFL relay element operated (phase-BC)
8600111C26	UVS-DIFL-CA	UVS-DIFL relay element operated (phase-CA)
8900111B61	UVS-DIFL	Check relay permitted by UVS
8000021C20	DIFL-CTF-A	DIFL-CTF relay element operated (phase-A)
8100021C21	DIFL-CTF-B	DIFL-CTF relay element operated (phase-B)
8200021C22	DIFL-CTF-C	DIFL-CTF relay element operated (phase-C)
8000021B60	DIFL-CTF_DET-A	CT failure detection (phase-A)
8100021B61	DIFL-CTF_DET-B	CT failure detection (phase-B)
8200021B62	DIFL-CTF_DET-C	CT failure detection (phase-C)
8300021B63	DIFL-CTF_DET	CT failure detection
8000021B64	DIFL-CTF_ALARM	Alarm signal by CT failure detection
8000021B65	DIFL-CTF_DETECT-A	CT failure detection (phase-A)
8100021B66	DIFL-CTF_DETECT-B	CT failure detection (phase-B)

◆ Signal monitoring point

DIFL (Function ID: 410001)

Element ID	Name	Description
8200021B67	DIFL-CTF_DETECT-C	CT failure detection (phase-C)
8300021B23	DIFL-CTF_DETECT	CT failure detection
8000001B6A	REMOTE.DIFL-A	Remote differential protection (phase-A)
8100001B6B	REMOTE.DIFL-B	Remote differential protection (phase-B)
8200001B6C	REMOTE.DIFL-C	Remote differential protection (phase-C)
8300001B6D	REMOTE.DIFL-OR	Remote differential protection (3-phase OR)
8200001B6E	REMOTE.DIFL-OPT	Remote differential protection
8000031C20	DIFL-SV-A	DIFL-SV relay element operated (phase-A)
8100031C21	DIFL-SV-B	DIFL-SV relay element operated (phase-B)
8200031C22	DIFL-SV-C	DIFL-SV relay element operated (phase-C)
8000031B60	DIFL-IDSV-A	Differential current monitoring (phase-A)
8100031B61	DIFL-IDSV-B	Differential current monitoring (phase-B)
8200031B62	DIFL-IDSV-C	Differential current monitoring (phase-C)
8300031B23	DIFL-IDSV	Differential current monitoring
8000001BB0	DIFL-TP_BLOCK	DIF-L trip block
8100021BB0	DIFL-CTF_BLOCK	DIF-L ctf detect block
8200001BB1	DIFL-RDIF_BLOCK	Remote differential detect block
8300031BB0	DIFL-SV_BLOCK	Differential current monitoring block
8F00001BB2	DIFL_BLOCK	Block all the above four
8000001BB3	DIFL_INST_OP	DIF-L protection instant operation command
8100001BB4	DIFL_3PTP	Trip signal by DIF-L protection operation (3-phase)
8200001BB5	DIFL_ARCBLOCK	Autoreclose block signal by DIF-L protection operation
8300011BB0	ADD.DIFLFS	Add File-safe condition
8400021BB1	EXTERNAL_DIFL-CTF	External CTF condition
8000001BB6	R1.DIFL-A_OP	Receiving signal from Remote Terminal 1 (phase-A)
8100001BB7	R1.DIFL-B_OP	Receiving signal from Remote Terminal 1 (phase-B)
8200001BB8	R1.DIFL-C_OP	Receiving signal from Remote Terminal 1 (phase-C)
8000001BB9	R2.DIFL-A_OP	Receiving signal from Remote Terminal 2 (phase-A)
8100001BBA	R2.DIFL-B_OP	Receiving signal from Remote Terminal 2 (phase-B)
8200001BBB	R2.DIFL-C_OP	Receiving signal from Remote Terminal 2 (phase-C)
3100011708	DIFLFS & CTF	Data ID for Setting hierarchy (4100013100001708)
3100001703	DIF-LP	Data ID for DIF-LP Function(Output)
3100001707	DIF-LP	Data ID for DIF-LP Function(Setting)

◆ Connection point in PLC logic

DIFL (Function ID: 41001)

Element ID	Name	Description
800000EBB0	DIFL-TP_BLOCK	DIF-L trip block
810002EBB1	DIFL-CTF_BLOCK	DIF-L ctf detect block
830003EBB3	DIFL-SV_BLOCK	Differential current monitoring block
8F0000EBB4	DIFL_BLOCK	Block all the above four
800000EBB5	DIFL_INST_OP	DIF-L protection instant operation command
810000EBB6	DIFL_3PTP	Trip signal by DIF-L protection operation (3-phase)
820000EBB7	DIFL_ARCBLOCK	Autoreclose block signal by DIF-L protection operation

◆ Connection point in PLC logic

DIFL (Function ID: 41001)

Element ID	Name	Description
830001EBB0	ADD.DIFLFS	Add File-safe condition
840002EBB0	EXTERNAL_DIFL-CTF	External CTF condition

2.2.8 Setting DIFL accounting for CT ratio/rating and fault currents

The user should take coordination about the DIFL settings when the difference exists between the CT ratios at the local-terminal and at the remote-terminal. Additionally, the user should consider a minimum fault current for the internal fault and an earth fault current flowing in a high-impedance for grounding. The user should note that the monitoring values—currents at the local and the remote-ends (Ia-L, Ia-R1, etc.) and differential currents (Id), which are shown in Chapter *Monitoring function*—will not screened and recorded even if matching procedures below has been performed.

(i) Nature of CT ratios matching

(i)-1 DIFL setting for CT ratios being identical

In the foregoing discussions, the DIFL settings at the local and remote-terminals are made, which are based on the assumption that the detection thresholds of a fault current are identical for the both terminals. Figure 2.2-9 exemplifies settings of the DIFL functions having the assumption; the DIFL sensitivity is taken account of 800 A in terms of the primary side of the CT. Thereby, at the both terminals, the settings ([**DIFL-I1**], [**DIFL-I2**] and others) have to be set identically.

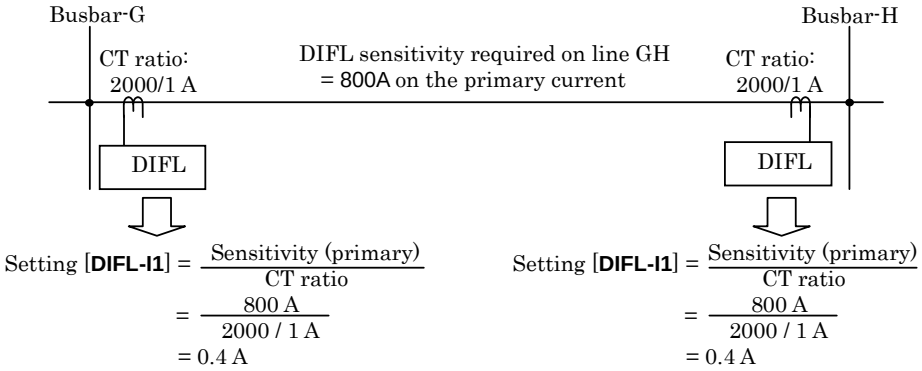


Figure 2.2-9 Setting example when ratios being identical

(i)-2 DIFL setting for CT ratios being not identical

When the CT ratio at the remote-terminal is not identical to the CT ratio at the local-terminal, the user should make matching ratios between two CTs. Figure 2.2-10 shows the two different CTs are arranged on the line GH. Thereby, for example, the user should have a setting [**DIFL-I1**] at terminal-G and another setting [**DIFL-I1**] at terminal-H. In like manner, we have different setting values for [**DIFL-I2**] and others.

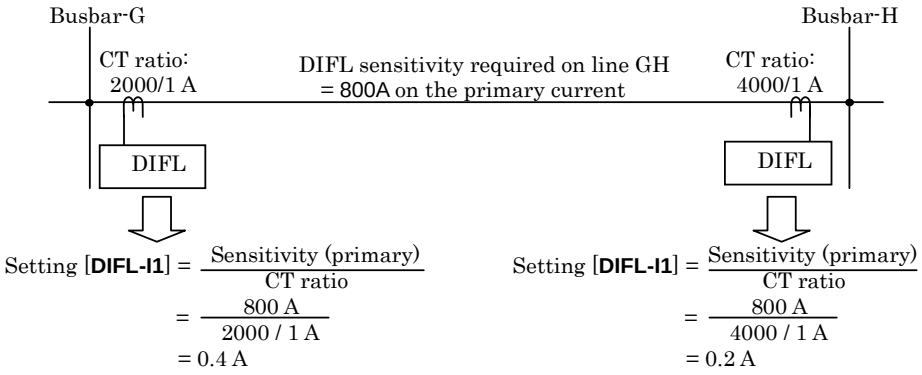


Figure 2.2-10 Setting example when ratios being not identical

(ii) Nature of CT ratings matching

In the previous section (i)-1 and (i)-2, we have the setting examples in terms of making matching CT ratios, but we have another example when the CT rating at the remote-terminal is not identical to the one at the local-terminal.

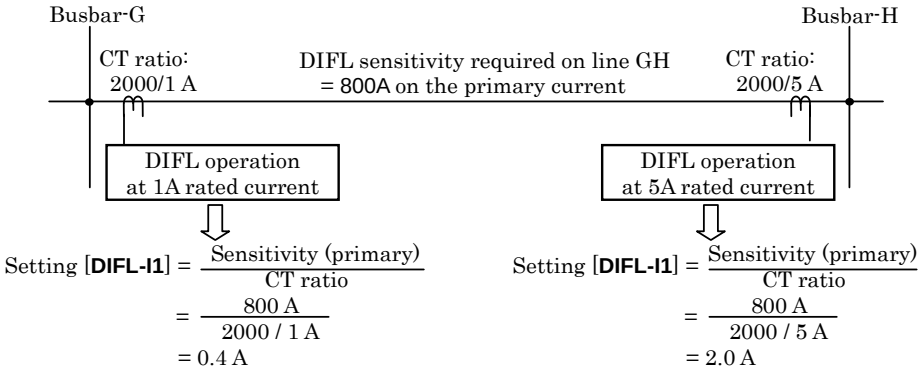


Figure 2.2-11 Setting example when ratings being not identical

In terms of the sensitivity at the CT primary side, setting values for detecting a fault is the same at both the terminal-G and the terminal-H; thereby the user can introduce the setting values by dividing the sensitivity to the rated current. Figure 2.2-11 shows the example of computation; the settings [**DIFL-I2**] and others are also obtained in the same means.

(iii) Nature for fault current setting

(iii)-1 Setting DIFL-I1 characteristic

The user should set the [**DIFL-I1**] by considering the minimum internal fault current to operate; whereas, expect for a fault condition the user should also consider the maximum erroneous differential current†. Accordingly, the user should set the [**DIFL-I1**] using below equation:

$$K \times I_c < \text{setting [DIFL-I1]} < \frac{I_f}{K} \qquad (2.2\text{-}12)$$

where,

K: Setting margin (1.2 to 1.5)

I_c: Internal charging current
I_f: Minimum internal fault current

†Note: The maximum erroneous differential current is mainly due to an internal charging current. We shall discuss it in section 2.2.8(iii)-5. The user does not need to consider a condition relating to the charging current flowing. This is because the function of charging-current compensation can operate.

The user should set the same value for the [**DIFL-I1**] at all terminals; hence, if CT ratios of all terminals are not identical, the user should set the [**DIFL-I1**] respectively so that the DIFL characteristics of the primary side are coordinated.

(iii)-2 Setting DIFL-I2 characteristic

When setting [**DIFL-I2**], the user should have three considerations below:

(1) Maximum erroneous current generated during CT saturation upon occurrence of an external fault. That is, the setting [**DIFL-I2**] should be set as small as possible; consequently, the DIFL function does not operate undesirably by the generation of a maximum erroneous current induced by CT saturation on the primary side when a through current flows due to an external fault. Thereby, the user should set two times rated current (2×In†) for the [**DIFL-I2**].

(2) Maximum load current: A sufficient value should be set for the [**DIFL-I2**] such that it does not encroach on load current.

(3) Maximum outflow current upon occurrence of an internal fault: This must be just considered when the DIFL function operates for three-terminal double-circuit lines (‡), lines with outer loop circuit(‡), or double-circuit lines with one-and-a-half busbar system (1.5CB‡). That is, for the [**DIFL-I2**], the user should set a value larger than the possible largest value of outflow current in case of an internal fault.

An outflow current flowing depends on the configuration or the operation in the power system. Thus, the user has to check whether it is possible for the fault current to flow out of the line. If so, the user must consider the influence when setting the [**DIFL-I2**].

†Note: The rated current (In) is defined while setting the VCT. For more information, see the Chapter *Technical description: Transformer module for AC analog input*.
‡Note: When the DIFL function is not used in those arrangements, the user does not need to consider the outflow current flowing.

(iii)-3 Setting DIFGL-I characteristic

The user should set a value for the [**DIFGL-I**] by considering an earth fault current flowing in

the high-impedance; the user should set the same value for the [**DIFGL-I**] at all terminals. When the terminals do not have an identical CT ratio, the user should set respective values so that the DIFGL characteristics on the primary side are coordinated.

(iii)-4 Setting DIFL-IDSV monitor

When the differential current monitoring function is used, the setting [**DIFL-IDSV**] should be determined using equation (2.2-13) by considering a maximum erroneous differential current (Ierr) except the occurrence of a fault.

$$K \times I_{err} < \text{setting}\,[\textbf{DIFL-IDSV}] < \frac{\text{setting}[\textbf{DIFL-I1}]}{1.5 \text{ to } 2.0} \qquad (2.2\text{-}13)$$

where,

Ierr: Maximum erroneous differential current

K: Setting margin (K= 1.2 to 1.5)

The user does not need to consider the condition relating to the charging current because the function of charging-current compensation can operate.

The user should set the same value for the setting [**DIFL-IDSV**] for all terminals. When the terminals do not have an identical CT ratio, the user should set respective values so that the Id monitors on the primary side are coordinated.

(iii)-5 Setting DIFL-IcC compensation

The user should set an internal charging current (Ic) and a rated power system voltage (V) for the [**DIFL-IcC**] and the [**DIFL-Vn**]; the user can measure the charging current (Ic) using a protected line being energized and another line being open.

If the power system has different rated voltages (V), the charging current (Ic) measured should be corrected. Additionally, the user should set the same value for the settings [**DIFL-IcC**] at all terminals. When the terminals do not have an identical CT ratio, the user should set respective values so that the compensations on the primary side are coordinated.

2.3 Zero-sequence current differential protection (DIFGL)

Zero-sequence current differential protection (DIFGL) function is provided to enhance sensitivity upon occurrence of an earth fault having high impedance. To perform sensitive protection in the DIFGL function, residual current (Ie) is applied. Note that the residual current is introduced by the CT for the residual circuit.

2.3.1 Differential protection characteristics (DIFGL)

(i) Ir-Id plane for DIFGL function

Figure 2.3-1 shows the percentage restraining characteristic in the DIFGL element. Differential current (I_{d0}) denotes a vector summation of the residual currents in all terminals; restraining current (I_{r0}) denotes a scalar summation of the residual currents in all terminals. The I_{d0} and I_{r0} currents are also derived using Equations (2.3-1) and (2.3-2):

$$I_{d0} = |I1_0 + I2_0 + I3_0| \quad (2.3\text{-}1)$$

$$I_{r0} = |I1_0| + |I2_0| + |I3_0| \quad (2.3\text{-}2)$$

where,

$I1_0$: Current in zero-sequence flowing at the local terminal1

$I2_0$: Current in zero-sequence flowing at the remote terminal2

$I3_0$: Current in zero-sequence flowing at the other remote terminal3

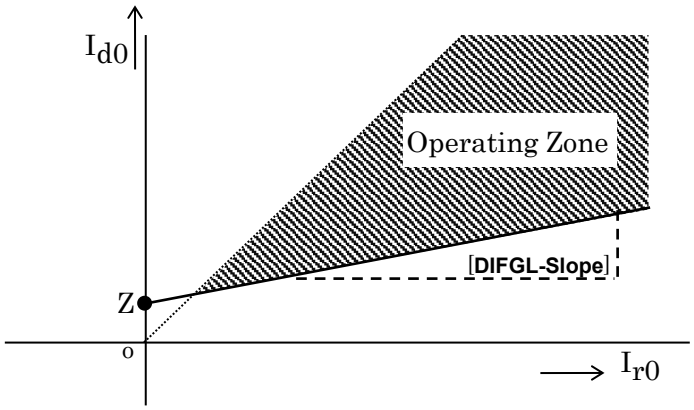


Figure 2.3-1 Zero-sequence current differential element (I_{r0}-I_{d0} Plane for DIFGL)

The DIFGL characteristic is identical to the DIFL characteristic for which is defined in the small current region. The DIFGL characteristic is expressed using the following equations:

$$I_{d0} \geq \gamma \times I_{r0} + Z \quad (2.3\text{-}3)$$

$$Z = (1 - \gamma) \times \text{setting } [\textbf{DIFGL-I}] \quad (2.3\text{-}4)$$

$$\gamma = \frac{\text{setting [DIFGL-Slope]}}{100} \qquad (2.3\text{-}5)$$

The user should set a minimum residual current for setting [**DIFGL-I**] for the occurrence of a fault. The user should also set slope characteristic for setting [**DIFGL-Slope**].

(ii) Inflow current (I_{in}) and Outflow current (I_{out}) plain for DIFGL function

Figure 2.3-2 provides another expression corresponding to the Figure 2.3-1 characteristic; the user can notice that the characteristic is expressed on the plane between the outflowing current (I_{out}) axis and inflow current (I_{in}) axis. The element of the DIFGL function operates for the hatched area on the I_{out}–I_{in} plain.

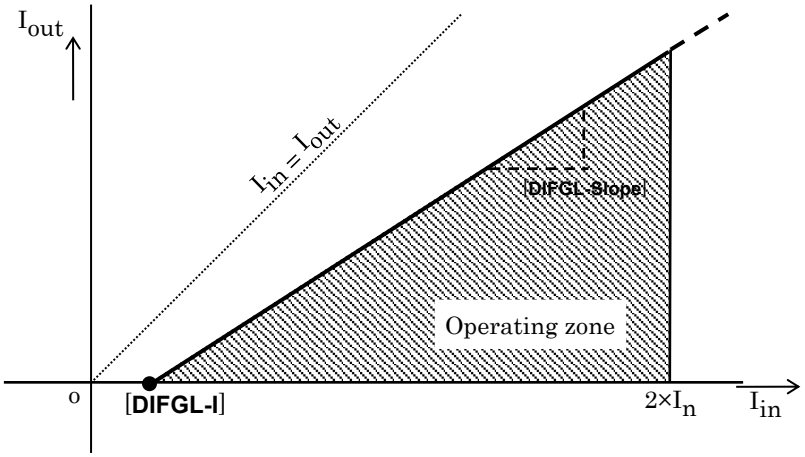


Figure 2.3-2 Zero-sequence current differential element (I_{in}-I_{out} Plane)

The hatched area is expressed using the following equation

$$I_{out} \leq \frac{100 - [\text{DIFGL_Slope}]}{100 + [\text{DIFGL_Slope}]} \times I_{in} - \frac{[\text{DIFGL_Slope}] - 100}{100 + [\text{DIFGL_Slope}]} \times [\text{DIFGL_I}] \qquad (2.3\text{-}6)$$

where the I_{in} should be less than two times a rated current (In); the In is defined in the VCT of the relay (for more information with regard to the VCT, see the Chapter *Technical description: Transformer module for AC analogue input*).

(iii) Trip delay timer in main logic

The DIFGL function has a delay timer to issue a trip signal; thereby, the operation of DIFGL function can be coordinated with the operations of the other protection relays. The delay timer is a kind of definite time type; the user can set a delay time for setting [**TDIFGL**]. Figure 2.3-3 illustrates issuing the trip signal for the TRC function† together with the delay timer.

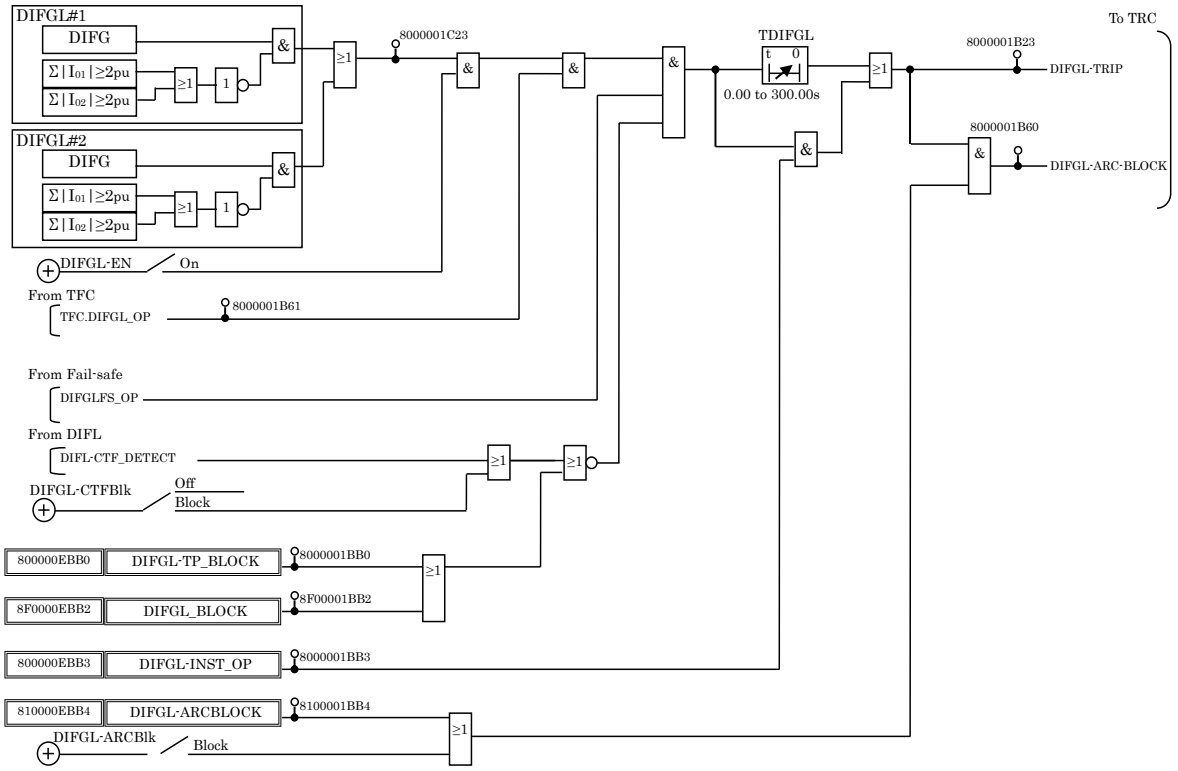


Figure 2.3-3 Generation of trip signal in the DIFGL function

†Note:The TRC function is discussed separately. See *Chapter Relay application: Trip circuit*.

(iv) Trip mode

The trip signal generated in the DIFGL function is a "three-phase trip (DIFGL-TRIP)" command. The "three-phase trip" command switches off the CB in the three-poles.

(v) Operation switch

The user should set **On** for scheme switch [**DIFGL-EN**]† prior to the DIFGL operation; the scheme switch is also illustrated in Figure 2.3-3.

Note: Also, see Chapter *Relay application: Communication application (COMM_APPL)*.

(vi) Setting for autoreclose function

When autoreclose function (ARC) is provided together with the DIFGL function, the ARC function can re-close the CB again after tripping the CB. When the user wishes to operate the ARC function, the user should set **Non** for scheme switch [**DIFGL-ARCBlk**]. On the other hand, the user wishes to not to operate the ARC function during the DIFGL operation, set **Block** for the scheme switch [**DIFGL-ARCBlk**] so that a block signal "DIFGL-ARC-BLOCK" is generated and injected to the autoreclose function (ARC). The ARC function is discussed separately. (See Chapter *Relay application: Autoreclose function*)

(vii) Block of issuing a trip signal

If the user does not wish that the DIFGL function issues a trip signal, the user can use PLC connection point "DIFGL_BLOCK" so that the DIFGL function cannot issue a trip signal when a block signal enters. The PLC connection point "DIFGL_BLOCK" is also shown in Figure 2.3-3; the one is useful when a user-made-program is required to instruct to block externally.

(viii) Specializing in micro earth faults

Since the DIFGL is used for high-impedance earth fault protection, a DIFGL output signal is blocked when zero-sequence phase current is true of the following equation:

$$\sum|I_{01}| \geq 2\text{pu} \quad \text{or} \quad \sum|I_{02}| \geq 2\text{pu} \qquad (2.3\text{-}7)$$

where,

$\Sigma|I_{01}|$: Scalar summation of zero-sequence phase current at the local-terminal

$\Sigma|I_{02}|$: Scalar summation of zero-sequence phase current at the remote-terminal

pu: per unit value

2.3.2 Check relay characteristic (EFD)

To remove unnecessary operations in the DIFGL function, a check relay are accommodated; consequently, the operation of the DIFGL function is possible during the check relay being in operation. Figure 2.3-4 shows the check relay and its logic.

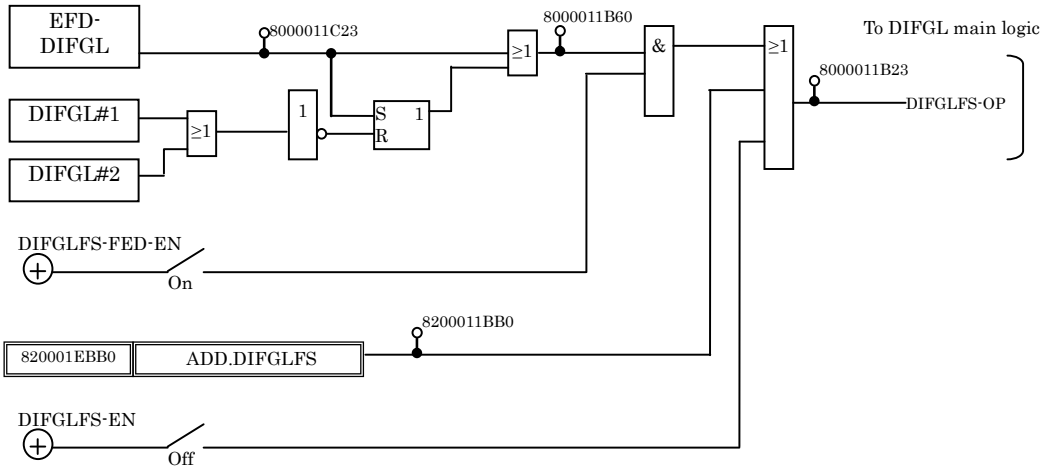


Figure 2.3-4 Check relay logic

(i) Earth-fault-current-change detection element (EFD-DIFGL)

Figure 2.3-5 shows a current vector (I_M) measured at the present and a pre-current vector (I_N) measured at one sampling cycle† ago. When the magnitude of difference between (I_S) is larger than a setting, the operation the EFD-DIFGL element is introduced. The EFD-DIFGL element

is expressed by the following equation:

$$|I_M - I_N| > I_s \qquad (2.3\text{-}8)$$

where I_S is referred in order to determine the operation of the EFD-DIFGL element; the user can set the value using setting [**EFD-DIFGL**], which is applied to adjust the decision point for the operation. The user can set the value among 0.05 to 0.20A when 1A rating‡ is set for the VCT module. When 5A rating‡ is set for the VCT module, the setting value is chosen among 0.25 to 1.00A.

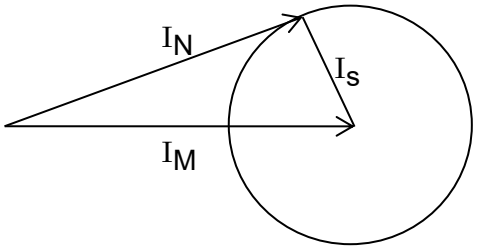


Figure 2.3-5 Current change I_S detected by I_M and I_N

†Note: One sampling cycle is discussed later.

‡Note: For the rating and the VCT module, see Chapter *Technical description: Transformer module for AC analog input*.

(ii) Check relay activation

For the operation of the check relay the user should set **On** for scheme switch [**DIFGL-EFD-EN**]. On the other hand, the user should set **Off** for scheme switch [**DIFGLFS-EN**] if the check relay is not required for the operation of the DIFGL function.

2.3.3 CT circuit-failure detection (DIFGL-CTF)

The user can set the DIFGL function not to operate upon occurrence of the failure in the CT circuit. As shown in Figure 2.3-3, the logic of DIFGL function can acquire a detection signal "DIFL-CTF-DETECT" from the DIFL function so that the DIFGL function cannot operate when the signal "DIFL-CTF-DETECT" enters. The user should set **On** for scheme switch [**DIFGL-CTFBlk**] to acquire the detection signal. (For more information of the CT circuit-failure detection, see section *CT circuit-failure detection in DIFL function*)

2.3.4 Charging-current compensation (DIFGL-Ic)

When the DIFGL function is applied for the protection of underground cables or long overhead transmission lines, charging-current should be taken account. In other word, the DIFGL function is influenced by the line capacitance. The user may see charging-current as an erroneous differential-current†. Therefore, the user should set the values of "line charging current" and "line voltage" using settings [**DIFGL-IcC**] and [**DIFGL-Vn**] when the charging

current compensation function is used in the DIFGL function. The setting values are used to calculate the line capacitance. The setting values are divided by two when there are two relays in the system, whereas the setting values are divided by three when there are three relays in the system.

If line-voltage is not absent, charging-current is shared continuously per-sample-by-sample basis. The equation is denoted as follows:

$$\mathrm{Ic} = \mathrm{C}\frac{dV}{dt} \qquad (2.3\text{-}9)$$

where,

Ic = line charging current

C = line capacitance calculated using settings [**DIFGL-IcC**] and [**DIFGL-Vn**]

V = line voltage measured

After that, the line current compensated for the charging-current is calculated per-sample-by-sample basis:

$$\mathrm{I} = \mathrm{I}' - \mathrm{Ic} \qquad (2.3\text{-}10)$$

where,

I = compensated current

I' = actual measured current

All necessary phase information has to be taken account basically. This is because the DIFL function calculates both the charging current and the compensated line current per sample-by-sample basis.

†Note:The differential-current also discussed in the DIFL function. See section 2.2.

2.3.5 Setting

Setting of DIFGL (Function ID: 411001)

Setting device		Range		Unit s	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
DIFG-LP	DIFGL-EN	Off / On		-	DIFGL protection enable	On		
	DIFGL-I	0.05 - 1.00	0.25 - 5.00	A	Minimum operating value	0.50	2.50	
	DIFGL-Slope	10 - 50		%	Percent slope of Id-Ir characteristic	17		
	DIFGL-IcC	0.00 - 1.00	0.00 - 5.00	A	DIFGL charging current compensation	0.00	0.00	
	DIFGL-Vn	100 - 120		V	DIFGL rated voltage	110		
	TDIFGL	0.00 - 300.00		s	DIFGL trip delay time	1.00		
	DIFGL-CTFBlk	Non / Block		-	DIFGL operation block by CTF	Non		
	DIFGL-ARCBlk	Non / Block		-	Autoreclose execution block by DIFGL-trip	Block		
Check relay	DIFGLFS-EN	Off / On		-	Check relay enable	Off		
	DIFGLFS-EFD-EN	Off / On		-	Check relay EFD-DIFGL enable	On		
	EFD-DIFGL	0.05 - 0.20	0.25 - 1.00	A	EFD for check relay, operating value	0.10	0.50	

2.3.6 Data ID

◆ Signal monitoring point

DIFGL (Function ID: 411001)

Element ID	Name	Description
8000001C23	DIFGL	DIFGL relay element operated
8000001B23	DIFGL-TRIP	Trip signal by DIFG-L protection operation
8000001B60	DIFGL-ARC-BLOCK	Autoreclose block signal by DIFG-L protection operation
8000011C23	EFD-DIFGL	EFD-DIFGL relay element operated
8000011B60	EFD-DIFGLFS	Check relay permitted by EFD
8000011B23	DIFGLFS_OP	Check relay for DIFG-L trip
8000001B61	TFC.DIFGL_OP	Remote terminal DIFGL relay element operated for TFC
8000001BB0	DIFGL-TP_BLOCK	DIFG-L trip block
8100001BB1	DIFGL-RDIF_BLOCK	Remote differential detect block
8F00001BB2	DIFGL_BLOCK	Block all the above 2
8000001BB3	DIFGL_INST_OP	DIFG-L protection instant operation command
8100001BB4	DIFGL_ARCBLOCK	Autoreclose block signal by DIFG-L protection operation
8200011BB0	ADD.DIFGLFS	Add File-safe condition
3100011708	DIFGLFS	DataID for Setting hierarchy (4110013100011708)
3100001703	DIFG	DataID for DIFG Function(Output)
3100001707	DIFG	DataID for DIFG Function(Setting)

◆ Connection point in PLC logic

DIFGL (Function ID: 411001)

Element ID	Name	Description
800000EBB0	DIFGL-TP_BLOCK	DIFG-L trip block
8F0000EBB2	DIFGL_BLOCK	Block all the above 2
800000EBB3	DIFGL_INST_OP	DIFG-L protection instant operation command
810000EBB4	DIFGL_ARCBLOCK	Autoreclose block signal by DIFG-L protection operation
820001EBB0	ADD.DIFGLFS	Add File-safe condition

2.3.7 Remote different trip

Figure 2.3-6 exemplifies the transmission line and the communication structure on the three-terminal line. Suppose a fault occurs on the three-terminal line; suppose that the communication from the terminal-H to the terminal-J is broken down. Then the DIFL function at the terminal-J cannot issue a trip signal (that is, the terminal-J cannot calculate because of the absent of remote-current data at terminal-H). However, the terminals G and H can generate a trip signal because that the DIFL functions at both are able to receive the data from the terminal-J. In Figure 2.3-6, trip signals should be issued at all terminals as for the fault occurrence; we know that DIFL functions can calculate in spite of the communication failure. That is, when the terminal-G starts to provide a trip signal to the terminal-J, the CB at the terminal-J begins to trip. Remote differential trip function (RDIF) is possible for the above operation when sub-channels† are provided in the communication. Note that the RDIF function is just possible to issue a trip signal under the following conditions: (1) a trip signal being received from a remote terminal, (2) a failure of local-DIFL operation being determined, (3) communication failure being determined, and (4) settings being completed for the RDIF operation.

The RDIF function is available for the DIFGL function, as well. In other words, the RDIF function can operate for both the DIFL and DIFGL functions.

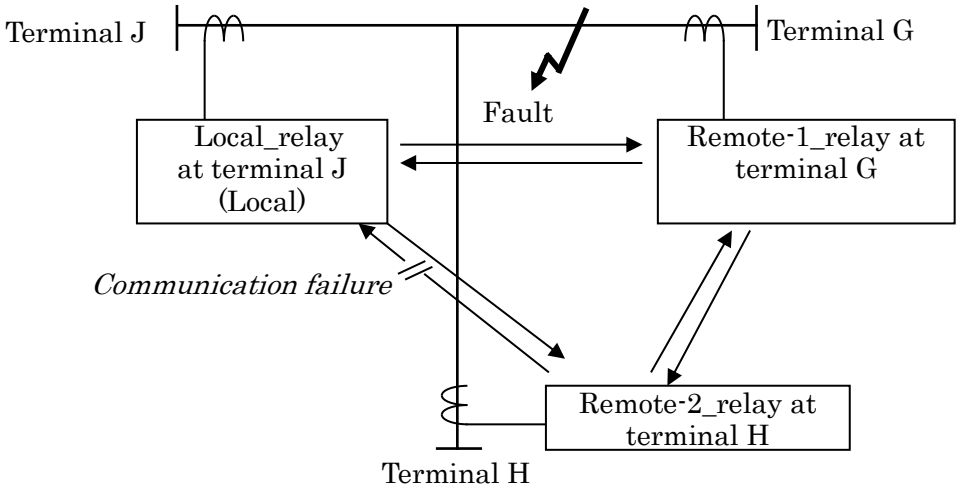


Figure 2.3-6 Occurrences of communication failure and fault on the three-terminal line

†Note:The sub-communication channels are provided when the communication between relays operates in the IEEE C37.94 (N=3) frame. (i.e., set **Wide** for scheme switch [**CH*-COM_WIDTH**]). With regard to the IEEE C37.94, several bits in the frame (N=3) are defined as auxiliary bits; users can use the auxiliary bits as the sub-communication channels for the RDIF operation. For more information, see Chapter *Relay application: Transmission control function (TC)"* and "*Communication application (COMM_APPL)*".

(i) RDIF operation relating to DIFL function

For the RDIF operation the user is required to send the local DIFL output-signals for the remote terminal by the communication; the user should set the local terminal to receive the remote DIFL output-signals.

(i)-1 Sending local-DIFL-operation signal

As mentioned earlier, the operation signals of the local DIFL function should be sent to the remote DIFL functions. Figure 2.3-7 shows PLC monitoring points "DIFL-A,-B, and -C" are provided for the sending.

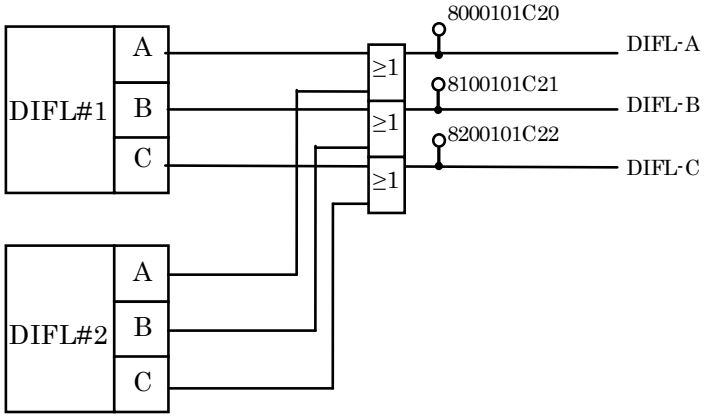


Figure 2.3-7 Sending local DIFL operation signals for remote relays

Figure 2.3-8 examples the PLC monitoring signals "DIFL-A,-B, and -C" are sent for the remote relays using sub-communication channels COM5-4,5,6 bits; communication application function (COMM_APPL) function provides the features of the sub-communication channel. In other words, the user should connect the PLC monitoring signals with PLC connection points "COM5-4,-5,-6_S"†.

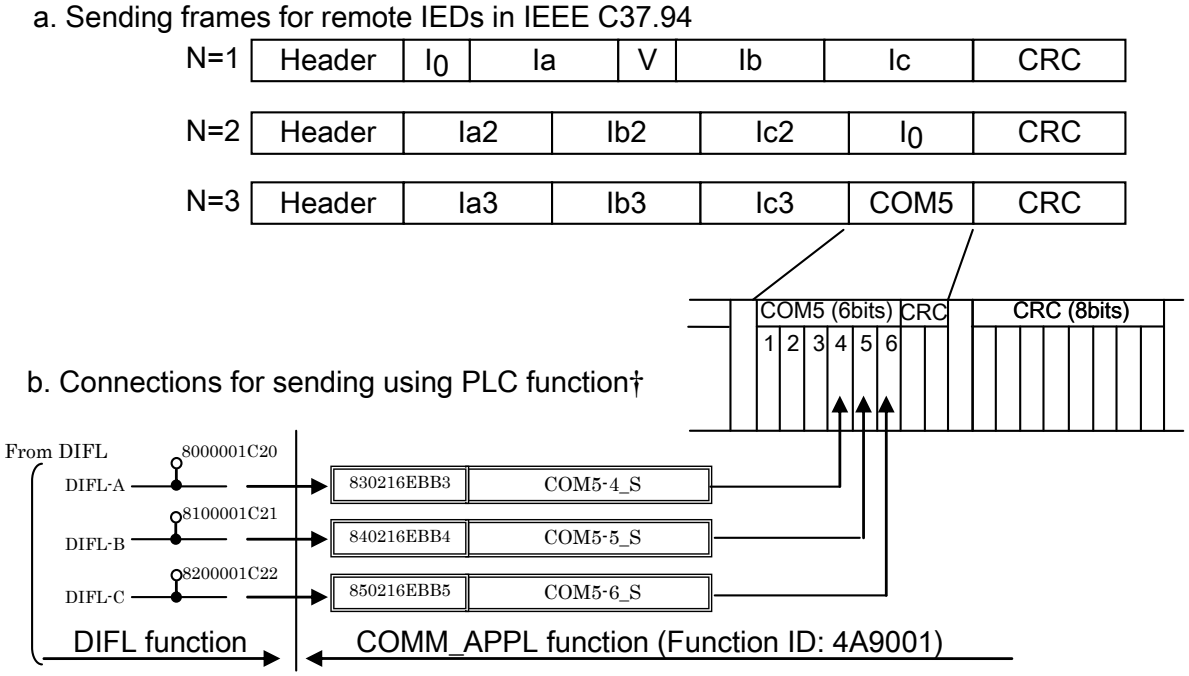


Figure 2.3-8 Mapping for sending signals using COM5 bits

†Note: For more information, see *Chapter Relay application: Communication Application*.

(i)-2 Reception of remote-DIFL-operation signal

We should receive remote-operation signals at the local RDIF function. Figure 2.3-9 shows the RDIF reception logic: PLC connection points "R1.DIFL-A,-B, -C_OP" are provided for the Remote-1_relay, the other PLC connection points "R2.DIFL-A,-B, -C_OP" are provided for the Remote-2_relay. The signals received from both remote-relays are ORed; then they are ANDed with the local signals provided the user sets **On** for scheme switch [**DIFL-RDIF-EN**]. Consequently, the local DIFL function begins to provide trip signals despite that the local DIFL function fails to operate.

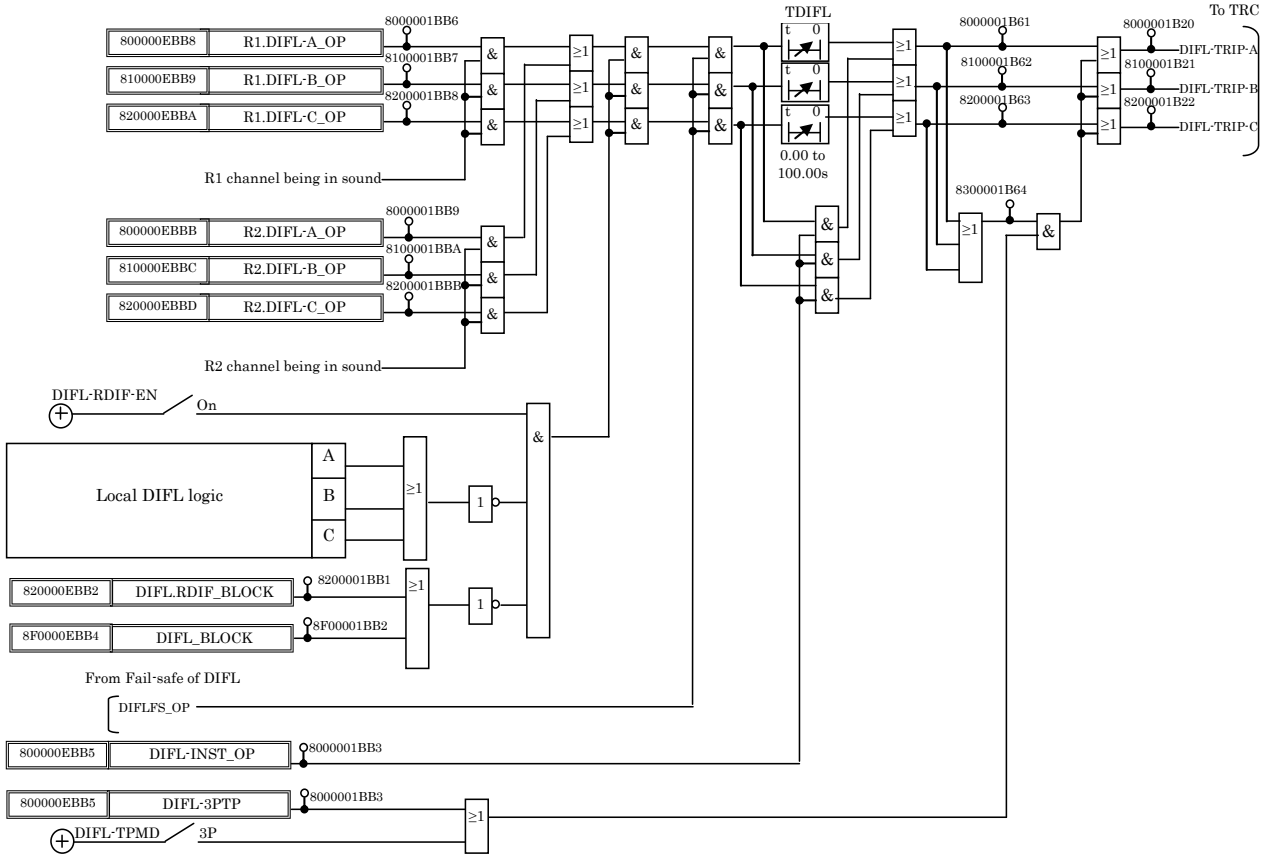
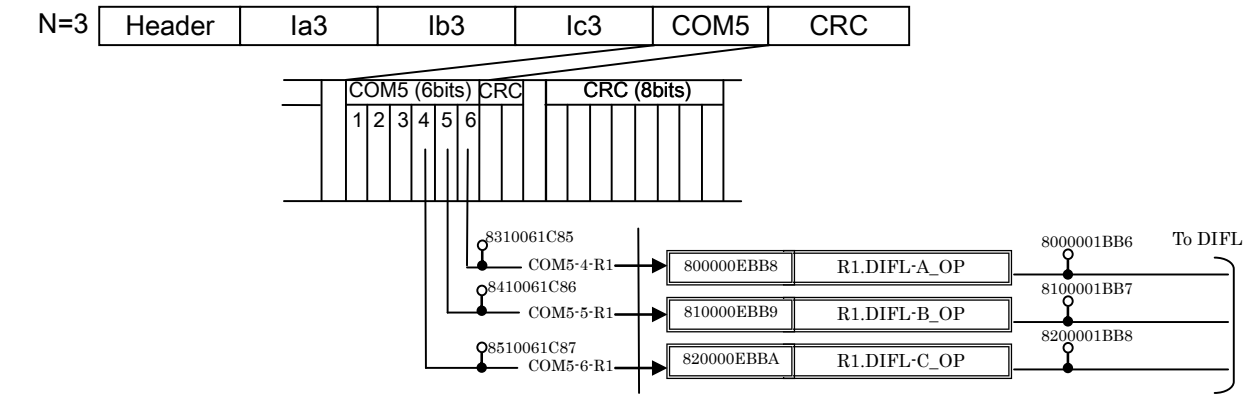


Figure 2.3-9 Reception of DIFL operation signals from remote relays

Figure 2.3-10 (a) exemplifies the signals received from the Remote-1_relay in the COM5-4,-5,-6 bits; the PLC connection points "COM5-4,-5,-6_R1" are required to be connected with PLC connection points "R1.DIFL-A,-B,-C_OP". Figure 2.3-10 (b) also exemplifies that the signals from the Remote-2_relay.

a. Receiving frames from Remote-1 IED in IEEE C37.94



b. Receiving frames from Remote-2 IED in IEEE C37.94

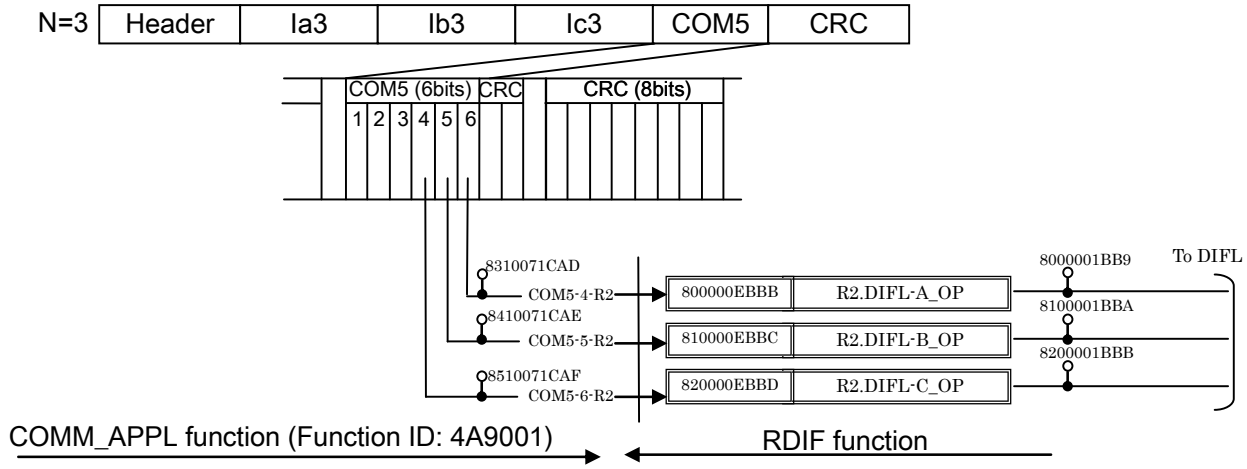


Figure 2.3-10 Mapping for reception signals using COM5 bits

(ii) RDIF operation relating to DIFGL function

The RDIF function is also available for the DIFGL function; hence, the operation signals of the DIFGL function are sent mutually for the opposite terminals.

(ii)-1 Sending local-DIFGL-operation signal

An operation signal at the local DIFGL function is required to transferred for the remote. Figure 2.3-11 shows PLC monitoring point "DIFGL" used at the local DIFGL function; the SCOM4-SA0 is used in the sub-communication channel.

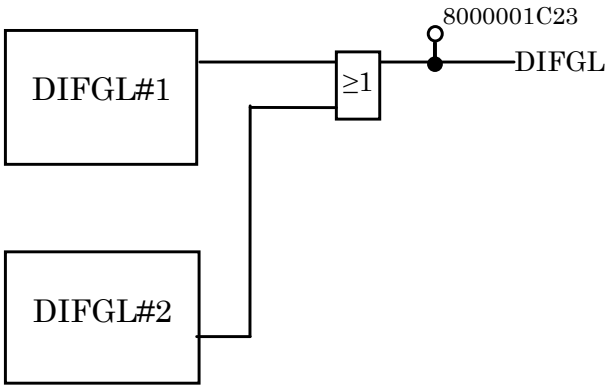
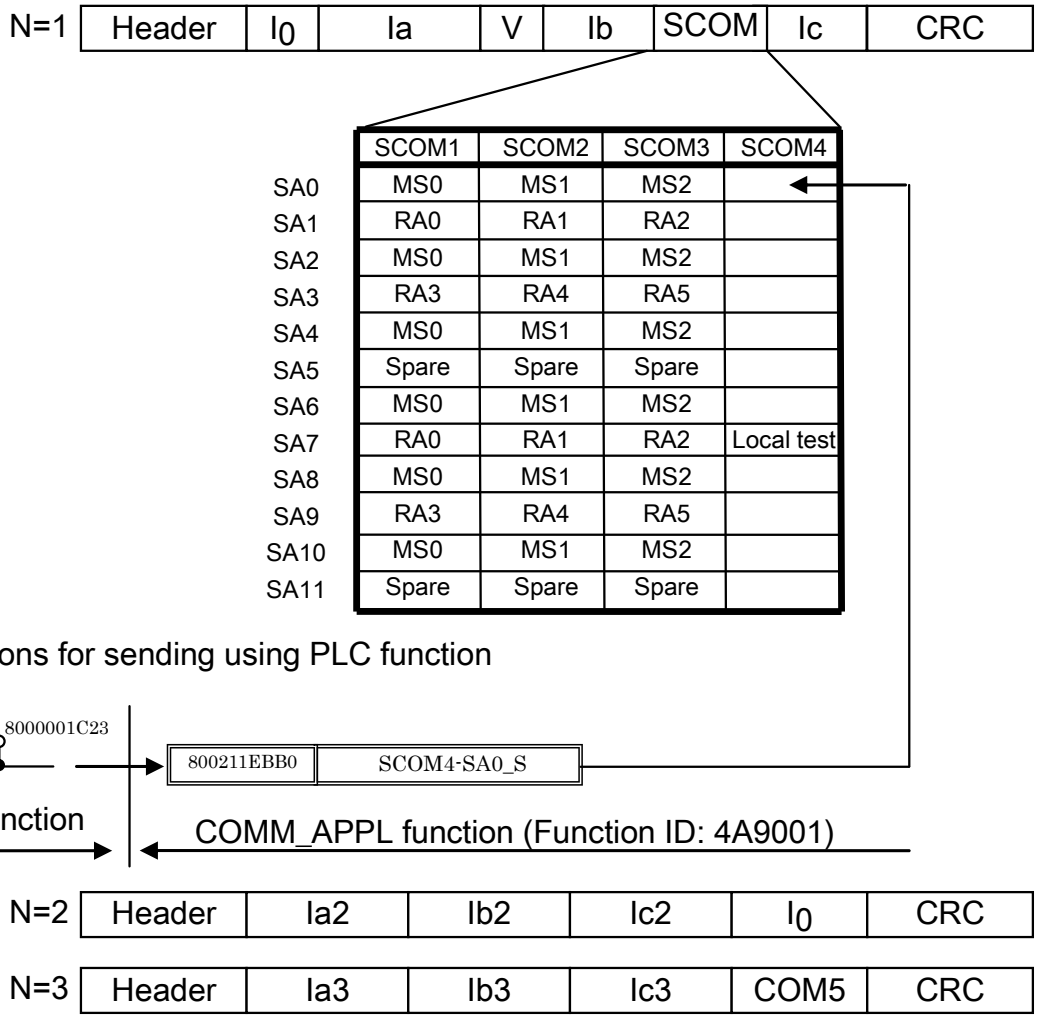


Figure 2.3-11 Sending local operation signal for remote relay

a. Sending frames for remote IEDs in IEEE C37.94



b. Connections for sending using PLC function

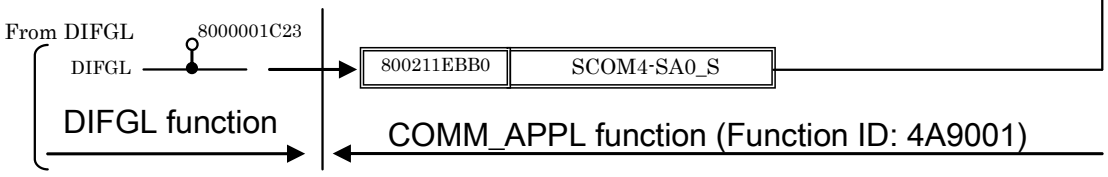


Figure 2.3-12 Mapping for sending signal using SCOM bit

(ii)-2 Reception of remote-DIFGL-operation signal

Figure 2.3-13 shows the RDIF reception logic for the DIFLG function: PLC connection point

"R1.DIFGL_OP" is provided for the signal reception from the Remote-1_relay, another PLC connection point "R2.DIFGL_OP" is provided for the Remote-2_relay. The receipt signals of both remote-relays are ORed; then they are ANDed with the local DIFGL operation signal when the user set **On** for scheme switch [**DIFGL-RDIF-EN**]. Finally, the RDIF function begins to issue a trip signal. The SCOM4-SA0 in the sub-communication channel is applied.

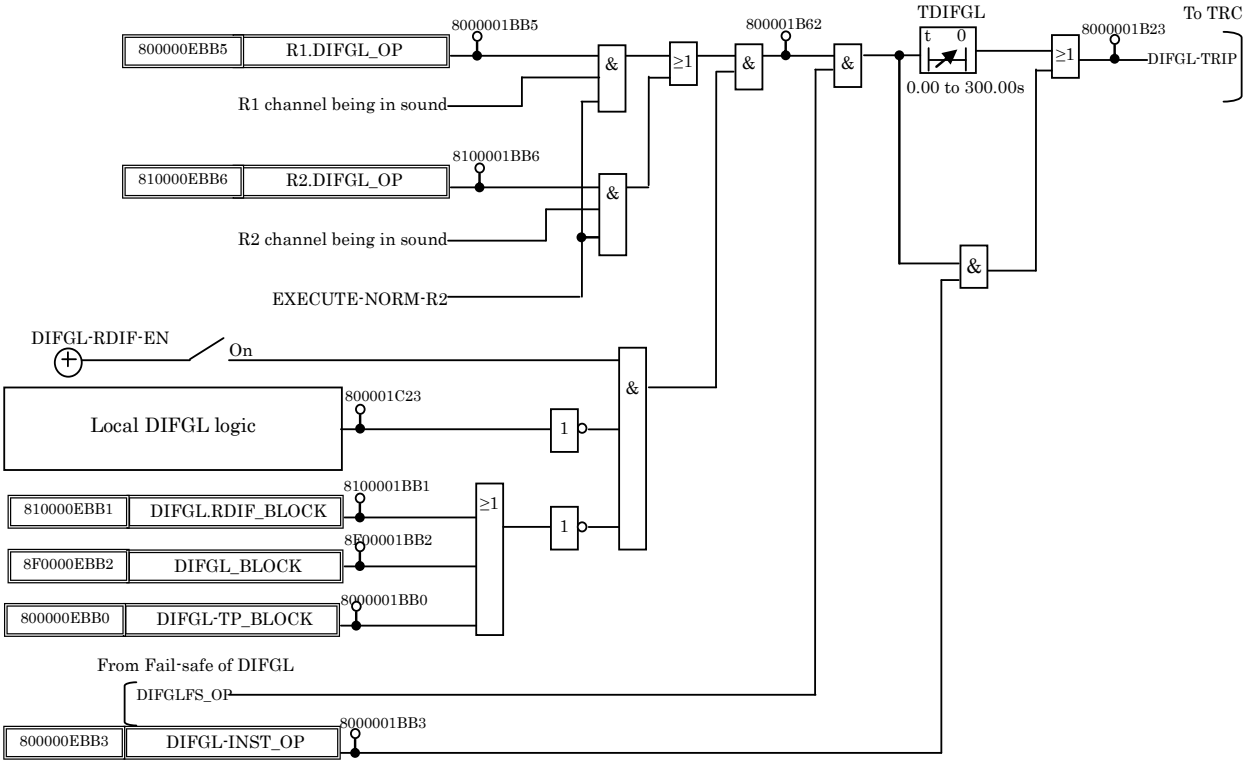


Figure 2.3-13 Reception of remote operation signal in RDIF

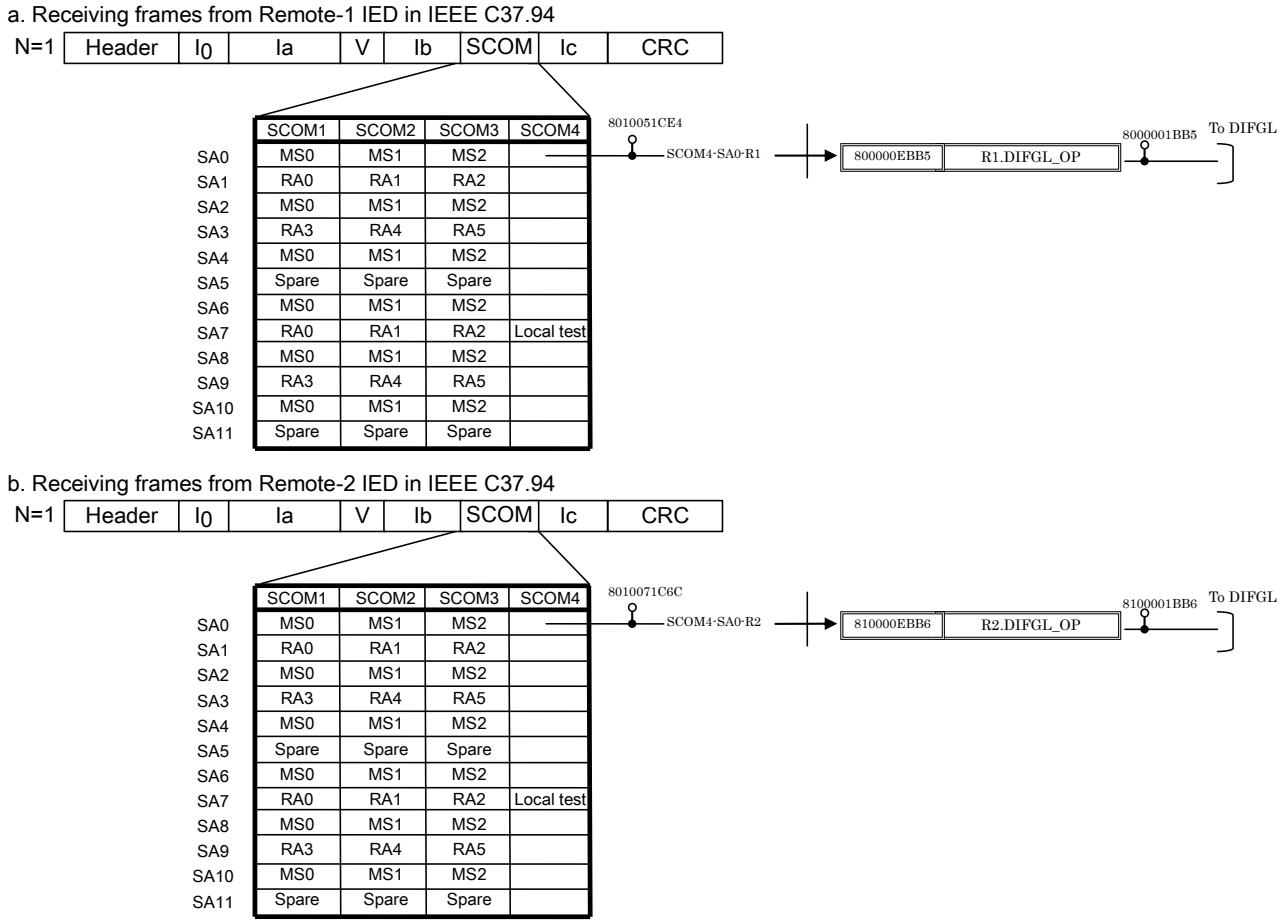


Figure 2.3-14 Mapping for reception signals using SCOM bits

2.3.8 Setting

Setting of RDIF relating to DIFL (Function ID: 410001)

Setting device	Range	Units	Contents	Default setting value	Notes
DIFL-RDIF-EN	Off / On	-	Remote differential protection enable	Off	

Setting of RDIF relating to DIFGL (Function ID: 411001)

Setting device	Range	Units	Contents	Default setting value	Notes
DIFGL-RDIF-EN	Off / On	-	Remote differential protection enable	Off	

2.3.9 Data ID

◆ Signal monitoring point

RDIF relating to DIFL (Function ID: 410001)

Element ID	Name	Description
8000001B6A	REMOTE.DIFL-A	Remote differential protection (phase-A)
8100001B6B	REMOTE.DIFL-B	Remote differential protection (phase-B)
8200001B6C	REMOTE.DIFL-C	Remote differential protection (phase-C)
8300001B6D	REMOTE.DIFL-OR	Remote differential protection (3-phase OR)
8200001B6E	REMOTE.DIFL-OPT	Remote differential protection
8200001BB1	DIFL-RDIF_BLOCK	Remote differential detect block
8000001BB6	R1.DIFL-A_OP	Receiving signal from Remote Terminal 1 (phase-A)
8100001BB7	R1.DIFL-B_OP	Receiving signal from Remote Terminal 1 (phase-B)
8200001BB8	R1.DIFL-C_OP	Receiving signal from Remote Terminal 1 (phase-C)
8000001BB9	R2.DIFL-A_OP	Receiving signal from Remote Terminal 2 (phase-A)
8100001BBA	R2.DIFL-B_OP	Receiving signal from Remote Terminal 2 (phase-B)
8200001BBB	R2.DIFL-C_OP	Receiving signal from Remote Terminal 2 (phase-C)

RDIF relating to DIFGL (Function ID: 411001)

Element ID	Name	Description
8000001B62	REMOTE.DIFGL	Remote differential trip
8100001B63	REMOTE.DIFGL-OPT	Remote differential trip operation
8000001BB5	R1.DIFGL_OP	Receiving signal from Remote Terminal 1
8100001BB6	R2.DIFGL_OP	Receiving signal from Remote Terminal 2

◆ Connection point in PLC logic

RDIF relating to DIFL (Function ID: 410001)

Element ID	Name	Description
800000EBB8	R1.DIFL-A_OP	Receiving signal from Remote Terminal 1 (phase-A)
810000EBB9	R1.DIFL-B_OP	Receiving signal from Remote Terminal 1 (phase-B)
820000EBBA	R1.DIFL-C_OP	Receiving signal from Remote Terminal 1 (phase-C)
800000EBBB	R2.DIFL-A_OP	Receiving signal from Remote Terminal 2 (phase-A)
810000EBBC	R2.DIFL-B_OP	Receiving signal from Remote Terminal 2 (phase-B)
820000EBBD	R2.DIFL-C_OP	Receiving signal from Remote Terminal 2 (phase-C)

RDIF relating to DIFGL (Function ID: 411001)

Element ID	Name	Description
810000EBB1	DIFGL-RDIF_BLOCK	Remote differential detect block
800000EBB5	R1.DIFGL_OP	Receiving signal from Remote Terminal 1
810000EBB6	R2.DIFGL_OP	Receiving signal from Remote Terminal 2

2.4 Distance protection (ZS/ZG)

The distance protection function can provide the user the zone information of the fault occurrence using relay elements. The user can determine the boundaries of respective zones using reactance-reaches.

Note: Several IED models do not have ZS/ZG features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.4-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
ZS	Distance protection for phase fault (No. of zones)	NA	NA	✓(4)	✓(5)	NA
	Power swing block	NA	NA	✓	✓	NA
	Switch on to fault protection	NA	NA	✓	✓	NA
ZG	Distance protection for earth fault (No. of zones)	NA	NA	✓(4)	✓(5)	NA
	Power swing block	NA	NA	✓	✓	NA
	Switch on to fault protection	NA	NA	✓	✓	NA

✓: Applicable NA: Not applicable

2.4.1 Principle of distance measurement

(i) Phase-to-phase fault

The distance protection function used to detect phase-to-phase faults measures the impedance from the relay to the fault point using delta voltage and current. The positive-sequence impedance is used to represent the line impedance.

Figure 2.4-1 provides an illustration of the power system for the condition of a phase-to-phase fault. The impedance from the relay to the fault is the same in phase-B and phase-C, the self-impedance is Zs and the mutual impedance between phases is Zm. If the voltages and currents of phase-B and phase-C are V_b, V_c, I_b and I_c and the fault point voltage is VF, then V_b and V_c are given by the following equations.

$$V_b = Zs \times I_b + Zm \times I_c + VF \quad (2.4\text{-}1)$$

$$V_c = Zs \times I_c + Zm \times I_b + VF \quad (2.4\text{-}2)$$

From equations (2.4-1) and (2.4-2), the following equation is obtained.

$$V_b - V_c = (Zs - Zm) \times (I_b - I_c) \quad (2.4\text{-}3)$$

where,

Zs: Self impedance

Zm: Mutual impedance

Since the effect of the phase-A current is small, and hence negligible in equation (2.4-3), there is no need to introduce it in equations (2.4-1) and (2.4-2).

When each phase of the line is symmetric with the other, the positive-sequence and zero-sequence impedances are Z_1 and Z_0 according to the method of symmetrical components. Z_1 and Z_0 are defined by the following equations, using the self-impedance Zs and the mutual impedance Zm:

$$Z_1 = Zs - Zm \quad (2.4\text{-}4)$$

$$Z_0 = Zs + 2Zm \quad (2.4\text{-}5)$$

where,

Z_1: Positive-sequence impedance

Z_0: Zero-sequence impedance

Equation (2.4-3) can be rewritten as follows:

$$Z_1 = \frac{V_b - V_c}{I_b - I_c} \qquad (2.4\text{-}6)$$

As shown above, the positive-sequence impedance is used when determining settings for phase faults.

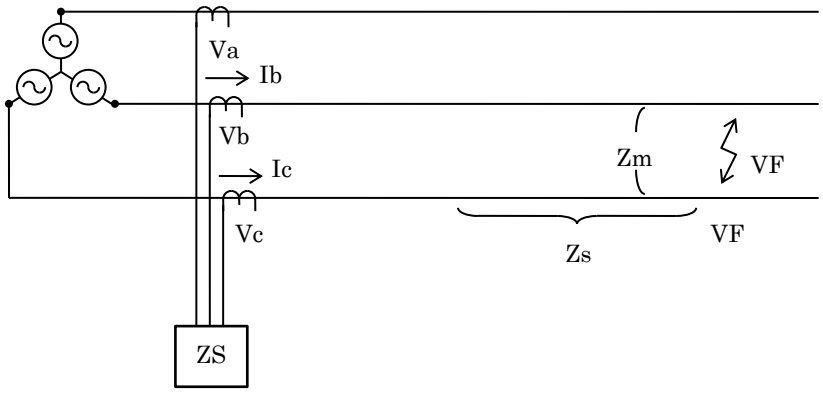


Figure 2.4-1 Phase-to-phase fault

(ii) Single-phase-earth fault

Figure 2.4-2 shows the power system in the event of a single-phase-earth fault. It is very difficult to measure precisely the distance to the fault point for a single-phase-earth fault. This is because the impedance of the zero-sequence circuit including the earth return is generally different from the positive-sequence impedance. Therefore, the faulted phase voltage is not simply proportional to the faulted phase current.

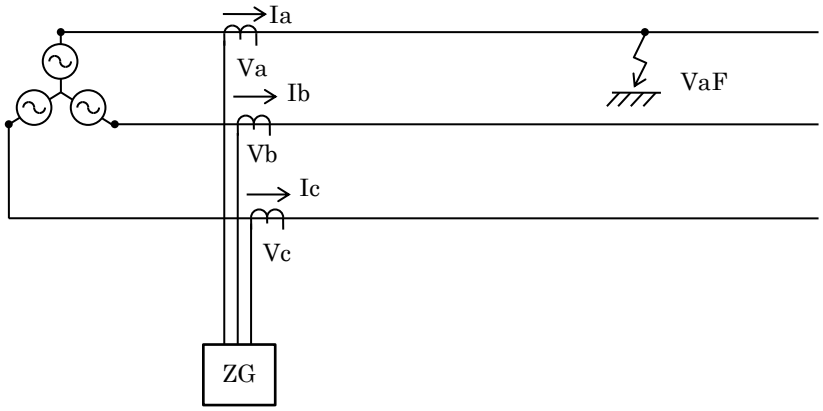


Figure 2.4-2 Single-phase-earth fault

It is necessary to analyze the impedance seen by the relay in the event of a single-phase-earth fault according to the method of symmetrical components. Figure 2.4-3 shows an equivalent circuit for a single-phase-earth fault based on the method of symmetrical components. If we define the positive-sequence, negative-sequence and zero-sequence voltages as being V_1F, V_2F and V_0F, then the voltage at the relaying point of each symmetrical circuit will be given by the following equations based upon the assumption that the positive-sequence

impedance and negative-sequence impedance are the same and that the influences of the fault resistance are ignored.

$$V_1 = Z_1 \times I_1 + V_1F \quad (2.4\text{-}7)$$

$$V_2 = Z_1 \times I_2 + V_2F \quad (2.4\text{-}8)$$

$$V_0 = Z_0 \times I_0 + Z_0m \times I_0m + V_0F \quad (2.4\text{-}9)$$

where,

V_1: Relay point positive-sequence voltage
V_2: Relay point negative-sequence voltage
V_0: Relay point zero-sequence voltage
V_1F: Fault point positive-sequence voltage
V_2F: Fault point negative-sequence voltage
V_0F: Fault point zero-sequence voltage
I_1: Relay point positive-sequence current
I_2: Relay point negative-sequence current
I_0: Relay point zero-sequence current
I_0m: Adjacent line zero-sequence current
Z_1: Fault point - relay point positive-sequence impedance
Z_0: Fault point - relay point zero-sequence impedance
Z_0m: Adjacent line zero-sequence mutual impedance

Considering the faulted phase voltage V_aF at the point of fault is,

$$V_aF = V_1F + V_2F + V_0F = 0 \quad (2.4\text{-}10)$$

Phase-A voltage V_a at the relay is calculated from the following equation:

$$V_a = V_1 + V_2 + V_0 = Z_1\left(I_a + \frac{Z_0 - Z_1}{Z_1} \times I_0 + \frac{Z_{m0}}{Z_1} \times I_{0m}\right) \quad (2.4\text{-}11)$$

Where, I_a is the current of phase-A at the relay and is defined in the following equation by the symmetrical component of the current:

$$I_a = I_1 + I_2 + I_0 \quad (2.4\text{-}12)$$

Here, defining the current synthesized using the phase-A current at the relay as I_a', and

$$I_a' = I_a + \frac{(Z_0 - Z_1)}{Z_1} \times I_0 + Z_0m/Z_1 \times I_0m \quad (2.4\text{-}13)$$

Then equation (2.4-11) can be re-written in the following form:

$$V_a = Z_1 \times I_a' \qquad (2.4\text{-}14)$$

That is, the positive-sequence impedance Z_1 up to the fault point can be obtained from the simple ratio of voltage V_a to compensated current I_a' according to equation (2.4-14).

Obtaining the compensated current according to equation (2.4-13) is called "zero-sequence compensation." Note that in this implementation of zero-sequence compensation, the compensation coefficient

$$\frac{Z_0 - Z_1}{Z_1}$$

and

$$\frac{Z_{0m}}{Z_1}$$

are not real numbers, but complex numbers. The distance protection function has a configuration that allows this compensation coefficient to be set as a complex number and setting the coefficient correctly makes it possible to measure exactly the distance to the fault point.

In equations (2.4-7) to (2.4-9), the fault resistance is ignored. Since the measurement of the distance up to the fault point, based on equation (2.4-14) is carried out using the reactance component, in principle there is no influence on the voltage component due to the fault resistance. However, under real operating conditions, distance measurement errors are introduced because of the fault resistance combined with the power flow or the current flowing into the fault point from the remote terminal opposite to the relay location.

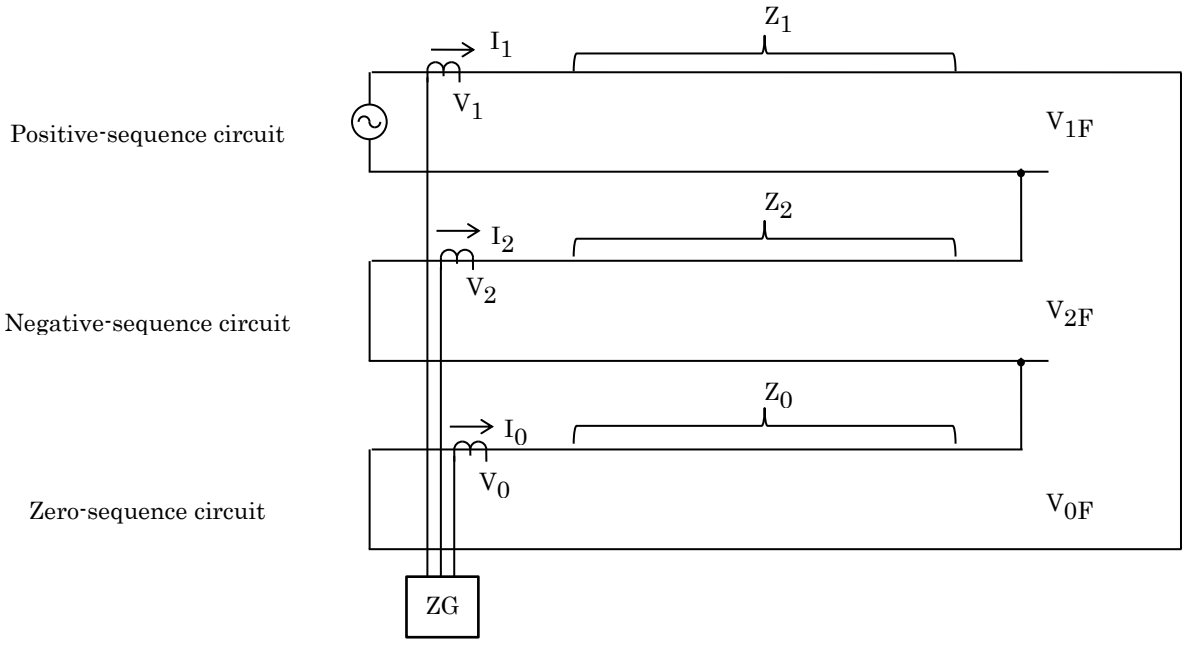


Figure 2.4-3 Equivalent circuit of single-phase earth fault

2.4.2 Element characteristic in distance relay

The distance protection function has four measurement zones; it is possible to identify the fault point using these zones. This function has ZS elements to determine phase-to-phase faults and ZG elements to determine single-phase-earth faults.

This distance protection function can be selected to have either a Mho characteristic (Mho) or a Quadrilateral characteristic (Quad) for both ZS and ZG. Each of the measuring zones in this function has a directional characteristic.

Note: The Asterisk (*) in the setting is used to show the zone number in ZS/ZG (either '1', '1X', '2', or '3 (or 4)'. The numbering and application of ZS/ZG are described later.

(i) Common characteristic of ZS and ZG

The distance protection function has a Mho characteristic (Mho) element and a Quadrilateral characteristic (Quad) element and either the Mho characteristic or the Quad characteristic is selected by the scheme switches [**ZS-Chara**] and [**ZG-Chara**].

Note: The complete elements and their characteristics, ZS and ZG are based on the scheme switches [**ZS-Chara**] and [**ZG-Chara**].

(i)-1 Mho characteristic

(i)-1-1 Conventional Mho characteristic

Figure 2.4-4 (a) and (b) show Z*S and Z*G with the Mho characteristic. Z*S can be set using the settings [**Z*S-Mho.Reach**] and [**Z*S-Mho.Angle**].

The blinder positions (left line and right line) are defined by the resistance and the angle in the Figure 2.4-4; they are set using settings [**Z*S-R.Reach**] and [**Z*S-R.Angle**]. The blinders are aligned symmetrically with the X-coordinate. Scheme switches [**Z*S-MhoR.EN**] should be set **On** to enable the blinders.

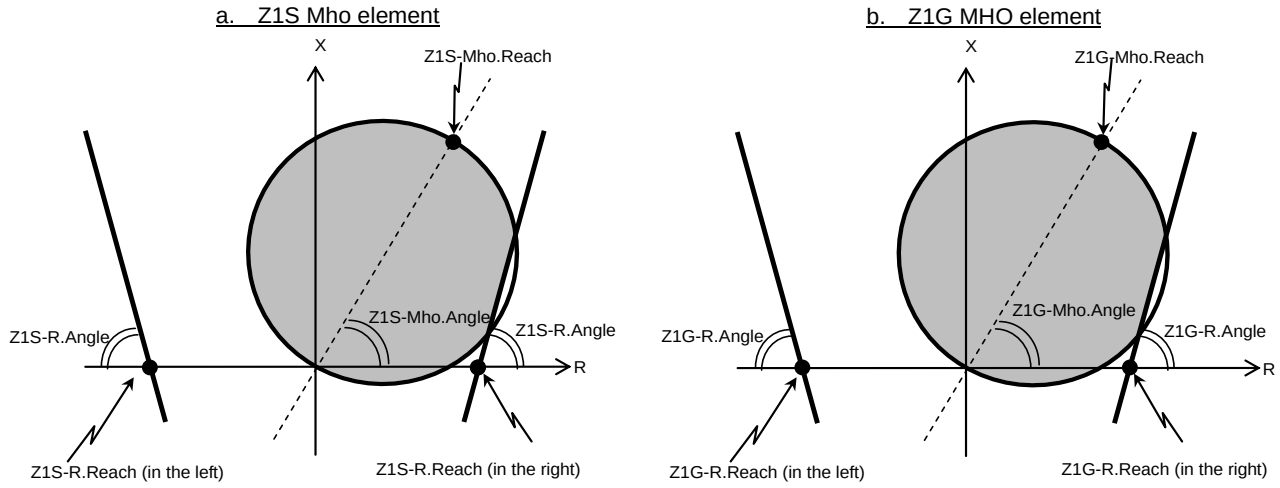


Figure 2.4-4 Z1S Mho element (Zone1 Mho element with Blinders)

(i)-1-2 Mho with reactance characteristic

Figure 2.4-5 (a) and (b) show Z1S MHO element and Z1G MHO element set with reactance X.

The ZS with the MHO reactance characteristic should be set using the setting [**Z*S-X.Reach**]. Similarly, ZG should be set using the setting [**Z*G-X.Reach**].

The 'knee' function is configured by using the settings [**ZSF-X.GrAngle1**] and [**ZSF-X.GrAngle2**]. When **On-Adapt** is set for the scheme switch [**ZS-X.GrAngleEN**], the 'knee' function operates when power flow is detected.

For the Mho characteristic, a composition component (Z-X) is provided. As shown in Figure 2.4-5 (a), if Z1S is set with reactance components (X), other components can be set using impedance components (Z).

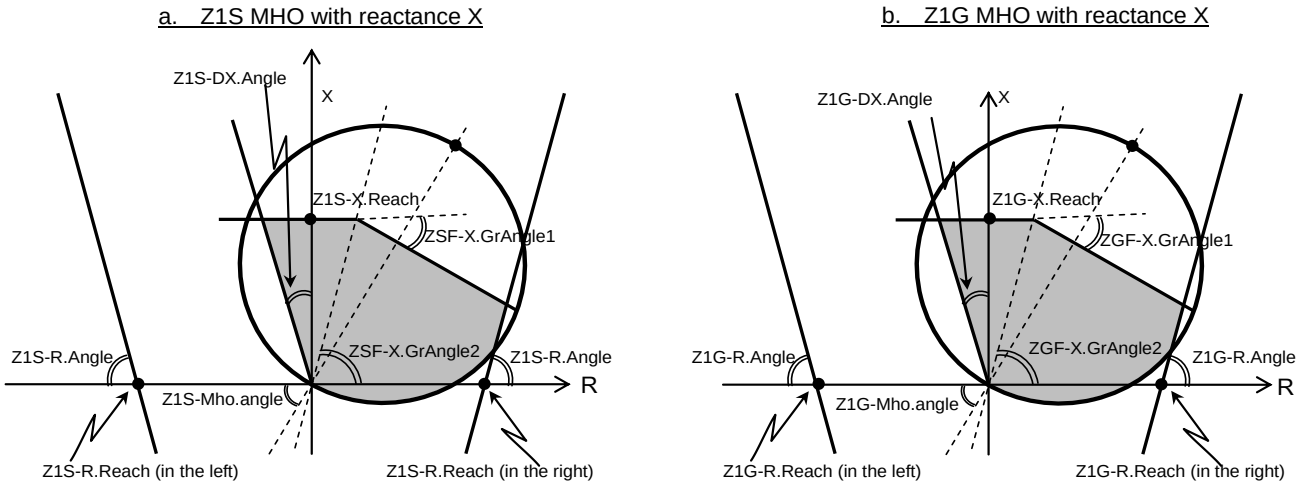


Figure 2.4-5 Zone1 MHO element set with reactance X in forward direction

(i)-2 Quad characteristic

Figure 2.4-6(a) and (b) show the Z*S and the Z*G used in the Quad characteristics. For example, the reach of Z*S (top line) is defined by reactance X and the reach value should be set for the scheme switch [**Z*S-X.Reach**]. A resistive element (left line) and a directional element (bottom line) can be set by the settings [**Z*S-DX.Angle**] and [**Z*S-DR.Angle**] respectively. The resistive elements (right and left lines) can be configured by the settings [**Z*S-R.Reach**] and [**Z*S-R.Angle**]; the blinder (left line) is used to cut the area of the Quad characteristic by applying settings [**Z*S-R.Reach**] and [**Z*S-R.Angle**].

The 'knee' function is configured by the settings [**ZSF-X.GrAngle1**] and [**ZSF-X.GrAngle2**]. When **On-Adapt** is set for the scheme switch [**ZS-X.GrAngleEN**], the 'knee' function operates when power flow is detected, similar to the MHO element.

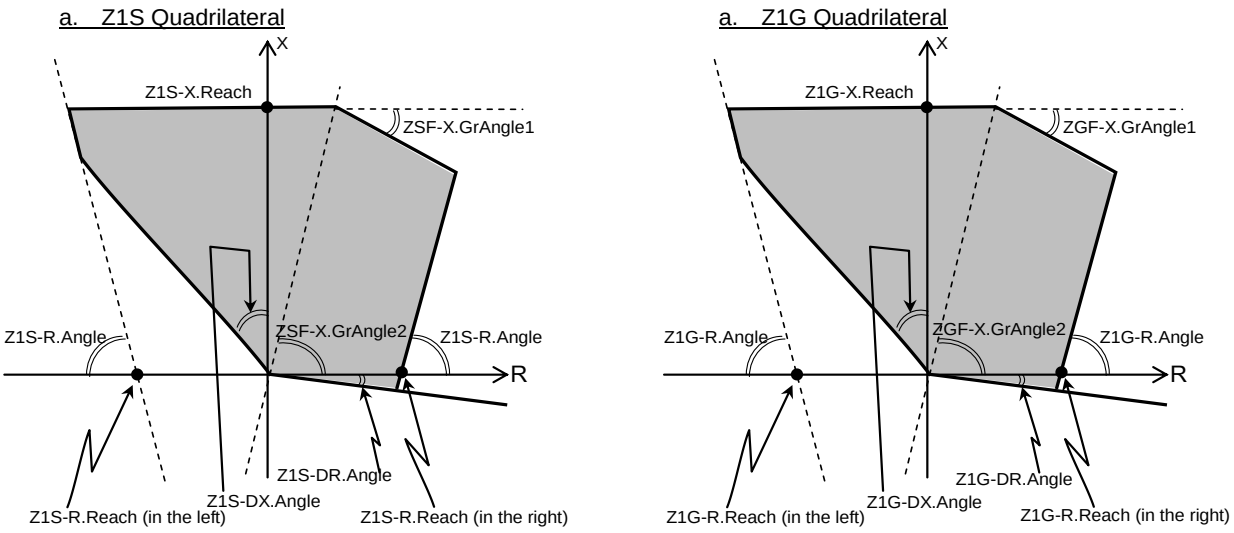


Figure 2.4-6 Zone1 Quadrilateral element in forward direction

(i)-3 Number of zones

The distance protection for phase-to-phase faults (ZS) includes four (five) measuring zones and these are termed Z1S, Z1XS, Z2S, and Z3S (Z4S). The distance protection for single-phase-earth faults (ZG) also includes six measuring zones that are similarly termed Z1G, Z1XG, Z2G, and Z3G (Z4G).

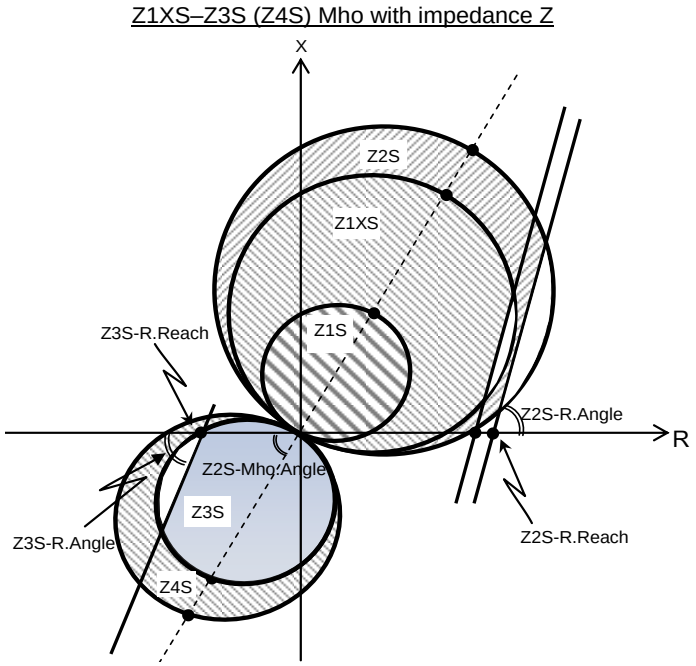


Figure 2.4-7 Composition feature for Mho characteristic

(i)-4 Selection of Forward, Reverse, or Non-directional for the respective zones

The selection of the element direction is provided with the setting [**Z*S-Dir**]. For instance, if **Forward** is set, then Z*S is set in forward direction, as shown in Figure 2.4-4 to Figure 2.4-6. If **Reverse** is set, then Z*S is set in reverse direction, as shown in Figure 2.4-8 to Figure 2.4-10. Z*S can be set non-directional by setting **NonDir**, as shown in Figure 2.4-11 and Figure 2.4-12. The other elements can be set in a similar manner.

Elements in the reverse direction of ZG are not drawn in Figure 2.4-8 to Figure 2.4-10, but they are similar to the ZS elements.

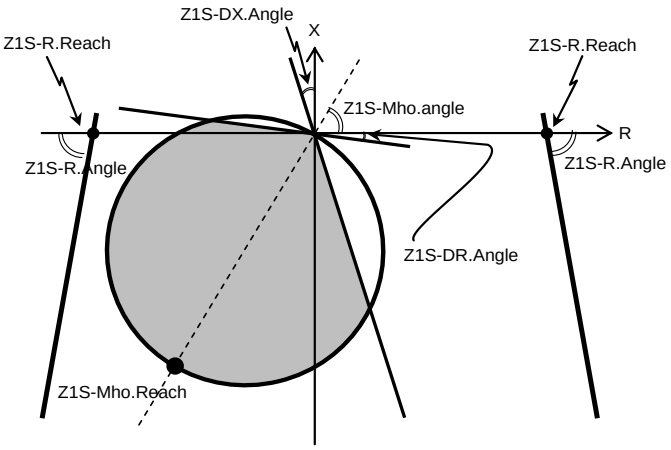


Figure 2.4-8 Z1S MHO element in reverse direction

†Note:The tilted line, crossing the originate, instructs the function of the non-directional element.

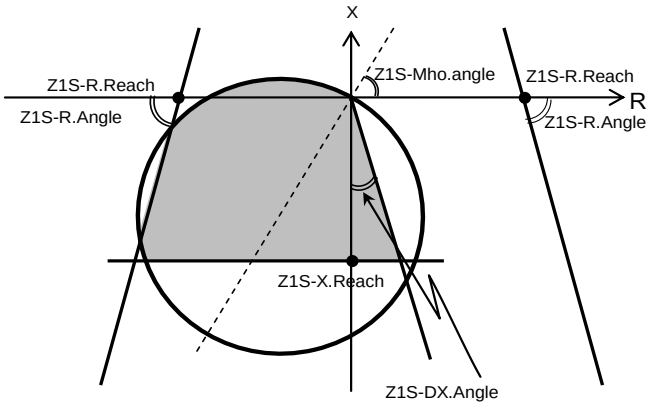


Figure 2.4-9 Z1S MHO element set with reactance X in reverse direction

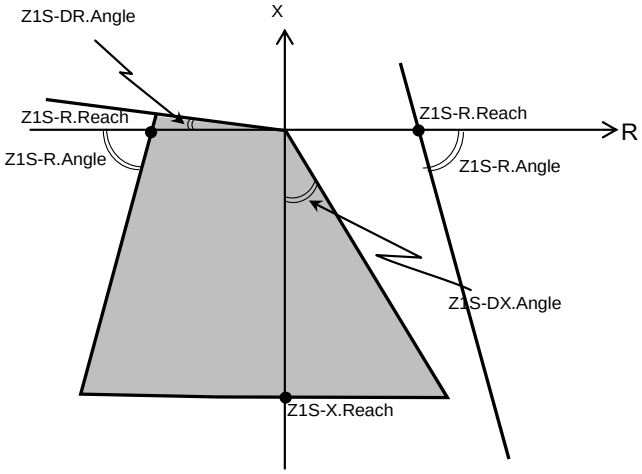


Figure 2.4-10 Z1S Quadrilateral element in reverse direction

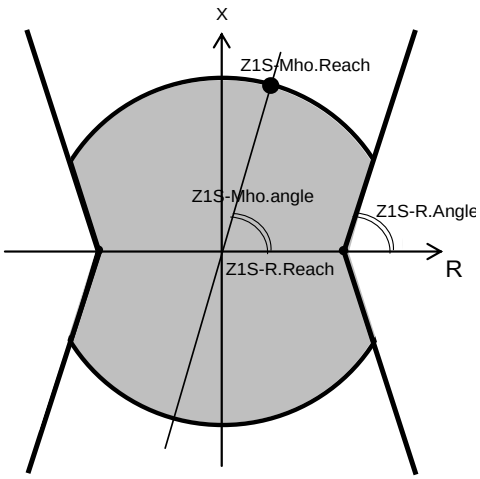


Figure 2.4-11 Z1S MHO element non-directional

†Note:The tilted line, crossing the originate, instructs the function of the non-directional element.

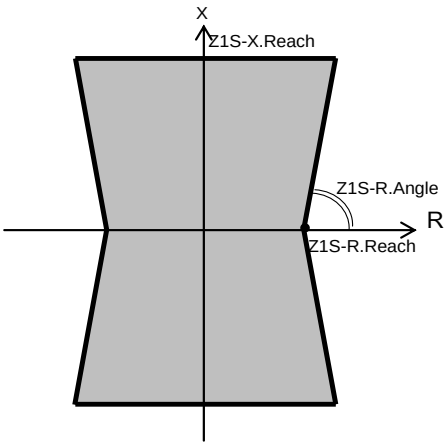


Figure 2.4-12 Z1S Quad element non-directional

(i)-5 Function and classification of 4 (5) zones

Table 2.4-2 provides a summary of the zones and characteristics for each element. Z1XS and Z1XG can be set to cover ≤ 80 or 100% of the protected line in their respective zones of protection in order to provide extended coverage beyond the settings of Z1S and Z1G. On the other hand, Z3S (Z4S) and Z3G (Z4G) can be used for the backup of Z1S or Z1G. The element characteristic used for Z1XS and Z3S (Z4S) is similar and so is the element characteristic for Z1XG and Z3G (Z4G).

Note that the elements Z2S to Z3S (Z4S) and the Z2G to Z3G (Z4G) can have either the Mho or the Quad characteristic element, but these elements do not have the 'knee' function.

Table 2.4-2 Zone element, characteristics and directional

Zone	Element	Purpose	Directional			Characteristic			Set the 'Knee'
			Forward	Reverse	Non-directional	Quadrilateral	MHO		
							Set Z	Set X	
1	Z1S /Z1G	Protection for Zone 1 (Relay reach ≤ 80 %)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1X	Z1XS/ Z1XG	Protection for Zone 1 extension (Relay reach ≤ 100 %)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	Z2S /Z2G	Back up for Z1S, Z1X	Yes	Yes	Yes	Yes	Yes	Yes	No
3	Z3S /Z3G	Back up for Z1S, Z1X	Yes	Yes	Yes	Yes	Yes	Yes	No
(4)	(Z4S) /(Z4G)	Back up for Z1S, Z1X	Yes	Yes	Yes	Yes	Yes	Yes	No

(i)-6 Charging current compensation

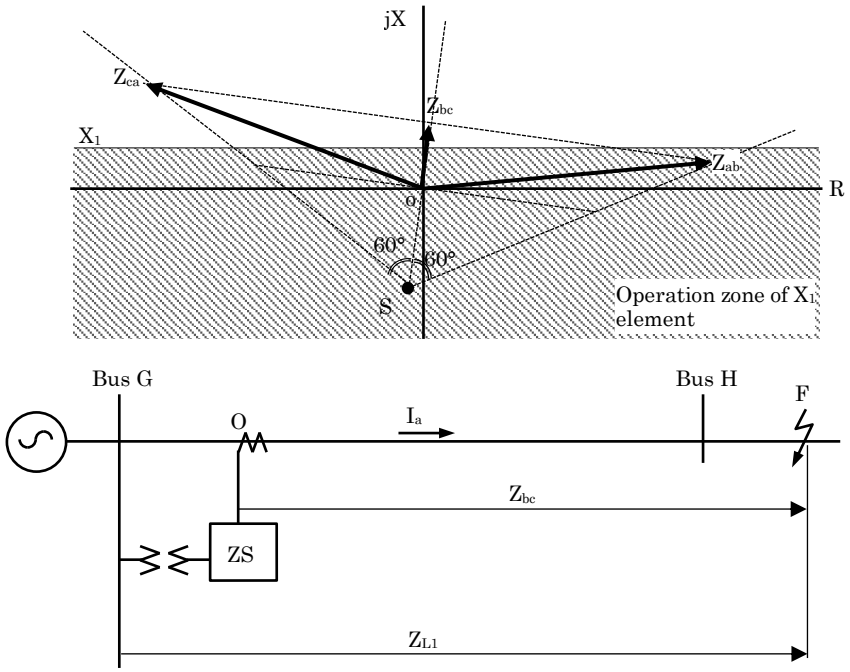
When this distance protection function is applied to underground cables or long-distance overhead lines, the effect of charging current is to be considered; it appears as a distance measurement error to the fault. In order to suppress the effect and maintain the high-accuracy distance-measurement capability, the charging current compensation function should be used. Compensation is recommended if the minimum fault current is three times less than the charging current.

The charging current compensation function has common scheme switches for both ZS and ZG. The **On** setting is selected for the scheme switch [**Z-IcC.EN**] along with a setting value for the setting [**Z-IcC**].

(ii) Special characteristic in ZS

(ii)-1 Overreach countermeasure

If we consider ZS, when a phase-to-phase fault occurs, the setting of the ZS reactance element tends to be less than the fault impedance. For example, Figure 2.4-13 shows the relationship between the phase-to-phase impedances in a three-phase system when a phase-to-phase BC fault arises across Bus H. Here, ZS is not required to operate because the fault lies outside of the protection zone. However, ZS may operate because the impedance of the phase-to-phase impedance AB is located inside the setting of the reactance element (X_1). This means that the phase-to-phase protection element AB, which is not connected with the faulted phase, may operate although the other elements do not operate.



F: Fault location
S: Infinite bus system
O: Location of Protective relay
Z_{L1}: Fault impedance seen from S
Z_{bc}: Fault impedance of phase-to-phase bc in the fault

Figure 2.4-13 Impedance seen from ZS on occurrence of phase-to-phase BC fault

The previous phenomenon is referred to as overreaching of the leading phase in distance protection terminology. A countermeasure is necessary to deal with this phenomenon. The countermeasure is to utilize a Zmin element as shown in section 2.4.6. It is generally recognised as being the result of a phase-to-phase fault impedance which is smaller than the normal impedance.In the above instance, the element Zmin-BC of the faulted phase would operate but the Zmin-AB and Zmin-CA elements of the healthy phases would not operate, so that the unnecessary overreaching operation of ZS-AB can be blocked.

(ii)-2 Offset in ZS

Some elements in ZS are used for the detection of faults in the reverse direction and these elements can have an offset characteristic, which assures the detection of a close-up three-phase fault. Offset impedance reach[1] is provided in Z1S[2] and Z1XS. The distance protection offset characteristic is invoked only when the fault occurs and the voltage drops to zero. The offset impedance reach characteristic is also utilized when the memory circuit detects zero voltage when the time for which the memory voltage is held has elapsed. The memory circuit has an important role in deciding whether the fault is in the forward or in the reverse direction based upon the relay location. The offset value is fixed at 1.5Ω for 5A rating[3], whereas it is fixed at 7.5Ω for 1A rating[3]. Figure 2.4-14 shows the offset Mho characteristic of Z1S for the reverse direction, and Figure 2.4-15shows the offset Quad characteristic.

[1]Note: Z2S and Z3S do not have the offset action in the reverse direction.

[2]Note: Z1S is normally utilized for the close-up three-phase fault. In other words, the user can instruct the Z1S element to operate an offset-Mho in the reverse direction; the operation zone of the Z1S element should be covered the origin (i.e., voltage=0), as shown in Figure 2.4-14. Accordingly, the Z1S element is able to detect a fault even if the memory action cannot run properly, provided the voltages in the three-phase are erased upon occurrence of the close-up three-phase fault. Incidentally, the memory action in the Z1S element is available within two cycles after the occurrence of the fault; the memory action is removed in three cycles.

[3]Note: Either 1A or 5A rating is chosen using jumper pins on a transfer modules (VCT). For more information of the VCT, see Chapter *Technical Description: Transformer module for AC analog input*.

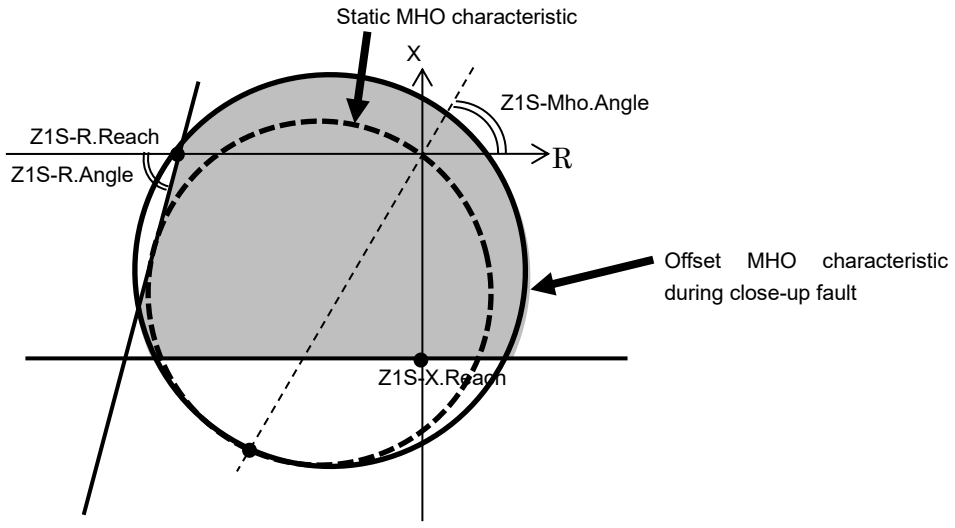


Figure 2.4-14 Z1S Mho element during close up fault (Offset action)

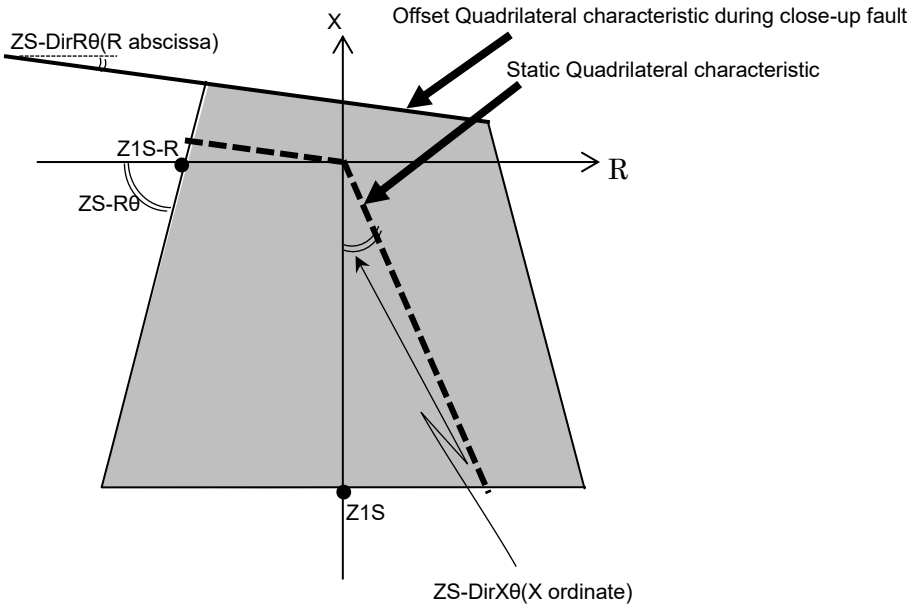


Figure 2.4-15 Z1S Quad element close-up fault (Offset action)

(ii)-3 Operation of ZS for earth and multi-phase-faults

ZS can operate for any of the following faults: a phase-to-phase fault, phase-to-phase ground fault, and a fault evolving into a multi-phase fault. To strengthen dependability in detecting the multi-phase fault, it is possible to add the judgement of fault phase identifier. The fault phase identifier consists of ZG elements. The judgement condition will be added when **On** is set for setting [**Z*S-MSDET**]†. In order not to add the judgement in ZS, the user can set **Off** for the setting.

†Note: It is recommended to set [**Z*S-MSDET**]=**On** in the instantaneous main protection element only. Since operating condition of Z*S elements is increased by setting **On**, it is desirable to set **Off** in the backup protection easier to operate.

(iii) Special characteristic in ZG

(iii)-1 Earth fault compensation (Zero-sequence current compensation)

On the detection of an earth fault, ZG requires a compensation function that corrects measuring errors caused by the earth return of zero-sequence current. By using the compensation function, the positive-sequence impedance to the fault point can be determined precisely by the reactance element in the faulted phase. For a double-circuit line, the zero-sequence current from the adjacent line is introduced to compensate for influences from zero-sequence mutual coupling. Considering a case where the angle of the positive-sequence impedance and the zero-sequence impedance differs, the distance protection function carries out zero-sequence current compensation vectorially. We can see this case commonly in cable

circuits.

In ZG, this function provides the compensation factors for all elements and these factors are defined with settings. For example, for Z1G, the settings [**Z1G-Krs**], [**Z1G-Kxs**], [**Z1G-Krm**], [**Z1G-Kxm**] are provided. Where, "s" refers to the protected line; the resistance "r"; the reactance "x" reflect its property and "m" refers to a mutual circuit line for parallel line applications.

Table 2.4-3 ZG compensation factors in lines

Element	Settings for Protected line	Settings for Parallel line
Z1G	[**Z1G-Krs**], [**Z1G-Kxs**]	[**Z1G-Krm**], [**Z1G-Kxm**]
Z1XG	[**Z1XG-Krs**], [**Z1XG-Kxs**]	[**Z1XG-Krm**], [**Z1XG-Kxm**]
Z2G	[**Z2G-Krs**], [**Z2G-Kxs**]	[**Z2G-Krm**], [**Z2G-Kxm**]
Z3G	[**Z3G-Krs**], [**Z3G-Kxs**]	[**Z3G-Krm**], [**Z3G-Kxm**]
(Z4G)	[**Z4G-Krs**], [**Z4G-Kxs**]	[**Z4G-Krm**], [**Z4G-Kxm**]

Measuring the positive-sequence impedance to the fault point is necessary. Therefore, for a single circuit line, the current input to the earth fault-measuring element is compensated by the residual current ($3I_0$) of the protected line.

On the other hand, for a double circuit line, the current input is compensated by the residual current ($3I_0$) of the protected line and residual current ($3I_0$') of the adjacent line.

Generally, the following equation is used to compensate the zero-sequence voltage drop, in this example for the case of phase "a".

$$Va = (Ia - I_0) \times Z1 + I_0 \times Z_0 + I_{0m} \times Z_{0m} \qquad (2.4\text{-}15)$$

where,

Va: Phase "a" voltage
Ia: Phase "a" current
I_0: Zero-sequence current of the protected line
I_{0m}: Zero-sequence current of the adjacent line
Z_1: Positive-sequence impedance ($Z_1 = R_1 + jX_1$)
Z_0: Zero-sequence impedance ($Z_0 = R_0 + jX_0$)
Z_{om}: Zero-sequence mutual impedance ($Z_{om} = R_{om} + jX_{om}$)

Equation (2.4-15) can be presented as follows:

$$
\begin{aligned}
Va = {} & (R_1 + j X_1)Ia + \{(R_0 - R_1) + j(X_0 - X_1)\}I_0 \\
& + (R_{om} + j X_{om}) I_{om} \\
& = R_1\left(I_a + \frac{R_0 - R_1}{R_1} I_0 + \frac{R_0 m}{R_1} I_{om}\right) + jX_1(Ia \\
& + \frac{X_0 - X_1}{X_1} I_0 + \frac{Xm}{X_1} I_{om})
\end{aligned}
\qquad (2.4\text{-}16)
$$

In the relay, the voltage is compensated independently for resistance and reactance components as shown in equation (2.4-16) instead of equation (2.4-15).

$$
\begin{aligned}
VaR + jVaX = {} & \{R1(IaR + \frac{\frac{Krs}{100} - 1}{3} \times 3I0R \\
& + \frac{\frac{Krm}{100}}{3} \times 3I_{omR}) - X1(IaX \\
& + \frac{\frac{Kxs}{100} - 1}{3} \times 3I_{0X} + \frac{\frac{Kxm}{100}}{3} \times 3I_{0mX})\} \\
& + j\{R1(IaX + \frac{\frac{Krs}{100} - 1}{3} \times 3I_{0X} \\
& + \frac{\frac{Krm}{100}}{3} \times 3I_{0mX}) + X1(IaR \\
& + \frac{\frac{Kxs}{100} - 1}{3} \times 3I_{0R} + \frac{\frac{Kxm}{100}}{3} \times 3I_{0mR})\}
\end{aligned}
\qquad (2.4\text{-}17)
$$

where,

Kxs: compensation factor (Kxs = X0/X1 × 100)
Krs: compensation factor (Krs = R0/R1 × 100)
Kxm: compensation factor (Kxm = Xom/X1 × 100)
Krm: compensation factor (Krm = Rom/R1 × 100)
X: imaginary part of the measured impedance
R: real part of the measured impedance
VaX: imaginary part of phase “a” voltage
VaR: real part of phase “a” voltage
IaX: imaginary part of phase “a” current
IaR: real part of phase “a” current
I_{0X}: imaginary part of zero-sequence current of the protected line
I_{0R}: real part of zero-sequence current of the protected line
I_{omX}: imaginary part of zero-sequence current of the adjacent line
I_{omR}: real part of zero-sequence current of the adjacent line

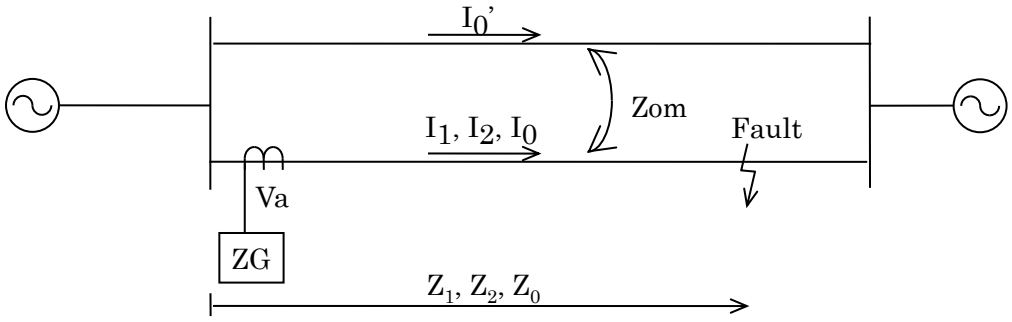


Figure 2.4-16 Earth fault compensation

The Zero-sequence Current Compensation function (ZPCC) controls the zero-sequence compensation required as a consequence of the influence of the adjacent line in parallel line applications.

When an earth fault occurs on the protected line, the ZPCC function will operate, in this case parallel line compensation is performed to prevent under-reach caused by the mutual zero-sequence current of the adjacent line.

When an earth fault occurs on the adjacent line, the ZPCC function does not operate, compensation for the adjacent line is not performed to prevent overreach. The operating condition of the ZPCC function is as follows:

$$\frac{3I_0}{3I_{0m}} \geq 0.8 \qquad (2.4\text{-}18)$$

(iii)-2 Operation of ZG for earth-faults and multi-phase faults

ZG uses an EFL function for the detection of earth faults; hence, ZG will operate when the EFL function operates. However, the operation of Z*G can be set to be either dependent or independent of the operation of EFL; that is, **On** is set for the scheme switch [**Z*G-EFL**] for the Z*G operation with EFL and **Off** is set for the scheme switch [**Z*G-EFL**] for the Z*G operation without EFL.

There is the possibility that ZG even operates in multi-phase fault. Since ZG cannot have the distance measurement accurately in the multi-phase fault, it is better to make just ZS operates in the multi-phase fault. In order for ZG not to operate in the multi-phase fault, it is possible for the user to set **Block** for setting [**Z*G-MPFBlk**]†. If this operation condition shall not be added in ZG operation, it is possible to set **Non** for the setting [**Z*G-MPFBlk**].

†Note:It is recommended to set [**Z*G-MPFBlk**]=**Block** in the instantaneous main protection element only. Since operating condition for Z*G elements is increased

by setting **Block**, it is desirable to set **Non** in the backup protection easier to operate.

With regard to the leading-phase-block function, where the leading phase of ZG tends to operate in event of a multi-phase fault. Thus it is possible to set **Non** for scheme switch [**Z*G-LPBlk**] in order to enable the operation of Z*G. However, **Block** can be set for this scheme switch in order to block the operation of Z*G.

2.4.3 Common application for ZS and ZG

Applications in ZS and ZG are divided into common features and special features. Each feature secures this distance protection function.

(i) Power swing block

(i)-1 Operation of power swing block (PSB)

Power swings occur when the output voltages of generators located at different points in the power system slip relative to one another because of system instabilities. This may be caused by sudden changes in load magnitude or direction, or by power system faults and their subsequent clearance. During the course of such a power swing, the impedance locus seen by the distance protection relay may move (relatively slowly) from the load area into the operating region of the distance protection. Actually, the relay may see this phenomenon as a three-phase fault condition and may issue a trip signal if no countermeasure is applied. The majority of power swings are transient and the power system recovers after a short period. Since a trip signal from the relay is undesirable in such cases, a power swing blocking function, (PSB) is provided enabling the operation of the distance protection to be blocked during the power swing. Figure 2.4-17 illustrates a typical impedance locus as seen by the relay during the transient power swing.

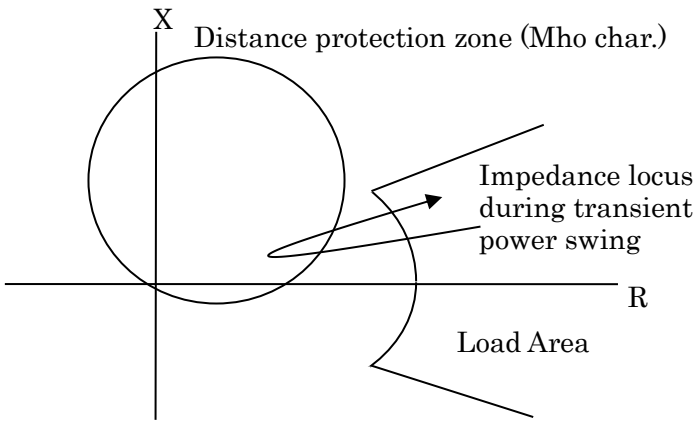
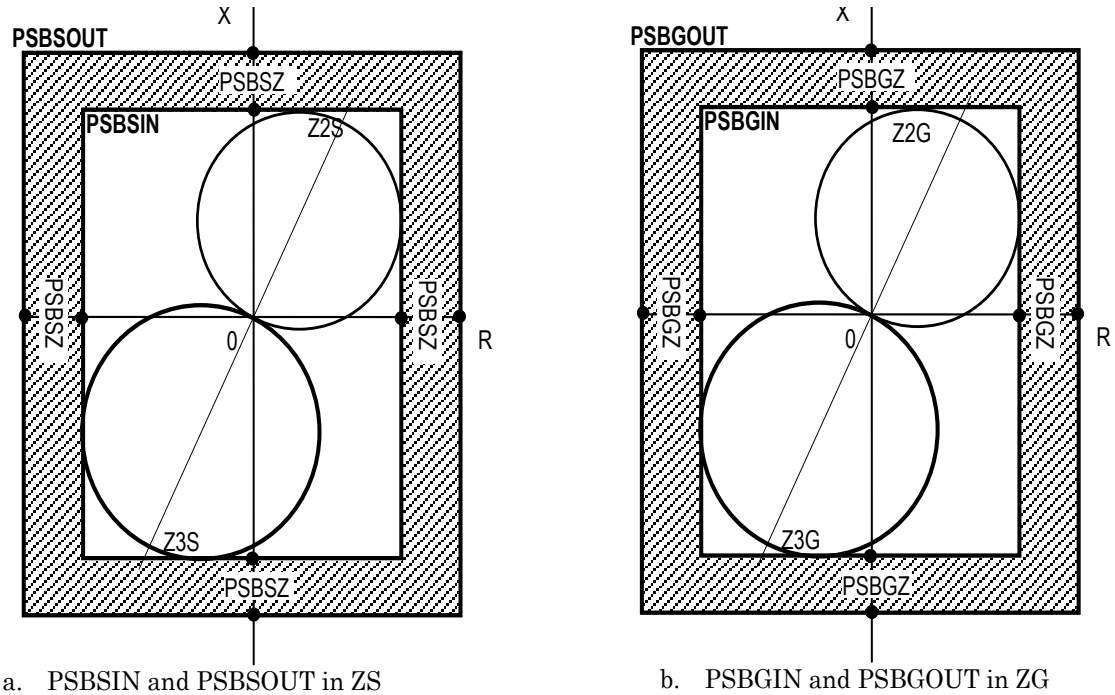


Figure 2.4-17 Impedance locus during transient power swing

As shown in Figure 2.4-18 (a), for ZS, the power swing blocking elements (PSBSOUT and PSBSIN) are formed as shown in the shaded area. For ZG, as shown in Figure 2.4-18 (b), power swing blocking elements (PSBGOUT and PSBGIN) are provided and have the same characteristic and feature. Both PSB (PSBS and PSBG) functions are disengaged when a residual overcurrent (EFL) element operates. The detection of earth faults is discussed later.



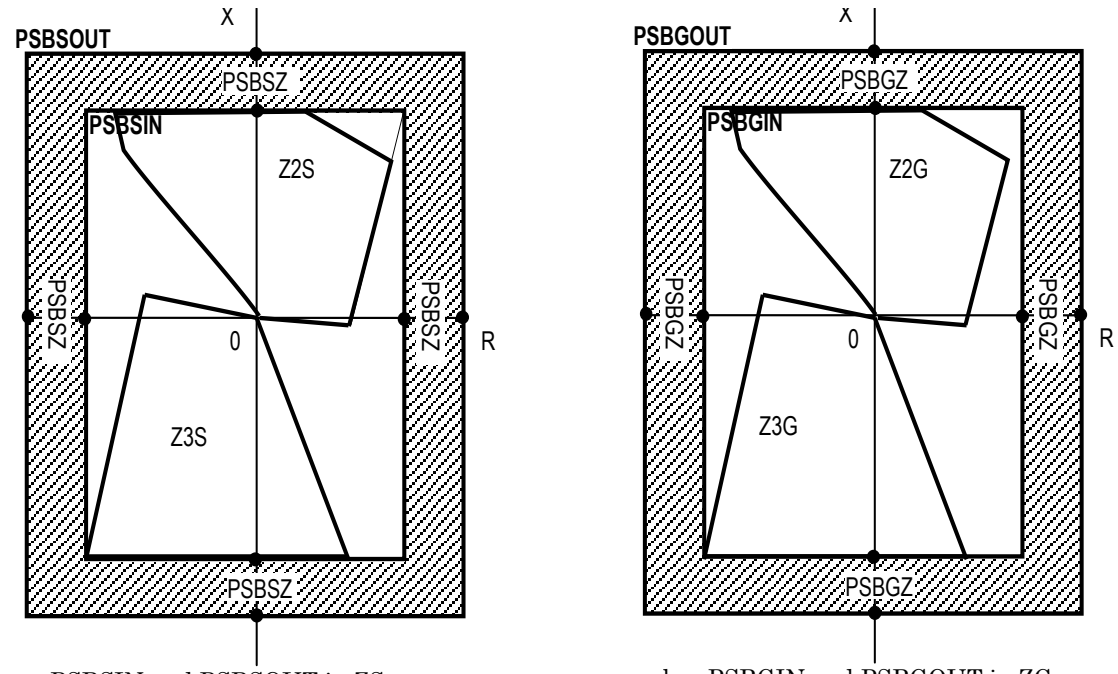
a. PSBSIN and PSBSOUT in ZS

b. PSBGIN and PSBGOUT in ZG

Figure 2.4-18 Example of PSB element in Mho characteristic

The setting of PSBSIN adjusts automatically so that the PSBS operates properly in accordance with the operation of ZS. The shaded area formed by the rectangle, which is tangential with the elements (circles) in both directions of ZS, determines the size of PSBSIN. For example, in Figure 2.4-18, Z2S is the most distant measuring element in the forward direction; Z3S is the most distant measuring element in reverse direction; the top line of the PSBSIN function is similar to the tangent of Z2S, the bottom line of the PSBSIN function is similar to the tangent of Z3S. The outer element PSBSOUT encloses the inner element PSBSIN with a width which can be set using the setting [**PSBSZ**].

The case of the Quad characteristic is similar to that of the Mho characteristic, as shown in Figure 2.4-19.



a. PSBSIN and PSBSOUT in ZS

b. PSBGIN and PSBGOUT in ZG

Figure 2.4-19 Example of PSB element in Quad characteristic

Figure 2.4-20 shows the PSBS-out and PSBS-in logic. During a power swing, the impedance viewed from the PSB elements passes through the area between the PSBSOUT and PSBSIN in a certain time. In the event of a system fault, the impedance passes through this area instantaneously. A power swing, therefore, can be detected in the time that the locus of the power swing remains within the shaded area of the rectangle between the outer and inner elements. A delayed pick-up timer [**TPSBS**] is initiated when the locus passes through the PSBSOUT element and continues until the PSBSIN element operates in order to measure the time duration for the locus to pass through the shaded area. If this time duration is longer than the set value of the delayed pick-up timer [**TPSBS**], the PSBS element will operate to block the operation of the distance protection trip signal.

Other than the power swing condition, measured impedance locus may stay in the PSBS zone for a certain time which is much longer than the PSBS detection timer [**TPSBS**]. In this case, the PSBS output can be reset forcibly when the locus remains in the PSBS zone for another timer setting [**TPSBSFR**] and scheme switch [**PSBSFR**] is set to **On**.

Another delayed timer resets the trip block signal that is generated by the PSBS element when the power swing is detected after the PSBSOUT operation is removed; 500ms is the value set for the delayed pick-up timer.

Similarly, a PSB element is also provided for ZG and its operation is termed as PSBG. (See Figure 2.4-21) The setting of PSBG is similar to that of PSBS.

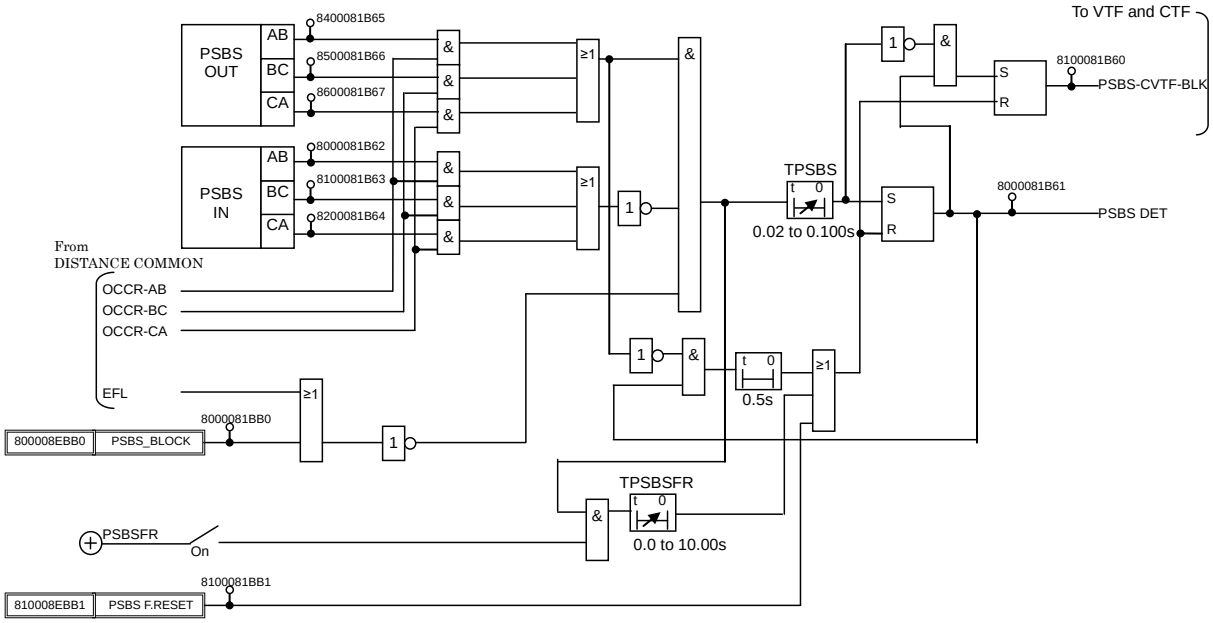


Figure 2.4-20 PSBS logic

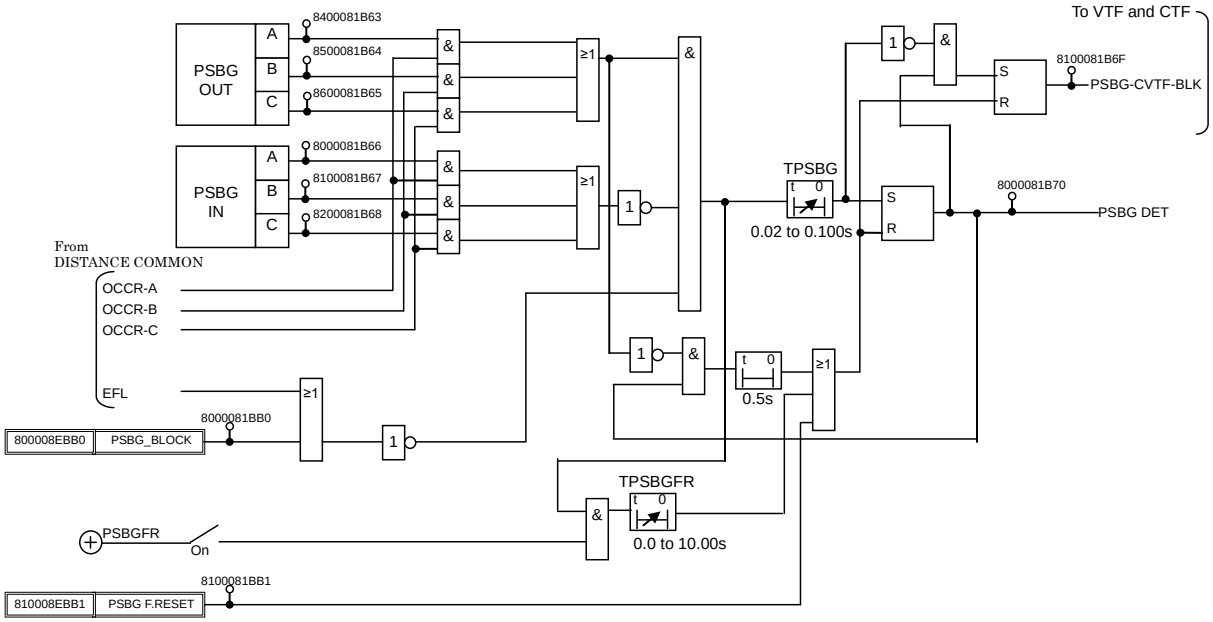


Figure 2.4-21 PSBG logic

(i)-2 Setting for blocking operation of Distance protection

Scheme switches [**Z*S-PSBBlk**] and [**Z*G-PSBBlk**] are provided to block the operation of the respective Z*S and Z*G elements. Generally, it is desirable to block the operation of the respective ZS elements and ZG elements during a power swing. Thus, **Block** is set for the respective scheme switches [**Z*S-PSBBlk**] and [**Z*G-PSBBlk**].

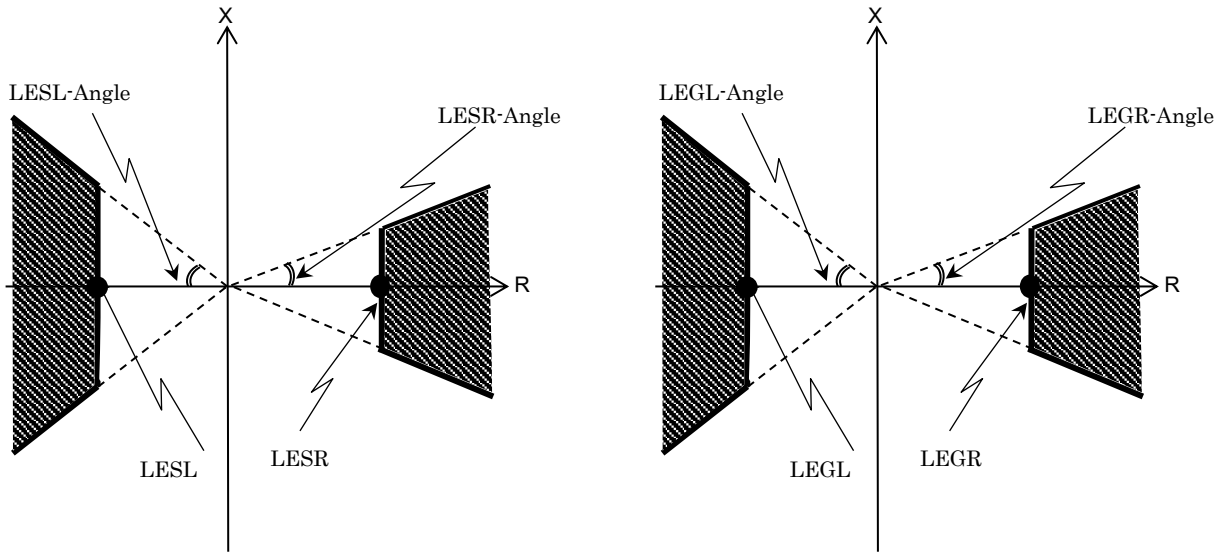
However, when it is required to continue the operation of respective ZS and ZG elements during a power swing, **Non** is set for respective scheme switches.

(ii) Load encroachment

The load encroachment element is used to improve security when heavy load current flows in a line. When the impedance remains within the hatched area as shown in Figure 2.4-22, a signal that reflects the operation of the load encroachment element is yielded and ZS is forbidden from operating by a blocking signal.

As shown in Figure 2.4-22(a), for ZS the minimum load resistance R is defined by the setting of scheme switches [**LESR**] and [**LESL**]. Setting of the maximum load angles across the R ordinate is performed using scheme switches [**LESR-Angle**] and [**LESL-Angle**], provided **On** is set for the scheme switches [**LES-EN**].

For ZG, when **On** is set for the scheme switches [**LEG-EN**], similar settings and scheme switches are provided: settings [**LEGR**], [**LEGL**], [**LEGR-Angle**], and [**LEGL-Angle**], are shown in Figure 2.4-22(b).



a. LESL and LESR for ZS

b. LEGL and LEGR for ZG

Figure 2.4-22 Load encroachment characteristic

(iii) Fail safe function

Both ZS and ZG have overcurrent elements, which can be used to stop the erroneous operation for checking the ZS/ZG operations.

For example, an overcurrent element is provided in Z*S, termed Z*S-OCFS-EN. The Z*S-OCFS-EN element can start when **On** is set for the scheme switch [**Z*S-OCFS-EN**], the overcurrent element is subject to the setting of [**OCF*S**] in Z*S. The setting value is chosen between 0.02–5.00 A (1 A rating) or 0.10–25.00 A (5 A rating).

Similarly, ZG has overcurrent elements for checking. When **On** is set for the scheme switch [**Z*G-OCFS-EN**], the overcurrent element is subject to the setting of [**OCF*G**] in Z*G.

(iv) Definite time delay operation

In accordance with the location of the fault, the timing of trip signals can be adjusted with delayed timers. For instance, a delay timer in Z*S tripping can be set by applying a time delay setting using [**TZ*S**] whose value can be chosen between 0.00–100.00s. Similarly, for ZG delayed timers can be applied using [**TZ*G**].

For Z1S and Z1G tripping, either instantaneous tripping or time delayed tripping can be selected; hence, the scheme switch [**Z1CNT-INSTOP**] is provided for the selection of the trip mode, which is described later.

(v) Autoreclose initiation blocking

If ZS and ZG detect a fault, the output signals of ZS and ZG are generated in trip circuit (TRC) and the CB is tripped. If autoreclose (ARC) is not required following the operation of Z*S, **Block** can be set using the scheme switch [**Z*S-ARCBlk**]. Conversely, if ARC is required following the operation of Z*S, then **Non** can be set using the scheme switch [**Z*S-ARCBlk**]. Similarly, for ZG scheme the following switch is provided: **[Z*G-ARCBlk**].

The function for blocking the initiation of autoreclose is also represented in Figure 2.4-30 and Figure 2.4-32 of section 2.4.6.

Note: The operation and setting of the ARC are discussed separately. For more information on ARC, see Chapter *Relay application: Autoreclose and voltage check*.

(vi) Zone 1 control

Both Z1S and Z1G offer a variety of trip modes in order to satisfy the diverse nature of the many schemes and applications in which the relay is required to operate. The following scheme switches provide the flexibility required to meet the wide range of applications. Figure 2.4-23 shows the scheme logic for Zone 1 control. When signal "Z1CNT_MPROT" is active, user can control Z1S and Z1G as follows:

- A trip signal is blocked if **On** is set for the scheme switch [**Z1CNT-TPBlk**].
- A three-phase trip is initiated by Z1G on the occurrence of a fault if **On** is set for the scheme switch [**Z1CNT-3PTP**].
- Autoreclose is blocked if **On** is set for the scheme switch [**Z1CNT-ARCBlk**].
- Both Z1S and Z1G generate an instantaneous operation signal if **On** is set for the scheme switch [**Z1CNT-INSTOP**].

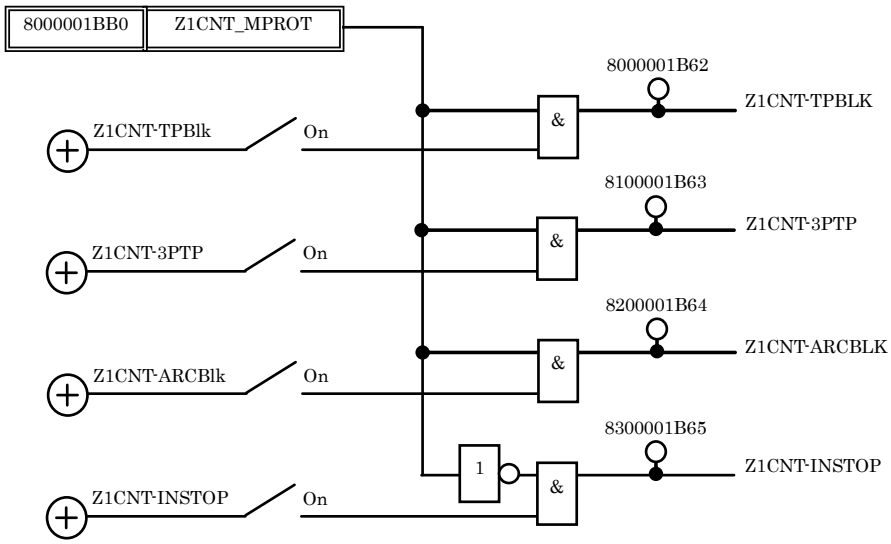


Figure 2.4-23 Scheme logic of Zone1 operation control

2.4.4 Carrier command protection feature

The means of telecommunication makes possible for protective relays to exchange its operation information. If the protective relays locate at each end of the protected line with the telecommunication, the distance protection functions can determine whether the fault is internal or external to the protected line.

As for the ZS, we provide you the function of distance protection telecommunicated as carrier command protection (ZCSF and ZCSR). As for the ZG, we also provide you the ZCSF and ZCSR for the command protection. You should take case that, discussed here are the elements and characteristic of the command protection only; we provide the operation instruction of this function separately. (See Chapter *Relay application: Distance carrier command protection*.)

(i) ZS carrier command protection

Figure 2.4-24 and Figure 2.4-25 show the ZS characteristic of the command protection. You can find the Mho or the Quad characteristic; and you can select its characteristic when you place the set of **Mho** or **Quad** for the scheme switch [**ZS-Chara**].

As shown in Figure 2.4-24, if you require placing an element in the Mho characteristic in forward direction (ZCSF), you should place the reach setting of the ZCSF for settings [**ZCSF-Mho.Reach**] and [**ZCSF-Mho.Angle**] both. On the other hand, when you need to prescribe the reach setting of the ZCSF in reactance X, you should place its setting value for setting [**ZCSF-X.Reach**] with a set of **On** being placed for scheme switch [**ZCSF-MhoX.EN**]. You can also prescribe resistive elements as shown on right and left side with settings [**ZCSF-R.Reach**] and [**ZCSF-R.Angle**]; the resistive elements are applicable when you place a set of **On** for scheme switch [**ZCSF-MhoR.EN**].

On the other hand, as shown in Figure 2.4-25, when you require placing an element in the Quad characteristic in forward direction, you should place the reach of the ZCSF with setting [**ZCSF-X.Reach**]. You can also place resistive elements, right side and left side in the figure with setting [**ZCSF-R.Reach**] and [**ZCSF-R.Angle**]. The resistive elements are symmetrical and the right side is placed across the origin from the left side. Additionally, you can place a directional element—as shown with a bottom line—with setting **[ZCSF-DR.Angle**].

The same holds true for an element in the Mho characteristic in reverse direction (ZCSR) and you can place the ZCSR with settings and scheme switches:

for the Mho, [**ZCSR-Mho.Reach**], [**ZCSR-Mho.Angle**], [**ZCSR-X.Reach**] [**ZCSR-R.Reach**], [**ZCSR-R.Angle**], [**ZCSR-MhoX.EN**] and [**ZCSR-MhoR.EN**] and

for the Quad, [**ZCSR-X.Reach**], [**ZCSR-R.Reach**], [**ZCSRF-R.Angle**], and [**ZCSR-DR.Angle**].

You should place a set of **Block** for setting [**ZCSF-PSBBlk**] because the operation of the ZCSF should stop when the power swing is detected. You should place a set of **Non** for the setting when you require the ZCSF operation keeping in the power swing detection.

You also should place a set of a set of **Block** for setting [**ZCSR-VTFBlk**] because the operation of the ZCSR should stop when the VTF is detected. Conversely, you should place a set of **Non** for the setting were you to require the ZCSR operation keeping in the VTF detection.

Make sure that the ZCSF does not supply the offset feature while the ZCSR supplies the offset feature. The settings for the offset element are fixed at 7.5 Ω for 1 A rating or 1.5 Ω for 5 A rating. The fix offset makes the ZCSR operate constantly even when the three-phase fault appears close in the reverse side. However, the ZCSF blocks its operation in the three-phase fault because the ZCSR runs together with the ZCSF. As a result, the command protection can avoid improper operations.

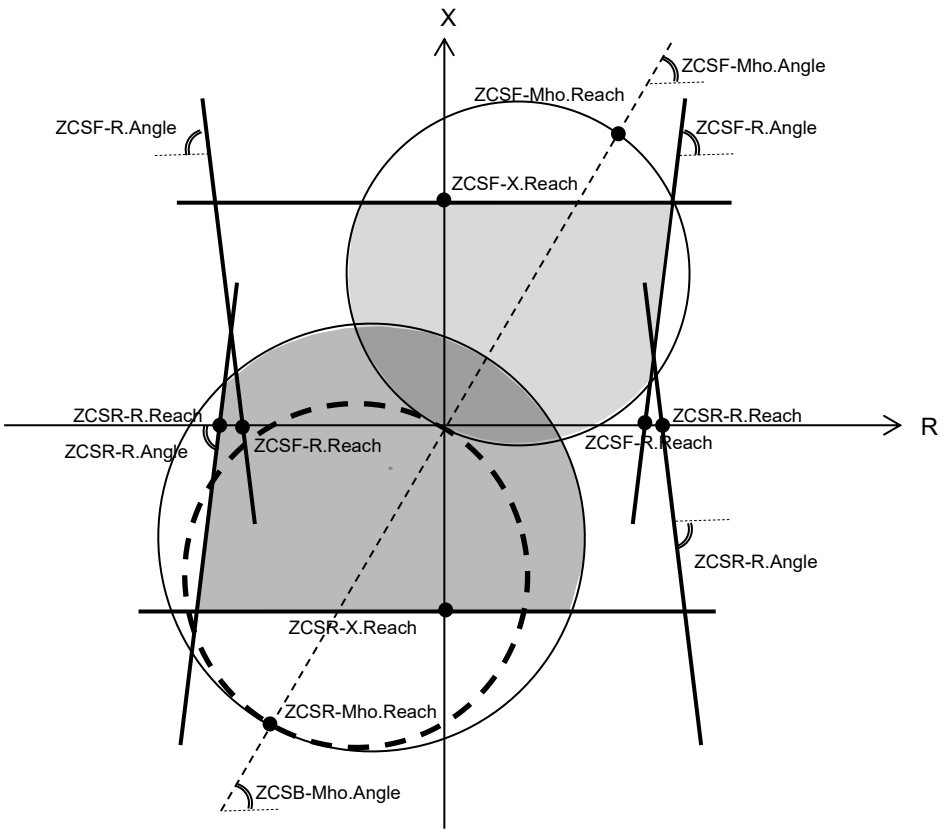


Figure 2.4-24 ZCSF and ZCSR in Mho characteristic

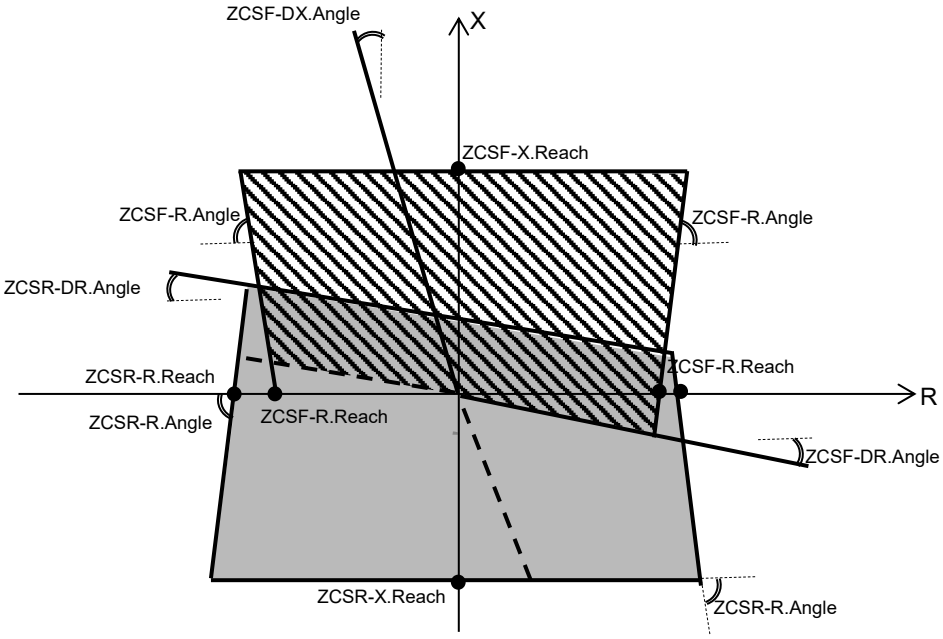


Figure 2.4-25 ZCSF and ZCSR in Quad characteristic

(ii) ZG carrier command protection

With respect to the ZCGF and the ZCGR both, these characteristics and functions are similar to the ZCSF and the ZCSR. However, you should make sure that the ZCGR does not have an

offset action in revers zone as shown in Figure 2.4-26 and Figure 2.4-27. That is, only static characteristics are drawn in the characteristic figures.

As for the cancellation of the ZCGF and the ZCGR, provided are settings [**ZCGF-PSBBlk**] and [**ZCGR-VTFBlk**].

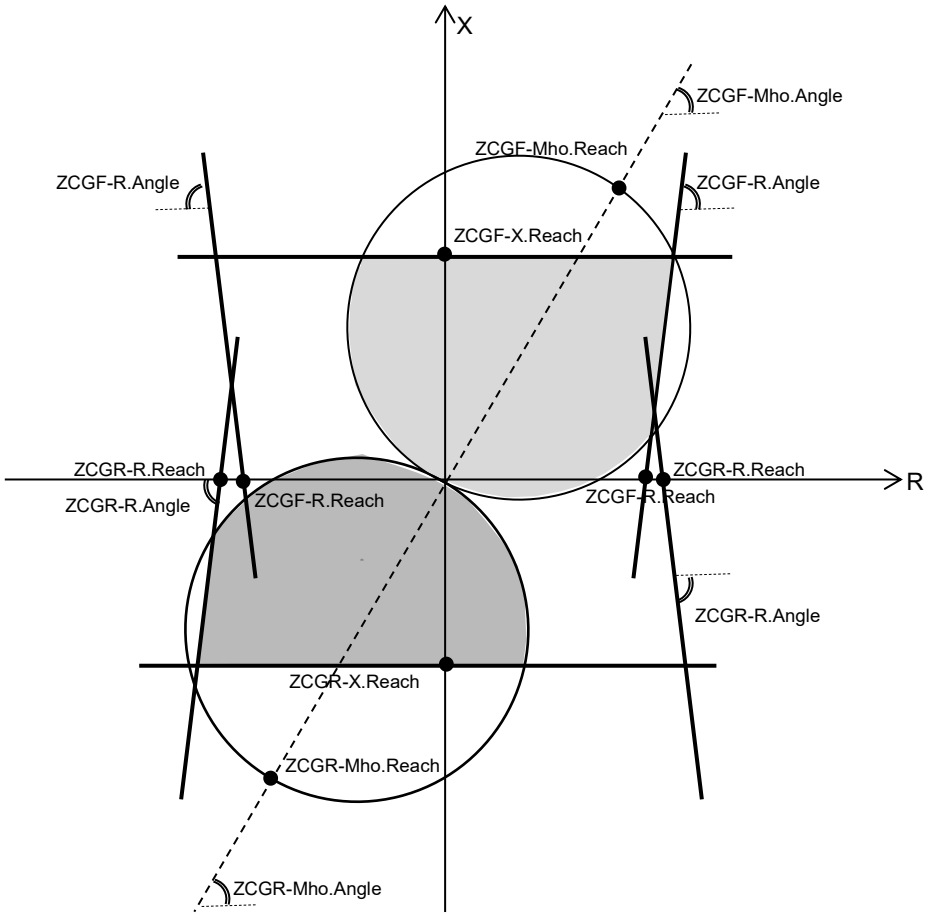


Figure 2.4-26 ZCGF and ZCGR in Mho characteristic

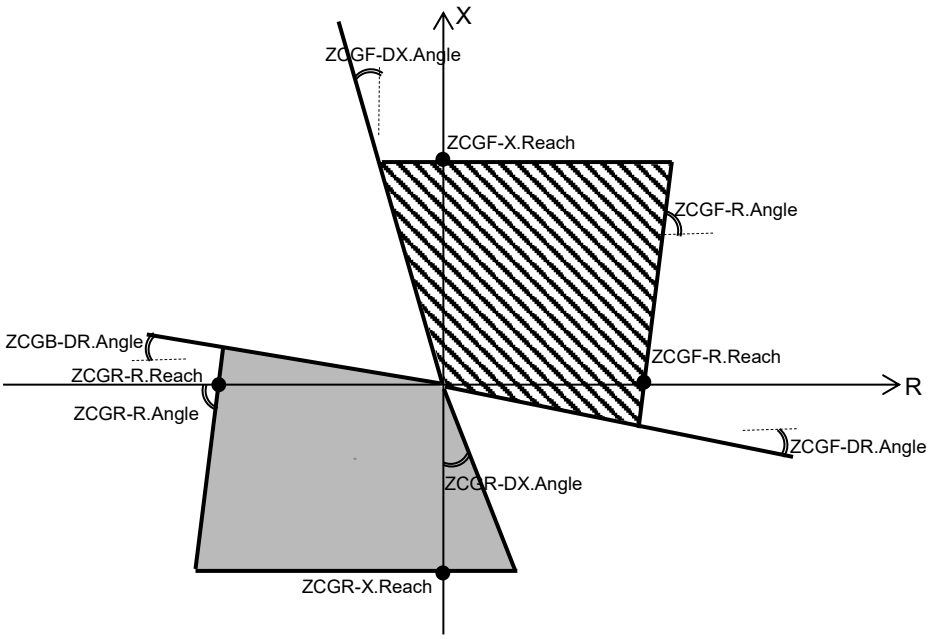


Figure 2.4-27 ZCGF and ZCGR in Quad characteristic

2.4.5 Extended application

(i) Switch-onto-fault (SOTF)

If a dead line has a fault prior to energization the CB should trip quickly upon when the line is energized. To trip the CB when the faulted line is energized, a switch-onto-fault (SOTF) protection function is provided. This function is armed for a certain period after the CB is closed.[1]

The SOTF function can operate, in the case when a line remains in a non-energized state for a certain time, which is termed as the deadline time defined by the protection common (PROT_COMMON[2]) function.

If Z*S is required to operate for the SOTF function, **On** is set for the scheme switch [**Z*S-SOTF**]. When Z*S is not required to operate for the SOTF operation, the scheme switch is set to **Off**.

The SOTF function is provided for all of the ZS/ZG elements; hence, all of the elements are provided with similar scheme switches and these switches are termed "SOTF" with the zone names [**Z*S-SOTF**] for ZS, [**Z*G-SOTF**] for ZG.

[1]Note: The distance- measuring element can operate for faults other than close-up three-phase faults.

[2]Note: The operation and settings of the PROT_COMMON is described separately, (See Chapter *Relay application: Protection common*)

(ii) Prevailing one-line-to-ground fault (1LG) in Z1G element

The Z1GCOV element is designed for two purposes in Quad characteristic. One is for making the coordination concerning the operating time between the reactance element (X), the resistive element (R), and the directional element (DR); the other is for prevailing the zone1 in the ZG function just for the incident with the one-line-to-ground (1LG) fault (i.e., the other faults will not be detected in the ZG function). The user should select a value from 2.0 (200%) to 3.0 (300%) for settings [**ZS-CovCoeff**] and [**ZG-CovCoeff**]. This is because, an adjacent line beyond the remote end (i.e., beyond the remote busbar) will be protected surely (i.e., 100% or far reach can be covered). Incidentally, prevailing for the zone1 operation in the ZG function will not be held unconditionally if a fault occurs at different terminals of the parallel lines and the fault is found in different phases. Figure 2.4-28 illustrates the characteristic of Z1GCOV element that is defined with the multiplier settings [**ZS-CovCoeff**] and [**ZG-CovCoeff**] so that the Z1GCOV element can operate between the zone2 and the zone3.

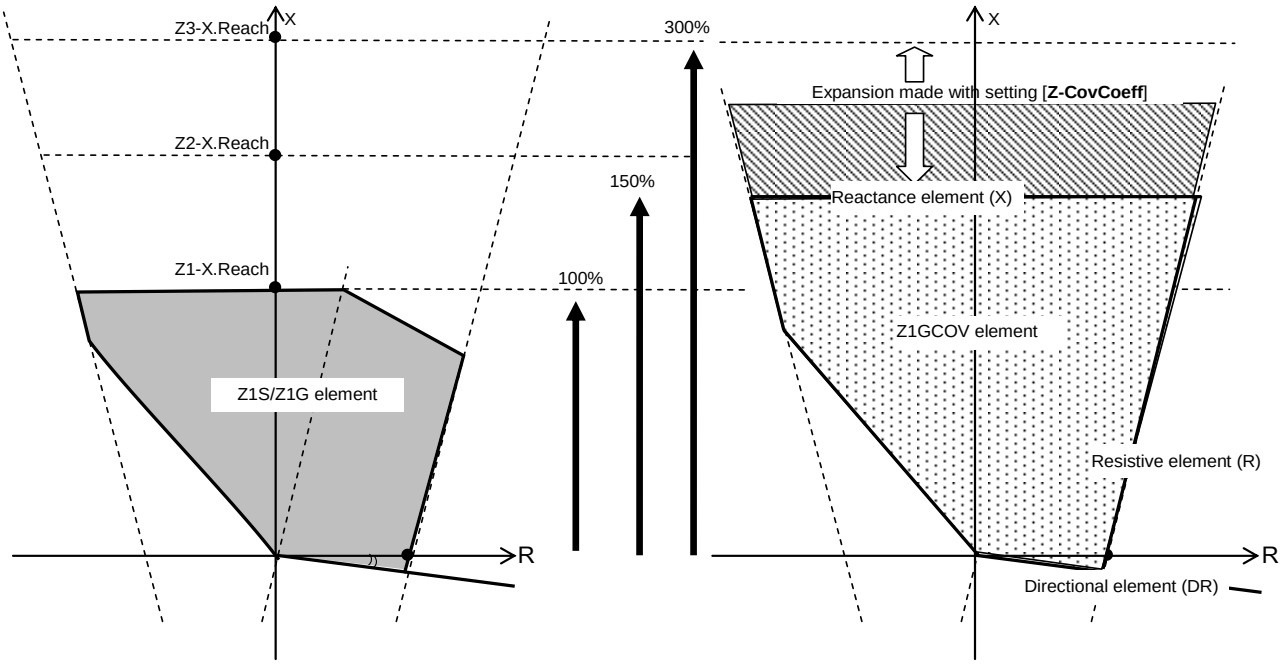


Figure 2.4-28 Z1GCOV element in Quad characteristic programmed by settings

2.4.6 Scheme logic

(i) ZS logic

Figure 2.4-29 shows the scheme logic of the Z1S and the SOTF.

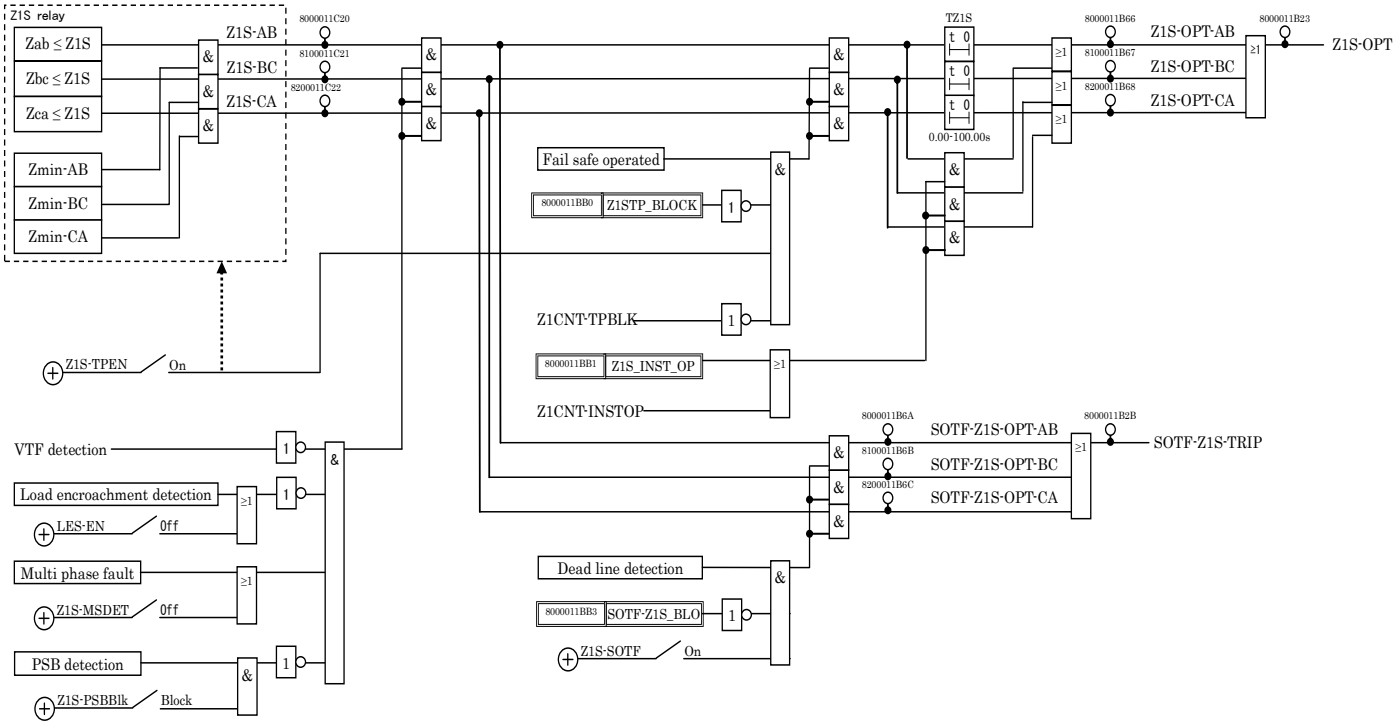


Figure 2.4-29 Scheme logic of Zone1 element and SOTF signal

In the above figure, the Z1S element generates a trip signal immediately when the instantaneous mode is selected using the scheme switch [**Z1CNT_INSTOP**]. Note that the scheme switch [**LES_EN**] can be used to block the Z1S element. The scheme switches [**Z1S-PSBBLK**] and [**Z1G-PSBBLK**] can be used to block tripping when a power swing occurs in the system. The scheme switch [**Z1S-MSDET**] is also used to cancel the operation condition, which we have discussed with regard to the selection of the operation of ZS effected by the occurrences of multi-phase fault or earth-fault. (see section 2.4.2(ii)-3).

Both ZS and ZG generate a trip signal if **On** is set for all of the scheme switches termed "TPEN" with zone names [**Z*S-TPEN**] for ZS and [**Z*G-TPEN**] for ZG.

The scheme switch is set to **Off** to disable the trip signal.

Figure 2.4-30 shows blocking of the ARC in Z1S. Based on the Z1S_ARCBLOCK signal, the Z1S element generates a final trip signal for all faults.

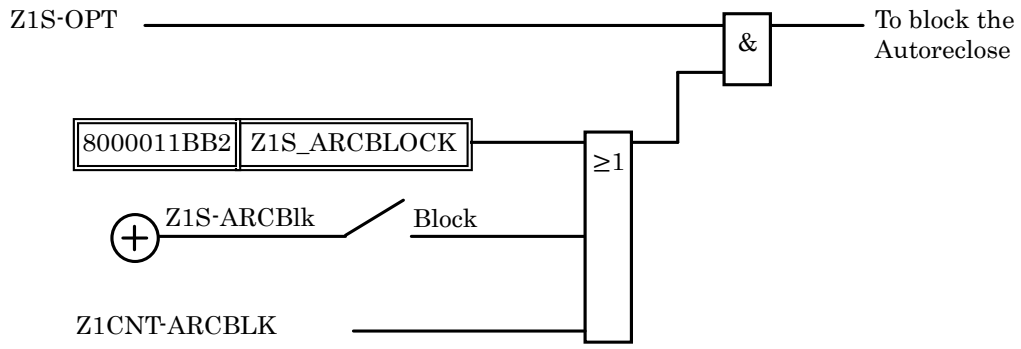


Figure 2.4-30 ARC_BLOCK functions for zone 1 of the distance protection (ZS)

(ii) ZG logic

Figure 2.4-31 shows the scheme logic for Z1G and SOTF. The SOTF function is available in every zone (Z1SG, Z1GX, Z2G, Z3G, Z4G, and Z5G) and can be selected using the scheme switches.

Scheme switch [**Z1G-EFL**] is used to select the EFL element for the detection of earth faults; when the EFL element operates, detection of the PSB is canceled.

Scheme switch [**Z1G-LPBlk**] is used to enable blocking of the operation of the leading-phase-block function. The ARC_BLOCK function configures the Z1G element to perform final three-phase tripping for all faults. The Z1G_3PTP configures the Z1G element to perform the three-phase trip.

The Z1G element is able to operate in an instantaneous mode by using the scheme switch [**Z1CNT_INSTOP**]. Furthermore, the scheme switch [**LEG_EN**] can block this element. The scheme switch [**Z1G-PSBBLK**] is selected for blocking the tripping when a power swing occurs in the system.

A residual overcurrent element (EFL) is provided as a common function. A value can be set using the setting [**EFL**].

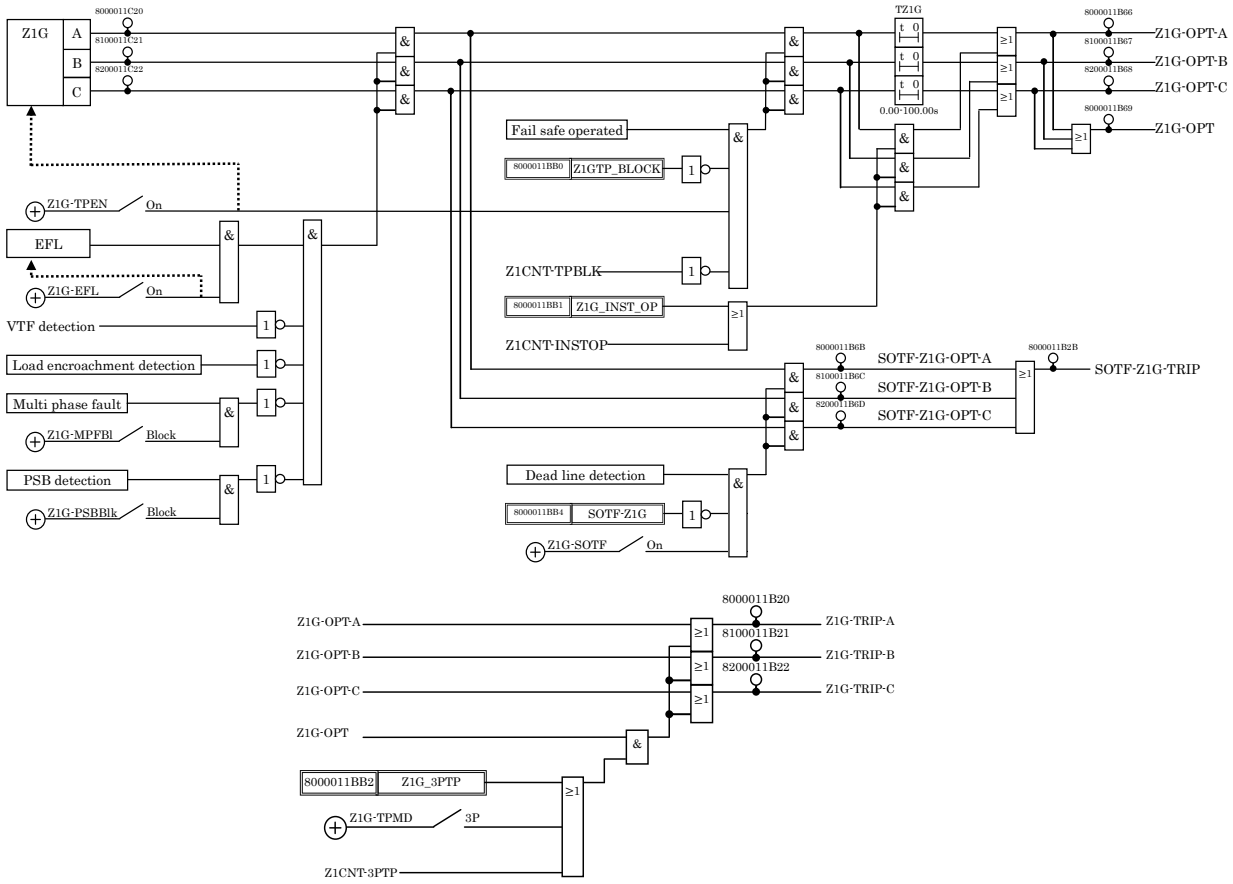


Figure 2.4-31 Scheme logic for Z1G, SOTF and EFL

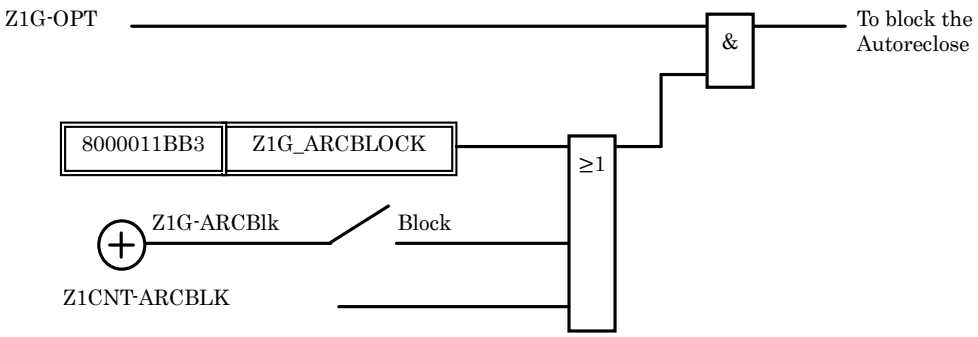


Figure 2.4-32 ARC BLOCK and 3TP for zone 1 of the distance protection (ZG)

2.4.7 Setting tips for main/remote backup relays using distance zones

To make the coordination between the main (primary) relay and backup relays on lines, using a reach[1] setting and a delay timer setting[2] can resolve the problems. Figure 2.4-33 exemplifies that respective reaches and delays in the distance protection (ZS/ZG) functions result in the coordination between the main (primary) relay and backup relays on the lines.

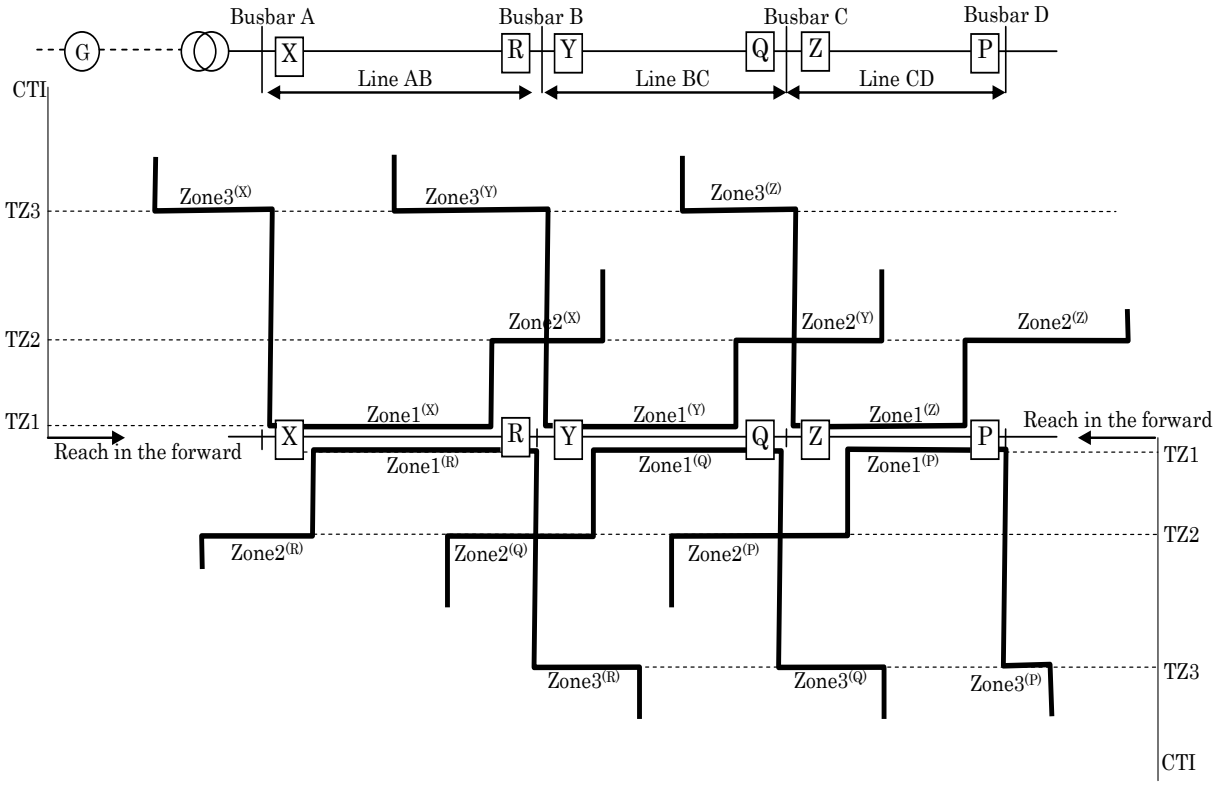


Figure 2.4-33 Zones and time coordination between terminals[3]

[1]Note: For the ZS elements, the 'reach' setting is possible using the settings [**Z*S-Mho.Reach**] and [**Z*S-Mho.Angle**] for the Mho characteristic. If the Quad characteristic is applied, the value of the reach setting is projected on the reactance-axis.

[2]Note: To realize the coordination time interval (CTI), the user can apply delay times for the operation in respective elements. For the ZS elements, for example, use the settings [**TZ*S**].

[3]Note: 'Zone1' and 'zone2' are zones seen by the ZS/ZG relays looking into the forward. On the other hand, 'zone3' is seen by the ZS/ZG relays looking into the backward. The locations of the ZS/ZG relays are shown with parentheses. That is, the zone1(X), which is operated at the location X, trips 'circuit breaker(X)'.

(i) Setting of the primary line (Zone1)

The zone1 of the ZS/ZG function can be used as a backup relay substituted into the DIF (main) function; the operation for the zone1 shall retarded rather than the main relay. As shown in Figure 2.4-33, the reach of the zone1(X) is required to cover the majority of the line length AB,

whereas the zone1(X) should be independent on faults that occur beyond the busbar B. Given the existence of the measuring errors in the VT and the CT, approximate 80 to 90% of the line AB is required to set for the reach setting at the zone1(X).

For the CTI as the backup relay, the delay timer in the zone1(X) should be set to retard. The delay timer is programmed using the setting [**TZ1S** or **TZ1G**].

(ii) Setting of adjacent lines (Zone2 serviced as a backup relay)

The reach setting in the zone2(X) is required to cover 100% of the line AB plus about 20% of the adjacent line BC. To preserve the operation selectivity for the adjacent line BC (i.e., the operation in the zone1(Y)), the user should set the reach of the zone2(X) not beyond the reach of the zone1(Y).

Note that setting TZ2(X) does not influence the CTI regarding the zone1(Y). If delayed tripping in the zone1(X) is preferred, the CTI between the zone2(X) and the zone1(Y) should be taken into account. Note that setting TZ2(X) should be satisfied with Equations (2.4-19) and (2.4-20):

$$TZ2^{(X)} > T_P^{(Y)} + T_{CB}^{(Y)} + T_{Zone2}^{(X)} - T2^{(X)} \qquad (2.4\text{-}19)$$

$$TZ2^{(X)} > TZ1^{(X)} \qquad (2.4\text{-}20)$$

where we have defined

$T_p^{(Y)}$: Maximum operating time in the main (primary) relay(Y),

$T_{cb}^{(Y)}$: Opening time in the circuit breaker(Y),

$T2^{(X)}$: Minimum operating time for the zone2(X),

$T_{Zone2}^{(X)}$: Reset time for the zone2(X)

(iii) Setting of backward lines (Zone3 serviced as backup relays)

If backward adjacent lines are required to protect by the relay(X), the zone3(X) is suitable to protect. For example, as shown in Figure 2.4-33, if setting the reach of the zone3(X) can be performed in the reverse to cover the busbar and the transformer, the zone3(X) will operate as a back-up relays.

(iv) Another setting of the primary zone (Zone1X serviced with autoreclosing)

The user should notice that disadvantages exist in the CTI schemes, because a fault occurred a bit beyond the zone1 may be cleared in delay by the zone2. That is, the zone1 plus the zone2 cannot clear speedily for any fault on the line AB†. Thus, the zone1 extension (zone1X) is designed to clear the fault occurred near the busbar B; its operation is taken together with the

operation of the autoreclose function (ARC‡).

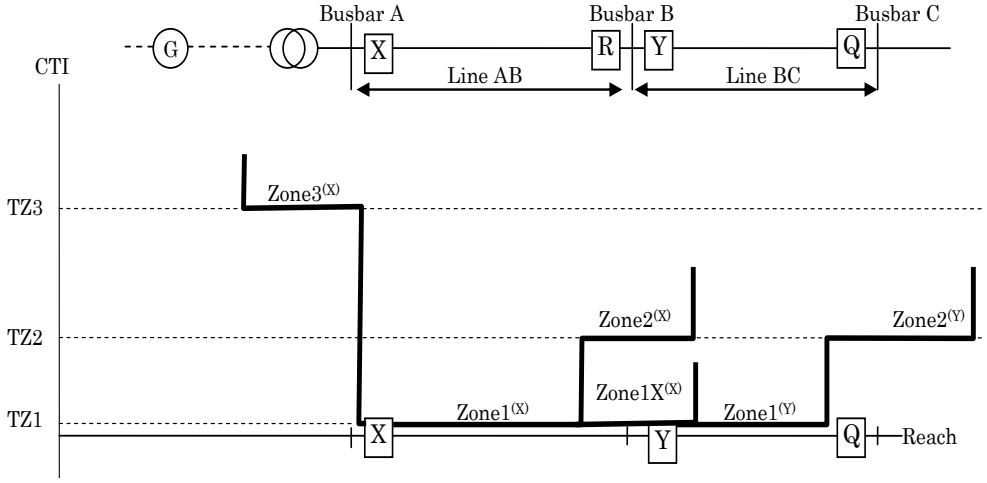


Figure 2.4-34 CTIs for zone1 and zone1X

As shown in Figure 2.4-34, the reach of the zone1X should be set to overreach the protected line AB. Once a fault occurs near busbar B, the ARC function must operate to follow the trip signal issued by the zone1X. The user must know that the zone1X is just effective about the transient fault for which the ARC operation§ can recover the power transmission.

If evolving faults occur, the zone1X will issue one-more trip signal successively to follow a CB reclose command issued by the ARC function. If the permanent fault occurs, the zone1X will issue no trip signal respond to a reclose-on-to-fault condition.

†Note: The command distance protection (DISCAR) is provided for the speedy protection when the telecommunication is provided. See chapter *Relay application: Command distance protection*.

‡Note: For more information about the ARC function, see chapter *Relay application: Autoreclosing function*.

§Note: For the transient fault, the power transmission could be recovered transiently by the operation of the ARC function, whereas the zone1X cannot operate effectively for the permanent fault (i.e., more of the network will be lost than necessary). We recommend one to use the DISCAR function when the DISCAR function is available.

2.4.8 Setting tips for multi-terminal lines using distance zones

(i) Setting of primary zone (Zone1 and a junction)

Suppose that a line AC is connected at line AF at junction J, as shown in Figure 2.4-36. The zone1(S) may underreach due that busbar A has feeding current from the far end, whereas, the zone1(S) is not allowed to overreach for any fault on the busbar B. Hence, the zone1(S) must be

set so that it can operate correctly for any faults within the protected zone even if a power source does not exist behind busbar B. Accordingly, as for the fault on the line AB, the user should have underreach setting in enough to the zone1(S).

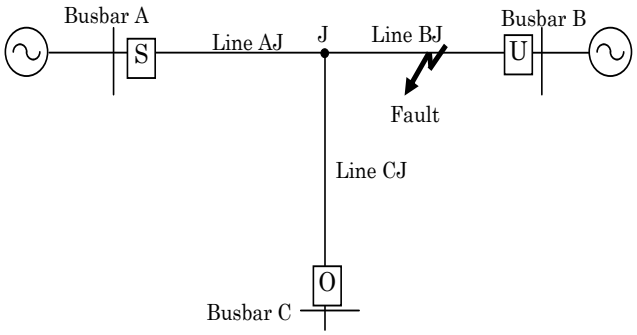


Figure 2.4-35 Line CJ tapped at junction J

(ii) Setting of primary zone (Zone1 and a short tapped line)

Suppose the busbar C is tapped at the junction J on the line AB, as shown in Figure 2.4-36. It is required to have the reach setting in both the zone1(S) and the zone1(U) so as to hold a part of the entire length of the line as shown in the long-dashed-short-dashed -circle line to avoid unwanted operations for external faults at busbar C. Consequently, clearing faults by a delayed zone2 are performed mostly, as shown in the broken-circle line that is operated at an end of the line AB†.

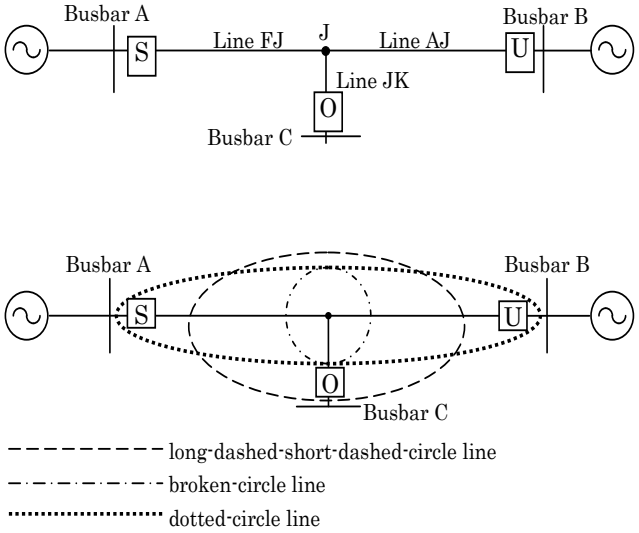


Figure 2.4-36 Short line CJ tapped at junction J

†Note: To solve the problem, we recommend using the distance carrier command protection or the current differential protection for the multi-terminals line shown in the dotted-circle line.

2.4.9 ZS/ZG test

(i) ZS-Test.CTRL

When the user wishes to have the relay characteristic test without the influence of the Zmin feature, **On** should be set for the setting [**ZS-Test.CTRL**] not to operate the Zmin feature.

(ii) ZS-Offset.CTRL

As shown in Figure 2.4-37, if the offset characteristic is required during the test regardless of the fault occurrences, the user should set **Offset** for the setting [**ZS-Offset.CTRL**]. Contrarily, if the offset one is not required, set **Non-Offset** for the setting. Note that **Normal** shall be set for the setting after the test.

(iii) ZS-Test.XAngle, ZG-Test.XAngle

Figure 2.4-37 illustrates that the ZS element with knee point, which can be ruled with the angles made with θ1 and θ2. Should **On-Adapt** be set for setting [**Z*S-X.GrAngleEN**], the knee slope can be made with θ1, which will be computed internally using a current difference measured before and after the fault. For the test, if a fixed 'θ1' is preferred during the **On-Adapt** has been set, the user can take the fixed 'θ1' by the setting [**ZS-Test.XAngle**]=**On**. Note that fixed 'θ1' will be taken from setting [**ZSF-X.GrAngle1**] during the test.

Similarly, the user can have the take the [**ZG-Test.XAngle**] for the ZG element.

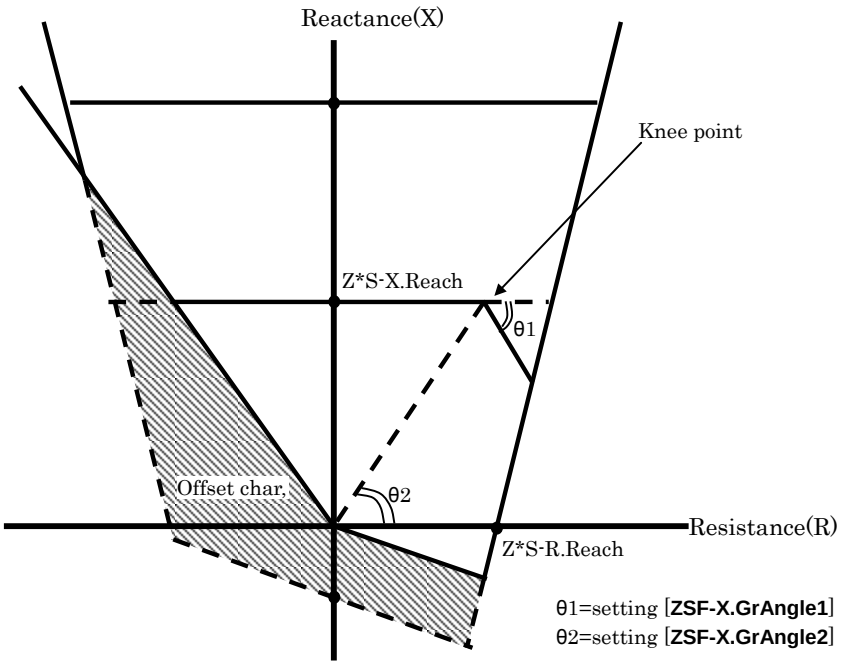


Figure 2.4-37 Example of ZS element with knee point

2.4.10 Setting

Setting of Distance common(Function ID: 432001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
	Z-IcC.EN	Off / On		–	Charging current compensation Off/On selection for ZG and ZS	Off		
	Z-IcC	0.00 – 1.00	0.00 – 5.00	A	Charging current compensation for ZG and ZS	0		
	Z-Vn	100 – 120		V	Rated voltage for ZG and ZS	110		
	EFL	0.10 – 1.00	0.50 – 5.00	A	EF element for ZG operation	0.20	1.00	
	Z1CNT-TPBlk	Off / On		–	Z1 operation control, set to Z1 trip block when main-protection is out-of-service	Off		
	Z1CNT-INSTOP	Off / On		–	Z1 operation control, set to Z1 instantaneous trip when main-protection is out-of-service	Off		
	Z1CNT-3PTP	Off / On		–	Z1 operation control, set to Z1 3-phase trip when main-protection is out-of-service	Off		
	Z1CNT-ARCBlk	Off / On		–	Z1 operation control, set to autoreclose block by Z1 operation when main-protection is out-of-service	Off		

Setting of ZS(Function ID: 430001)

Setting item			Range		Unit s	Contents	Default setting value		Notes
			1A rating	5A rating			1A	5A	
ZS	Common	ZS-Chara	Quad / Mho		-	ZS relay character	Quad		
		ZSF-X.GrAngle1	0 - 45		deg	ZS-forward gradient characteristic angle (for Quad and Mho-X)	0		
		ZSF-X.GrAngle2	45 - 90		deg	ZS-forward gradient characteristic angle (for Quad and Mho-X)	75		
		ZS-CovCoeff	1.5 - 3.0		-	Covered characteristic size coefficient	1.5		
		ZS-Offset	-- (7.5)	-- (1.5)	ohm	ZS-mho offset	-- (7.5)	-- (1.5)	
		ZS-Vpol	-- (1.96)		V	The polarising voltage level	-- (1.96)		
		ZS-Beta.V	-- (55.0)		V	ZS-Voltage threshold (for beta zone)	-- (55.0)		
		ZS-direction.V	-- (80.0)		V	ZS-Voltage threshold (for current direction)	-- (80.0)		
		ZS-ZMINK	-- (0 - 100)		%	ZS-Zmin compensation controller	-- (5)		
		ZS-XMINK	-- (0 - 100)		%	ZS-Xmin compensation controller	-- (5)		
	Z1S	Z1S-TPEN	Off / On		-	Z1S protection enable	On		
		Z1S-SOTF	Off / On		-	SOTF using Z1S	Off		
		Z1S-Dir	Forward / Reverse / NonDir		-	Z1S directional characteristic	Forward		
		Z1S-Mho.Angle	30 - 90		deg	Z1S mho characteristic angle (for Mho)	85		
		Z1S-Mho.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z1S mho reach (for Mho)	8.00	1.60	
		Z1S-MhoX.EN	Off / On		-	Z1S reactance reach use or not (for Mho)	Off		
		Z1S-X.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z1S reactance reach	8.00	1.60	
		Z1S-X.GrAngleEN	Off / On-Set / On-Adapt		-	ZS gradient characteristic	Off		
		Z1S-MhoR.EN	Off / On		-	Z1S resistive reach use or not (for Mho)	Off		
		Z1S-R.Angle	30 - 90		deg	Z1S resistive reach characteristic angle	75		
		Z1S-R.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z1S resistive reach	25.50	5.10	
		Z1S-DX.EN	Off / On		-	Z1S directional-X characteristic use or not (for Mho)	Off		
		Z1S-DX.Angle	0 - 60		deg	Z1S directional-X characteristic angle	30		
		Z1S-DR.Angle	0 - 60		deg	Z1S directional-R characteristic angle (for Quad)	5		
		TZ1S	0.00 - 100.00		s	Z1S operation delay time	0.00		
		Z1S-MSDET	Off / On		-	Multi-phase or non-earth-falut condition is used or not	On		
		Z1S-PSBBlk	Non / Block		-	Z1S operation block or not by PSB detection	Block		
		Z1S-ARCBlk	Non / Block		-	Autoreclose execution block by Z1S-trip	Non		
	Z1XS	Z1XS-TPEN	Off / On		-	Z1XS protection enable	Off		
		Z1XS-SOTF	Off / On		-	SOTF using Z1XS	Off		
		Z1XS-Dir	Forward / Reverse / NonDir		-	Z1XS directional characteristic	Forward		
		Z1XS-Mho.Angle	30 - 90		deg	Z1XS mho characteristic angle (for Mho)	85		
		Z1XS-Mho.Reach	0.10 - 500.0	00.01 - 100.00	ohm	Z1XS mho reach (for Mho)	12.00	2.40	
		Z1XS-MhoX.EN	Off / On		-	Z1XS reactance reach use or not (for Mho)	Off		
		Z1XS-X.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z1XS reactance reach	12.00	2.40	
		Z1XS-X.GrAngleEN	Off / On-Set / On-Adapt		-	ZS gradient characteristic	Off		
		Z1XS-MhoR.EN	Off / On		-	Z1XS resistive reach use or not (for Mho)	Off		
		Z1XS-R.Angle	30 - 90		deg	Z1XS resistive reach characteristic angle	75		
		Z1XS-R.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z1XS resistive reach	25.50	5.10	
		Z1XS-DX.EN	Off / On		-	Z1XS directional-X characteristic use or not (for Mho)	Off		

Setting of ZS(Function ID: 430001)

Setting item			Range		Unit	Contents	Default setting value		Notes
			1A rating	5A rating			1A	5A	
		Z1XS-DX.Angle	0 - 60		deg	Z1XS directional-X characteristic angle	30		
		Z1XS-DR.Angle	0 - 60		deg	Z1XS directional-R characteristic angle (for Quad)	5		
		TZ1XS	0.00 - 100.00		s	Z1XS operation delay time	0.00		
		Z1XS-MSDET	Off / On		-	Multi-phase or non-earth-falut condition is used or not	On		
		Z1XS-PSBBlk	Non / Block		-	Z1XS operation block or not by PSB detection	Block		
		Z1XS-ARCBlk	Non / Block		-	Autoreclose execution block by Z1XS-trip	Non		
	Z2S	Z2S-TPEN	Off / On		-	Z2S protection enable	On		
		Z2S-SOTF	Off / On		-	SOTF using Z2S	Off		
		Z2S-Dir	Forward / Reverse / NonDir		-	Z2S directional characteristic	Forward		
		Z2S-Mho.Angle	30 - 90		deg	Z2S mho characteristic angle (for Mho)	85		
		Z2S-Mho.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z2S mho reach (for Mho)	20.00	4.00	
		Z2S-MhoX.EN	Off / On		-	Z2S reactance reach use or not (for Mho)	Off		
		Z2S-X.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z2S reactance reach	20.00	4.00	
		Z2S-MhoR.EN	Off / On		-	Z2S resistive reach use or not (for Mho)	Off		
		Z2S-R.Angle	30 - 90		deg	Z2S resistive reach characteristic angle	75		
		Z2S-R.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z2S resistive reach	25.50	5.10	
		Z2S-DX.EN	Off / On		-	Z2S directional-X characteristic use or not (for Mho)	Off		
		Z2S-DX.Angle	0 - 60		deg	Z2S directional-X characteristic angle	30		
		Z2S-DR.Angle	0 - 60		deg	Z2S directional-R characteristic angle (for Quad)	5		
		TZ2S	0.00 - 100.00		s	Z2S operation delay time	0.30		
		Z2S-MSDET	Off / On		-	Multi-phase or non-earth-falut condition is used or not	Non		
		Z2S-PSBBlk	Non / Block		-	Z2S operation block or not by PSB detection	Non		
		Z2S-ARCBlk	Non / Block		-	Autoreclose execution block by Z2S-trip	Block		
	Z3S	Z3S-TPEN	Off / On		-	Z3S protection enable	On		
		Z3S-SOTF	Off / On		-	SOTF using Z3S	Off		
		Z3S-Dir	Forward / Reverse / NonDir		-	Z3S directional characteristic	Forward		
		Z3S-Mho.Angle	30 - 90		deg	Z3S mho characteristic angle (for Mho)	85		
		Z3S-Mho.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z3S mho reach (for Mho)	30.00	6.00	
		Z3S-MhoX.EN	Off / On		-	Z3S reactance reach use or not (for Mho)	Off		
		Z3S-X.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z3S reactance reach	30.00	6.00	
		Z3S-MhoR.EN	Off / On		-	Z3S resistive reach use or not (for Mho)	Off		
		Z3S-R.Angle	30 - 90		deg	Z3S resistive reach characteristic angle	75		
		Z3S-R.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z3S resistive reach	25.50	5.10	
		Z3S-DX.EN	Off / On		-	Z3S directional-X characteristic use or not (for Mho)	Off		
		Z3S-DX.Angle	0 - 60		deg	Z3S directional-X characteristic angle	30		
		Z3S-DR.Angle	0 - 60		deg	Z3S directional-R characteristic angle (for Quad)	5		
		TZ3S	0.00 - 100.00		s	Z3S operation delay time	0.40		
		Z3S-MSDET	Off / On		-	Multi-phase or non-earth-falut condition is used or not	Non		

Setting of ZS(Function ID: 430001)

Setting item			Range		Unit s	Contents	Default setting value		Notes
			1A rating	5A rating			1A	5A	
		Z3S-PSBBlk	Non / Block		-	Z3S operation block or not by PSB detection	Non		
		Z3S-ARCBlk	Non / Block		-	Autoreclose execution block by Z3S-trip	Block		
	(Z4S)	Z4S-TPEN	Off / On		-	Z4S protection enable	On		
		Z4S-SOTF	Off / On		-	SOTF using Z4S	Off		
		Z4S-Dir	Forward / Reverse / NonDir		-	Z4S directional characteristic	Forward		
		Z4S-Mho.Angle	30 - 90		deg	Z4S mho characteristic angle (for Mho)	85		
		Z4S-Mho.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z4S mho reach (for Mho)	30.00	6.00	
		Z4S-MhoX.EN	Off / On		-	Z4S reactance reach use or not (for Mho)	Off		
		Z4S-X.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z4S reactance reach	30.00	6.00	
		Z4S-MhoR.EN	Off / On		-	Z4S resistive reach use or not (for Mho)	Off		
		Z4S-R.Angle	30 - 90		deg	Z4S resistive reach characteristic angle	75		
		Z4S-R.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z4S resistive reach	25.50	5.10	
		Z4S-DX.EN	Off / On		-	Z4S directional-X characteristic use or not (for Mho)	Off		
		Z4S-DX.Angle	0 - 60		deg	Z4S directional-X characteristic angle	30		
		Z4S-DR.Angle	0 - 60		deg	Z4S directional-R characteristic angle (for Quad)	5		
		TZ4S	0.00 - 100.00		s	Z4S operation delay time	0.40		
		Z4S-MSDET	Off / On		-	Multi-phase or non-earth-falut condition is used or not	Non		
		Z4S-PSBBlk	Non / Block		-	Z4S operation block or not by PSB detection	Non		
		Z4S-ARCBlk	Non / Block		-	Autoreclose execution block by Z4S-trip	Block		

Note 1: **On-Adapt** is only applicable when **Forward** is placed for the ZS.

Note 2: When **On-Adapt** is placed for the scheme switch [**ZS-X.GrAngleEN**], the setting value of [**ZSF-X.GrAngle1**] is calculated automatically. Conversely, set value for the setting [**ZSF-X.GrAngle2**] regardless of the scheme switch [**ZS-X.GrAngleEN**].

Setting of power swing blocking in ZS(Function ID: 430001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
PSB	PSBSZ	2.50 - 75.00	0.50 - 15.00	ohm	Power swing block detection	10.00	2.00	
	TPSBS	0.020 - 0.100		s	Power swing block detection timer	0.040		
	PSBSFR	Off / On		–	Power swing reset enable	Off		
	TPSBSFR	0.00 – 10.00		s	Power swing reset timer	1.00		

Setting of load encroachment in ZS(Function ID: 430001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
Load encroachment	LES-EN	Off / On		–	Load encroachment enable	Off		
	LESR	0.10 – 500.00	0.01 – 100.00	ohm	Minimum load resistance on the right	25.50	5.10	
	LESR-Angle	5 – 75		deg	Maximum load angle on the right	10		
	LESL	0.10 – 500.00	0.01 – 100.00	ohm	Minimum load resistance on the left	25.50	5.10	
	LESL-Angle	5 – 75		deg	Maximum load angle on the left	10		

Setting of test of ZS(Function ID: 430001)

Test Setting device		Range	Units	Contents	Default setting value	Notes
	ZS-Test.CTRL	Off/On	–	ZS-test mode Off/On selection	Off	
	ZS-Test.XAngle	Off/On	–	ZS-reactance test mode Off/On selection	Off	

Setting of Failsafe of ZS(Function ID: 430001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
Fail Safe	Z1S	Z1S-OCFS	Off / On		-	Fail-safe OC for Z1S-trip	Off		
		OCF1S	0.02 - 5.00	0.10 - 25.00	A	Fail-safe OC operation level for Z1S-trip	0.20	1.00	
	Z1XS	Z1XS-OCFS	Off / On		-	Fail-safe OC for Z1XS-trip	Off		
		OCF1XS	0.02 - 5.00	0.10 - 25.00	A	Fail-safe OC operation level for Z1XS-trip	0.20	1.00	
	Z2S	Z2S-OCFS	Off / On		-	Fail-safe OC for Z2S-trip	Off		
		OCF2S	0.02 - 5.00	0.10 - 25.00	A	Fail-safe OC operation level for Z2S-trip	0.20	1.00	
	Z3S	Z3S-OCFS	Off / On		-	Fail-safe OC for Z3S-trip	Off		
		OCF3S	0.02 - 5.00	0.10 - 25.00	A	Fail-safe OC operation level for Z3S-trip	0.20	1.00	
	(4S)	Z4S-OCFS	Off / On		-	Fail-safe OC for Z4S-trip	Off		
		OCF4S	0.02 - 5.00	0.10 - 25.00	A	Fail-safe OC operation level for Z4S-trip	0.20	1.00	

Setting of ZCSF and ZCSR(Function ID: 430001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
	ZCSF	ZCSF-Mho.Angle	30 - 90		deg	ZCSF mho characteristic angle (for Mho)	85		
		ZCSF-Mho.Reach	0.10 - 500.00	0.01 - 100.00	ohm	ZCSF mho reach (for Mho)	30.00	6.00	
		ZCSF-MhoX.EN	Off / On		-	ZCSF reactance reach use or not (for Mho)	Off		
		ZCSF-X.Reach	0.10 - 500.00	0.01 - 100.00	ohm	ZCSF reactance reach	30.00	6.00	
		ZCSF-MhoR.EN	Off / On		-	ZCSF resistive reach use or not (for Mho)	Off		
		ZCSF-R.Angle	30 - 90		deg	ZCSF resistive reach characteristic angle	75		
		ZCSF-R.Reach	0.10 - 500.00	0.01 - 100.00	ohm	ZCSF resistive reach	25.50	5.10	
		ZCSF-MhoDX.EN	Off / On		-	ZCSF directional-X characteristic use or not (for Mho)	Off		
		ZCSF-DX.Angle	0 - 60		deg	ZCSF directional-X characteristic angle	30		
		ZCSF-DR.Angle	0 - 60		deg	ZCSF directional-R characteristic angle (for Quad)	5		
		ZCSF-PSBBlk	Non / Block		-	ZCSF operation block or not by PSB detection	Block		
	ZCSR	ZCSR-Mho.Angle	30 - 90		deg	ZCSR mho characteristic angle (for Mho)	85		
		ZCSR-Mho.Reach	0.10 - 500.00	0.01 - 100.00	ohm	ZCSR mho reach (for Mho)	40.00	8.00	
		ZCSR-MhoX.EN	Off / On		-	ZCSR reactance reach use or not (for Mho)	Off		
		ZCSR-X.Reach	0.10 - 500.00	0.01 - 100.00	ohm	ZCSR reactance reach	40.00	8.00	
		ZCSR-MhoR.EN	Off / On		-	ZCSR resistive reach use or not (for Mho)	Off		
		ZCSR-R.Angle	30 - 90		deg	ZCSR resistive reach characteristic angle	75		
		ZCSR-R.Reach	0.10 - 500.00	0.01 - 100.00	ohm	ZCSR resistive reach	25.50	5.10	
		ZCSR-DX.EN	Off / On		-	ZCSR directional-X characteristic use or not (for Mho)	Off		
		ZCSR-DX.Angle	0 - 60		deg	ZCSR directional-X characteristic angle	30		
		ZCSR-DR.Angle	0 - 60		deg	ZCSR directional-R characteristic angle (for Quad)	5		
		ZCSR-VTFBlk	Non / Block		-	ZCSR operation block or not by VTF detection	Block		

Setting of ZG(Function ID: 431001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
ZG	Common	ZG-Chara	Quad / Mho		-	ZG relay characteristic	Quad		
		ZGF-X.GrAngle1	0 - 45		deg	ZG-forward gradient characteristic angle (for Quad and Mho-X)	0		
		ZGF-X.GrAngle2	45 - 90		deg	ZG-forward gradient characteristic angle (for Quad and Mho-X)	60		
		ZG-CovCoeff	1.5 - 3.0		-	Covered characteristic size coefficient	1.5		
		ZG-Vpol	-- (1.96)		V	The polarising voltage level	-- (1.96)		
		ZG-Beta.V	-- (55.0)		V	ZG-Voltage threshold (for beta zone)	-- (55.0)		
		ZG-direction.V	-- (80.0)		V	ZG-Voltage threshold (for current direction)	-- (80.0)		
	Z1G	Z1G-TPEN	Off / On		-	Z1G protection enable	On		
		Z1G-SOTF	Off / On		-	SOTF using Z1G	Off		
		Z1G-Dir	Forward / Reverse / NonDir		-	Z1G direction to protect	Forward		
		Z1G-Mho.Angle	30 - 90		deg	Z1G mho characteristic angle (for Mho)	85		
		Z1G-Mho.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z1G mho reach (for Mho)	8.00	1.60	
		Z1G-MhoX.EN	Off / On		-	Z1G reactance reach use or not (for Mho)	Off		
		Z1G-X.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z1G reactance reach	8.00	1.60	
		Z1G-X.GrAngleEN	Off / On-Set / On-Adapt		-	ZG gradient characteristic	Off		
		Z1G-MhoR.EN	Off / On		-	Z1G resistive reach use or not (for Mho)	Off		
		Z1G-R.Angle	30 - 90		deg	Z1G resistive reach characteristic angle	75		
		Z1G-R.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z1G resistive reach	25.50	5.10	
		Z1G-MhoDX.EN	Off / On		-	Z1G directional-X characteristic use or not (for Mho)	Off		
		Z1G-DX.Angle	0 - 60		deg	Z1G directional-X characteristic angle	30		
		Z1G-DR.Angle	0 - 60		deg	Z1G directional-R characteristic angle (for Quad)	5		
		Z1G-Krs	0 - 1000		%	Zero phase current factor, Self line R0/R1	340		
		Z1G-Kxs	0 - 1000		%	Zero phase current factor, Self line X0/X1	340		
		Z1G-Krm	0 - 1000		%	Zero phase current factor, Adjacent line R0m/R1	300		
		Z1G-Kxm	0 - 1000		%	Zero phase current factor, Adjacent line X0m/X1	300		
		TZ1G	0.00 - 100.00		s	Z1G operation delay time	0.00		
		Z1G-EFL	Off / On		-	EFL operation condition used or not for Z1G operation	On		
		Z1G-MPFBlk	Non / Block		-	Z1G operation block or not in multi phase fault	Block		
		Z1G-PSBBlk	Non / Block		-	Z1G operation block or not by PSB detection	Block		
		Z1G-LPBlk	Non / Block		-	Z1G leading phase operation block or not in multi-phase-falut mode	Non		
		Z1G-TPMD	1P / 3P		-	Z1G trip mode, phase segregated trip or 3-phase trip	1P		
		Z1G-ARCBlk	Non / Block		-	Autoreclose execution block by Z1G-trip	Non		
	Z1XG	Z1XG-TPEN	Off / On		-	Z1XG protection enable	Off		
		Z1XG-SOTF	Off / On		-	SOTF using Z1XG	Off		

Setting of ZG(Function ID: 431001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
		Z1XG-Dir	Forward / Reverse / NonDir		-	Z1XG direction to protect	Forward		
		Z1XG-Mho.Angle	30 - 90		deg	Z1XG mho characteristic angle (for Mho)	85		
		Z1XG-Mho.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z1XG mho reach (for Mho)	12.00	2.40	
		Z1XG-MhoX.EN	Off / On		-	Z1XG reactance reach use or not (for Mho)	Off		
		Z1XG-X.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z1XG reactance reach	12.00	2.40	
		Z1XG-X.GrAngleEN	Off / On-Set / On-Adapt		-	ZG gradient characteristic	Off		
		Z1XG-MhoR.EN	Off / On		-	Z1XG resistive reach use or not (for Mho)	Off		
		Z1XG-R.Angle	30 - 90		deg	Z1XG resistive reach characteristic angle	75		
		Z1XG-R.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z1XG resistive reach	25.50	5.10	
		Z1XG-MhoDX.EN	Off / On		-	Z1XG directional-X characteristic use or not (for Mho)	Off		
		Z1XG-DX.Angle	0 - 60		deg	Z1XG directional-X characteristic angle	30		
		Z1XG-DR.Angle	0 - 60		deg	Z1XG directional-R characteristic angle (for Quad)	5		
		Z1XG-Krs	0 - 1000		%	Zero phase current factor, Self line R0/R1	340		
		Z1XG-Kxs	0 - 1000		%	Zero phase current factor, Self line X0/X1	340		
		Z1XG-Krm	0 - 1000		%	Zero phase current factor, Adjacent line R0m/R1	300		
		Z1XG-Kxm	0 - 1000		%	Zero phase current factor, Adjacent line X0m/X1	300		
		TZ1XG	0.00 - 100.00		s	Z1XG operation delay time	0.00		
		Z1XG-EFL	Off / On		-	EFL operation condition used or not for Z1XG operation	On		
		Z1XG-MPFBlk	Non / Block		-	Z1XG operation block or not in multi phase fault	Blcok		
		Z1XG-PSBBlk	Non / Block		-	Z1XG operation block or not by PSB detection	Block		
		Z1XG-LPBlk	Non / Block		-	Z1XG leading phase operation block or not in multi-phase-falut mode	Non		
		Z1XG-TPMD	1P / 3P		-	Z1XG trip mode, phase segregated trip or 3-phase trip	1P		
		Z1XG-ARCBlk	Non / Block		-	Autoreclose execution block by Z1XG-trip	Non		
	Z2G	Z2G-TPEN	Off / On		-	Z2G protection enable	On		
		Z2G-SOTF	Off / On		-	SOTF using Z2G	Off		
		Z2G-Dir	Forward / Reverse / NonDir		-	Z2G direction to protect	Forward		
		Z2G-Mho.Angle	30 - 90		deg	Z2G mho characteristic angle (for Mho)	85		
		Z2G-Mho.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z2G mho reach (for Mho)	20.00	4.00	
		Z2G-MhoX.EN	Off / On		-	Z2G reactance reach use or not (for Mho)	Off		
		Z2G-X.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z2G reactance reach	20.00	4.00	
		Z2G-MhoR.EN	Off / On		-	Z2G resistive reach use or not (for Mho)	Off		
		Z2G-R.Angle	30 - 90		deg	Z2G resistive reach characteristic angle	75		
		Z2G-R.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z2G resistive reach	25.50	5.10	

Setting of ZG(Function ID: 431001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
		Z2G-MhoDX.EN	Off / On		-	Z2G directional-X characteristic use or not (for Mho)	Off		
		Z2G-DX.Angle	0 - 60		deg	Z2G directional-X characteristic angle	30		
		Z2G-DR.Angle	0 - 60		deg	Z2G directional-R characteristic angle (for Quad)	5		
		Z2G-Krs	0 - 1000		%	Zero phase current factor, Self line R0/R1	340		
		Z2G-Kxs	0 - 1000		%	Zero phase current factor, Self line X0/X1	340		
		Z2G-Krm	0 - 1000		%	Zero phase current factor, Adjacent line R0m/R1	300		
		Z2G-Kxm	0 - 1000		%	Zero phase current factor, Adjacent line X0m/X1	300		
		TZ2G	0.00 - 100.00		s	Z2G operation delay time	0.30		
		Z2G-EFL	Off / On		-	EFL operation condition used or not for Z2G operation	On		
		Z2G-MPFBlk	Non / Block		-	Z2G operation block or not in multi phase fault	Non		
		Z2G-PSBBlk	Non / Block		-	Z2G operation block or not by PSB detection	Non		
		Z2G-LPBlk	Non / Block		-	Z2G leading phase operation block or not in multi-phase-falut mode	Block		
		Z2G-TPMD	1P / 3P		-	Z2G trip mode, phase segregated trip or 3-phase trip	3P		
		Z2G-ARCBlk	Non / Block		-	Autoreclose execution block by Z2G-trip	Block		
	Z3G	Z3G-TPEN	Off / On		-	Z3G protection enable	On		
		Z3G-SOTF	Off / On		-	SOTF using Z3G	Off		
		Z3G-Dir	Forward / Reverse / NonDir		-	Z3G direction to protect	Forward		
		Z3G-Mho.Angle	30 - 90		deg	Z3G mho characteristic angle (for Mho)	85		
		Z3G-Mho.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z3G mho reach (for Mho)	40.00	8.00	
		Z3G-MhoX.EN	Off / On		-	Z3G reactance reach use or not (for Mho)	Off		
		Z3G-X.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z3G reactance reach	40.00	8.00	
		Z3G-MhoR.EN	Off / On		-	Z3G resistive reach use or not (for Mho)	Off		
		Z3G-R.Angle	30 - 90		deg	Z3G resistive reach characteristic angle	75		
		Z3G-R.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z3G resistive reach	25.50	5.10	
		Z3G-MhoDX.EN	Off / On		-	Z3G directional-X characteristic use or not (for Mho)	Off		
		Z3G-DX.Angle	0 - 60		deg	Z3G directional-X characteristic angle	30		
		Z3G-DR.Angle	0 - 60		deg	Z3G directional-R characteristic angle (for Quad)	5		
		Z3G-Krs	0 - 1000		%	Zero phase current factor, Self line R0/R1	340		
		Z3G-Kxs	0 - 1000		%	Zero phase current factor, Self line X0/X1	340		
		Z3G-Krm	0 - 1000		%	Zero phase current factor, Adjacent line R0m/R1	300		
		Z3G-Kxm	0 - 1000		%	Zero phase current factor, Adjacent line X0m/X1	300		
		TZ3G	0.00 - 100.00		s	Z3G operation delay time	0.40		
		Z3G-EFL	Off / On		-	EFL operation condition used or not for Z3G operation	On		

Setting of ZG(Function ID: 431001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
		Z3G-MPFBlk	Non / Block		-	Z3G operation block or not in multi phase fault	Non		
		Z3G-PSBBlk	Non / Block		-	Z3G operation block or not by PSB detection	Non		
		Z3G-LPBlk	Non / Block		-	Z3G leading phase operation block or not in multi-phase-falut mode	Non		
		Z3G-TPMD	1P / 3P		-	Z3G trip mode, phase segregated trip or 3-phase trip	3P		
		Z3G-ARCBlk	Non / Block		-	Autoreclose execution block by Z3G-trip	Block		
	(4G)	Z4G-TPEN	Off / On		-	Z4G protection enable	On		
		Z4G-SOTF	Off / On		-	SOTF using Z4G	Off		
		Z4G-Dir	Forward / Reverse / NonDir		-	Z4G direction to protect	Forward		
		Z4G-Mho.Angle	30 - 90		deg	Z4G mho characteristic angle (for Mho)	85		
		Z4G-Mho.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z4G mho reach (for Mho)	40.00	8.00	
		Z4G-MhoX.EN	Off / On		-	Z4G reactance reach use or not (for Mho)	Off		
		Z4G-X.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z4G reactance reach	40.00	8.00	
		Z4G-MhoR.EN	Off / On		-	Z4G resistive reach use or not (for Mho)	Off		
		Z4G-R.Angle	30 - 90		deg	Z4G resistive reach characteristic angle	75		
		Z4G-R.Reach	0.10 - 500.00	0.01 - 100.00	ohm	Z4G resistive reach	25.50	5.10	
		Z4G-MhoDX.EN	Off / On		-	Z4G directional-X characteristic use or not (for Mho)	Off		
		Z4G-DX.Angle	0 - 60		deg	Z4G directional-X characteristic angle	30		
		Z4G-DR.Angle	0 - 60		deg	Z4G directional-R characteristic angle (for Quad)	5		
		Z4G-Krs	0 - 1000		%	Zero phase current factor, Self line R0/R1	340		
		Z4G-Kxs	0 - 1000		%	Zero phase current factor, Self line X0/X1	340		
		Z4G-Krm	0 - 1000		%	Zero phase current factor, Adjacent line R0m/R1	300		
		Z4G-Kxm	0 - 1000		%	Zero phase current factor, Adjacent line X0m/X1	300		
		TZ4G	0.00 - 100.00		s	Z4G operation delay time	0.40		
		Z4G-EFL	Off / On		-	EFL operation condition used or not for Z4G operation	On		
		Z4G-MPFBlk	Non / Block		-	Z4G operation block or not in multi phase fault	Non		
		Z4G-PSBBlk	Non / Block		-	Z4G operation block or not by PSB detection	Non		
		Z4G-LPBlk	Non / Block		-	Z4G leading phase operation block or not in multi-phase-falut mode	Non		
		Z4G-TPMD	1P / 3P		-	Z4G trip mode, phase segregated trip or 3-phase trip	3P		
		Z4G-ARCBlk	Non / Block		-	Autoreclose execution block by Z4G-trip	Block		

Note 1: **On-Adapt** is only applicable when **Forward** is set for the ZG. If **On-Adapt** is set in place of **Reverse**, it is deemed to be set **Off** for the scheme switch [**ZG-X.GrAngleEN**].

Note 2: When **On-Adapt** is set for the scheme switch [**ZG-X.GrAngleEN**], values of setting [**ZGF-X.GrAngle1**] is calculated automatically. Conversely, the user should set value for setting [**ZGF-X.GrAngle2**] regardless of the scheme switch

[**ZG-X.GrAngleEN**].

Setting of PSB of ZG(Function ID: 431001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1Arating	5A rating	
PSB	PSBGZ	2.50 – 75.00	0.50 – 15.00	ohm	Power swing block detection	10.00	2.00	
	TPSBG	0.020 – 0.100		s	Power swing block detection timer	0.040		
	PSBGFR	Off / On		–	Power swing block reset enable	Off		
	TPSBGFR	0.00 – 10.00		s	Power swing block reset timer	1.00		

Setting of Load encroachment of ZG(Function ID: 431001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A	5A	
Load encroachment	LEG-EN	Off / On		–	Load encroachment enable	Off		
	LEGR	0.10 – 500.00	0.01 – 100.00	ohm	Minimum load resistance on the right	25.50	5.10	
	LEGR-Angle	5 – 75		deg	Maximum load angle on the right	10		
	LEGL	0.10 – 500.00	0.01 – 100.00	ohm	Minimum load resistance on the left	25.50	5.10	
	LEGL-Angle	5 – 75		deg	Maximum load angle on the left	10		

Setting of Failsafe of ZG(Function ID: 430001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A	5A	
Fail Safe	Z1G	Z1G-OCFS	Off / On		-	Fail-safe OC for Z1G-trip	Off		
		OCF1G	0.02 - 5.00	0.10 - 25.00	A	Fail-safe OC operation level for Z1G-trip	0.20	1.00	
	Z1XG	Z1XG-OCFS	Off / On		-	Fail-safe OC for Z1XG-trip	Off		
		OCF1XG	0.02 - 5.00	0.10 - 25.00	A	Fail-safe OC operation level for Z1XG-trip	0.20	1.00	
	Z2G	Z2G-OCFS	Off / On		-	Fail-safe OC for Z2G-trip	Off		
		OCF2G	0.02 - 5.00	0.10 - 25.00	A	Fail-safe OC operation level for Z2G-trip	0.20	1.00	
	Z3G	Z3G-OCFS	Off / On		-	Fail-safe OC for Z3G-trip	Off		
		OCF3G	0.02 - 5.00	0.10 - 25.00	A	Fail-safe OC operation level for Z2G-trip	0.20	1.00	
	(4G)	Z4G-OCFS	Off / On		-	Fail-safe OC for Z4G-trip	Off		
		OCF4G	0.02 - 5.00	0.10 - 25.00	A	Fail-safe OC operation level for Z3G-trip	0.20	1.00	

Setting of UV for positive week infeed of ZG(Function ID: 431001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
UVPWI	ZG-UVPWIEN	Off / On		–	UV for positive weak infeed	Off		
	UVPWI	5.0 – 130.0		V	UVPWI relay operation level	30.0		

Setting of ZCGF and ZCGR(Function ID: 431001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
	ZCGF	ZCGF-Mho.Angle	30 - 90		deg	ZCGF mho characteristic angle (for Mho)	85		
		ZCGF-Mho.Reach	0.10 - 500.00	0.01 - 100.00	ohm	ZCGF mho reach (for Mho)	40.00	8.00	
		ZCGF-MhoX.EN	Off / On		-	ZCGF reactance reach use or not (for Mho)	Off		
		ZCGF-X.Reach	0.10 - 500.00	0.01 - 100.00	ohm	ZCGF reactance reach	40.00	8.00	
		ZCGF-MhoR.EN	Off / On		-	ZCGF resistive reach use or not (for Mho)	Off		
		ZCGF-R.Angle	30 - 90		deg	ZCGF resistive reach characteristic angle	75		
		ZCGF-R.Reach	0.10 - 500.00	0.01 - 100.00	ohm	ZCGF resistive reach	25.50	5.10	
		ZCGF-MhoDX.EN	Off / On		-	ZCGF directional-X characteristic use or not (for Mho)	Off		
		ZCGF-DX.Angle	0 - 60		deg	ZCGF directional-X characteristic angle	30		
		ZCGF-DR.Angle	0 - 60		deg	ZCGF directional-R characteristic angle (for Quad)	5		
		ZCGF-Krs	0 - 1000		%	Zero phase current factor, Self line R0/R1	340		
		ZCGF-Kxs	0 - 1000		%	Zero phase current factor, Self line X0/X1	340		
		ZCGF-Krm	0 - 1000		%	Zero phase current factor, Adjacent line R0m/R1	300		
		ZCGF-Kxm	0 - 1000		%	Zero phase current factor, Adjacent line X0m/X1	300		
		ZCGF-PSBBlk	Non / Block		-	ZCGF operation block or not by PSB detection	Block		
	ZCGR	ZCGR-Mho.Angle	30 - 90		deg	ZCGR mho characteristic angle (for Mho)	85		
		ZCGR-Mho.Reach	0.10 - 500.00	0.01 - 100.00	ohm	ZCGR mho reach (for Mho)	40.00	8.00	
		ZCGR-MhoX.EN	Off / On		-	ZCGR reactance reach use or not (for Mho)	Off		
		ZCGR-X.Reach	0.10 - 500.00	0.01 - 100.00	ohm	ZCGR reactance reach	40.00	8.00	
		ZCGR-MhoR.EN	Off / On		-	ZCGR resistive reach use or not (for Mho)	Off		
		ZCGR-R.Angle	30 - 90		deg	ZCGR resistive reach characteristic angle	75		
		ZCGR-R.Reach	0.10 - 500.00	0.01 - 100.00	ohm	ZCGR resistive reach	25.50	5.10	
		ZCGR-MhoDX.EN	Off / On		-	ZCGR directional-X characteristic use or not (for Mho)	Off		
		ZCGR-DX.Angle	0 - 60		deg	ZCGR directional-X characteristic angle	30		
		ZCGR-DR.Angle	0 - 60		deg	ZCGR directional-R characteristic angle (for Quad)	5		
		ZCGR-Krs	0 - 1000		%	Zero phase current factor, Self line R0/R1	340		
		ZCGR-Kxs	0 - 1000		%	Zero phase current factor, Self line X0/X1	340		
		ZCGR-Krm	0 - 1000		%	Zero phase current factor, Adjacent line R0m/R1	300		
		ZCGR-Kxm	0 - 1000		%	Zero phase current factor, Adjacent line X0m/X1	300		
		ZCGR-VTFBlk	Non / Block		-	ZCGR operation block or not by VTF detection	Block		

2.4.11 Data ID

◆ Signal monitoring point

ZS ZG Common (Function ID: 432001)

Element ID	Name	Description
8300001C27	EFL	Earth fault relay element operated
8000001C20	OCCR-A	OCCR relay element operated(phase-A)
8100001C21	OCCR-B	OCCR relay element operated(phase-B)
8200001C22	OCCR-C	OCCR relay element operated(phase-C)
8100001B63	Z1CNT-3PTP	Z1 control command (3-phase trip)
8200001B64	Z1CNT-ARCBLK	Z1 control command (Autoreclose block)
8300001B65	Z1CNT-INSTOP	Z1 control command (Instantaneous operation)
8000001B62	Z1CNT-TPBLK	Z1 control command (Trip block)
8000001BB0	Z1CNT_MPROT	Z1 control signal for multi protection

◆ Connection point on PLC logic

ZS ZG Common (Function ID: 432001)

Element ID	Name	Description
800000EBB0	Z1CNT_MPROT	Z1 control setting for multi protection

◆ Signal monitoring point

ZS (Function ID: 430001)

Element ID	Name	Description
8000081B6E	LD_ENC-AB	Load encroachment operated (phase-AB)
8100081B6F	LD_ENC-BC	Load encroachment operated (phase-BC)
8200081B70	LD_ENC-CA	Load encroachment operated (phase-CA)
8000081B6B	LES-L A	LES-L relay element operated (phase-AB)
8100081B6C	LES-L B	LES-L relay element operated (phase-BC)
8200081B6D	LES-L C	LES-L relay element operated (phase-CA)
8000081B68	LES-R A	LES-R relay element operated (phase-AB)
8100081B69	LES-R B	LES-R relay element operated (phase-BC)
8200081B6A	LES-R C	LES-R relay element operated (phase-CA)
8000011B64	OCF1S OP	OCF1S operated
8000011C24	OCF1S-AB	OCF1S relay element operated (phase-AB)
8100011C25	OCF1S-BC	OCF1S relay element operated (phase-BC)
8200011C26	OCF1S-CA	OCF1S relay element operated (phase-CA)
8100061B64	OCF1XS OP	OCF1XS element operated
8400061C24	OCF1XS-AB	OCF1XS relay element operated (phase-AB)
8500061C25	OCF1XS-BC	OCF1XS relay element operated (phase-BC)
8600061C26	OCF1XS-CA	OCF1XS relay element operated (phase-CA)
8200021B64	OCF2S OP	OCF2S operated
8000021C24	OCF2S-AB	OCF2S relay element operated (phase-AB)
8100021C25	OCF2S-BC	OCF2S relay element operated (phase-BC)
8200021C26	OCF2S-CA	OCF2S relay element operated (phase-CA)
8300031B64	OCF3S OP	OCF2S operated
8400031C24	OCF3S-AB	OCF2S relay element operated (phase-AB)
8500031C25	OCF3S-BC	OCF2S relay element operated (phase-BC)

◆ Signal monitoring point

ZS (Function ID: 430001)

Element ID	Name	Description
8600031C26	OCF3S-CA	OCF2S relay element operated (phase-CA)
8400041B64	OCF4S OP	OCF2S operated
8800041C24	OCF4S-AB	OCF2S relay element operated (phase-AB)
8900041C25	OCF4S-BC	OCF2S relay element operated (phase-BC)
8A00041C26	OCF4S-CA	OCF2S relay element operated (phase-CA)
8000081B61	PSBS DET	PSBS detection
8000081B62	PSBSIN-AB	PSBS-IN operated (phase-AB)
8100081B63	PSBSIN-BC	PSBS-IN operated (phase-BC)
8200081B64	PSBSIN-CA	PSBS-IN operated (phase-CA)
8400081B65	PSBSOUT-AB	PSBS-OUT operated (phase-AB)
8500081B66	PSBSOUT-BC	PSBS-OUT operated (phase-BC)
8600081B67	PSBSOUT-CA	PSBS-OUT operated (phase-CA)
8000011B6A	SOTF-Z1S-OPT-AB	SOTF operated for Z1S (phase-AB)
8100011B6B	SOTF-Z1S-OPT-BC	SOTF operated for Z1S (phase-BC)
8200011B6C	SOTF-Z1S-OPT-CA	SOTF operated for Z1S (phase-CA)
8000011B2B	SOTF-Z1S-TRIP	SOTF operated for Z1S (3-phases OR)
8400061B6A	SOTF-Z1XS-OPT-AB	SOTF operated for Z1XS (phase-AB)
8500061B6B	SOTF-Z1XS-OPT-BC	SOTF operated for Z1XS (phase-BC)
8600061B6C	SOTF-Z1XS-OPT-CA	SOTF operated for Z1XS (phase-CA)
8100061B2B	SOTF-Z1XS-TRIP	SOTF operated for Z1XS (3-phases OR)
8000021B6A	SOTF-Z2S-OPT-AB	SOTF operated for Z2S (phase-AB)
8100021B6B	SOTF-Z2S-OPT-BC	SOTF operated for Z2S (phase-BC)
8200021B6C	SOTF-Z2S-OPT-CA	SOTF operated for Z2S (phase-CA)
8200021B2B	SOTF-Z2S-TRIP	SOTF operated for Z2S (3-phases OR)
8400031B6A	SOTF-Z3S-OPT-AB	SOTF operated for Z3S (phase-AB)
8500031B6B	SOTF-Z3S-OPT-BC	SOTF operated for Z3S (phase-BC)
8600031B6C	SOTF-Z3S-OPT-CA	SOTF operated for Z3S (phase-CA)
8300031B2B	SOTF-Z3S-TRIP	SOTF operated for Z3S (3-phases OR)
8800041B6A	SOTF-Z4S-OPT-AB	SOTF operated for Z4S (phase-AB)
8900041B6B	SOTF-Z4S-OPT-BC	SOTF operated for Z4S (phase-BC)
8A00041B6C	SOTF-Z4S-OPT-CA	SOTF operated for Z4S (phase-CA)
8400041B2B	SOTF-Z4S-TRIP	SOTF operated for Z4S (3-phases OR)
8C00001B66	SOTF-ZS-OPT-ABR	SOTF AB phase operated
8D00001B67	SOTF-ZS-OPT-BCR	SOTF BC phase operated
8E00001B68	SOTF-ZS-OPT-CAR	SOTF CA phase operated
8300001B2B	SOTF-ZS-TRIP	SOTF protection trip
8000011C20	Z1S-AB	Z1S relay element operated (phase-AB)
8100011C21	Z1S-BC	Z1S relay element operated (phase-BC)
8200011C22	Z1S-CA	Z1S relay element operated (phase-CA)
8000011B23	Z1S-OPT	Z1S operated (3-phases OR)
8000011B66	Z1S-OPT-AB	Z1S operated (phase-AB)
8100011B67	Z1S-OPT-BC	Z1S operated (phase-BC)
8200011B68	Z1S-OPT-CA	Z1S operated (phase-CA)
8300011B63	Z1S-ORX	Z1S-X operation level pick up (3-phases OR)

◆ Signal monitoring point

ZS (Function ID: 430001)

Element ID	Name	Description
8400061C20	Z1XS-AB	Z1XS relay element operated (phase-AB)
8500061C21	Z1XS-BC	Z1XS relay element operated (phase-BC)
8600061C22	Z1XS-CA	Z1XS relay element operated (phase-CA)
8100061B23	Z1XS-OPT	Z1XS operated (3-phases OR)
8400061B66	Z1XS-OPT-AB	Z1XS operated (phase-AB)
8500061B67	Z1XS-OPT-BC	Z1XS operated (phase-BC)
8600061B68	Z1XS-OPT-CA	Z1XS operated (phase-CA)
8700061B63	Z1XS-ORX	Z1XS-ORX operation level pick up (3-phases OR)
8000021C20	Z2S-AB	Z2S relay element operated (phase-AB)
8100021C21	Z2S-BC	Z2S relay element operated (phase-BC)
8200021C22	Z2S-CA	Z2S relay element operated (phase-CA)
8200021B23	Z2S-OPT	Z2S operated (3-phases OR)
8000021B66	Z2S-OPT-AB	Z2S operated (phase-AB)
8100021B67	Z2S-OPT-BC	Z2S operated (phase-BC)
8200021B68	Z2S-OPT-CA	Z2S operated (phase-CA)
8300021B63	Z2S-ORX	Z2S-ORX operated (3-phases OR)
8400031C20	Z3S-AB	Z3S relay element operated (phase-AB)
8500031C21	Z3S-BC	Z3S relay element operated (phase-BC)
8600031C22	Z3S-CA	Z3S relay element operated (phase-CA)
8300031B23	Z3S-OPT	Z3S operated (3-phases OR)
8400031B66	Z3S-OPT-AB	Z3S operated (phase-AB)
8500031B67	Z3S-OPT-BC	Z3S operated (phase-BC)
8600031B68	Z3S-OPT-CA	Z3S operated (phase-CA)
8700031B63	Z3S-ORX	Z3S-ORX operated (3-phases OR)
8800041C20	Z4S-AB	Z4S relay element operated (phase-AB)
8900041C21	Z4S-BC	Z4S relay element operated (phase-BC)
8A00041C22	Z4S-CA	Z4S relay element operated (phase-CA)
8400041B23	Z4S-OPT	Z4S operated (3-phases OR)
8800041B66	Z4S-OPT-AB	Z4S operated (phase-AB)
8900041B67	Z4S-OPT-BC	Z4S operated (phase-BC)
8A00041B68	Z4S-OPT-CA	Z4S operated (phase-CA)
8B00041B63	Z4S-ORX	Z4S-ORX operated (3-phases OR)
8000071B60	ZCSF-AB	ZCSF protection operated (phase-AB)
8100071B61	ZCSF-BC	ZCSF protection operated (phase-BC)
8200071B62	ZCSF-CA	ZCSF protection operated (phase-CA)
8400071B69	ZCSR-AB	ZCSR protection operated (phase-AB)
8500071B6A	ZCSR-BC	ZCSR protection operated (phase-BC)
8600071B6B	ZCSR-CA	ZCSR protection operated (phase-CA)
8500001B61	ZS-ARC-BLOCK	Autoreclose block signal by ZS
8C00001B62	ZS-OPT-ABR	ZS protection operated (phase-A)
8D00001B63	ZS-OPT-BCR	ZS protection operated (phase-B)
8E00001B64	ZS-OPT-CAR	ZS protection operated (phase-C)
8300001B23	ZS-TRIP	ZS trip
3000081B71	ZS_BLKZN	BlkZn status signal in RPSB of IEC61580 LN

◆ Connection point on PLC logic

ZS (Function ID: 430001)

Element ID	Name	Description
800008EBB2	LES BLOCK	LES block
800008EBB0	PSBS BLOCK	PSBS block
810008EBB1	PSBS F.RESET	PSBS forcible reset
800001EBB3	SOTF-Z1S BLOCK	SOTF block signal for Z1S
810006EBB3	SOTF-Z1XS BLOCK	SOTF block signal for Z1XS
820002EBB3	SOTF-Z2S BLOCK	SOTF block signal for Z2S
830003EBB3	SOTF-Z3S BLOCK	SOTF block signal for Z3S
840004EBB3	SOTF-Z4S BLOCK	SOTF block signal for Z4S
850005EBB3	SOTF-Z5S BLOCK	SOTF block signal for Z5S
800001EBB0	Z1STP_BLOCK	Z1S trip block signal
800001EBB2	Z1S_ARCBLOCK	Autoreclose block signal for Z1S
800001EBB1	Z1S_INST_OP	Z1S instantaneously operated
810006EBB0	Z1XSTP_BLOCK	Z1XS trip block signal
810006EBB2	Z1XS_ARCBLOCK	Autoreclose block signal for Z1XS
810006EBB1	Z1XS_INST_OP	Z1XS instantaneously operated
820002EBB0	Z2STP_BLOCK	Z2S trip block signal
820002EBB2	Z2S_ARCBLOCK	Autoreclose block signal for Z2S
820002EBB1	Z2S_INST_OP	Z2S instantaneously operated
830003EBB0	Z3STP_BLOCK	Z3S trip block signal
830003EBB2	Z3S_ARCBLOCK	Autoreclose block signal for Z3S
830003EBB1	Z3S_INST_OP	Z3S instantaneously operated
840004EBB0	Z4STP_BLOCK	Z4S trip block signal
840004EBB2	Z4S_ARCBLOCK	Autoreclose block signal for Z4S
840004EBB1	Z4S_INST_OP	Z4S instantaneously operated
850005EBB0	Z5STP_BLOCK	Z5S trip block signal

(2.28)

◆ Signal monitoring point

ZG (Function ID: 431001)

Element ID	Name	Description
8000081B71	LD_ENC-A	Load encroachment operated (phase-A)
8100081B72	LD_ENC-B	Load encroachment operated (phase-B)
8200081B73	LD_ENC-C	Load encroachment operated (phase-C)
8000081B6C	LEG-L-A	LEG-L relay element operated (phase-A)
8100081B6D	LEG-L-B	LEG-L relay element operated (phase-B)
8200081B6E	LEG-L-C	LEG-L relay element operated (phase-C)
8000081B69	LEG-R-A	LEG-R relay element operated (phase-A)
8100081B6A	LEG-R-B	LEG-R relay element operated (phase-B)
8200081B6B	LEG-R-C	LEG-R relay element operated (phase-C)
8000011B64	OCF1G OP	OCF1G operated
8000011C24	OCF1G-A	OCF1G relay element operated (phase-A)
8100011C25	OCF1G-B	OCF1G relay element operated (phase-B)
8200011C26	OCF1G-C	OCF1G relay element operated (phase-C)

◆ Signal monitoring point

ZG (Function ID: 431001)

Element ID	Name	Description
8100061B64	OCF1XG OP	OCF1XG operated
8400061C24	OCF1XG-A	OCF1XG relay element operated (phase-A)
8500061C25	OCF1XG-B	OCF1XG relay element operated (phase-B)
8600061C26	OCF1XG-C	OCF1XG relay element operated (phase-C)
8200021B64	OCF2G OP	OCF2G operated
8000021C24	OCF2G-A	OCF2G relay element operated (phase-A)
8100021C25	OCF2G-B	OCF2G relay element operated (phase-B)
8200021C26	OCF2G-C	OCF2G relay element operated (phase-C)
8300031B64	OCF3G OP	OCF3G operated
8400031C24	OCF3G-A	OCF3G relay element operated (phase-A)
8500031C25	OCF3G-B	OCF3G relay element operated (phase-B)
8600031C26	OCF3G-C	OCF3G relay element operated (phase-C)
8400041B64	OCF4G OP	OCF4G operated
8800041C24	OCF4G-A	OCF4G relay element operated (phase-A)
8900041C25	OCF4G-B	OCF4G relay element operated (phase-B)
8A00041C26	OCF4G-C	OCF4G relay element operated (phase-C)
8000081B70	PSBG DET	PSBG detection
8000081B66	PSBGIN-A	PSBGIN relay element operated (phase-A)
8100081B67	PSBGIN-B	PSBGIN relay element operated (phase-B)
8200081B68	PSBGIN-C	PSBGIN relay element operated (phase-C)
8400081B63	PSBGOUT-A	PSBGOUT relay element operated (phase-A)
8500081B64	PSBGOUT-B	PSBGOUT relay element operated (phase-B)
8600081B65	PSBGOUT-C	PSBGOUT relay element operated (phase-C)
8000011B6B	SOTF-Z1G-OPT-A	SOTF operated for Z1G (phase-A)
8100011B6C	SOTF-Z1G-OPT-B	SOTF operated for Z1G (phase-B)
8200011B6D	SOTF-Z1G-OPT-C	SOTF operated for Z1G (phase-C)
8000011B2B	SOTF-Z1G-TRIP	SOTF operated for Z1G (3-phases OR)
8400061B6B	SOTF-Z1XG-OPT-A	SOTF operated for Z1XG (phase-A)
8500061B6C	SOTF-Z1XG-OPT-B	SOTF operated for Z1XG (phase-B)
8600061B6D	SOTF-Z1XG-OPT-C	SOTF operated for Z1XG (phase-C)
8100061B2B	SOTF-Z1XG-TRIP	SOTF operated for Z1XG (3-phases OR)
8000021B6B	SOTF-Z2G-OPT-A	SOTF operated for Z2G (phase-A)
8100021B6C	SOTF-Z2G-OPT-B	SOTF operated for Z2G (phase-B)
8200021B6D	SOTF-Z2G-OPT-C	SOTF operated for Z2G (phase-C)
8200021B2B	SOTF-Z2G-TRIP	SOTF operated for Z2G (3-phases OR)
8400031B6B	SOTF-Z3G-OPT-A	SOTF operated for Z3G (phase-A)
8500031B6C	SOTF-Z3G-OPT-B	SOTF operated for Z3G (phase-B)
8600031B6D	SOTF-Z3G-OPT-C	SOTF operated for Z3G (phase-C)
8300031B2B	SOTF-Z3G-TRIP	SOTF operated for Z3G (3-phases OR)
8800041B6B	SOTF-Z4G-OPT-A	SOTF operated for Z4G (phase-A)
8900041B6C	SOTF-Z4G-OPT-B	SOTF operated for Z4G (phase-B)
8A00041B6D	SOTF-Z4G-OPT-C	SOTF operated for Z4G (phase-C)
8400041B2B	SOTF-Z4G-TRIP	SOTF operated for Z4G (3-phases OR)
8300001B2B	SOTF-ZG-TRIP	SOTF protection trip

◆ Signal monitoring point

ZG (Function ID: 431001)

Element ID	Name	Description
8000081B60	UVPWI-A	UVPWI relay element operated (phase-A)
8100081B61	UVPWI-B	UVPWI relay element operated (phase-B)
8200081B62	UVPWI-C	UVPWI relay element operated (phase-C)
8000011C20	Z1G-A	Z1G relay element operated (phase-A)
8100011C21	Z1G-B	Z1G relay element operated (phase-B)
8200011C22	Z1G-C	Z1G relay element operated (phase-C)
8000011B69	Z1G-OPT	Z1G operated (3-phases OR)
8000011B66	Z1G-OPT-A	Z1G operated (phase-A)
8100011B67	Z1G-OPT-B	Z1G operated (phase-B)
8200011B68	Z1G-OPT-C	Z1G operated (phase-C)
8300011B63	Z1G-ORX	Z1G-ORX operated (3-phases OR)
8400061C20	Z1XG-A	Z1XG relay element operated (phase-A)
8500061C21	Z1XG-B	Z1XG relay element operated (phase-B)
8600061C22	Z1XG-C	Z1XG relay element operated (phase-C)
8100061B69	Z1XG-OPT	Z1XG operated (3-phases OR)
8400061B66	Z1XG-OPT-A	Z1XG operated (phase-A)
8500061B67	Z1XG-OPT-B	Z1XG operated (phase-B)
8600061B68	Z1XG-OPT-C	Z1XG operated (phase-C)
8700061B63	Z1XG-ORX	Z1XG-ORX operated (3-phases OR)
8000021C20	Z2G-A	Z2G relay element operated (phase-A)
8100021C21	Z2G-B	Z2G relay element operated (phase-B)
8200021C22	Z2G-C	Z2G relay element operated (phase-C)
8200021B69	Z2G-OPT	Z2G operated (3-phases OR)
8000021B66	Z2G-OPT-A	Z2G operated (phase-A)
8100021B67	Z2G-OPT-B	Z2G operated (phase-B)
8200021B68	Z2G-OPT-C	Z2G operated (phase-C)
8300021B63	Z2G-ORX	Z2G-ORX operated (3-phases OR)
8400031C20	Z3G-A	Z3G relay element operated (phase-A)
8500031C21	Z3G-B	Z3G relay element operated (phase-B)
8600031C22	Z3G-C	Z3G relay element operated (phase-C)
8300031B69	Z3G-OPT	Z3G operated (3-phases OR)
8400031B66	Z3G-OPT-A	Z3G operated (phase-A)
8500031B67	Z3G-OPT-B	Z3G operated (phase-B)
8600031B68	Z3G-OPT-C	Z3G operated (phase-C)
8700031B63	Z3G-ORX	Z3G-ORX operated (3-phases OR)
8800041C20	Z4G-A	Z4G relay element operated (phase-A)
8900041C21	Z4G-B	Z4G relay element operated (phase-B)
8A00041C22	Z4G-C	Z4G relay element operated (phase-C)
8400041B69	Z4G-OPT	Z4G operated (3-phases OR)
8800041B66	Z4G-OPT-A	Z4G operated (phase-A)
8900041B67	Z4G-OPT-B	Z4G operated (phase-B)
8A00041B68	Z4G-OPT-C	Z4G operated (phase-C)
8B00041B63	Z4G-ORX	Z4G-ORX operated (3-phases OR)
8000071B75	ZCGF-A	ZCGF relay element operated (phase-A)

◆ Signal monitoring point

ZG (Function ID: 431001)

Element ID	Name	Description
8100071B76	ZCGF-B	ZCGF relay element operated (phase-B)
8200071B77	ZCGF-C	ZCGF relay element operated (phase-C)
8400071B78	ZCGR-A	ZCGR relay element operated (phase-A)
8500071B79	ZCGR-B	ZCGR relay element operated (phase-B)
8600071B7A	ZCGR-C	ZCGR relay element operated (phase-C)
8500001B7C	ZG-ARC-BLOCK	Autoreclose block signal by ZG
8800001B7D	ZG-OPT-AR	ZG A phase operated
8900001B7E	ZG-OPT-BR	ZG B phase operated
8A00001B7F	ZG-OPT-CR	ZG C phase operated
8000001B20	ZG-TRIP-A	ZG A phase trip
8100001B21	ZG-TRIP-B	ZG B phase trip
8200001B22	ZG-TRIP-C	ZG C phase trip
8000001B63	ZGFCOV-A	ZGFCOV relay element operated (phase-A)
8100001B64	ZGFCOV-B	ZGFCOV relay element operated (phase-B)
8200001B65	ZGFCOV-C	ZGFCOV relay element operated (phase-C)
8400001B66	ZGRCOV-A	ZGRCOV relay element operated (phase-A)
8500001B67	ZGRCOV-B	ZGRCOV relay element operated (phase-B)

◆ Connection point on PLC logic

ZG (Function ID: 431001)

Element ID	Name	Description
800008EBB2	LEG BLOCK	LEG block
800008EBB0	PSBG BLOCK	PSBG block
810008EBB1	PSBG F.RESET	PSBG forcible reset
800001EBB4	SOTF-Z1G BLOCK	SOTF block signal for Z1G
810006EBB4	SOTF-Z1XG BLOCK	SOTF block signal for Z1XG
820002EBB4	SOTF-Z2G BLOCK	SOTF block signal for Z2G
830003EBB4	SOTF-Z3G BLOCK	SOTF block signal for Z3G
840004EBB4	SOTF-Z4G BLOCK	SOTF block signal for Z4G
850005EBB4	SOTF-Z5G BLOCK	SOTF block signal for Z5G
800001EBB0	Z1GTP_BLOCK	Z1G trip block signal
800001EBB2	Z1G_3PTP	Z1G trip (3-phases)
800001EBB3	Z1G_ARCBLOCK	Autoreclose block signal for Z1G
800001EBB1	Z1G_INST_OP	Z1G instantaneously operated
810006EBB0	Z1XGTP_BLOCK	Z1XG trip block signal
810006EBB2	Z1XG_3PTP	Z1XG trip (3-phases)
810006EBB3	Z1XG_ARCBLOCK	Autoreclose block signal for Z1XG
810006EBB1	Z1XG_INST_OP	Z1XG instantaneously operated
820002EBB0	Z2GTP_BLOCK	Z2G trip block signal
820002EBB2	Z2G_3PTP	Z2G trip (3-phases)
820002EBB3	Z2G_ARCBLOCK	Autoreclose block signal for Z2G
820002EBB1	Z2G_INST_OP	Z2G instantaneously operated
830003EBB0	Z3GTP_BLOCK	Z3G trip block signal

◆ Connection point on PLC logic

ZG (Function ID: 431001)

Element ID	Name	Description
830003EBB2	Z3G_3PTP	Z3G trip (3-phases)
830003EBB3	Z3G_ARCBLOCK	Autoreclose block signal for Z3G
830003EBB1	Z3G_INST_OP	Z3G instantaneously operated
840004EBB0	Z4GTP_BLOCK	Z4G trip block signal
840004EBB2	Z4G_3PTP	Z4G trip (3-phases)
840004EBB3	Z4G_ARCBLOCK	Autoreclose block signal for Z4G
840004EBB1	Z4G_INST_OP	Z4G instantaneously operated

(2.28)

2.5 Direct transfer trip (DTT)

When direct transfer trip (DTT) function receives a trip signal from the remote, the DTT function will issue the trip signal for the trip circuit (TRC) to open a circuit breaker (CB). The DTT function consists of two shemes[1]: DTT1 and DTT2. Each can receive the trip signal separately; the trip signal can be transferred with the communication[2].

[1]Note: An asterisk (*) is used to express either DTT1 or DTT2 schemes.

[2]Note: The communication feature is available with the communication features. See Chapter *Relay application: Transmission control function and Communication application*. The user should make the PLC logic for this DTT operation. See *Chapter PLC function: PLC setting samples* for more information.

Note: Several IED models do not have direct transfer trip feature. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.5-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
DTT	Direct transfer trip function (DTT)	NA	✓	✓	✓	✓

✓: Applicable NA: Not applicable

2.5.1 Setting for the operation

To the operation, the user should set **On** for scheme switch [**DTT*-EN**]; then, the user should set for the scheme switch [**DTT*-Output**] to select an mode when the DTT function receives a command from the remote terminal. The user should set **TRIP** for the scheme switch [**DTT*-Output**] when tripping the CB[1] is required. Conversely, set **BO** for the scheme switch [**DTT*-Output**] when tripping the CB is not required but issuing an alarm is required using the binary output circuit[2].

To delay for issuing the trip signal, the user can set the delay time using [**TDTT***] among 0.00 to 300.00sec.

If the operation of the autoreclose (ARC[3]) function must be blocked when the DTT function receives a signal from the remote end, set **Block** for scheme switch [**DTT*-ARCBlk**].

[1]Note: Issuing the trip command is performed in trip circuit (TRC). For more information, see chapter *Relay application: Trip circuit*, separately.

[2]Note: For programing binary output circuits, see chapter *Technical description: Binary IO module*.

[3]Note: ARC is discussed separately. See chapter *Relay application: Autoreclose*.

2.5.2 Scheme logic

Figure 2.5-1shows the DTT scheme logics. For the reception of a pair of trip signals from a remote terminal, the logic has two PLC connection points 'R1.DTT1' and 'R1.DTT2'. The user should connect a remote trip signal provided by the communication with the PLC connection points using PLC function.

Blocking the DTT1 function is also available when an external signal is injected to the logic using PLC connection point "DTT1_BLOCK". Incidentally, the user can program to operate the DTT1 function with the absence of the delaying [**TDD1**] using PLC connection point "DTT1_INST_OP". The user should notice that issuing for the TRC function is just designed for the three-phase tripping command.

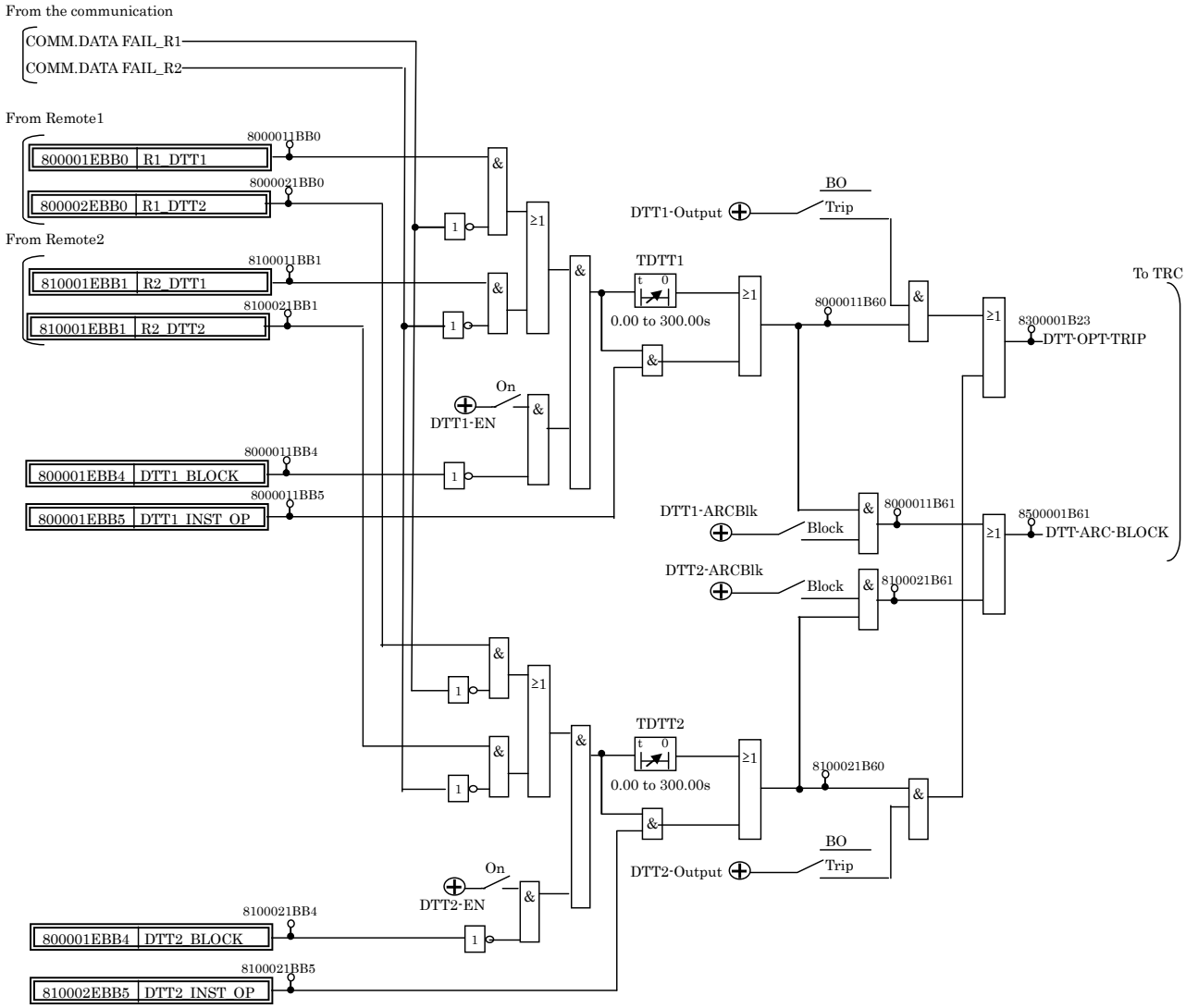


Figure 2.5-1 DTT1 and DTT2 scheme logics

2.5.3 Setting

Setting of DTT(Function ID: 485001)

Setting item		Range	Units	Contents	Default setting value	Notes
DTT1	DTT1-EN	Off/On	–	Enabling operation (Direct transfer trip 1)	Off	
	TDTT1	0.00-300.00	S	Delay time in DTT1	0.00	
	DTT1-Output	Trip/BO	–	Selection of either a trip or an alarm	Trip	
	DTT1-ARCBlk	Non/Block	–	Blocking autoreclose with DTT1 signal	Block	
DTT2	DTT2-EN	Off/On	–	Enabling operation (Direct transfer trip 2)	Off	
	TDTT2	0.00-300.00	S	Delay time in DTT2	0.00	
	DTT2-Output	Trip/BO	–	Selection of either a trip or an alarm	Trip	
	DTT2-ARCBlk	Non/Block	–	Blocking autoreclose with DTT2 signal	Block	

2.5.4 Data ID

◆ Signal monitoring point

DTT(Function ID: 485001)

Element ID	Name	Description
8500001B61	DTT-ARC-BLOCK	Autoreclose block signal by DTT protection operation
8300001B23	DTT-OPT-TRIP	Direct transfer trip operation
8000011B61	DTT1-ARC-BLOCK	Autoreclose block signal by DTT1 protection operation
8000011B60	DTT1-OPT	Direct transfer trip 1 operation
8000011BB4	DTT1_BLOCK	DTT1 scheme block
8000011BB5	DTT1_INST_OP	DTT1 protection instant operation command
8100021B61	DTT2-ARC-BLOCK	Autoreclose block signal by DTT2 protection operation
8100021B60	DTT2-OPT	Direct transfer trip 2 operation
8100021BB4	DTT2_BLOCK	DTT2 scheme block
8100021BB5	DTT2_INST_OP	DTT2 protection instant operation command
8000011BB0	R1.DTT1	Transfer trip command 1 receiving from terminal 1
8000021BB0	R1.DTT2	Transfer trip command 2 receiving from terminal 1
8100011BB1	R2.DTT1	Transfer trip command 1 receiving from terminal 2
8100021BB1	R2.DTT2	Transfer trip command 2 receiving from terminal 2
8200011BB2	R3.DTT1	Transfer trip command 1 receiving from terminal 3
8200021BB2	R3.DTT2	Transfer trip command 2 receiving from terminal 3
8300011BB3	R4.DTT1	Transfer trip command 1 receiving from terminal 4
8300021BB3	R4.DTT2	Transfer trip command 2 receiving from terminal 4

◆ Connection point in PLC logic

DTT(Function ID: 485001)

Element ID	Name	Description
800001EBB4	DTT1_BLOCK	DTT1 scheme block
800001EBB5	DTT1_INST_OP	DTT1 protection instant operation command
810002EBB4	DTT2_BLOCK	DTT2 scheme block
810002EBB5	DTT2_INST_OP	DTT2 protection instant operation command
800001EBB0	R1.DTT1	Transfer trip command 1 receiving from terminal 1
800002EBB0	R1.DTT2	Transfer trip command 2 receiving from terminal 1
810001EBB1	R2.DTT1	Transfer trip command 1 receiving from terminal 2
810002EBB1	R2.DTT2	Transfer trip command 2 receiving from terminal 2
820001EBB2	R3.DTT1	Transfer trip command 1 receiving from terminal 3
820002EBB2	R3.DTT2	Transfer trip command 2 receiving from terminal 3
830001EBB3	R4.DTT1	Transfer trip command 1 receiving from terminal 4

(2.59)

2.6 Distance carrier command protection (DISCAR)

When every IED can exchange operational information mutually using communication system, accurate decision of whether or not a fault is internal on the line can be made. Distance carrier command protection (DISCAR) can provide such protection using the distance protection (ZS/ZG). Consequently, the whole length of the line can be protected promptly for any fault. The following techniques are provided in DISCAR:

1. Permissive underreach protection (PUP)
2. Permissive overreach protection (POP)
3. Unblocking overreach protection (UOP)
4. Blocking overreach protection (BOP)

The function of autoreclose (ARC) can be operated speedy using these protections above; and these can issue either a single-pole trip signal or three-poles trip signal in accordance with DISCAR settings and the states of faults.

Note: Several IED models do not have carrier features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.6-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
DISCAR	Distance carrier command protection	NA	NA	✓	(✓)	NA

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among OC, EF, OCN, THM, BCD, CBF, SOTF-OC, OV, OVS, UV, UVS, FRQ/DFRQ, FS, VTF, CTF, ARC, VCHK..

2.6.1 Permissive underreach protection (PUP)

(i) Application

When an underreach element operates at local terminal, and when the circuit breaker (CB) is tripped by this element, a trip permission signal† is sent to other opposite terminals. When the opposite terminals receive the signal, CBs at these terminals are tripped instantly if an overreaching element at respective these terminals has been operated. In PUP, Z1S/Z1G elements in ZS/ZG are used for the underreach element, and ZCSF/ZCGF elements are used for the overreaching element.

The trip permission signal is not sent until it is observed that the fault exists in the protection zone of Z1S/Z1G; hence, PUP can provide excellent security., but PUP cannot provide sufficient dependability if faults exist on the line including open terminals or weak infeed terminals. This is because Z1S/Z1G cannot operate for this case‡.

†Note: The trip permission signal yielded by the underreaching element is transmitted only; hence, respective terminals can share a telecommunication channel; and a simplex channel can be used.

‡Note: At remote terminals, Z1X/ Z2 have a delay timer. Thus, they can remove the faults.

(ii) Scheme logic

Figure 2.6-1 shows PUP logic. When Z1S/Z1G operate at the local terminal, Z1S/Z1G issue a single-phase trip signal or three-phase trip signal instantaneously; and a trip permission signal (DISCAR-CS-*) is sent to the opposite terminals through the sending circuit. Figure 2.6-2 shows the sending circuit of PUP; the trip permission signals are given at PLCs signal monitoring point (INT.DISCAR-S-*). The selection of either the single-phase trip (**1P**) or the three-phase trip (**3P**) is carried out using scheme switch [**DisCAR-TPMD**].

When the opposite terminal receives the trip permission signal, PUP at the opposite terminal also issues a trip signal instantly when either ZCSF/ZCGF have been operated. Receipt of the trip permission signals are found at PLC connection points (INT.DISCAR-R*).

PUP can operate when **PUP** is set for scheme switch [**Dis-CAR**]. If PUP requires operating ARC, set scheme switch [**DisCAR-ARCBlk**] **Non**. (For more information of ARC, see chapter *Relay application: Autoreclose*.)

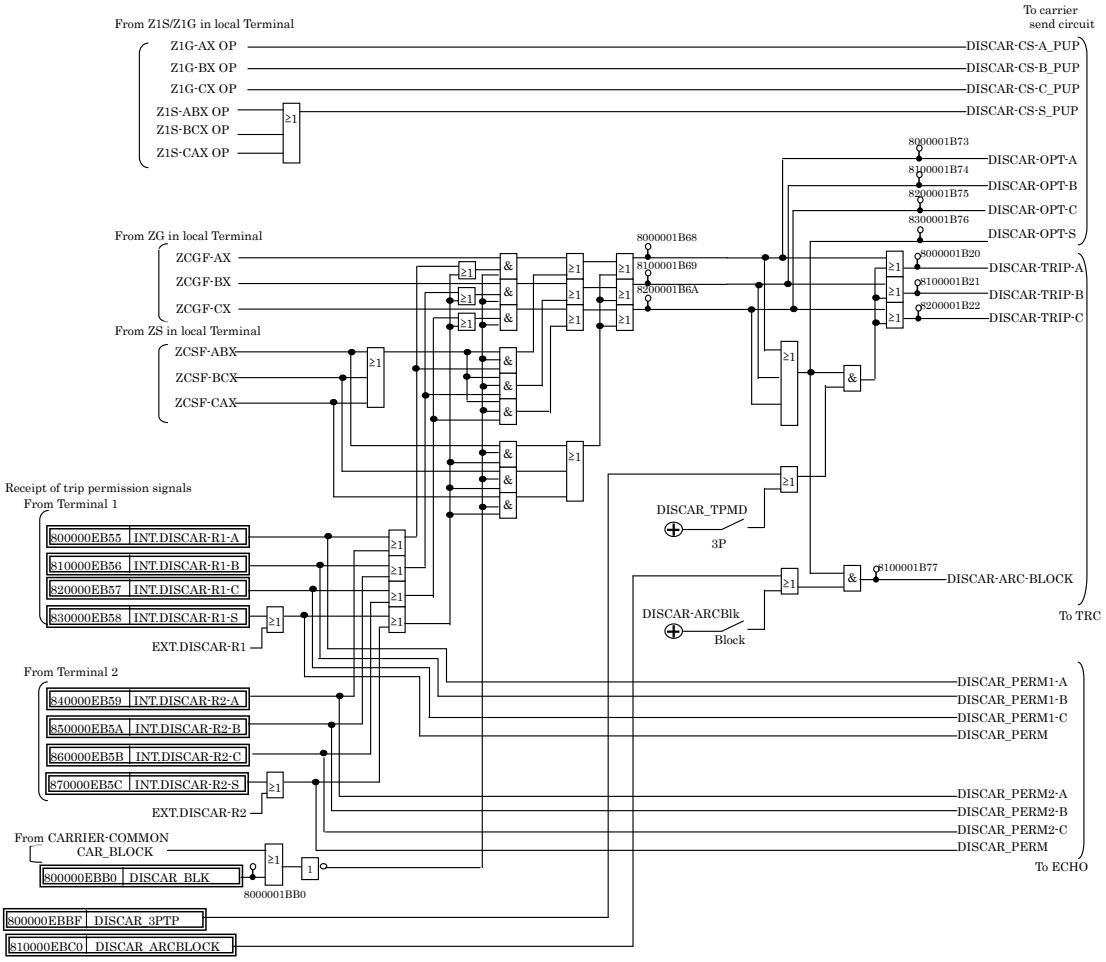


Figure 2.6-1 PUP scheme logic

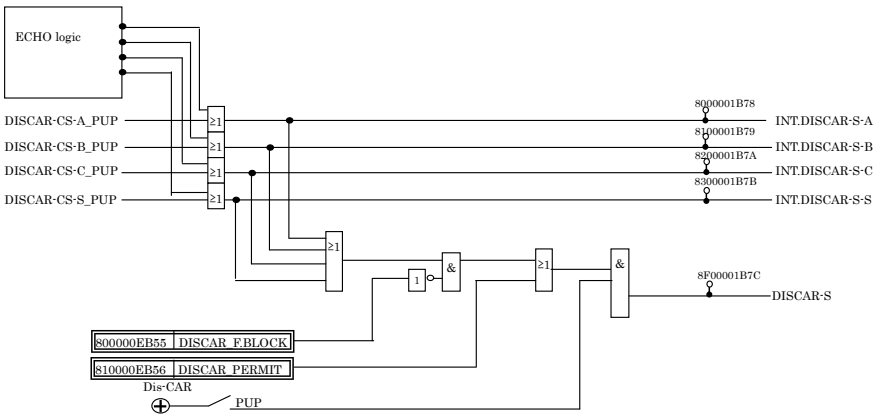


Figure 2.6-2 Sending circuit in PUP

2.6.2 Permissive overreach protection (POP)

(i) Application

When a forward overreaching element operates at a terminal, the terminal sends a trip permission signal to the other opposite terminals. When the forward overreaching element operates at a terminal, and when a trip permission signal† has been received from an opposite

terminal, the CB at the terminal is tripped in permission overreach protection (POP).

In other words, POP can determine if the fault exists inside the protected line based on the overlapping operation of the forward overreaching elements at both terminals. ZCSF/ZCGF elements are used for the forward overreaching element.

†Note: POP sends a trip permission signal when the forward overreaching element operates. Thus, multiplex signaling channels or one channel for each direction is required in POP. This is because that the terminal sending signals shall not trip erroneously due to reception of its own sending signal if an external fault occurs in the zone of forward overreaching element.

(ii) Operation of echo (ECHO) and week infeed trip (WKIT)

POP has an echo function (ECHO) and a weak infeed trip function (WKIT) in order that the line including an open terminal or a weak infeed terminal can be protected by POP. Thus, POP enables to trip CBs fast at both terminals for any fault along the whole length of the protected line. (For more information of ECHO and WKIT, see section 2.6.5)

(iii) Countermeasure of current reversal (CRL)

When a fault exist on one of parallel lines, tripping CBs sequential may cause a current reversal on another of parallel lines. The current reversal results in the false operation of POP, hence, countermeasure logic is provided for the current reversal (CRL). (For more information of CRL, see section 2.6.6)

(iv) Criterion of POP tripping

POP at the local terminal issues either a single-phase tripping signal or a three-phase trip signal when the following conditions are satisfied:

- ✓ Trip permission signal is received from the opposite terminal
- ✓ The current reversal has not been observed
- ✓ One of the following conditions is established:
  - The forward overreaching element operates.
  - When **On** is set for scheme switch [**Dis-WIKT**], the undervoltage element UVL† (UVLS or UVLG) operates and the forward overreaching element and the reverse looking element have not operated.

†Note: UVL is provided in the function of protection common (PROT_COMMON). For more information, see Chapter *Relay application: Protection common*.

(v) Scheme logic

Figure 2.6-3 shows POP scheme logics. POP sends a trip permission signal for the opposite

terminals when any of the following conditions are satisfied:

1. The forward overreaching element operates; and CRL has not observed the current reversal.
2. When **On** is set for scheme switch [**Dis-ECHO**], CB is opened; and a trip permission signal (DISCAR-CS-*) is received from the other terminal.
3. When **On** is set for scheme switch [**Dis-ECHO**], the forward overreaching element (ZCSF/ZCGF) and the reverse looking element (ZCSR/ZCGR) have not operated; and a trip permission signal is received from the other terminal.

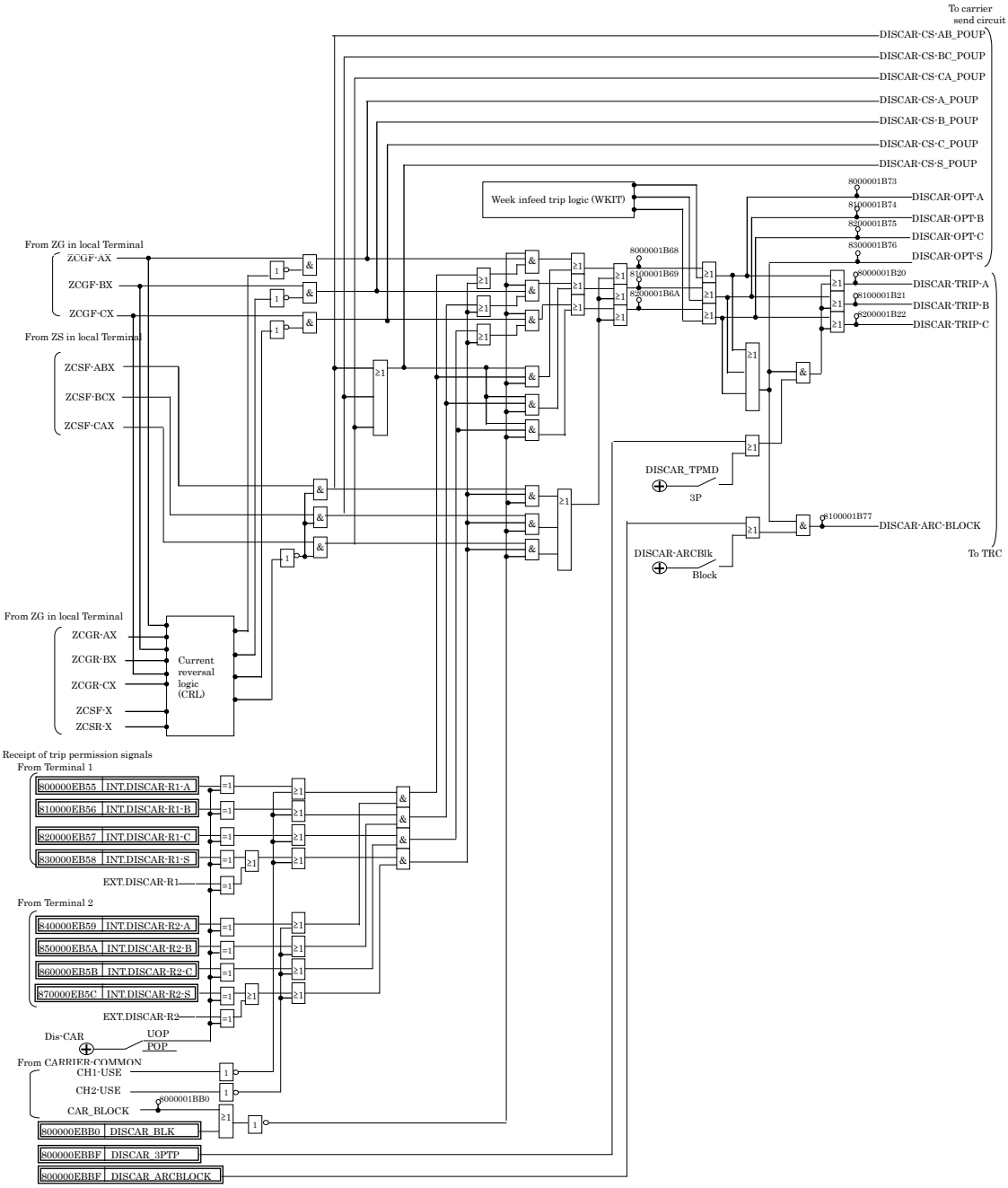


Figure 2.6-3 POP and UOP scheme logic

(vi) Delay of trip permission signal

Figure 2.6-4 shows POP sending circuit. The trip permission signals are given at PLCs signal monitoring point (INT.DISCAR-S-*). The selection of either the single-phase trip (**1P**) or the three-phase trip (**3P**) is carried out using scheme switch [**DisCAR-TPMD**].

Transmission of the trip permission signal continues for setting [**TSBCT-dis**] even after the local terminal issues a trip signal.

In many cases, at both ends of the line, the overreaching elements operate at the same time. However, there may be some cases where they cannot operate simultaneously because fault currents do not flow symmetrically. That is, the overreaching elements far from a fault cannot operate by the fault, but the overreaching elements far from the fault will be operated indirectly if the other terminals are induced to trip. To avoid this case, transmission of the trip permission signal continues for a while set by [**TSBCT-dis**] after reset of ZCSF/ZCSG operation. Consequently, the overreaching elements far from the fault can also generate a trip signal because the trip permission signal is picked up delayed.

Thus, this command protection ensures its operation at the remote terminal.

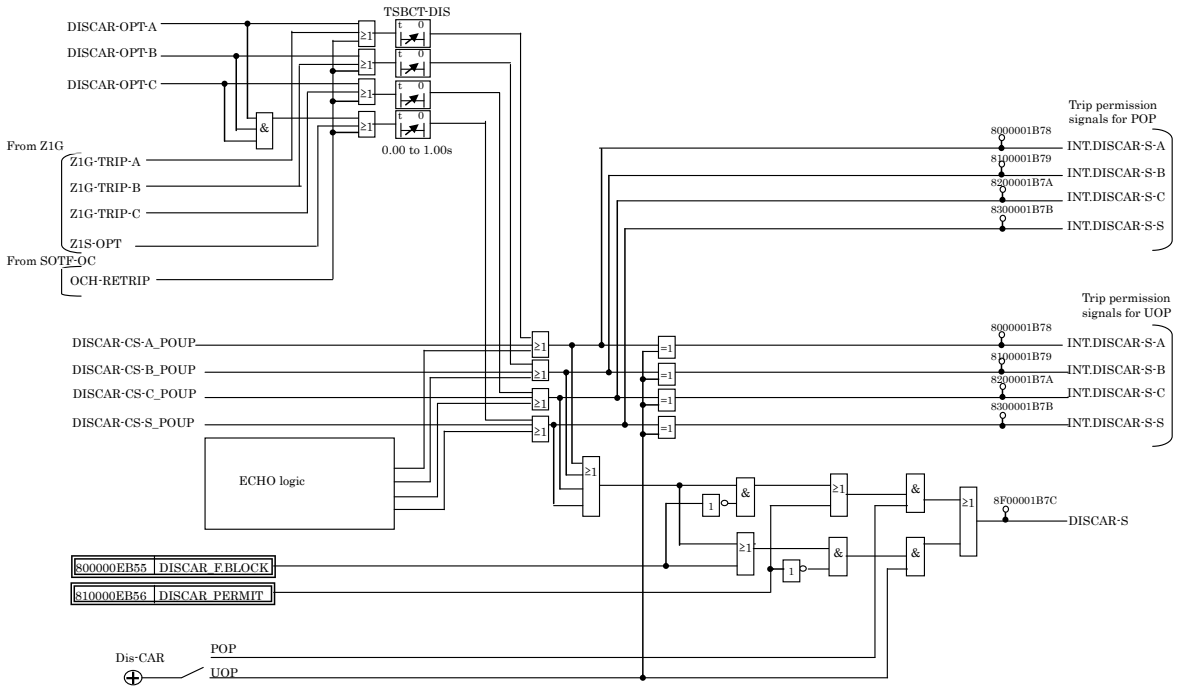


Figure 2.6-4 Sending circuit in POP and UOP

2.6.3 Unblocking overreach protection (UOP)

When information are exchanged using a transmission line (the power line carrier), PUP and POP cannot trip dependably. This is because a trip permission signal may not be exchanged through the transmission line because that the transmission line includes a fault; the fault

may reduce the power of the signal and then PUP and POP may fail to operate. Unblocking overreach protection (UOP) is introduced in order to negate this issue.

We can regard a transmitted signal as a trip block signal; and the trip block signal is transmitted continuously except for the fault conditions. When the forward overreaching element operates, signal transmission is stopped; hence, a trip block signal is not reached at an opposite terminal. Consequently, the opposite terminal is allowed to trip; and CB tripping is carried out when the forward overreaching element on its own operates.

ZCSF/ZCGF elements are used for the forward overreaching element. On the other hand, ZCSR/ZCGR elements are used for the reverse looking element.

In UOP, the signal is required to send except for the occurrence of internal faults. Therefore, a failure to operate or false operation due to attenuation of the signal will be removed even if the power line carrier is used to exchange operation information.

(i) Operation of echo (ECHO) and week infeed trip (WKIT)

UOP can have the functions of ECHO and WKIT, as well as POP. To operate these function, user should set [**Dis-ECHO**] **On** or [**Dis-WIKT**] **On**. (For more information of ECHO and WKIT, see section 2.6.5)

(ii) Countermeasure of current reversal (CRL)

UOP has the countermeasure of current reversal, as well as POP. (For more information of CRL, see section 2.6.6)

(iii) Delay of trip block signal

As similar to POP, UOP has setting [**TSBCT-dis**] not to send the trip block signal even after the local terminal issues a trip signal.

(iv) Scheme logic

Figure 2.6-3 and Figure 2.6-4 also show UOP scheme logic. In UOP, a trip block signal is observed PLCs signal monitoring point (INT.DISCAR-S-*) when the logic level in UOP is equal to “1”. Conversely, a trip block signal is not observed when the logic level is equal to “0”.

UOP does not send a trip block signal when one of the following conditions are observed:

- ✓ The forward overreaching element operates and the current reversal is not occurred.
- ✓ When **On** is set for scheme switch [**Dis-ECHO**], CB is open and the trip block signal is not received from the other terminals.
- ✓ When **On** is set for scheme switch [**Dis-ECHO**], both the forward overreaching

element and the reverse looking element are not operating and a trip block signal is not received from the other terminals.

The trip block signals are given at PLCs signal monitoring point (INT.DISCAR-S-*). The selection of either the single-phase trip (**1P**) or the three-phase trip (**3P**) is carried out using scheme switch [**DisCAR-TPMD**].

UOP issues single-phase tripping signal or three-phase trip signal locally when the following conditions are established:

- ✓ Trip block signal is not received from the opposite terminals.
- ✓ Current reversal is not observed
- ✓ One of the following conditions are observed:
  - The forward overreaching element operates.
  - When **On** is set for scheme switch [**Dis-WIKT**], the undervoltage element UVL (UVLS or UVLG) operates and the forward overreaching element (ZCSF/ZCGF) and the reverse looking element (ZCSR/ZCGR) have not operated.

2.6.4 Blocking overreach protection (BOP)

BOP sends a trip block signal if the reverse overreach element operates and the forward overreaching element dose not operate. Thus, at local terminal, CB tripping is performed when the forward overreaching element has operated and a trip block signal has not been received from the opposite terminal.

BOP does not send a trip block signal normally; and a trip block signal is sent only when the reverse looking element operates. In BOP, a trip block signal is required to send in the event of an external fault. Hence, failure operation or false operation can be removed when the communication is performed by power line carrier,

BOP does not receive a trip block signal except by the occurrence of internal fault. If an external fault occurs in forward, the forward overreaching element at a local terminal issues a trip signal instantly. However, if an internal fault occurs, the reverse looking element at an opposite terminal can operate and it transmits a trip block signal. At the local terminal, the trip block signal will be received in the delay due to the propagation of communication channel. Therefore, a short delay is required for CB tripping to check for the reception of a trip block signal.

BOP can trip for any fault along the whole length of the protected line even if an open terminal exists. A strong infeed terminal operates for all internal faults even if a weak infeed terminal exists; therefore, ECHO is not required in BOP. WIKT is not applicable in BOP; hence,

the weak infeed terminal cannot operate.

(i) Countermeasure of current reversal (CRL)

BOP has the countermeasure of current reversal, as well as PUP. (For more information of CRL, see section 2.6.6)

(ii) Scheme logic

Figure 2.6-5 and Figure 2.6-6 show BOP scheme logic. In BOP, a trip block signal is observed at PLC signal monitoring point (INT.DISCAR-S-*) when the logic level in BOP is equal to "1". Conversely, a trip block signal is not observed when the logic level is equal to "0".

In BOP, a trip block signal is not transmitted. If the reverse overreaching element operates while the forward overreaching element does not operate, a trip block signal is transmitted.

A trip block signal is not sent for setting [**TREBK-dis**] even after the local terminal issues a trip signal so that command tripping at the remote terminal is secured.

The selection of either the single-phase trip (**1P**) or the three-phase trip (**3P**) is carried out when the trip block signal is not received.

The delayed pick-up timer [**TCHD-dis**] is provided to allow for the transmission delay for receipt of the trip block signal from the remote terminal in the event of a forward external fault.

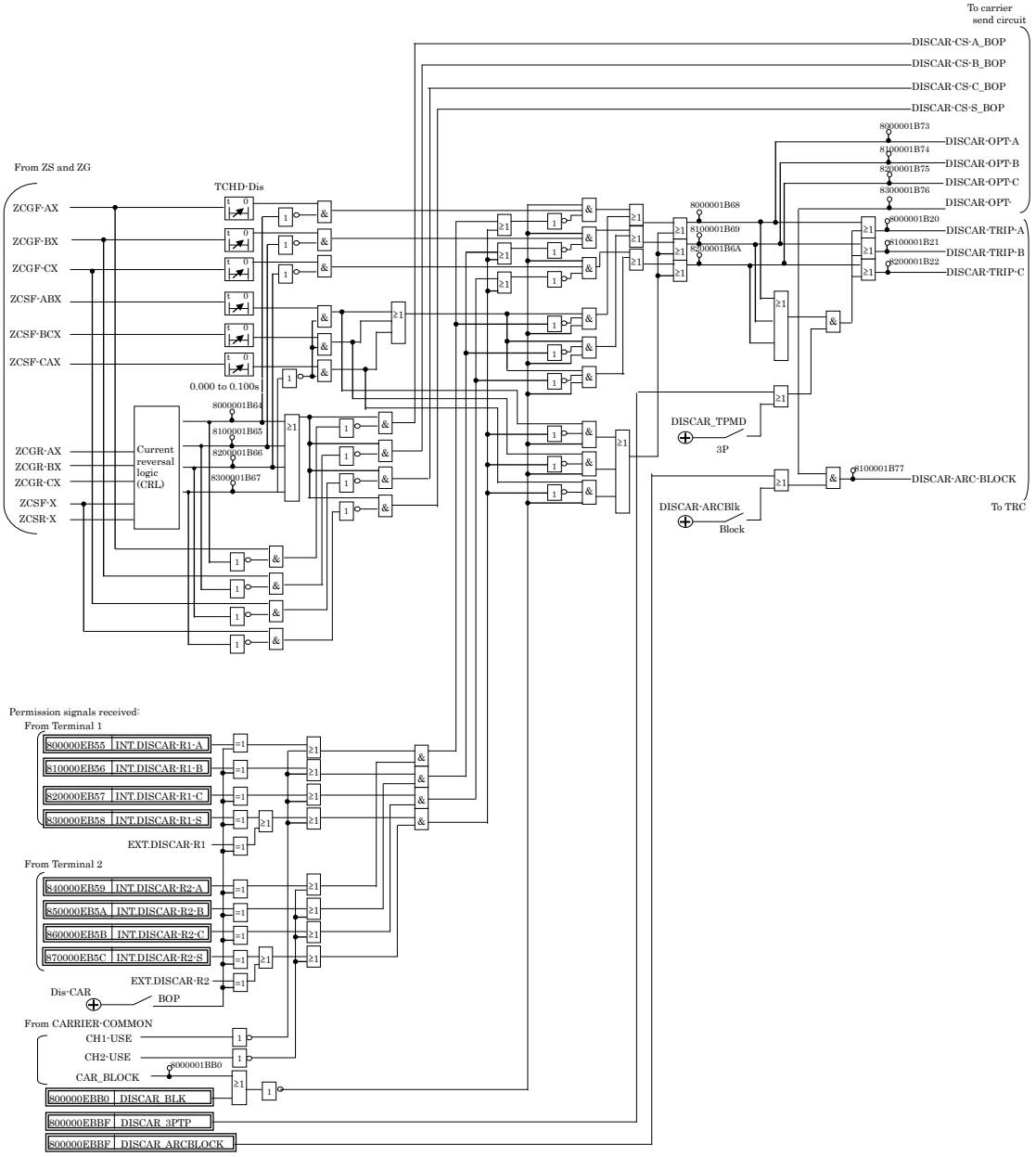


Figure 2.6-5 BOP scheme logic

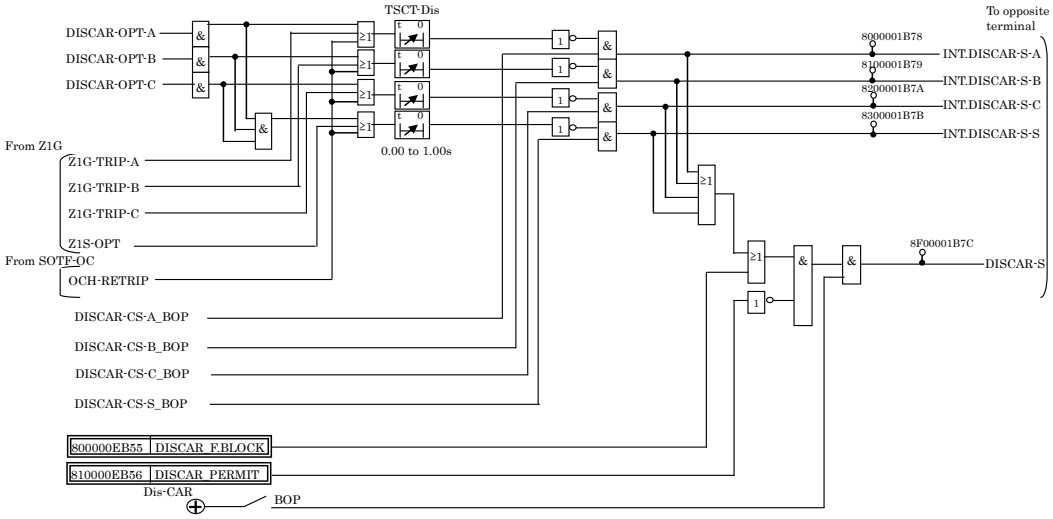


Figure 2.6-6 Sending circuit of BOP

2.6.5 Protection for week infeed terminal

Both POP and UOP are provided with ECHO and WIKT; both are used for a line including weak infeed terminals.

(i) ECHO function

With regard to POP, if a terminal receives a trip permission signal when neither forward overreaching element nor reverse looking element have operated, ECHO sends back the received signal to the opposite terminal.

With regard to UOP, if a terminal receives a block signal when neither forward overreaching element nor reverse looking element have operated, ECHO stops sending the block signal to the opposite terminal.

When CB is open, ECHO sends back the trip permission signal or stops sending the trip block signal. User can set the time from CB opened to ECHO enabled using setting [**TCARECCB**].

The terminal on which the forward overreaching element has operated can issue a trip signal speedy by using the signal by ECHO.

Once the forward overreaching element or reverse looking element have operated, transmission of the echo signal is inhibited for 250 ms by delayed drop-off timer T1 even after these elements are reset.

To prevent any spurious echo signal from looping round between the terminals in a

healthy state, the echo signal is restricted to last for 200 ms by delayed pickup timer T2.

Figure 2.6-7 and Figure 2.6-8 shows ECHO logic. Users can enable ECHO operation using scheme switch [**Dis-ECHO**] by setting it to **Off**.

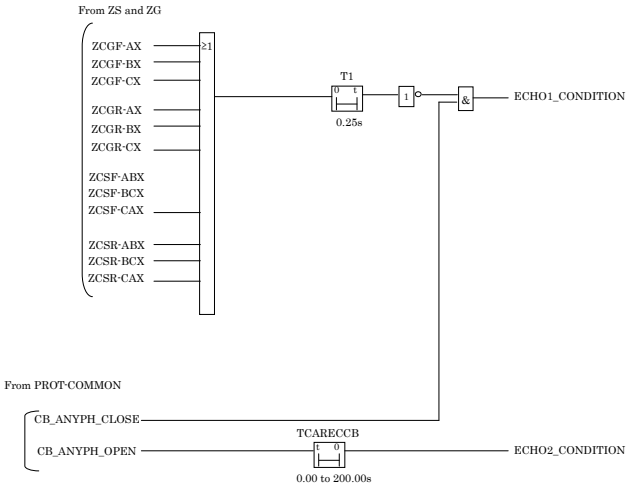


Figure 2.6-7 ZCS and ZCG for ECHO/WKIT operation

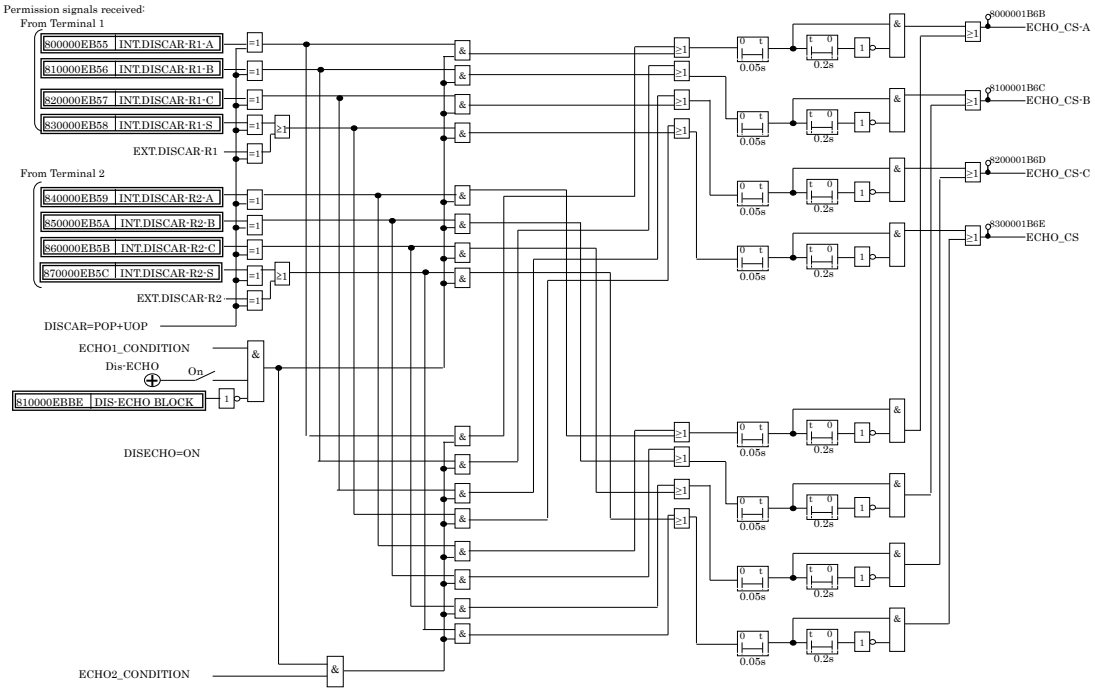


Figure 2.6-8 ECHO logic

(ii) WIKT function

Figure 2.6-9 shows WIKT logic. WIKT can issue a trip signal on condition that a trip permission signal has been received when POP operates. On the other hand, when UOP operates, WIKT can issue a trip signal when a trip block signal has been stopped.

To operate WIKT, the following conditions are required:

- ✓ Undervoltage elements (UVLS or UVLG) being operated.
- ✓ Neither forward overreaching element nor reverse looking element being operated.

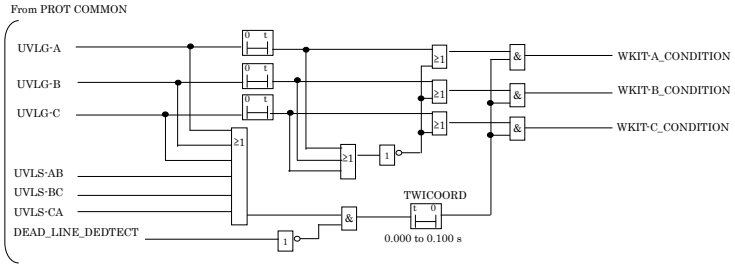


Figure 2.6-9 UV for WIKT

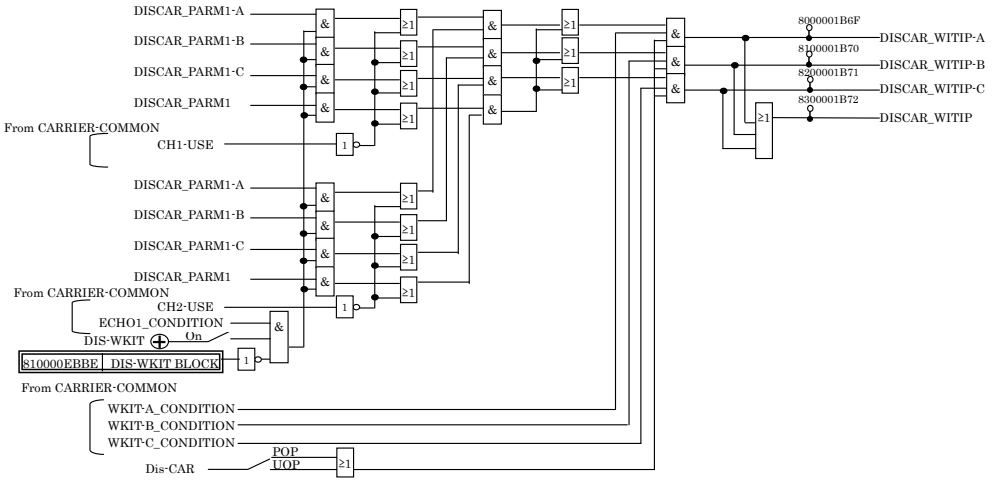


Figure 2.6-10 WIKT logic

UV responds to three phase-to-phase voltages and three phase-to-ground voltages. UV prevents false weak infeed tripping due to spurious operation of the channel.

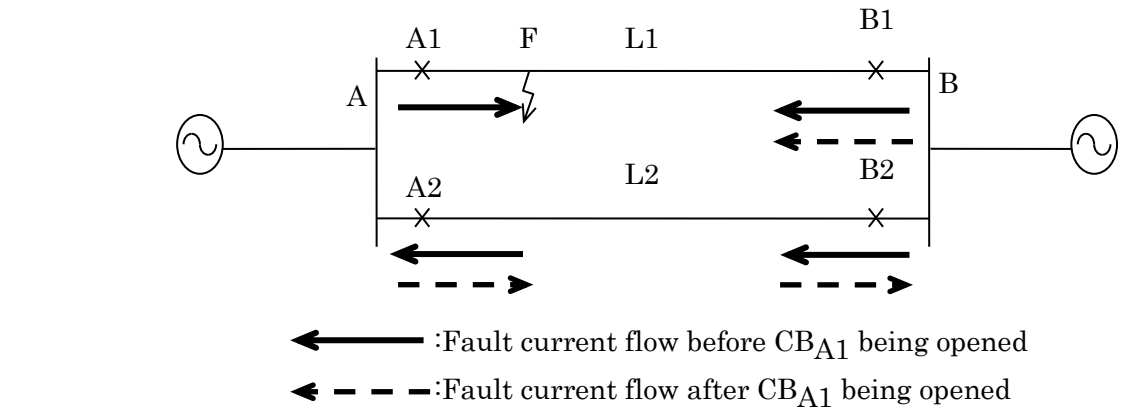
WIKT can be enabled using scheme switch [**Dis-WKIT**] **On**.

2.6.6 Countermeasure for current reversal

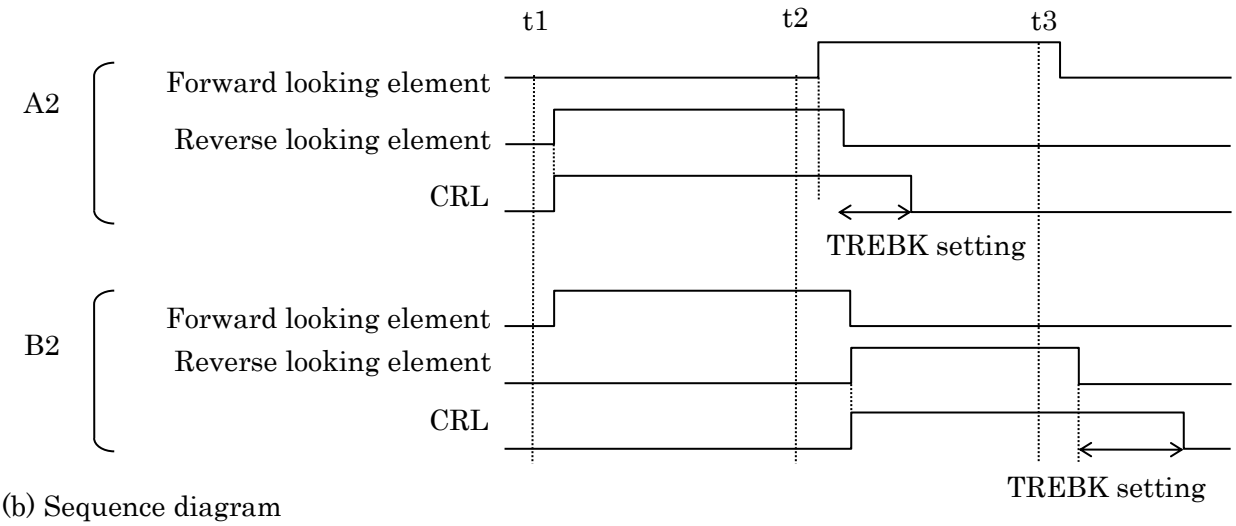
When a fault occurs on one of the parallel lines, the reversal of fault current may be found on another line owing to sequential CB opening. In the worst case, the current reversal can result in false operation in POP, UOP and BOP. Thus, POP, UOP and BOP have current reversal logic (CRL) to prevent the false operation.

Figure 2.6-11(a) shows the arrangement of parallel lines, as an example. Suppose that a fault occurs at location F on line L1 at time t1. CB_{A1} is tripped at time t2; and later, CB_{B1} is tripped at time t3. The current direction on line L2 can be reversed at time t2. That is, the current (⟶) from terminal B to terminal A is found from time t1 to t2. However, the current (- - >) from terminal A to terminal B is found from time t2 to t3. The current

reversal may be found when an external looped circuit exists if not for parallel lines.



(a) Direction of fault current



(b) Sequence diagram

Figure 2.6-11 Current reversal phenomeon

Figure 2.6-11 (b) shows sequentially the operation of the forward looking element, the reverse looking element, and CRL on line L2 before and after the occurrence of the current reversal.

At terminal A2, the forward looking element does not run, but the reverse looking element runs when the current reversal is yielded. At terminal B2, the forward looking element runs, but the reverse looking element does not run.

Provided that the forward looking element runs at terminal A2 before the forward looking element does not run at terminal B2. This may cause false operation of POP, UOP and BOP on line L2.

Figure shows CRL logic. CRL logic can determine the current reversal when the reverse looking element runs and the forward looking element does not run. If the current reversal is found, CRL declares for the opposite terminal to block the trip operation immediately. At the same time, CRL blocks CB tripping at its own terminal. If the condition of current reversal continues longer than 20ms, CRL lasts to run for setting [**TREBK-Dis**] even after the current reversal ceases.

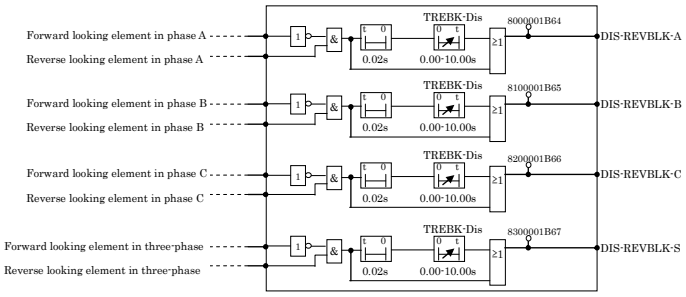


Figure 2.6-12 Current reversal logic

The operation of CRL and its effect in the current reversal are follows:

- CRL at terminal A2 runs immediately after the fault occurs.
- The operation of CRL continues to last for another period of off-delay timer setting [**TREBK-dis**] even after the reverse looking element does not run and the forward looking element runs; CRL continuously blocks the local tripping and transmitting a trip block signal to terminal B2.

Even if operation overlap of the forward looking elements between terminal A2 and terminal B2 arises due to the current reversal, the operation overlap will disappear during the operation of CRL. Thus, the false operation on the healthy line of parallel lines can be removed. When the current reversal occurs in the direction opposite to the above, CRL at terminal B2 will respond similarly.

CRL does not pick up for internal faults; thus, high-speed operation of any protection scheme is not obstructed.

2.6.7 Programing DISCAR using PLC function

It is required to make the connection between the DISCAR function and the DIF_COMM function. This is because the DISCAR function needs to operate with the communication. The PLC function can provide the means of the connections; see *Chapter PLC function*.

2.6.8 Setting

Setting of CARCOM(Function ID: 438001)

Setting item			Range		Unit	Contents	Default setting value		Notes
			1A rating	5A rating	s		1A rating	5A rating	
		CAR-CHNUM	2-TERM/3-TERM		–	Carrier scheme terminal number	2-TERM		
		TCARECCB	0.00 to 200.00		s	Echo enable timer from CB opened	0.10		
		TWICOORD	0.000-0.100		s	Time coordination for UV relay operation	0.000		

Setting of DISCAR (Function ID: 436001)

Setting item			Range		Unit	Contents	Default setting value		Notes
			1A rating	5A rating	s		1A rating	5A rating	
		Dis-CAR	Off/PUP/POP/UOP/BOP			Distance carrier scheme enable	Off		
		Dis-ECHO	Off/On			Echo function enable	Off		
		Dis-WKIT	Off/On			Weak-infeed trip function enable	Off		
		DisCAR-CHSEL	Single/And/Guard			Carrier channel configuration	Single		
		TREBK-Dis	0.00 to 10.00		s	Current reverse blocking time	0.10		
		TCHD-Dis	0.000 to 0.100		s	Coordination timer in BOP function	0.012		
		TSBCT-Dis	0.00 to 1.00		s	SBCNT timer	0.10		
		DisCAR-TPMD	1P/3P			Distance carrier trip mode, phase segregated trip or 3-phase trip	1P		
		DisCAR-ARCBlk	Non/Block			Autoreclose block by distance carrier trip	Non		

2.6.9 Data ID

◆ Connection point on PLC logic

CARCOM(Function ID: 438001)

Element ID	Name	Description
800000EBB0	CAR_BLOCK	Carrier block signal

◆ Signal monitoring point

DISCAR(Function ID: 436001)

Element ID	Name	Description
8000001B60	EXT.DISCAR-R1	
8000001B61	LOSS-DISCAR1	
8100001B62	EXT.DISCAR-R2	
8100001B63	LOSS-DISCAR2	
8000001B64	DIS-REVBLK-A	
8100001B65	DIS-REVBLK-B	
8200001B66	DIS-REVBLK-C	
8300001B67	DIS-REVBLK-S	
8000001B68	PPUB_TRIP-A	PPUB trip signal(phase-A)
8100001B69	PPUB_TRIP-B	PPUB trip signal(phase-B)
8200001B6A	PPUB_TRIP-C	PPUB trip signal(phase-C)
8000001B6B	ECHO_CS-A	
8100001B6C	ECHO_CS-B	
8200001B6D	ECHO_CS-C	
8300001B6E	ECHO_CS	
8000001B6F	DISCAR_WITRIP-A	WI trip signal(phase-A)
8100001B70	DISCAR_WITRIP-B	WI trip signal(phase-B)
8200001B71	DISCAR_WITRIP-C	WI trip signal(phase-C)
8300001B72	DISCAR_WITRIP	
8000001B73	DISCAR-OPT-A	DISCAR operation(phase-A)
8100001B74	DISCAR-OPT-B	DISCAR operation(phase-B)
8200001B75	DISCAR-OPT-C	DISCAR operation(phase-C)
8300001B76	DISCAR-OPT	DISCAR operation
8000001B20	DISCAR-TRIP-A	Distance carrier trip signal(phase-A)
8100001B21	DISCAR-TRIP-B	Distance carrier trip signal(phase-B)
8200001B22	DISCAR-TRIP-C	Distance carrier trip signal(phase-C)
8100001B77	DISCAR-ARC-BLOCK	Distance carrier ARC block signal
8000001B78	INT.DISCAR-S-A	
8100001B79	INT.DISCAR-S-B	
8200001B7A	INT.DISCAR-S-C	
8300001B7B	INT.DISCAR-S-S	
8F00001B7C	DISCAR-S	
8800001B7E	DISCAR-OPT-AR	Distance carrier operation(phase-A)
8900001B7F	DISCAR-OPT-BR	Distance carrier operation(phase-B)
8A00001B80	DISCAR-OPT-CR	Distance carrier operation(phase-C)
8C00001B81	DISCAR-OPT-ABR	Distance carrier operation(phase-AB)

◆ Signal monitoring point

DISCAR(Function ID: 436001)

Element ID	Name	Description
8D00001B82	DISCAR-OPT-BCR	Distance carrier operation(phase-BC)
8E00001B83	DISCAR-OPT-CAR	Distance carrier operation(phase-CA)
8000001BB0	DISCAR_BLOCK	Distance carrier block signal
8000001BB1	DISCAR-R1	
8000001BB2	DISCAR-R1-2	
8100001BB3	DISCAR-R2	
8100001BB4	DISCAR-R2-2	

◆ Connection point on PLC logic

DISCAR(Function ID: 436001)

Element ID	Name	Description
800000EBB0	DISCAR_BLOCK	Distance carrier block signal
800000EBB1	DISCAR-R1	
800000EBB2	DISCAR-R1-2	
810000EBB3	DISCAR-R2	
810000EBB4	DISCAR-R2-2	
800000EBB5	INT.DISCAR-R1-A	
810000EBB6	INT.DISCAR-R1-B	
820000EBB7	INT.DISCAR-R1-C	
830000EBB8	INT.DISCAR-R1-S	
840000EBB9	INT.DISCAR-R2-A	
850000EBBA	INT.DISCAR-R2-B	
860000EBBB	INT.DISCAR-R2-C	
870000EBBC	INT.DISCAR-R2-S	
800000EBBD	DIS-ECHO BLOCK	
810000EBBE	DIS-WKIT BLOCK	
800000EBBF	DISCAR_3PTP	DISCAR 3phase trip command
810000EBC0	DISCAR_ARCBLOCK	DISCAR ARC block command
800000EBC1	DISCAR_F.BLOCK	
810000EBC2	DISCAR_F.PERMIT	

2.7 Directional earth fault command protection (DEFCAR)

Directional earth fault command protection (DEFCAR) provides POP, UOP and BOP techniques† using two elements of earth fault protection between in forward and in reverse (DEFCF and DEFCR‡). POP, UOP and BOP can issue either a single-pole trip (1P) or three-phase trip (3P). These can also enable to run the function of autoreclose (ARC). User can select either first tripping or delayed tripping in DEFCAR with set of delay timer. Thus, it is possible to give priority to the function of distance carrier protection (DISCAR) so that DISCAR runs faster than DEFCAR. DEFCAR send a trip block signal for the opposite terminal when one or two poles in CB are open and when the failure of voltage transformer occurs.

†Note: When both DISCAR and DEFCAR are used mutually for the command protection, user should coordinate the technique between DISCAR and DEFCAR. For the selection of the techniques in DEFCAR, see section 2.6.

‡Note: In DEFCAR, EF1 is used for a forward element (DEFCF); EF2 is used for a reverse element (DEFCR). Both EF1 and EF2 are the function of earth fault protection (EF). For more information, see Chapter *Relay application: Earth fault protection*.

Note: Several IED models do not have carrier features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.7-1 Comparative table in respective ordering numbers

feature	Ordering No. at "G&T"	10	11	13	19	22
DEFCAR	Directional-earth-fault carrier command protection	NA	NA	✓	(✓)	NA

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among OC, EF, OCN, THM, BCD, CBF, SOTF-OC, OV, OVS, UV, UVS, FRQ/DFRQ, FS, VTF, CTF, ARC, VCHK.

2.7.1 Permissive overreach protection (POP)

DEFCAR sends a trip permission signal in POP; and POP does not send a trip permission signal for non-internal fault. Figure 2.7-1 shows POP scheme logic. The elements of OCD are used to select a phase which should be tripped in CB.

When POP receives a trip permission signal, POP issues a trip signal on condition that DEFCF has operated. To assure issuing a trip signal at the opposite terminal, POP continues to send a trip permission signal for setting [**TSBCT-DEF**] after DEFCF stops. (Figure 2.7-2)

DEFCR is used for CRL as a revers looking element; DEFCF is used as a forward looking element, as shown in Figure 2.7-3. (For more information of CRL, see section 2.6.6) When DEFCR runs but DEFCF continues to stop for 20 ms or more—even if DEFCF starts to run or DEFCR stops later—tripping CB at local terminal or transmission of the trip permission signal is blocked for setting [**TREBK-DEF**].

In POP, users can delay the DEFCAR sending using settings [**TDEFCF**] and [**TDEFCB**]. Users can also delay the DEFCAR tripping using setting [**TDEFC**]. Thus, if users wish to carry out the DEFCAR sending and the DEFCAR tripping separately, users should set a value for the setting [**TDEFCF**] and another value for the setting [**TDEFC**]. For example, when 0 ms set for the [**TDEFCF**] and 50 ms set for the [**TDEFC**], the DEFCAR sending is performed faster than the DEFCAR tripping. (See section 2.7.4 for more information)

POP can provide ECHO and WKIT functions, which are used for the line having weak infeed terminals. ECHO allows fast CB tripping at the terminal on which DEFCF has operated when applied to the line having an open terminal or a weak infeed earth fault current terminal. (Figure 2.7-4 to Figure 2.7-7) (For more information of ECHO and WKIT, see section 2.6.5)

When a trip permission signal is received if neither DEFCF nor DEFCR operates, ECHO sends back the received signal to the opposite terminal. When CB is open, ECHO also sends back the trip permission signal.

Once DEFCF or DEFCR operates, ECHO inhibits to send the echo signal for 250 ms by delayed drop-off timer T1 even after DEFCF and DEFCR stop to operate.

In order to prevent any spurious echo signal from looping round between terminals in a healthy state, sending ECHO signal is restricted for 200 ms by delayed pick-up timer T2. Echo can operate using scheme switch [**DEF-ECHO**] **On**.

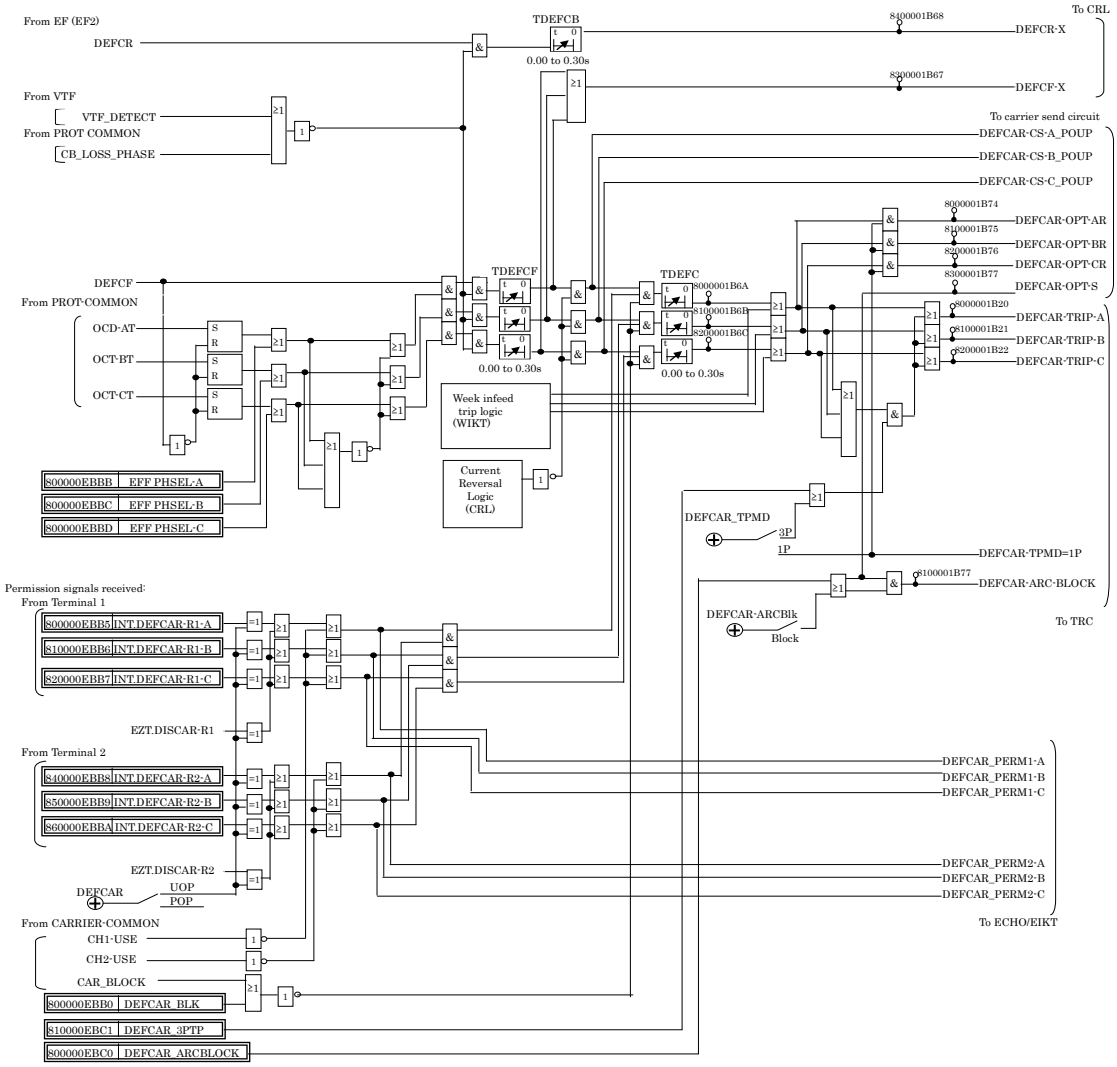


Figure 2.7-1 POP and UOP scheme logic

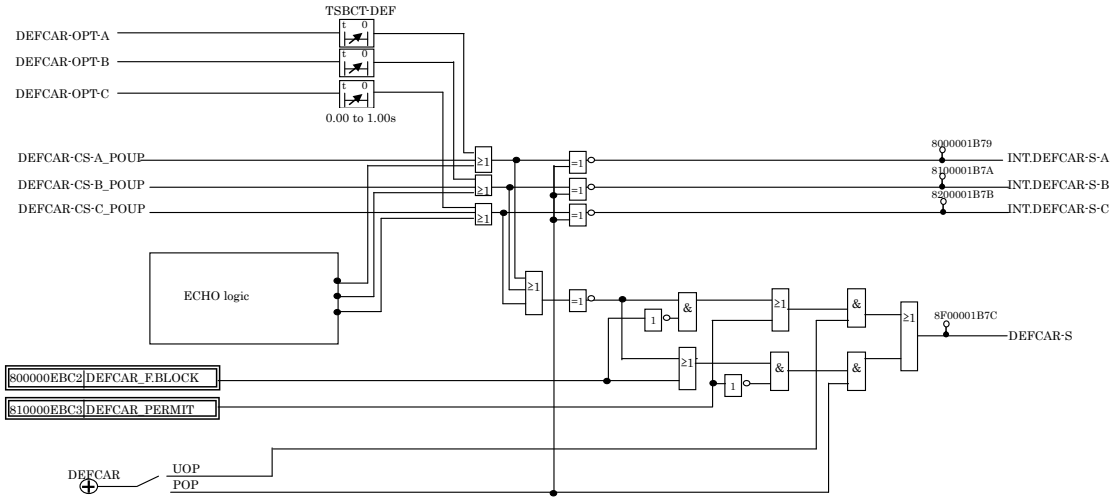


Figure 2.7-2 Sending circuit in POP and UOP

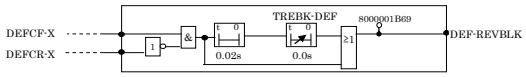


Figure 2.7-3 Current reversal logic

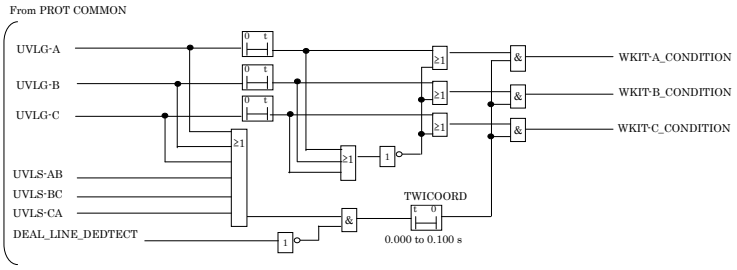


Figure 2.7-4 UVL for WKIT operation

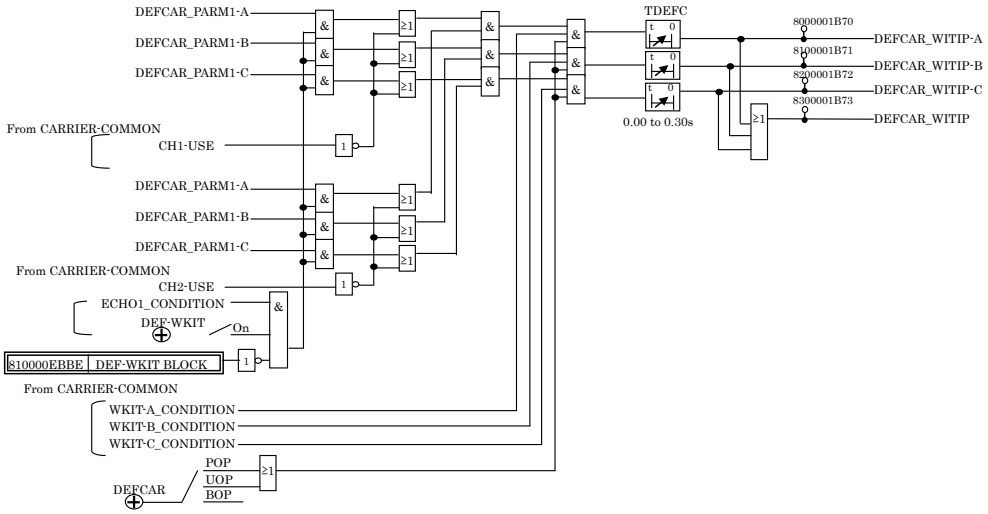


Figure 2.7-5 WKIT logic

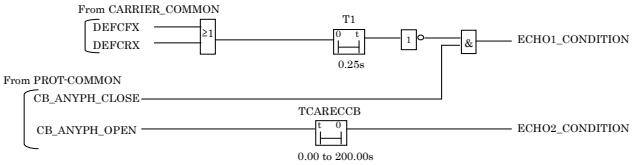


Figure 2.7-6 EF for ECHO/WKIT operation

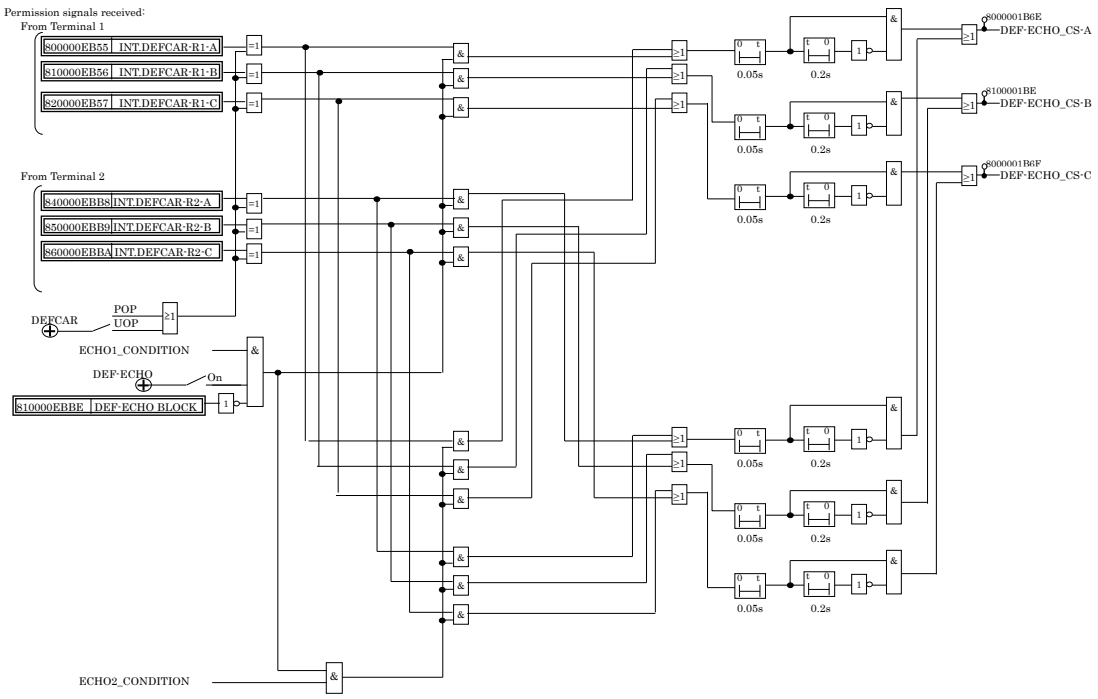


Figure 2.7-7 ECHO logic

2.7.2 Unblocking overreach protection (UOP)

DEFCAR sends a trip block signal in UOP. Thus, UOP stops to send a trip block signal for an internal fault. Settings and operation of UOP is the same as POP.

2.7.3 Blocking overreach protection (BOP)

BOP send a trip block signal except for an internal fault. When DEFCF operates, BOP issues a trip single unless a trip blocking single is received.

The delayed pick-up timer [**TCHD-DEF**] is provided to allow for the transmission delay of the trip block signal from the opposite terminal. Therefore, user should set a time depending on the delay of communication channel.

Setting **[TCHD-DEF]** = maximum signal transmission delay time† + 5ms

†Note: Including operation time of circuits of Binary IO modules; these circuits are used to send/receive a trip blocking signal.

For setting [**TREBK-DEF**], see section 2.7.1.

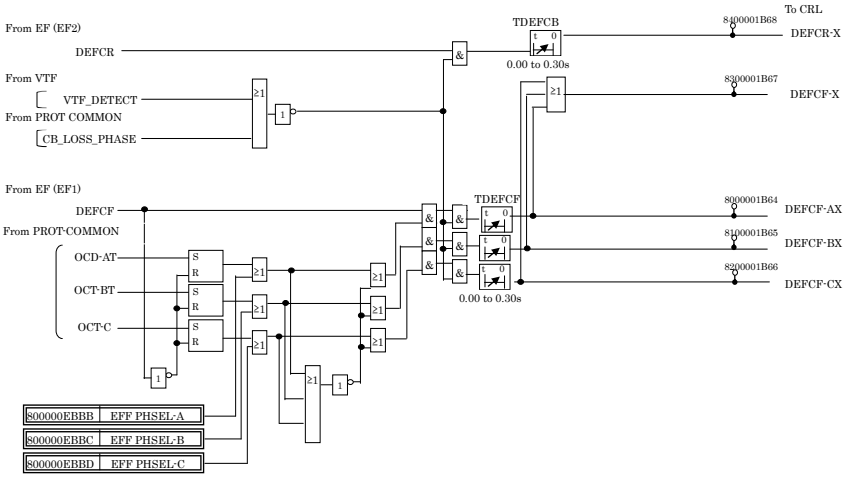


Figure 2.7-8 OCD circuit for BOP

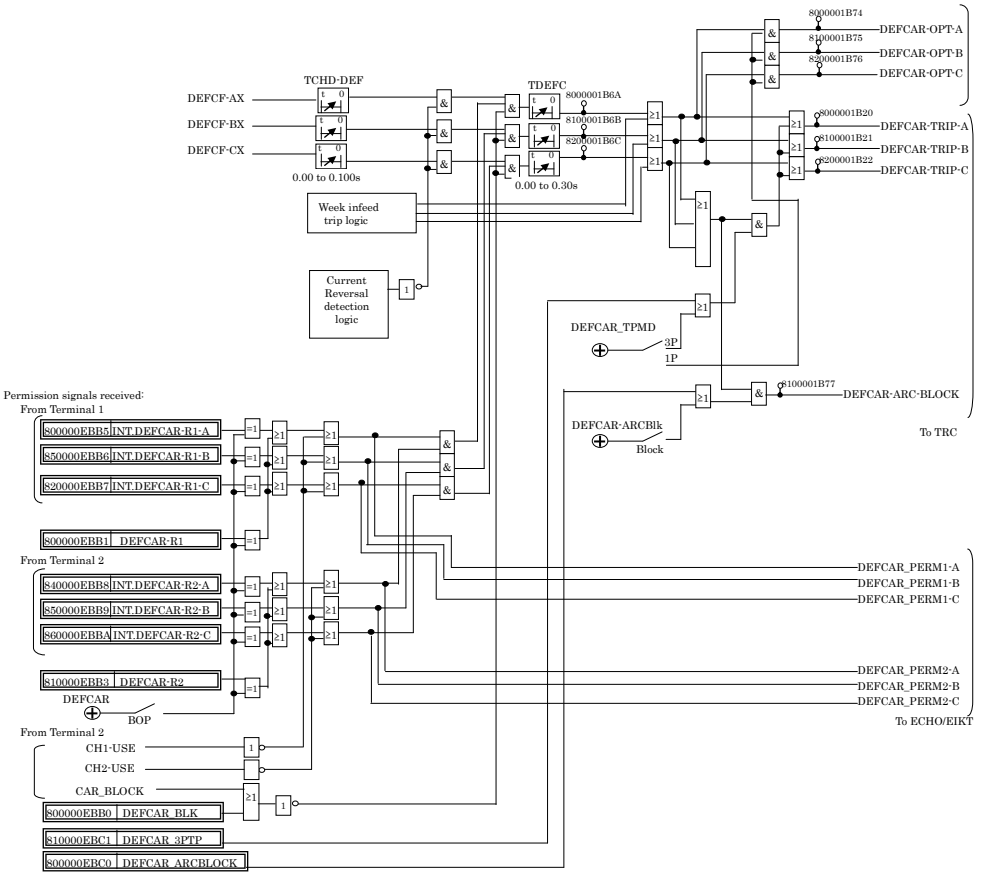


Figure 2.7-9 BOP scheme logic

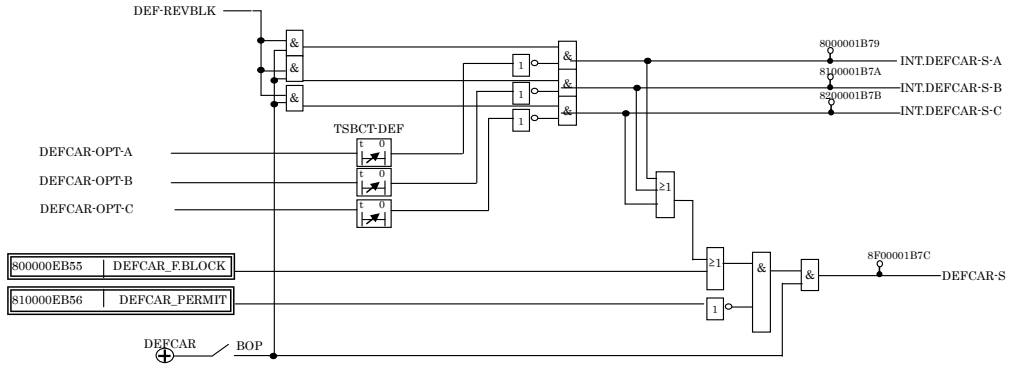


Figure 2.7-10 Sending circuit of BOP

2.7.4 Coordination with DISCAR protection

The DEFCAR function, as rule, is used together with the distance carrier command protection (DISCAR†); hence, the user is required to establish the coordination between the DEFCAR function and the DISCAR function so that both can operate without interference. The followings exemplify how to establish the coordination using the DEFCAR settings sand signals.

†Note: For more information of the DISCAR, see chapter *Relay application: Distance carrier command protection*.

(i) DISCAR and DEFCAR signals being separated

When the DISCAR signal and the DEFCAR signal are used separately, the user should set 0 for the [**TDEFCF**]. Consequently, the DEFCAR function can trip in **TDEFC** after the reception of the DEFCAR signal. Figure 2.7-11 shows the relationship of sending-signal, receiving-signal, and tripping in the DEFCAR function.

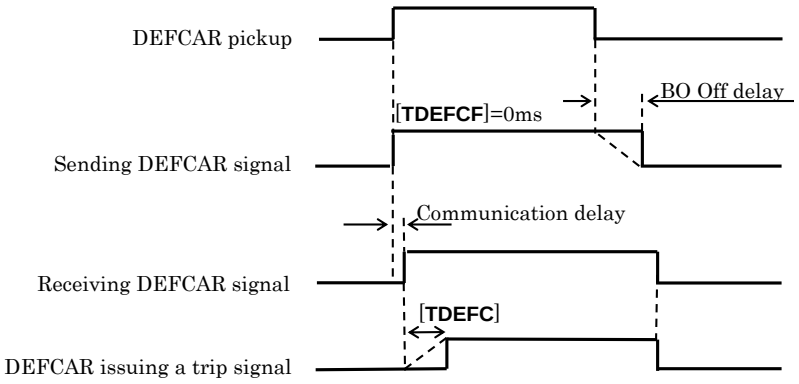


Figure 2.7-11 Sending signal and receiving signal in DEFCAR

Note: It is recommend prolonging DEFCAR signal.

(ii) DISCAR and DEFCAR signals being shared

When the DISCAR signal and the DEFCAR signal are used as a shared signal, the user should set should set 0 for the [**TDEFC**]. Consequently, the DEFCAR function can issue a trip signal

after the reception of the DEFCAR signal that is prolonged by the setting [**TDEFCF**]. Figure 2.7-12 shows the relationship of sending-signal, receiving-signal, and tripping in the DEFCAR function.

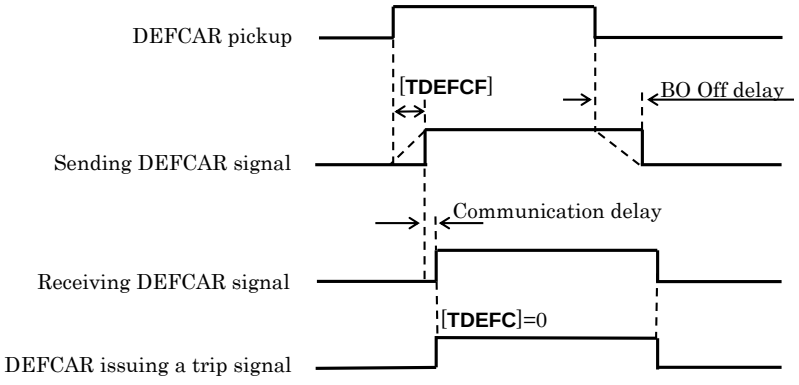


Figure 2.7-12 Sending signal and receiving signal shared in DEFCAR

2.7.5 Programing DEFCAR using PLC function

It is required to make the connection between the DEFCAR function and the DIF_COMM function. This is because the DEFCAR function needs to operate with the communication. The PLC function can provided the means of the connections; see *Chapter PLC function*.

2.7.6 Setting

Setting of DEFCAR (Function ID: 437001)

Setting item			Range		Unit	Contents	Default setting value		Notes
			1A rating	5A rating	s		1A rating	5A rating	
		DEF-CAR	Off/POP/UOP/BOP			DEF carrier scheme enable	Off		
		DEF-ECHO	Off/On			Echo function enable	Off		
		DEF-WKIT	Off/On			Weak infeed trip function enable	Off		
		DEFCAR-CHSEL	Single/And/Guard			Carrier channel configuration	Single		
		TDEFCF	0.00 – 0.30		s	DEF carrier trip delay time	0.15		
		TDEFCB	0.00 – 0.30		s	DEF carrier trip delay time	0.15		
		TDEFC	0.00 – 0.30		s	DEF carrier trip delay time	0.00		
		TREBK-DEF	0-10		s	Current reverse blocking time	0.1		
		TCHD-DEF	0-0.1		s	Coordination timer in BOP function	0.012		
		TSBCT-DEF	0-1		s	SBCNT timer	0.1		
		DEFCAR-TPMD	1P/3P			DEF carrier trip mode, phase segregated trip or 3-phase trip	3P		
		DEFCAR-ARCBlk	Non/Block			Autoreclose block by DEF carrier trip	Block		

2.7.7 Data ID

◆ Signal monitoring point

DEFCAR (Function ID: 437001)

Element ID	Name	Description
8000001B60	EXT.DEFCAR-R1	External DEF carrier received from remote 1
8000001B61	LOSS-DEFCAR1	DEF carrier loss condition for remote 1
8100001B62	EXT.DEFCAR-R2	External DEF carrier received from remote 2
8100001B63	LOSS-DEFCAR2	DEF carrier loss condition for remote 2
8000001B64	DEFCF-AX	DEF carrier A phase (Forward)
8100001B65	DEFCF-BX	DEF carrier B phase (Forward)
8200001B66	DEFCF-CX	DEF carrier C phase (Forward)
8300001B67	DEFCF-X	DEF carrier 3-phases OR (Forward)
8400001B68	DEFCR-X	DEF carrier (Reverse)
8000001B69	DEF-REVBLK	
8000001B6A	DEFPPUB_TRIP-A	DEF carrier trip of A phase (For POP+UOP)
8100001B6B	DEFPPUB_TRIP-B	DEF carrier trip of B phase (For POP+UOP)
8200001B6C	DEFPPUB_TRIP-C	DEF carrier trip of C phase (For POP+UOP)
8000001B6D	DEF-ECHO_CS-A	ECHO carrier send (A phase)
8100001B6E	DEF-ECHO_CS-B	ECHO carrier send (B phase)
8200001B6F	DEF-ECHO_CS-C	ECHO carrier send (C phase)
8000001B70	DEFCAR_WITRIP-A	Weak infeed trip of A phase
8100001B71	DEFCAR_WITRIP-B	Weak infeed trip of B phase
8200001B72	DEFCAR_WITRIP-C	Weak infeed trip of C phase
8300001B73	DEFCAR_WITRIP	Weak infeed trip (3-phases OR)
8000001B74	DEFCAR-OPT-A	DEF carrier operation of A phase
8100001B75	DEFCAR-OPT-B	DEF carrier operation of B phase
8200001B76	DEFCAR-OPT-C	DEF carrier operation of C phase
8300001B77	DEFCAR-OPT	DEF carrier operation (3-phases OR)
8000001B20	DEFCAR-TRIP-A	DEF carrier trip of A phase
8100001B21	DEFCAR-TRIP-B	DEF carrier trip of B phase
8200001B22	DEFCAR-TRIP-C	DEF carrier trip of C phase
8100001B78	DEFCAR-ARC-BLOCK	ARC block signal by DEF carrier
8000001B79	INT.DEFCAR-S-A	DEF carrier of A phase send (Integral type)
8100001B7A	INT.DEFCAR-S-B	DEF carrier of B phase send (Integral type)
8200001B7B	INT.DEFCAR-S-C	DEF carrier of C phase send (Integral type)
8F00001B7C	DEFCAR-S	DEF carrier send (3-phases OR)
8800001B7E	DEFCAR-OPT-AR	DEF carrier operation of A phase (For record)
8900001B7F	DEFCAR-OPT-BR	DEF carrier operation of B phase (For record)
8A00001B80	DEFCAR-OPT-CR	DEF carrier operation of C phase (For record)
8000001B83	DEFCAR=ON	DEF carrier scheme enabled condition

◆ Connection point on PLC logic

DEFCAR (Function ID: 437001)

Element ID	Name	Description
800000EBB0	DEFCAR_BLOCK	DEF carrier block signal
800000EBB1	DEFCAR-R1	DEF carrier received from remote 1
800000EBB2	DEFCAR-R1-2	DEF carrier received from remote 1-2

◆ Connection point on PLC logic

DEFCAR (Function ID: 437001)

Element ID	Name	Description
810000EBB3	DEFCAR-R2	DEF carrier received from remote 2
810000EBB4	DEFCAR-R2-2	DEF carrier received from remote 2-2
800000EBB5	INT.DEFCAR-R1-A	DEF carrier of A phase received from remote 1 (Integral type)
810000EBB6	INT.DEFCAR-R1-B	DEF carrier of B phase received from remote 1 (Integral type)
820000EBB7	INT.DEFCAR-R1-C	DEF carrier of C phase received from remote 1 (Integral type)
840000EBB8	INT.DEFCAR-R2-A	DEF carrier of A phase received from remote 2 (Integral type)
850000EBB9	INT.DEFCAR-R2-B	DEF carrier of B phase received from remote 2 (Integral type)
860000EBBA	INT.DEFCAR-R2-C	DEF carrier of C phase received from remote 2 (Integral type)
800000EBBB	DEF PHSEL-A	DEF selected A phase
810000EBBC	DEF PHSEL-B	DEF selected B phase
820000EBBD	DEF PHSEL-C	DEF selected C phase
800000EBBE	DEF-ECHO BLOCK	Echo function blocked
810000EBBF	DEF-WKIT BLOCK	Weak infeed trip function blocked
800000EBC0	DEFCAR_3PTP	DEF Carrier 3 phase trip
810000EBC1	DEFCAR_ARCBLOCK	ARC block signal by DEF carrier
800000EBC2	DEFCAR_F.BLOCK	Blocked DEF carrier send
810000EBC3	DEFCAR_F.PERMIT	Permitted DEF carrier send
800000EBB0	DEFCAR_BLOCK	DEF carrier block signal

2.8 Switch on to fault (SOTF-OC)

The switch-onto-fault function (SOTF-OC) is used to detect and rapidly clear faults when circuit breakers (CBs) are closed onto a pre-existing fault in the protected zone. If a circuit breaker is closed onto a permanent fault, the memory circuit in the IED will be unable to memorize the voltage data required to retain the pre-fault values. This is because the voltage input to distance measuring elements is absent continuously prior to and after the fault particularly with voltage transformers installed on the line side; as a result, the fault cannot be detected by conventional standard protection functions. Therefore, in order to avoid such failures, SOTF-OC is applied so that the fault can be detected for a specific period following the closure of the CB.

Note: Several IED models do not have switch-on-to-fault features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.8-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
SOTF-OC	Switch on to fault protection	NA	✓	✓	(✓)	✓

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, OCN, THM, BCD, CBF, OV, OVS, UV, UVS, FRQ/DFRQ, FS, VTF, CTF, ARC, VCHK.

2.8.1 Scheme logic

The SOTF-OC function provides signals to the TRC function: SOTFOC-OPT-A,-B,-C, SOTFOC-TRIP, and SOTFOC-ARC-BLOCK. The SOTF-OC function issues a trip signal upon the operation of the OCSOTF element if CBs are closed onto a fault when energizing a transmission line following a period of non-operation. The criterion for the transmission line being in the non-operation state are when (1) the CBs are open for more than 0.5 seconds and (2) the undervoltage elements in the PROT COMMON function remain operated for more than 0.5 seconds. The TRIP and PROT COMMON functions are discussed separately. (See chapter *Relay application: Trip circuit and Protection common*.)

Setting [**OCSOTF**] is provided to determine the SOTF threshold. Setting [**OCSOTF-2fBlk**] is used to override the SOTF function when the SOTF-OC detects a second harmonic. If **Block-3P** is set for the setting [**OCSOTF-2fBlk**], all of the OCSOTF elements are overridden when second harmonic is present. Alternatively, if **Block-PerP** is set for the setting [**OCSOTF-2fBlk**], each individual OCSOTF element of the SOTF function is overridden for second harmonic currents. The detection of the second harmonic is determined by the function of the inrush current detector (ICD). The ICD function is discussed separately. (See chapter *Relay application: Inrush current detection function*.)

The SOTF-OC function is active when **On** is set for the setting [**SOTFOC-EN**]. Setting [**SOTF-test**] is used for the mandatory condition of cold load when testing. When wishing to add another condition into the logic for the SOTF operation, the user can inject the signal using PLC connection point “ADD.SOTF.EN”.

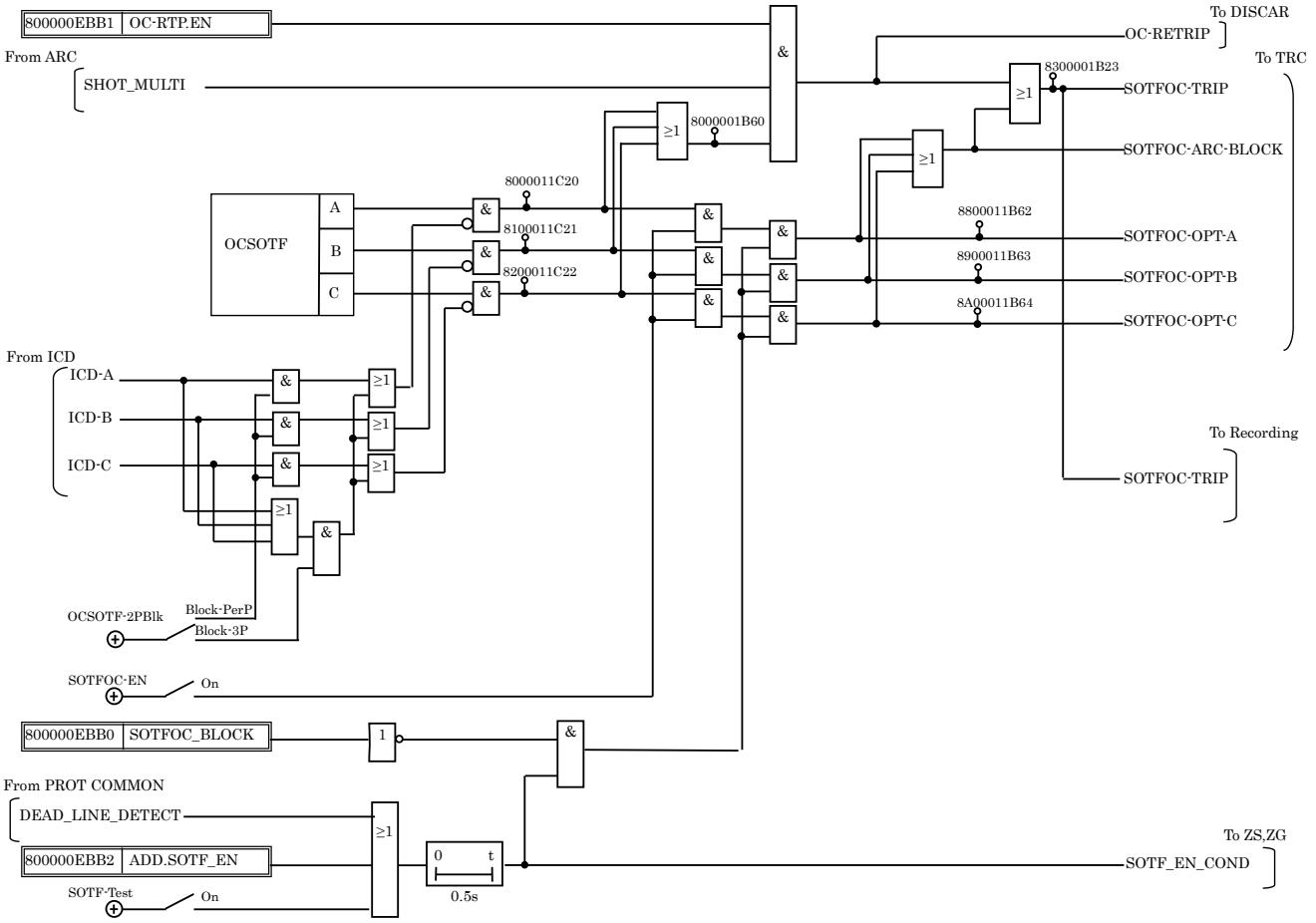


Figure 2.8-1 Scheme logic for the SOTF-OC

2.8.2 Setting

Setting of SOTF-OC(Function ID: 454001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
SOTF-OC	SOTFOC-EN	Off / On		-	SOTF-OC protection enable	Off		
	OCSOTF	0.02 - 3.00	0.10 - 15.00	A	OC relay for SOTF threshold	1.20	6.00	
	OCSOTF-2fBlk	Non / Block-3P / Block-PerP		-	OCSOTF operation block by 2f-detection	Non		
	SOTF-Test	Off / On		-	Forcibly establishing the cold load condition	Off		

2.8.3 Data ID

◆ Monitoring point for operation

SOTF-OC(Function ID: 454001)

Element ID	Name	Description
8000001B67	OC-RETRIP	OC-RETRIP
8000001C20	OCSOTF-A	SOTFOC relay element operated (phase-A)
8100001C21	OCSOTF-B	SOTFOC relay element operated (phase-B)
8200001C22	OCSOTF-C	SOTFOC relay element operated (phase-C)
8000001B60	OCSOTF-OR	SOTFOC relay element operated (3-phases OR)
8800001B62	SOTFOC-OPT-A	SOTFOC protection operated (phase-A)
8900001B63	SOTFOC-OPT-B	SOTFOC protection operated (phase-B)
8A00001B64	SOTFOC-OPT-C	SOTFOC protection operated (phase-C)
8300001B23	SOTFOC-TRIP	Trip signal by SOTFOC protection operation

◆ Connection point on PLC logic

SOTF-OC(Function ID: 454001)

Element ID	Name	Description
800000EBB2	ADD.SOTF_EN	Additional SOTFOC enable
800000EBB1	OC-RTP.EN	OC-Retrip enable
800000EBB0	SOTFOC_BLOCK	SOTFOC protection block command

2.9 Overcurrent protection (OC)

The phase overcurrent (OC) protection is the major protection function and has both time characteristic and directional elements. Either two or four stages (elements) are available in the OC protection; the number of the stages (elements) depends on the models. The user can select various features using the scheme switches provided. The elements are named OC1, OC2, and others; they operate independently.

To simplify the description, only OC1 is discussed but is applicable to the other OCs; hence, read the expression for OC1 as OC2 etc. at each OC stage unless a special explanation or instruction has been provided.

Note: The number of relay elements depends on the IED model. To know the number in respective IED models, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.9-1 Comparative table in respective ordering numbers

Features	Ordering No. at "G&T"				
	10	11	13	19	22
Non-directional/directional definite time OC protection	✓	✓	✓	(✓)	✓
Number of stages	4	2	2	4	2

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, EF, OCN, THM, BCD, CBF, SOTF-OC, OV, OVS, UV, UVS, FRQ/DFRQ, FS, VTF, CTF, ARC, VCHK.

2.9.1 Relay polarity

The user can choose either non-directional OC or directional OC for each OC stage. In addition, the user can further select either the forward or the reverse direction for each of the directional OC elements selected.

(i) Characteristic of non-directional OC

The characteristic of the non-directional type OC is a circle that has a center at the origin. A setting and a scheme switch is used to configure each non-directional OC element; i.e., the user can set the threshold value of the non-directional OC element for stage 1 using setting [**OC1-DT**], provided time characteristic is required for define time delay (DT) described in section 2.9.2(i). **Nondir** is set for the scheme switch [**OC1-Dir**].

(ii) Characteristic of directional-OC element in the forward direction

As shown in Figure 2.9-1, the characteristic of the directional-OC elements in the forward direction is a semi-circle based upon the border-line; the hatched area shows the operating region of a directional-OC element.

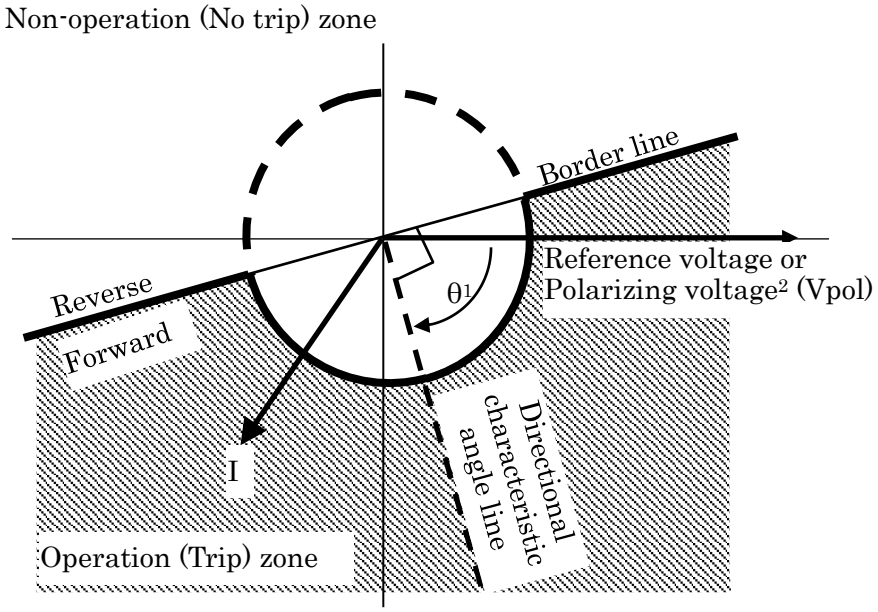


Figure 2.9-1 Characteristic of the directional-OC element in the forward direction

[1]Note: Directional characteristic angle (θ) forms the angle between the reference quantity and the directional characteristic angle line. The half plane represents the zone of operation bordered on one side by the border line and extending in the direction that contains both the reference (polarizing) and operating quantities.

[2]Note: For the polarizing voltage (Vpol), greater than 1.0 voltage should be applied for sensing.

A reference signal, that is, a polarization signal is required by the directional OC element, the reference signal is derived from a phase-to-phase voltage: for example, the directional OC

element for phase-A (OC-A) uses the phase-B-to-phase-C voltage rotated by 90° ($V_{BC}\angle 90°$) in the leading direction, this reference signal is illustrated in Figure 2.9-2. The direction of the current in the protected circuit, in this case the phase-A current (I_A), is determined from the angle measured for I_A against $V_{BC}\angle 90°$. The purpose of using V_{BC} in the 90° leading position is so that the reference voltage ($V_{BC}\angle 90°$) takes the same direction as the phase-A voltage (V_A) because the directional-sensing element requires a reference quantity that is reasonably constant against which the current in the protected circuit can be compared. As a result, when a fault occurs, the fault current I_A will lag $V_{BC}\angle 90°$. Similarly, for the phase-B directional OC element (OC-B) where the object current is (I_B) the reference voltage ($V_{CA}\angle 90°$) is adopted. The phase-C directional element (OC-C) uses the same approach as the OC-A and OC-B elements. Table 2.9-2 shows the relationship between each current and its respective reference voltage.

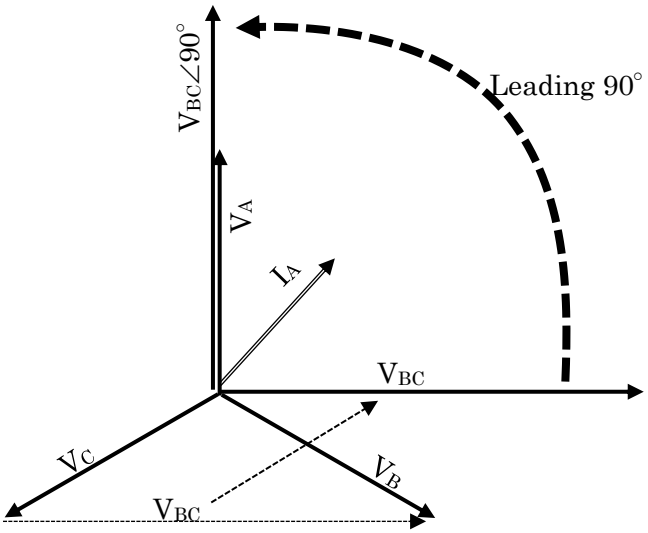


Figure 2.9-2 Object current (I_A) and reference voltage ($V_{BC}\angle 90°$)

Table 2.9-2 Directional polarizing signal

Directional element	Object current	Reference voltage
OC-A	I_A	$V_{BC}\angle 90°$
OC-B	I_B	$V_{CA}\angle 90°$
OC-C	I_C	$V_{AB}\angle 90°$

For a close-in three-phase fault, the three reference voltages $V_{BC}\angle 90°$, $V_{CA}\angle 90°$ and $V_{AB}\angle 90°$ may fall below the minimum threshold voltage for the directional OC element. In order to cover this case, a voltage memory function is used to provide a polarizing signal. The polarizing signals are provided during three-phase faults so that the OC element is able to determine the direction of the fault. In addition, the directional element function determines its output based on the loss of voltage memory and is effective while the fault current flows in accordance with Figure 2.9-3.

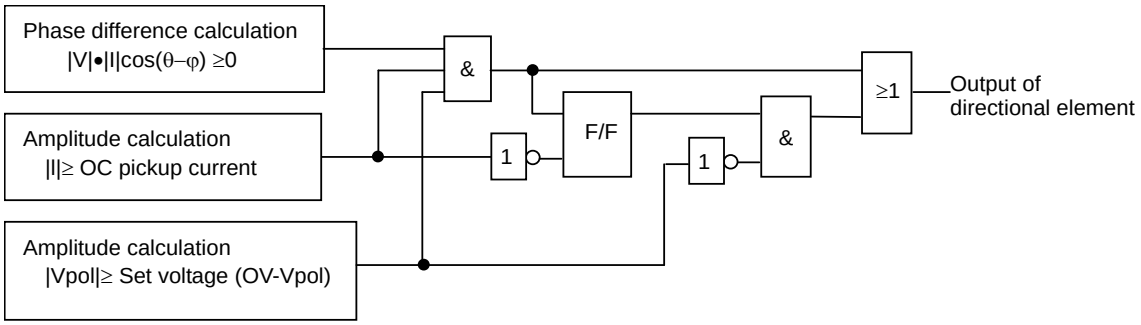


Figure 2.9-3 Direction determination after loss of voltage memory

If a single phase is connected to a heavy load, and the other phases are not connected to heavy loads, the user can program separately the directional OC element such that OC will send a trip signal only when the fault current detected is in the same direction among two phases or more of the three-phases.

A setting and a scheme switch, as well as the non-directional OC element, provide the settings for the directional OC element: for example, the user can set the threshold value of the OC at stage 1 with the setting [**OC1-DT**] and **Forward** can be set for the scheme switch [**OC1-Dir**]. Setting of the sensing angle (θ) is configured by the setting [**OC1-Angle**] with the value of θ set in the range of 0–180°. Figure 2.9-4 shows an example of an angle and a characteristic set with θ.

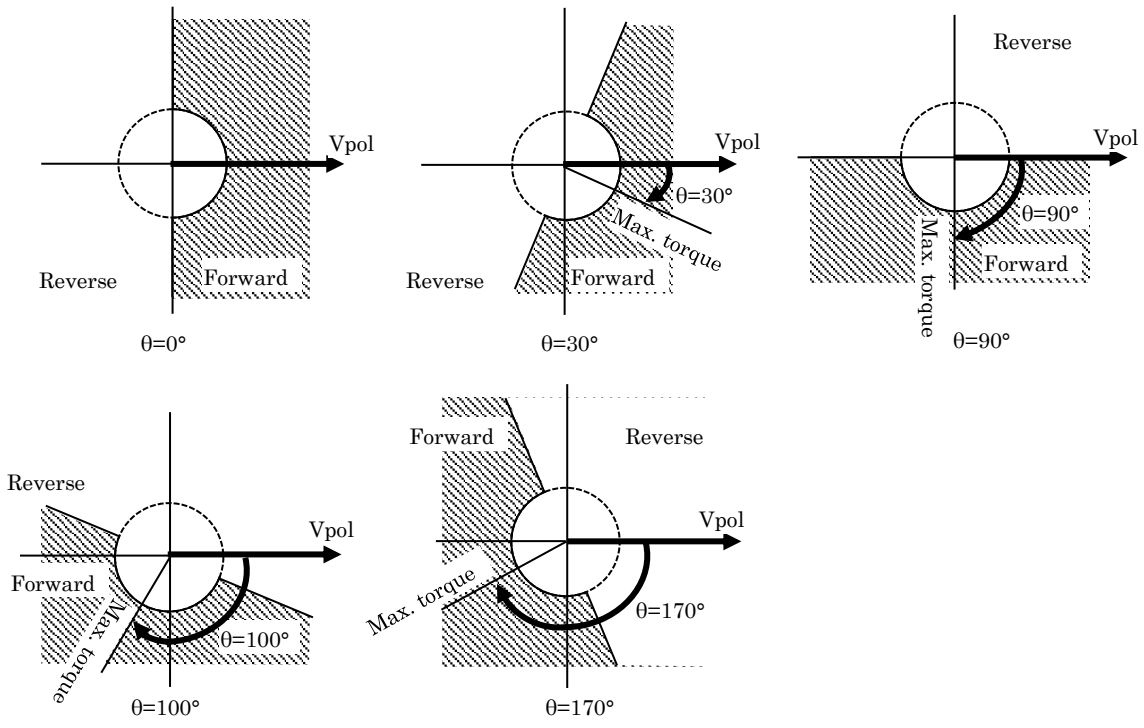


Figure 2.9-4 Examples of directional characteristic angle (θ)

(iii) Characteristic of directional OC in the reverse direction

The reverse characteristic is a mirror image of the forward characteristic. The setting and the scheme switch, as well as the setting of the directional OC element in the forward direction, provides the setting of the directional OC element in the reverse direction: for example, **Reverse** is set for the scheme switch [**OC1-Dir**] when the direction of the OC on stage 1 is considered.

2.9.2 Inverse definite mean time and definite time characteristic

The OC element monitors the currents; when one of the currents is beyond the threshold of operation, the OC element will operate within a period that is defined by the time characteristic feature. The user can choose the OC operate time delay characteristics, either dependent (inverse) time characteristic delay (i.e., IDMT) or independent (definite) time characteristic delay (i.e., DT). The operate time of the IDMT depends upon the level of the energizing current, and the operate time in the DT is a constant.

For the reset-time-delay in the IDMT, either inverse (dependent)-time-reset or definite (independent)-time-reset is characterized by setting..

The user can select which characteristic will be applied to each stage of the OC element by setting a scheme switch. We shall see the scheme switch later.

(i) DT characteristic

The operate time in the DT characteristic will be a constant time and is not affected by the level of current. The reset time is set to zero so that resetting is performed immediately. The user can set the operate time using a setting; it is discussed in in sections (v) and (vi).

(ii) IDMT characteristic

The operate time in the IDMT characteristic is inversely proportional to the level of the fault current. The user can determine the operate time from a preset curve. Ten characteristic curves are available; i.e. nine pre-installed curves covering IEC, IEEE, US and UK standard characteristic curves and one original (user programmable) characteristic curve for which the user can set the equation parameters. The IDMT curve equation and parameters will be explained in section (iii).

The reset time in the IDMT is user-selectable; either inverse-time-reset or definite-time-reset is selected. For the inverse-time-reset, the user can choose the reset time for the preset characteristic from six characteristic curves; i.e. IEEE and US standard five pre-installed characteristic curves and one user original characteristic curve where the user can set the equation parameters. The inverse-time-reset curve equation and parameters will be discussed

in section (v).

(iii) Operate time of IDMT

The operate time in the IDMT is defined by Equation (2.9-1). (ref. IEC 60255-151):

$$t(I) = TMS \times \left\{ \left[\frac{k}{\left(I/I_s \right)^{\alpha} - 1} \right] + c \right\} \qquad (2.9\text{-}1)$$

where:

t = operate time with constant current I (seconds),

I = operate (energizing) current (amperes),

Is = overcurrent setting (amperes),

TMS = time multiplier setting number,

k, α, c = constants defining curve.

The nine pre-programmed standard characteristic curves are defined in Table 2.9-3. In addition, one original (user-programmable) curve can be applied. One curve can be chosen for each OC stage. Figure 2.9-5 illustrates these characteristic curves. For example, the user should set one for the scheme switch [**OC1-Type**]. ("**IEC-NI**" is for IEC Normal Inverse characteristic; "**IEC-VI**" for IEC Very inverse; "**IEC-EI**" for IEC Extremely Inverse; "**UK-LTI**" for UK Long Time Inverse; "**IEEE-MI**" for IEEE Moderately Inverse; "**IEEE-VI**" for IEEE Very Inverse; "**IEEE-EI**" for IEEE Extremely Inverse; "**US-CO8**" for US CO8 Inverse; "**US-CO2**" for US CO2 Short Time Inverse, and "**Original**" for user-programmable characteristic.)

In the IDMT, the user can also program the characteristic using time-multiplier-setting (TMS) for the required operate time. For example, when the IEC characteristic is selected, the user can set the TMS value using the setting [**OC1-TMS-IEC**] (incidentally, the default value for the TMS is 1.00). The other TMSs are also available by the [**OC1-TMS-UK**], [**OC1-TMS-IEEE**], [**OC1-TMS-US**] and [**OC1-TMS-ORG**].

Table 2.9-3 Constants for IDMT

Curve type (IEC 60255-151)	Curve Description	k sec	α	c sec
A	IEC Normal Inverse (IEC-NI)	0.14	0.02	0
B	IEC Very Inverse (IEC-VI)	13.5	1	0
C	IEC Extremely Inverse (IEC-EI)	80	2	0
-	UK Long Time Inverse (UK-LTI)	120	1	0
D	IEEE Moderately Inverse (IEEE-MI)	0.0515	0.02	0.114
E	IEEE Very Inverse (IEEE-VI)	19.61	2	0.491
F	IEEE Extremely Inverse (IEEE-EI)	28.2	2	0.1217
-	US CO8 inverse (US-CO8)	5.95	2	0.18
-	US CO2 short time inverse (US-CO2)	0.02394	0.02	0.01694

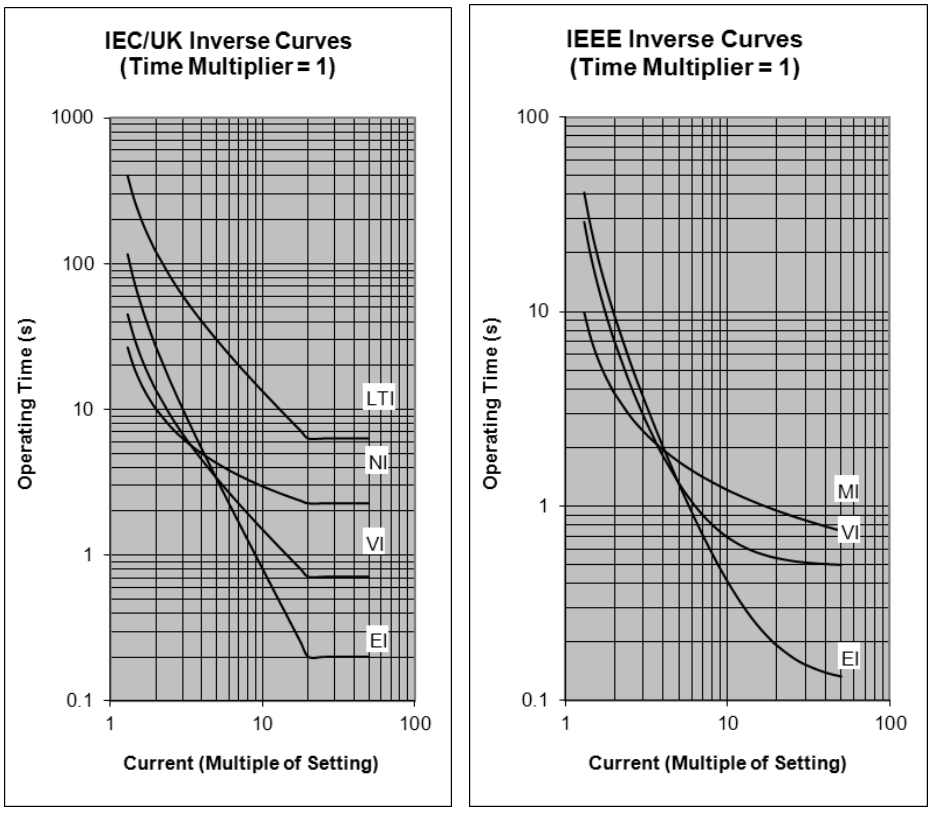


Figure 2.9-5 IDMT characteristic curves

(iv) Operate time of DT

The operate time in the DT is a constant.

(iv)-1 Time characteristic

The user should set **DT** for the scheme switches [**OC1-Type**]. The value of the required operate time is set for the setting [**TOC1**] in the range 0.00–300.00s.

(iv)-2 Instantaneous activation

The operate time of the instantaneous characteristic is achieved by setting zero for the [**TOC1**], but the instantaneous one can also obtained when the logic signal '1(High)' is programmed to be injected at PLC connection point "OC1_INST_OP".

(v) Reset time of IDMT

Programming the reset time characteristic is available for the IEEE standard, US standard and original (user-programmable) inverse-time-reset characteristic†. In the IEEE standard, for example, the user should set **DEP** for the scheme switch [**OC1-Rtype**]. The following equation defines the reset time for the inverse-time-reset characteristic. (ref. IEC 60255-151):

$$t(I) = RTMS \times \left[\frac{kr}{1 - \left(I / I_s \right)^{\beta}} \right] \qquad (2.9\text{-}2)$$

where,

t = time required for the element to reset fully after complete operation (seconds),

I = energizing current (amperes),

I_S = overcurrent setting (amperes),

RTMS = time multiplier setting for resetting,

kr = time required to reset fully after complete operation when the energizing current is zero (seconds),

ß = constants defining curve.

For setting the RTMS for the IEEE standard, the user can use the setting [**OC1-RTMS-IEEE**] (incidentally, the default value is 1.000). Similarly, setting [**OC1-RTMS-US**] and setting [**OC1-RTMS-ORG**] are provided for the US standard and the original, respectively (For more information w.r.t the value for kr and ß, see Table 2.9-4; Figure 2.9-6 shows the characteristic curves).

Table 2.9-4 Constants for inverse-time-reset characteristics

Curve Type IEC 60255-151	Curve Description	kr sec	ß
A	IEC Normal Inverse (IEC-NI‡)	N/A	N/A
B	IEC Very Inverse (IEC-VI‡)	N/A	N/A
C	IEC Extremely Inverse (IEC-EI‡)	N/A	N/A
-	UK Long Time Inverse (UK-LTI‡)	N/A	N/A
D	IEEE Moderately Inverse (IEEE-MI)	4.85	2
E	IEEE Very Inverse (IEEE-VI)	21.6	2
F	IEEE Extremely Inverse (IEEE-EI)	29.1	2
-	US CO8 inverse (US-CO8)	5.95	2
-	US CO2 short time inverse (US-CO2)	2.261	2

†Note: The user can set **DEF** for the scheme switch [**OC1-Rtype**] when the definite-time-reset characteristic is preferred. The definite-time-reset is available in all IDMTs (see Table 2.9-5). After that, the user should set an intentional delay reset time for the setting [**TOC1R**].

‡Note: The user should set **DEF** for the scheme switch [**OC1-Rtype**] when the IEC and the UK standards are selected.

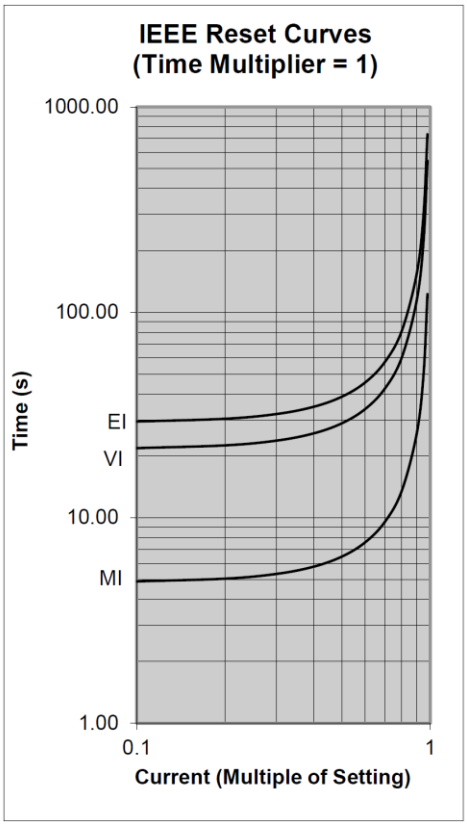


Figure 2.9-6 Inverse-time-reset characteristics curves

Figure 2.9-7 illustrates the effect of inverse-time-reset on the internal time delay counter. An object current (I), where I is greater than a setting (I_S) provides an energizing quantity for the function which continues to flow for a cumulative period causing the operation of the function. If the operating quantity falls below the I_S setting, the function will return to its reset state after the time t(I). The time t(I) is calculated using Equation (2.9-2).

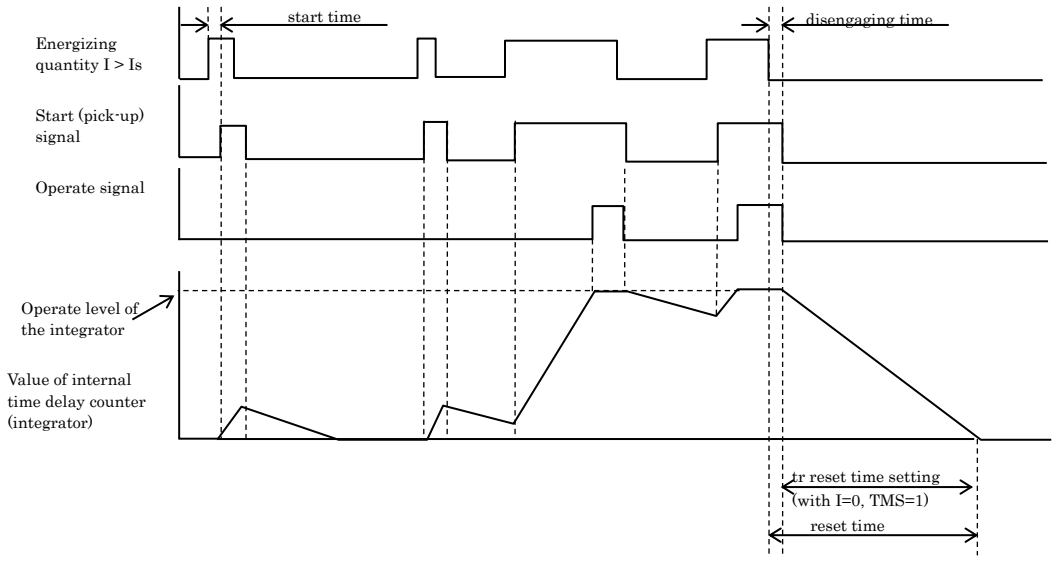


Figure 2.9-7 Inverse-time-reset characteristics

(vi) Reset time of DT

In the DT characteristic, the reset time is designed to be instant. Thus, the user has no points for the settings [**OC1-Rtype**] and [**TOC1R**].

(vii) Summary of OC operation

Table 2.9-5 shows the summary of OC operation.

Table 2.9-5 Type and standard board in the OC1 (A tick shows a selectable function)

Characteristics		DT	IDMT									
			IEC-NI	IEC-VI	IEC-EI	UK-LTI	IEEE-MI	IEEE-VI	IEEE-EI	US-CO2	US-CO8	Original
Scheme switch [OC1-Type]	DT	✓										
	IEC-NI		✓									
	IEC-VI			✓								
	IEC-EI				✓							
	UK LTI					✓						
	IEEE-MI						✓					
	IEEE-VI							✓				
	IEEE-EI								✓			
	US-CO2									✓		
	US-CO8										✓	
	Original											✓
Scheme switch [OC1-Rtype]	DEF	N.A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	DEP	N.A					✓					
		N.A						✓				
		N.A							✓			
		N.A								✓		
		N.A									✓	
		N.A										✓

2.9.3 Threshold value for operation

The value of threshold current at which the OC element will pick-up is configured by settings; the settings [**OC1-IDMT**] and [**OC1-DT**] are provided for both the IDMT and DT characteristics. Note that the settings of the threshold levels are allowed to have distinct values in the respective OC elements. A rating current for the input is defined either 1A or 5A; the input rating is defined on a VCT. (For more information about the VCT, see Chapter *Technical description: Transformer module for AC analogue input*).

2.9.4 Reset Ratio

The ratio of the threshold current for pick-up to reset is applied using a setting; for example, the ratio for the OC1 element is set using the setting [**OC1-DPR**]. The reset ratios for the other OC elements are also provided.

2.9.5 Miscellaneous functions

(i) Trip mode

Every OC element has a selectable tripping mode; the mode is selected using a scheme switch. For the OC1 element, for example, a scheme switch [**OC1-OPMD**] is provided. When a trip is required for any faults that are detected, **3POR** (a fault occurs in one or more phases) is set for the scheme switch [**OC1-OPMD**]. Conversely, when a trip is only required for faults that occur in two or more phases, **2OUTOF3** (a fault occurs in two or more phases) is set for the scheme switch [**OC1-OPMD**].

Table 2.9-6 Fault type and tripping mode

Fault type			Setting [OC1-OPMD]	
Phase-A	Phase-B	Phase-C	3POR	2OUTOF3
X	–	–	✓	No trip
–	X	–	✓	No trip
–	–	X	✓	No trip
X	X	–	✓	✓
–	X	X	✓	✓
X	–	X	✓	✓
X	X	X	✓	✓

Note: A tick (✓) indicates that a trip is issued when faults are detected.
A mark (X) indicates the occurrence of a fault on a particular phase. A mark shown thus (–) indicates that no fault has occurred on that particular phase.

(ii) Blocking OC by ICD

The operation of each OC element can be blocked if the ICD function detects a second harmonic current caused by the magnetizing inrush current phenomenon when a transformer is energized. For example, for the OC1 element, the scheme switch [**OC1-2fBlk**] is provided, and **Block-3P** should be set when the user wishes to block all three-phases of the OC1 element when the second harmonic associated with the magnetizing inrush current is present. Alternatively, **Block-PerP** is set if blocking is just required for a single phase concerting to the phenomenon. **Non** is set for the scheme switch [**OC1-2fBlk**] as the default setting. For more information about the ICD function, see Chapter *Relay application: Inrush current detection function*.

(iii) Blocking OC by VTF

The operation of the OC element can be blocked by the voltage transformer failure (VTF) function via a scheme switch. For example, **Block** can be set for the scheme switch [**OC1-VTFBlk**] to block the operation of the OC1 element during a VTF condition. **Non** is set for the scheme switch [**OC1-VTFBlk**] as a default. For more information about the VTF, see Chapter *Relay application: VT failure detection*.

(iv) OC operation for auto-reclose

The OC element activates the auto-reclose (ARC) function. However, if for example ARC

is not required, **Block** is set for the scheme switch [**OC1-ARCBlk**]. **Block** is set for the scheme switch [**OC1-ARCBlk**] as a default.

(v) Signal of OC trip

When a user requires an alarm signal in place of the trip signal; for example, set **Alarm** for the scheme switch [**OC1-UseFor**]. **Trip** is set for the scheme switch [**OC1-UseFor**] for the normal trip operation.

2.9.6 Scheme logic

The scheme logic for both the non-directional and the directional OC1 element is illustrated in Figure 2.9-8; Figure 2.9-9 shows grouping commands for the trip circuit (TRC). Each phase of the OC1 element issues a pick-up when a current has been exceeded over the setting; then the pick-up signal is transferred to into the TRC as trip signals. (For more information, see Chapter *Relay application: Trip circuit function*)

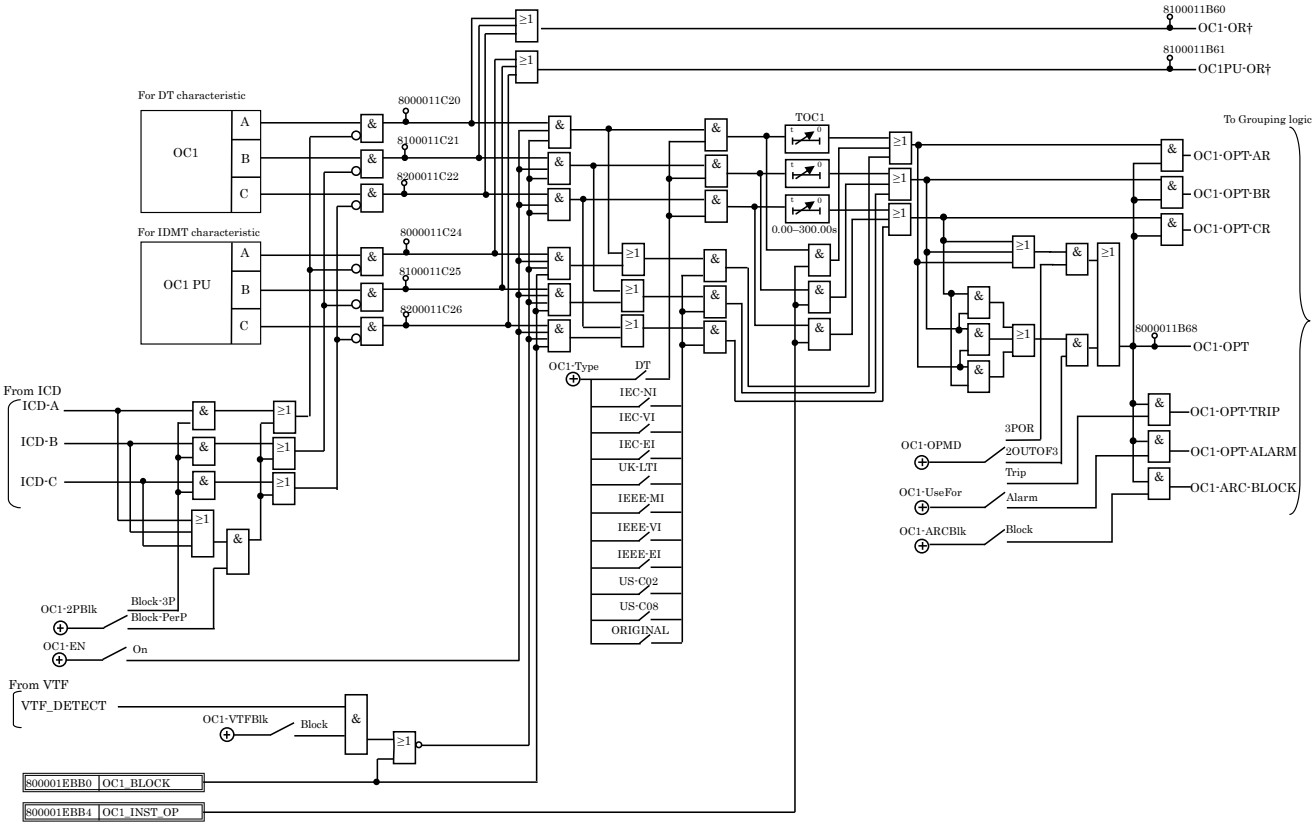


Figure 2.9-8 Scheme logic for the OC1

†Note:The presence of 'OC1-OR' and 'OC1PU-OR' signals depends on the operation characteristic defined with setting [**OC1_Type**], as shown in Table 2.9-7.

Table 2.9-7 Signal behaviors of PLC monitoring points 'OC1-OR' and 'OC1PU-OR'

PLC monitoring points	Setting [**OC1_Type**]

	DT	IEC-NT,VI,EI, UK-LTI, IEET-MI,VI,EI, US-CO2,CO8, ORIGINAL
OC1-OR	①	③
OC1PU-OR	②	④

①: A pick-up signal is generated instantly when the element operates.

②: No signal due that the PU element is killed. Use 'OC1-OR' in place of this.

③: A pick-up signal is generated, but delayed with the IDMT characteristic.

④: A pick-up signal is generated instantly.

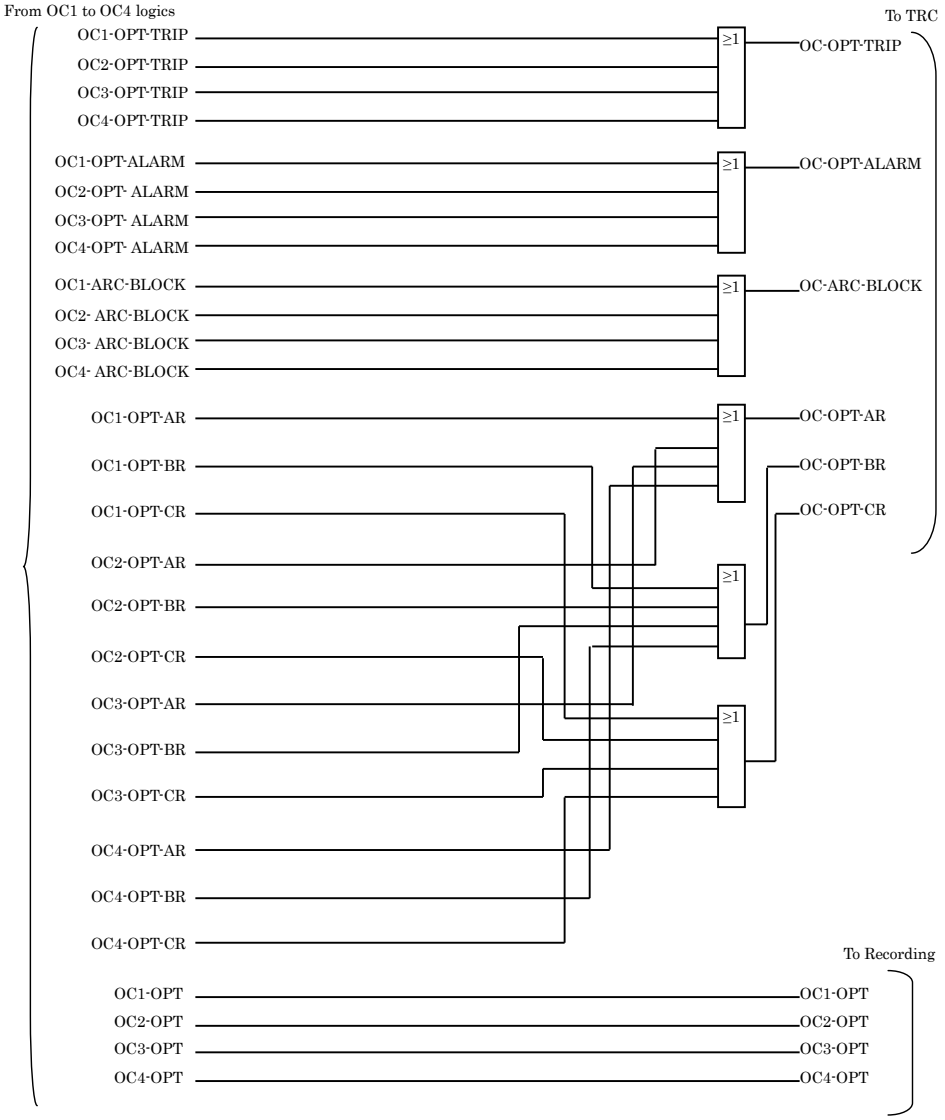


Figure 2.9-9 Grouping logic for TRC/Recording functions

2.9.7 Setting

Setting of OC (Function ID: 440001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
Common	OC-Vpol	(1.0)		V	Polarizing voltage (fixed)	-----		
OC1	OC1-EN	Off / On		-	OC1 protection enable	Off		
	OC1-Dir	NonDir / Forward / Reverse		-	OC1 directional characteristic	NonDir		
	OC1-Angle	0 – 180		deg	OC1 directional characteristic angle	45		
	OC1-Type	DT / IEC-NI / IEC-VI / IEC-EI/ UK-LTI / IEEE-MI / IEEE-VI / IEEE-EI / US-CO2 / US-CO8 / Original		-	OC1 delay type	DT		
	OC1-DT	0.02 - 50.00	0.10 - 250.00	A	OC1 threshold (in DT mode)	1.00	5.00	
	OC1-IDMT	0.02 - 5.00	0.10 - 25.00	A	OC1 threshold (in IDMT mode)	1.00	5.00	
	OC1-DPR	10 – 100		%	OC1 drop-out/pick-up ratio	100		
	TOC1	0.00 - 300.00		s	OC1 operating delay time (in DT mode)	1.00		
	OC1-TMS-IEC	0.010 - 50.000		-	OC1 time multiplier for IEC inverse curve	1.000		
	OC1-TMS-UK	0.010 - 50.000		-	OC1 time multiplier for UK inverse curve	1.000		
	OC1-TMS-IEEE	0.010 - 50.000		-	OC1 time multiplier for IEEE inverse curve	1.000		
	OC1-TMS-US	0.010 - 50.000		-	OC1 time multiplier for US inverse curve	1.000		
	OC1-TMS-ORG	0.010 - 50.000		-	OC1 time multiplier for user-defined 'Original' inverse curve	1.000		
	OC1-Rtype	DEF / DEP		-	OC1 reset delay type	DEF		
	TOC1R	0.00 - 300.00		s	OC1 definite time reset delay	0.00		
	OC1-RTMS-IEEE	0.010 - 50.000		-	OC1 dependent reset time multiplier for IEEE inverse curve	1.000		
	OC1-RTMS-US	0.010 - 50.000		-	OC1 dependent reset time multiplier for US inverse curve	1.000		
	OC1-RTMS-ORG	0.010 - 50.000		-	OC1 dependent reset time multiplier for Original inverse curve	1.000		
	OC1-k	0.00000 - 500.00000		-	OC1 user original curve coefficient	0.00000		
	OC1-a	0.00000 - 10.00000		-	OC1 user original curve coefficient	0.00000		
	OC1-c	0.00000 - 10.00000		-	OC1 user original curve coefficient	0.00000		
	OC1-kr	0.00000 - 500.00000		-	OC1 user original curve coefficient	0.00000		
	OC1-b	0.00000 - 10.00000		-	OC1 user original curve coefficient	0.00000		
	OC1-2fBlk	Non / Block-3P / Block-PerP		-	OC1 operation block by 2f-detection	Non		
	OC1-VTFBlk	Non / Block		-	OC1 operation block by VTF	Non		
	OC1-OPMD	3POR / 2OUTOF3		-	OC1 operation mode	3POR		
	OC1-UseFor	Trip / Alarm		-	OC1 used for trip or alarm	Trip		
	OC1-ARCBlk	Non / Block		-	Autoreclose block by OC1	Block		
OC2	OC2-EN	Off / On		-	OC2 protection enable	Off		
	OC2-Dir	NonDir / Forward / Reverse		-	OC2 directional characteristic	NonDir		
	OC2-Angle	0 – 180		deg	OC2 directional characteristic angle	45		
	OC2-Type	DT / IEC-NI / IEC-VI / IEC-EI/ UK-LTI / IEEE-MI / IEEE-VI / IEEE-EI / US-CO2 / US-CO8 / Original		-	OC2 delay type	DT		
	OC2-DT	0.02 - 50.00	0.10 - 250.00	A	OC2 threshold (in DT mode)	1.00	5.00	
	OC2-IDMT	0.02 - 5.00	0.10 - 25.00	A	OC2 threshold (in IDMT mode)	1.00	5.00	
	OC2-DPR	10 - 100		%	OC2 drop-out/pick-up ratio	100		
	TOC2	0.00 - 300.00		s	OC2 operating delay time (in DT mode)	1.00		

Setting of OC (Function ID: 440001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
		OC2-TMS-IEC	0.010 - 50.000		-	OC2 time multiplier for IEC inverse curve	1.000		
		OC2-TMS-UK	0.010 - 50.000		-	OC2 time multiplier for UK inverse curve	1.000		
		OC2-TMS-IEEE	0.010 - 50.000		-	OC2 time multiplier for IEEE inverse curve	1.000		
		OC2-TMS-US	0.010 - 50.000		-	OC2 time multiplier for US inverse curve	1.000		
		OC2-TMS-ORG	0.010 - 50.000		-	OC2 time multiplier for user-defined 'Original' inverse curve	1.000		
		OC2-Rtype	DEF / DEP		-	OC2 reset delay type	DEF		
		TOC2R	0.00 - 300.00		s	OC2 definite time reset delay	0.00		
		OC2-RTMS-IEEE	0.010 - 50.000		-	OC2 dependent reset time multiplier for IEEE inverse curve	1.000		
		OC2-RTMS-US	0.010 - 50.000		-	OC2 dependent reset time multiplier for US inverse curve	1.000		
		OC2-RTMS-ORG	0.010 - 50.000		-	OC2 dependent reset time multiplier for user-defined 'Original' inverse curve	1.000		
		OC2-k	0.00000 - 500.00000		-	OC2 user-defined 'original' curve coefficient	0.00000		
		OC2-a	0.00000 - 10.00000		-	OC2 user-defined 'original' curve coefficient	0.00000		
		OC2-c	0.00000 - 10.00000		-	OC2 user-defined 'original' curve coefficient	0.00000		
		OC2-kr	0.00000 - 500.00000		-	OC2 user-defined 'original' curve coefficient	0.00000		
		OC2-b	0.00000 - 10.00000		-	OC2 user-defined 'original' curve coefficient	0.00000		
		OC2-2fBlk	Non / Block-3P / Block-PerP		-	OC2 operation block by 2f-detection	Non		
		OC2-VTFBlk	Non / Block		-	OC2 operation block by VTF	Non		
		OC2-OPMD	3POR / 2OUTOF3		-	OC2 operation mode	3POR		
		OC2-UseFor	Trip / Alarm		-	OC2 used for trip or alarm	Trip		
		OC2-ARCBlk	Non / Block		-	Auto-reclose block by OC2	Block		
	OC3	OC3-EN	Off / On		-	OC3 protection enable	Off		
		OC3-Dir	NonDir / Forward / Reverse		-	OC3 directional characteristic	NonDir		
		OC3-Angle	0 - 180		deg	OC3 directional characteristic angle	45		
		OC3-Type	DT / IEC-NI / IEC-VI / IEC-EI/ UK-LTI / IEEE-MI / IEEE-VI / IEEE-EI / US-CO2 / US-CO8 / Original		-	OC3 delay type	DT		
		OC3-DT	0.02 - 50.00	0.10 - 250.00	A	OC3 threshold (in DT mode)	1.00	5.00	
		OC3-IDMT	0.02 - 5.00	0.10 - 25.00	A	OC3 threshold (in IDMT mode)	1.00	5.00	
		OC3-DPR	10 - 100		%	OC3 drop-out/pick-up ratio	100		
		TOC3	0.00 - 300.00		s	OC3 operating delay time (in DT mode)	1.00		
		OC3-TMS-IEC	0.010 - 50.000		-	OC3 time multiplier for IEC inverse curve	1.000		
		OC3-TMS-UK	0.010 - 50.000		-	OC3 time multiplier for UK inverse curve	1.000		
		OC3-TMS-IEEE	0.010 - 50.000		-	OC3 time multiplier for IEEE inverse curve	1.000		
		OC3-TMS-US	0.010 - 50.000		-	OC3 time multiplier for US inverse curve	1.000		
		OC3-TMS-ORG	0.010 - 50.000		-	OC3 time multiplier for user-defined 'Original' inverse curve	1.000		
		OC3-Rtype	DEF / DEP		-	OC3 reset delay type	DEF		
		TOC3R	0.00 - 300.00		s	OC3 definite time reset delay	0.00		
		OC3-RTMS-IEEE	0.010 - 50.000		-	OC3 dependent reset time multiplier for IEEE inverse curve	1.000		
		OC3-RTMS-US	0.010 - 50.000		-	OC3 dependent reset time multiplier for US inverse curve	1.000		
		OC3-RTMS-ORG	0.010 - 50.000		-	OC3 dependent reset time multiplier for user-defined 'Original' inverse curve	1.000		
		OC3-k	0.00000 - 500.00000		-	OC3 user-defined 'original' curve coefficient	0.00000		

Setting of OC (Function ID: 440001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
		OC3-a	0.00000 - 10.00000		-	OC3 user-defined 'original' curve coefficient	0.00000		
		OC3-c	0.00000 - 10.00000		-	OC3 user-defined 'original' curve coefficient	0.00000		
		OC3-kr	0.00000 - 500.00000		-	OC3 user-defined 'original' curve coefficient	0.00000		
		OC3-b	0.00000 - 10.00000		-	OC3 user-defined 'original' curve coefficient	0.00000		
		OC3-2fBlk	Non / Block-3P / Block-PerP		-	OC3 operation block by 2f-detection	Non		
		OC3-VTFBlk	Non / Block		-	OC3 operation block by VTF	Non		
		OC3-OPMD	3POR / 2OUTOF3		-	OC3 operation mode	3POR		
		OC3-UseFor	Trip / Alarm		-	OC3 used for trip or alarm	Trip		
		OC3-ARCBlk	Non / Block		-	Autoreclose block by OC3	Block		
	OC4	OC4-EN	Off / On		-	OC4 protection enable	Off		
		OC4-Dir	NonDir / Forward / Reverse		-	OC4 directional characteristic	NonDir		
		OC4-Angle	0 - 180		deg	OC4 directional characteristic angle	45		
		OC4-Type	DT / IEC-NI / IEC-VI / IEC-EI/ UK-LTI / IEEE-MI / IEEE-VI / IEEE-EI / US-CO2 / US-CO8 / Original		-	OC4 delay type	DT		
		OC4-DT	0.02 - 50.00	0.10 - 250.00	A	OC4 threshold (in DT mode)	1.00	5.00	
		OC4-IDMT	0.02 - 5.00	0.10 - 25.00	A	OC4 threshold (in IDMT mode)	1.00	5.00	
		OC4-DPR	10 - 100		%	OC4 drop-out/pick-up ratio	100		
		TOC4	0.00 - 300.00		s	OC4 operating delay time (in DT mode)	1.00		
		OC4-TMS-IEC	0.010 - 50.000		-	OC4 time multiplier for IEC inverse curve	1.000		
		OC4-TMS-UK	0.010 - 50.000		-	OC4 time multiplier for UK inverse curve	1.000		
		OC4-TMS-IEEE	0.010 - 50.000		-	OC4 time multiplier for IEEE inverse curve	1.000		
		OC4-TMS-US	0.010 - 50.000		-	OC4 time multiplier for US inverse curve	1.000		
		OC4-TMS-ORG	0.010 - 50.000		-	OC4 time multiplier for user-defined 'Original' inverse curve	1.000		
		OC4-Rtype	DEF / DEP		-	OC4 reset delay type	DEF		
		TOC4R	0.00 - 300.00		s	OC4 definite time reset delay	0.00		
		OC4-RTMS-IEEE	0.010 - 50.000		-	OC4 dependent reset time multiplier for IEEE inverse curve	1.000		
		OC4-RTMS-US	0.010 - 50.000		-	OC4 dependent reset time multiplier for US inverse curve	1.000		
		OC4-RTMS-ORG	0.010 - 50.000		-	OC4 dependent reset time multiplier for user-defined 'Original' inverse curve	1.000		
		OC4-k	0.00000 - 500.00000		-	OC4 user-defined 'original' curve coefficient	0.00000		
		OC4-a	0.00000 - 10.00000		-	OC4 user-defined 'original' curve coefficient	0.00000		
		OC4-c	0.00000 - 10.00000		-	OC4 user-defined 'original' curve coefficient	0.00000		
		OC4-kr	0.00000 - 500.00000		-	OC4 user-defined 'original' curve coefficient	0.00000		
		OC4-b	0.00000 - 10.00000		-	OC4 user-defined 'original' curve coefficient	0.00000		
		OC4-2fBlk	Non / Block-3P / Block-PerP		-	OC4 operation block by 2f-detection	Non		
		OC4-VTFBlk	Non / Block		-	OC4 operation block by VTF	Non		
		OC4-OPMD	3POR / 2OUTOF3		-	OC4 operation mode	3POR		
		OC4-UseFor	Trip / Alarm		-	OC4 used for trip or alarm	Trip		
		OC4-ARCBlk	Non / Block		-	Auto-reclose block by OC4	Block		

2.9.8 Data ID

◆ Signal monitoring points

OC(Function ID: 440001)

Element ID	Name	Description
8000011C20	OC1-A	OC1 relay element operated (phase-A)
8100011C21	OC1-B	OC1 relay element operated (phase-B)
8200011C22	OC1-C	OC1 relay element operated (phase-C)
8000011B60	OC1-OR	OC1 relay element operated (3-phases OR)
8000011C24	OC1PU-A	OC1 relay operation level pick up (phase-A)
8100011C25	OC1PU-B	OC1 relay operation level pick up (phase-B)
8200011C26	OC1PU-C	OC1 relay operation level pick up (phase-C)
8000011B61	OC1PU-OR	OC1 relay operation level pick up (3-phases OR)
8000011B62	OC1-OPT-A	OC1 protection operated (phase-A)
8100011B63	OC1-OPT-B	OC1 protection operated (phase-B)
8200011B64	OC1-OPT-C	OC1 protection operated (phase-C)
8000011B68	OC1-OPT	OC1 protection operated
8400021C20	OC2-A	OC2 relay element operated (phase-A)
8500021C21	OC2-B	OC2 relay element operated (phase-B)
8600021C22	OC2-C	OC2 relay element operated (phase-C)
8100021B60	OC2-OR	OC2 relay element operated (3-phases OR)
8400021C24	OC2PU-A	OC2 relay operation level pick up (phase-A)
8500021C25	OC2PU-B	OC2 relay operation level pick up (phase-B)
8600021C26	OC2PU-C	OC2 relay operation level pick up (phase-C)
8100021B61	OC2PU-OR	OC2 relay operation level pick up (3-phases OR)
8400021B62	OC2-OPT-A	OC2 protection operated (phase-A)
8500021B63	OC2-OPT-B	OC2 protection operated (phase-B)
8600021B64	OC2-OPT-C	OC2 protection operated (phase-C)
8100021B68	OC2-OPT	OC2 protection operated
8800031C20	OC3-A	OC3 relay element operated (phase-A)
8900031C21	OC3-B	OC3 relay element operated (phase-B)
8A00031C22	OC3-C	OC3 relay element operated (phase-C)
8200031B60	OC3-OR	OC3 relay element operated (3-phases OR)
8800031C24	OC3PU-A	OC3 relay operation level pick up (phase-A)
8900031C25	OC3PU-B	OC3 relay operation level pick up (phase-B)
8A00031C26	OC3PU-C	OC3 relay operation level pick up (phase-C)
8200031B61	OC3PU-OR	OC3 relay operation level pick up (3-phases OR)
8800031B62	OC3-OPT-A	OC3 protection operated (phase-A)
8900031B63	OC3-OPT-B	OC3 protection operated (phase-B)
8A00031B64	OC3-OPT-C	OC3 protection operated (phase-C)
8200031B68	OC3-OPT	OC3 protection operated
8C00041C20	OC4-A	OC4 relay element operated (phase-A)
8D00041C21	OC4-B	OC4 relay element operated (phase-B)
8E00041C22	OC4-C	OC4 relay element operated (phase-C)
8300041B60	OC4-OR	OC4 relay element operated (3-phases OR)
8C00041C24	OC4PU-A	OC4 relay operation level pick up (phase-A)
8D00041C25	OC4PU-B	OC4 relay operation level pick up (phase-B)
8E00041C26	OC4PU-C	OC4 relay operation level pick up (phase-C)

◆ Signal monitoring points

OC(Function ID: 440001)

Element ID	Name	Description
8300041B61	OC4PU-OR	OC4 relay operation level pick up (3-phases OR)
8C00041B62	OC4-OPT-A	OC4 protection operated (phase-A)
8D00041B63	OC4-OPT-B	OC4 protection operated (phase-B)
8E00041B64	OC4-OPT-C	OC4 protection operated (phase-C)
8300041B68	OC4-OPT	OC4 protection operated

◆ Connection point in PLC logic

OC(Function ID: 440001)

Element ID	Name	Description
800001EBB0	OC1_BLOCK	OC1 protection block command
810002EBB1	OC2_BLOCK	OC2 protection block command
820003EBB2	OC3_BLOCK	OC3 protection block command
830004EBB3	OC4_BLOCK	OC4 protection block command
800001EBB4	OC1_INST_OP	OC1 protection instant operation command
810002EBB5	OC2_INST_OP	OC2 protection instant operation command
820003EBB6	OC3_INST_OP	OC3 protection instant operation command
830004EBB7	OC4_INST_OP	OC4 protection instant operation command

2.10 Earth fault protection (EF)

The earth fault protection (EF) function has either two stages or four stages (elements); the number of the stages depends on the models. Each stage can have either a directional characteristic or non-directional characteristic.

To simplify the description, only EF1 is discussed but is applicable to the other EFs; hence, read the expression for EF1 as EF2 etc. at each EF stage unless a special explanation or instruction has been provided.

Note: The number of relay elements depends on the IED model. To know the number in respective IED models, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.10-1 Comparative table in respective ordering numbers

Features	Ordering No. at "G&T"				
	10	11	13	19	22
Non-directional/directional definite time EF protection	✓	✓	✓	(✓)	✓
Number of stages	4	2	2	4	2

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, OCN, THM, BCD, CBF, SOTF-OC, OV, OVS, UV, UVS, FRQ/DFRQ, FS, VTF, CTF, ARC, VCHK.

2.10.1 Relay polarity

The user can choose either non-directional EF or directional EF for each EF stage. In addition, the user can further select either the forward or the reverse for each of the directional EF elements selected.

(i) Characteristic of non-directional EF

The characteristic of the non-directional type EF function is a circle at the origin. A setting and a scheme switch is used to configure each non-directional EF element; i.e., the user can set the threshold value of the non-directional EF element for stage1 using setting [**EF1-DT**], provided time characteristic is required for define time delay (DT) described in section 2.10.2(i). The user should set **NonDir** for the scheme switch [**EF1-Dir**].

(ii) Characteristic of directional-EF in the forward direction

As shown in Figure 2.10-1, the characteristic of the directional-EF elements in the forward direction is a semi-circle based upon the border-line; the hatched area shows the operating region of the directional-EF element.

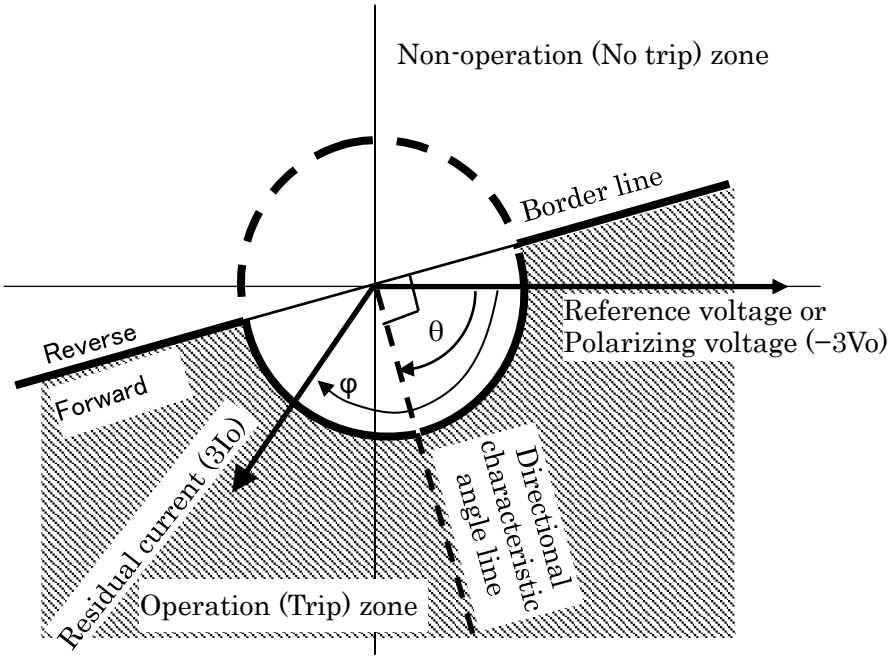


Figure 2.10-1 Characteristic of the directional-EF element in the forward direction

Note: Directional characteristic angle (θ) forms the angle between the reference quantity and the directional characteristic angle line. The half plane represents the zone of operation bordered on one side by the border line and extending in the direction that contains both the reference (polarizing) and operating quantities.

A setting and a scheme switch, as well as the non-directional EF element, provide the settings for the directional EF element. For example, the user can set the threshold value (I_{EF}) for stage 1 with the setting [**EF1-DT**]; **Forward** can be set for the scheme switch [**EF1-Dir**].

Setting of the sensing angle (θ) is configured by the setting [**EF1-Angle**] with the value of θ set in the range of 0–180°. Figure 2.10-2 shows an example of an angle and a characteristic using the θ.

The operation of the EF element is based upon the following equation.

$$3I_0 \geq I_{EF} \quad (2.10\text{-}1)$$

$$3I_0 \times \cos(\varphi - \theta) \geq 0 \quad (2.10\text{-}2)$$

$$3V_0 \geq EF_Vpol \quad (2.10\text{-}3)$$

where

3Io = residual current

3Vo = residual voltage

−3Vo = reference voltage (or polarizing voltage)

φ= lagging angle

θ = EF setting angle

I_{EF} = Setting value of the EF element ([**EF1-DT**] and the others)

EF_Vpol = Setting value of the polarizing voltage ([**EF-Vpol**])

Note: In the case of an internal fault, the phase angle is equal to the angle of the zero-sequence impedance of the system, in a directly-earthed system this value is in the range of approximately 50° to 90°. The sensing angle θ of the EF element can be set between 0° to 180°. The minimum voltage necessary to maintain directionality can be set from 0.5 to 100.0 V.

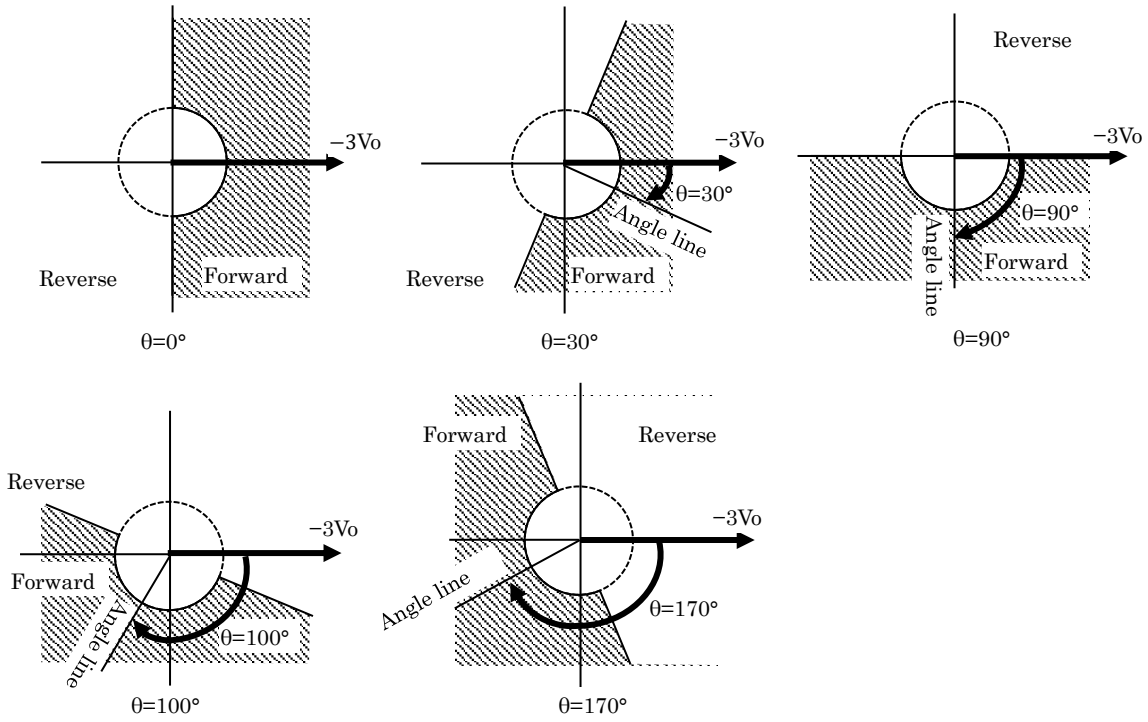


Figure 2.10-2 Examples of directional characteristic angle (θ)

(iii) Characteristic of directional EF in the reverse direction

The reverse characteristic is a mirror image of the forward characteristic. The setting and the scheme switch, in addition to providing the setting of the directional EF element in the forward direction, provides the setting of the directional EF element in the reverse direction: for example, **Reverse** is set for the scheme switch [**EF1-Dir**] when the direction of the EF element for stage 1 is considered.

2.10.2 Inverse time and definite time delay characteristic

The EF element monitors the earth-fault currents; when one of the currents is beyond the threshold for the operation, the EF element will operate within a period that is defined by the time characteristic feature. The user can choose the EF operate time delay characteristics, either dependent (inverse) time characteristic delay (i.e., IDMT) or independent (definite) time characteristic delay (i.e., DT). The operate time of the IDMT depends upon the level of the energizing current, and the operate time in the DT is a constant.

For the reset time delay in the IDMT, either inverse(dependent)-time-reset or definite(independent)-time-reset is characterized by the setting.

The user can select which characteristic will be applied to each stage of the EF element by setting a scheme switch. We shall see the scheme switches later.

(i) DT characteristic

The operate time in the DT characteristic will be a constant time and is not affected by the level of current. The reset time is set to zero so that resetting is performed immediately. The user can set the operate time using a setting; it is discussed in section (iv).

(ii) IDMT characteristic

The operate time in the IDMT characteristic is inversely proportional to the level of the fault current. The user can choose the operate time from a preset curve. Ten characteristic curves are available; i.e. nine pre-installed curves covering IEC, IEEE, US and UK standard characteristic curves and one original (user programmable) characteristic curve for which the user can set the equation parameters. The IDMT curve equation and parameters will be explained in section (iii).

The reset time of the IDMT is user selectable; either inverse-time-reset or definite-time-reset is selected. For the inverse-time-rest, the user can choose the reset time for the preset characteristic from six characteristic curves; i.e. IEEE and US standard five pre-installed characteristic curves and one user original characteristic carver where the user can set the equation parameters. The inverse-time-reset curve equation and parameters will be discussed in section (v).

(iii) Operate time of IDMT

The dependent time in the IDMT is defined by Equation (2.10-4). (ref IEC 60255-151):

$$t(I) = TMS \times \left\{ \left[\frac{\mathrm{k}}{\left({}^{\mathrm{I}}/_{\mathrm{I_s}} \right)^{\alpha} - 1} \right] + \mathrm{c} \right\} \qquad (2.10\text{-}4)$$

where:

t = operating time for constant current I (seconds),

I = energizing current (amperes),

Is = earth fault current setting (amperes),

TMS = time multiplier setting,

k, α, c = constants defining curve.

The nine pre-programmed standard characteristic curve are defined in Table 2.10-2. In addition, one original (user-programmable) curve can be applied. One curve can be chosen for each EF stage. Figure 2.10-3 illustrates these characteristic curves. For example, the user should set one for the scheme switches [**EF1-Type**]. (That is, "**IEC-NI**" is for IEC Normal Inverse, "**IEC-VI**" for IEC Very Inverse, "**IEC-EI**" for IEC Extremely Inverse, "**UK-LTI**" for UK Long Time Inverse, "**IEEE-MI** " for IEEE Moderately Inverse, "**IEEE-VI**" for IEEE Very Inverse, "**IEEE-EI**" for IEEE Extremely Inverse, "**US-CO2**" for US CO2 short time inverse, "**US-CO8**" for US CO8 inverse, and "**Original**" for user-programmable characteristic.)

In the IDMT operation, the user can also program the characteristic using time-multiplier-setting (TMS) for the required operate time. For example, the IEC characteristic is selected, the user can set the TMS value using the setting [**EF1-TMS-IEC**] (incidentally, the default value of the TMS is 1.00). The other TMSs are also available by the [**EF1-TMS-UK**], [**EF1-TMS-IEEE**], [**EF1-TMS-US**] and [**EF1-TMS-ORG**].

Table 2.10-2 Constants for IDMT

Curve type (IEC 60255-151)	Curve Description	k	α	c
A	IEC Normal Inverse (IEC-NI)	0.14	0.02	0
B	IEC Very Inverse (IEC-VI)	13.5	1	0
C	IEC Extremely Inverse (IEC-EI)	80	2	0
-	UK Long Time Inverse (UK-LTI)	120	1	0
D	IEEE Moderately Inverse (IEEE-MI)	0.0515	0.02	0.114
E	IEEE Very Inverse (IEEE-VI)	19.61	2	0.491
F	IEEE Extremely Inverse (IEEE-EI)	28.2	2	0.1217
-	US CO8 inverse (US-CO8)	5.95	2	0.18
-	US CO2 short time inverse (US-CO2)	0.02394	0.02	0.01694

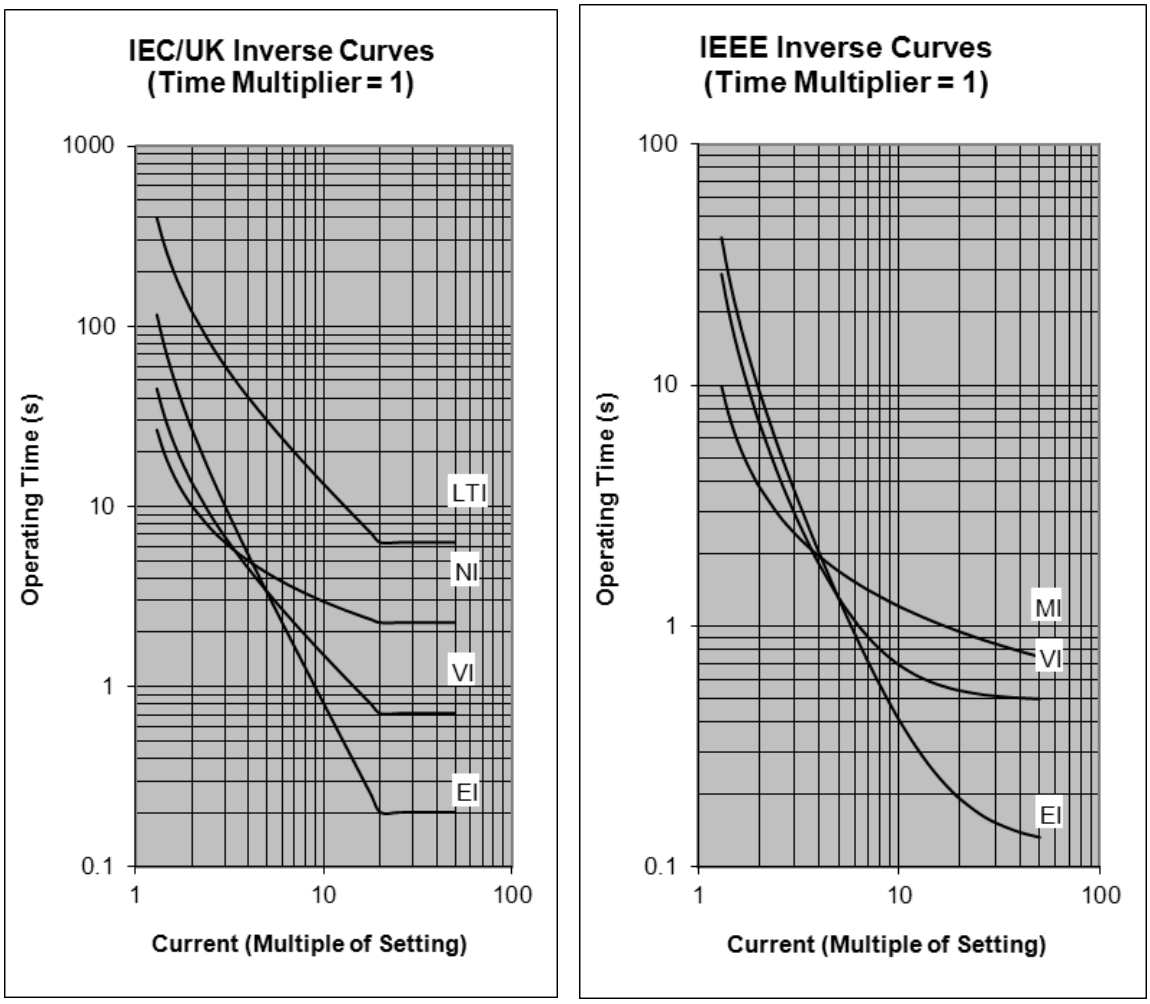


Figure 2.10-3 IDMT Characteristics curves

(iv) Operate time of DT

The operate time in the DT is a constant.

(iv)-1 Time characteristic

The user should set **DT** for the scheme switch [**EF1-Type**]. The value of the required operate time is set for the setting [**TEF1**] in the range 0.00–300.00s.

(iv)-2 Instantaneous activation

The instantaneous operation characteristic is achieved by setting zero for the [**TEF1**], but the instantaneous one can be also obtained when the logic signal '1(High)" is programmed to be injected at the PLC connection point "EF1_INST_OP".

(v) Reset time for IDMT

Programming the reset time characteristic is available for the IEEE standard, US standard and original (user-programmable) dependent time characteristic†. In the IEEE standard, for

example, the user should set **DEP** for the scheme switch [**EF1-Rtype**]. The following equation defines the reset time for the inverse-time-reset characteristic (ref. IEC 60255-151):

$$t(\mathrm{I}) = RTMS \times \left[\frac{\mathrm{kr}}{1 - \left({}^{\mathrm{I}}/_{\mathrm{I_s}} \right)^{\beta}} \right] \qquad (2.10\text{-}2)$$

where:

t = time required for the element to reset fully after complete operation (seconds),

I = energizing current (amperes),

Is = earth fault current setting (amperes),

kr = time required to reset fully after complete operation when the energizing current is zero

RTMS = time multiplier setting for resetting.

ß = constants defining curve.

For setting the RTMS for the IEEE standard, the user can use setting [**EF1-RTMS-IEEE**] (incidentally, the default value is 1.000). Similarly, settings [**EF1-RTMS-US**] and [**EF1-RTMS-ORG**] are provided for the US standard and the original, respectively (For more information w.r.t the values for the kr and ß, see Table 2.10-3; Figure 2.10-4 shows the characteristic curves).

Table 2.10-3 Constants for inverse-time-reset characteristics

Curve Type IEC 60255-151	Curve Description	kr sec	ß
A	IEC Normal Inverse (IEC-NI‡)	N/A	N/A
B	IEC Very Inverse (IEC-VI‡)	N/A	N/A
C	IEC Extremely Inverse (IEC-EI‡)	N/A	N/A
-	UK Long Time Inverse (UK-LTI‡)	N/A	N/A
D	IEEE Moderately Inverse (IEEE-MI)	4.85	2
E	IEEE Very Inverse (IEEE-VI)	21.6	2
F	IEEE Extremely Inverse (IEEE-EI)	29.1	2
-	US CO8 inverse (US-CO8)	5.95	2
-	US CO2 short time inverse (US-CO2)	2.261	2

†Note: **DEF** is set for scheme switch [**EF1-Rtype**] when the definite-time-reset characteristic is preferred. The definite-reset-time characteristic is available in all IDMTs characteristic (See Table 2.10-4). After that, the user should set an intentional delay reset time for the setting [**TEF1R**].

‡Note: The user should set **DEF** for scheme switch [**EF1-Rtype**] when the IEC and the UK standard is selected.

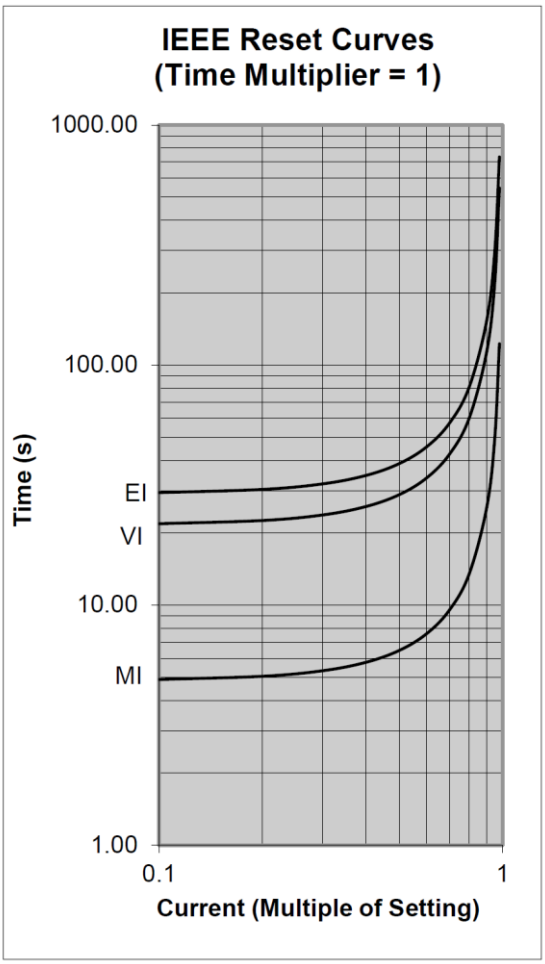


Figure 2.10-4 Inverse-time-reset characteristics curves

Figure 2.10-5 illustrates the effect of invers-time-reset on the internal time delay counter. An object current (I), where I is greater than a setting (I_S) provides an energizing quantity for the function which continues to flow for a cumulative period causing the operation of the function. If the operating quantity falls below the value of I_S setting, the function will return to its reset state after time t(I). Time t(I) is calculated using equation (2.10-2).

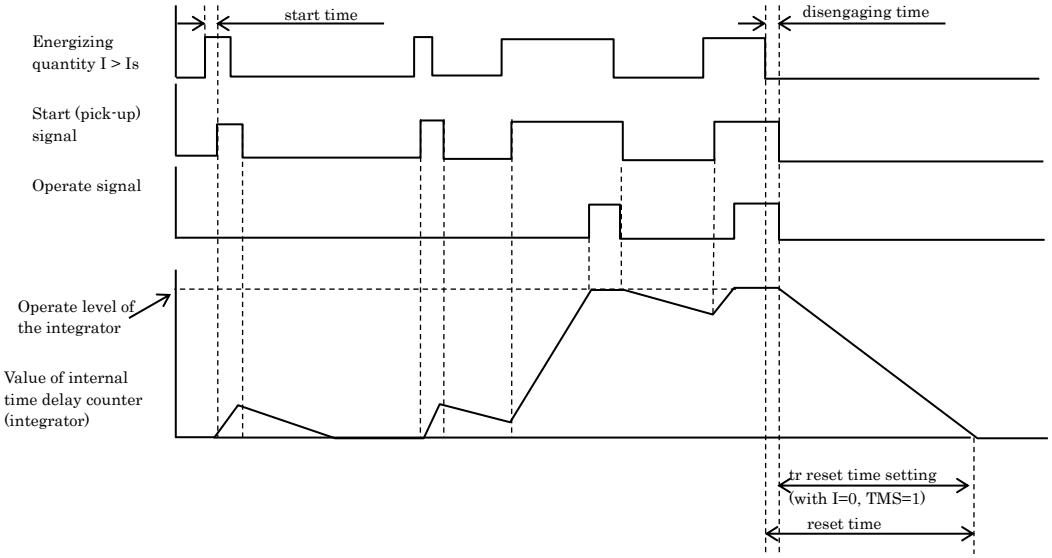


Figure 2.10-5 Inverse-time-reset characteristics

(vi) Reset time of DT

In the DT characteristic, the reset time is designed to be instant. Thus, the user has no points for settings [**EF1-Rtype**] and [**TEF1R**].

(vii) Summary of EF operation

Table 2.10-4 shows a summary for EF operation.

Table 2.10-4 Type and standard board in the EF (A tick represents a selectable function)

Characteristics		DT	IDMT									
			IEC-NI	IEC-VI	IEC-EI	UK-LTI	IEEE-MI	IEEE-VI	IEEE-EI	US-CO2	US-CO8	Original
Scheme switch [EF1-Type]	DT	✓										
	IEC-NI		✓									
	IEC-VI			✓								
	IEC-EI				✓							
	UK LTI					✓						
	IEEE-MI						✓					
	IEEE-VI							✓				
	IEEE-EI								✓			
	US-CO2									✓		
	US-CO8										✓	
	Original											✓
Scheme switch [EF1-Rtype]	DEF	N.A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	DEP	N.A					✓					
		N.A						✓				
		N.A							✓			
		N.A								✓		
		N.A									✓	
		N.A										✓

2.10.3 Threshold level for operation

The value of threshold current at which the EF (I_{EF}) element will pick-up is configured by settings; the settings [**EF1-IDMT**] and [**EF1-DT**] are provided for both the IDMT and the DT characteristic. Note that the settings of the threshold levels are allowed to have distinct values in the respective EF elements. A rating current for the input is defined either 1A or 5A; the input rating is defined on a VCT. (For more information about the VCT, see Chapter *Technical description: Transformer module for AC analogue input*).

2.10.4 Reset Ratio

The ratio of the threshold current for pick-up to reset is applied using a setting; for example, the ratio for the EF1 element is set using the setting [**EF1-DPR**]. The reset ratios for the other EF elements are also provided.

2.10.5 Miscellaneous functions

(i) Blocking EF by ICD

The operation of each EF element can be blocked if the ICD function detects a second harmonic current caused by the magnetizing inrush current phenomenon when a transformer is energized. For example, for the EF1 element, the scheme switch [**EF1-2fBlk**] is provided, and **Block** should be set when the user wishes to block the EF1 element when the second harmonic

associated with magnetizing inrush is present. **Non** is set for the scheme switch [**EF1-2fBlk**] as the default setting. For more information about the ICD function, see Chapter *Relay application: Inrush current detection function*.

(ii) Blocking EF by VTF

The operation of the EF element can be blocked by the voltage transformer failure (VTF) function via a scheme switch. For example, **Block** is set for the scheme switch [**EF1-VTFBlk**] to block the operation of the EF1 element during a VTF condition. **Non** is set for the scheme switch [**EF1-VTFBlk**] as a default.

(iii) Blocking EF by CTF

The operation of the EF element can be blocked by the current transformer failure (CTF) function via a scheme switch. For example, **Block** is set for the scheme switch [**EF1-CTFBlk**] to block the operation of the EF1 element during a CTF condition. **Non** is set for the scheme switch [**EF1-CTFBlk**] as a default.

(iv) EF operation for autoreclose

The EF element activates the auto-reclose (ARC) function. However, if ARC is not required, **Block** is set for the scheme switch [**EF1-ARCBlk**]. **Block** is set for the scheme switch [**EF1-ARCBlk**] as a default.

(v) Signal of EF trip

When a user requires an alarm signal in place of the trip signal; for example, set **Alarm** for the scheme switch [**EF1-UseFor**]. **Trip** is set for the scheme switch [**EF1-UseFor**] for the normal trip operation.

2.10.6 Scheme logic

The scheme logic for both the non-directional and the directional EF1 element is illustrated in Figure 2.10-6; Figure 2.10-7 shows grouping commands for the trip circuit (TRC). The EF1 signal is generated when the pickup current exceeds a threshold, and then trip signals are injected into the TRC. (For more information, see Chapter *Relay application: Trip circuit function*)

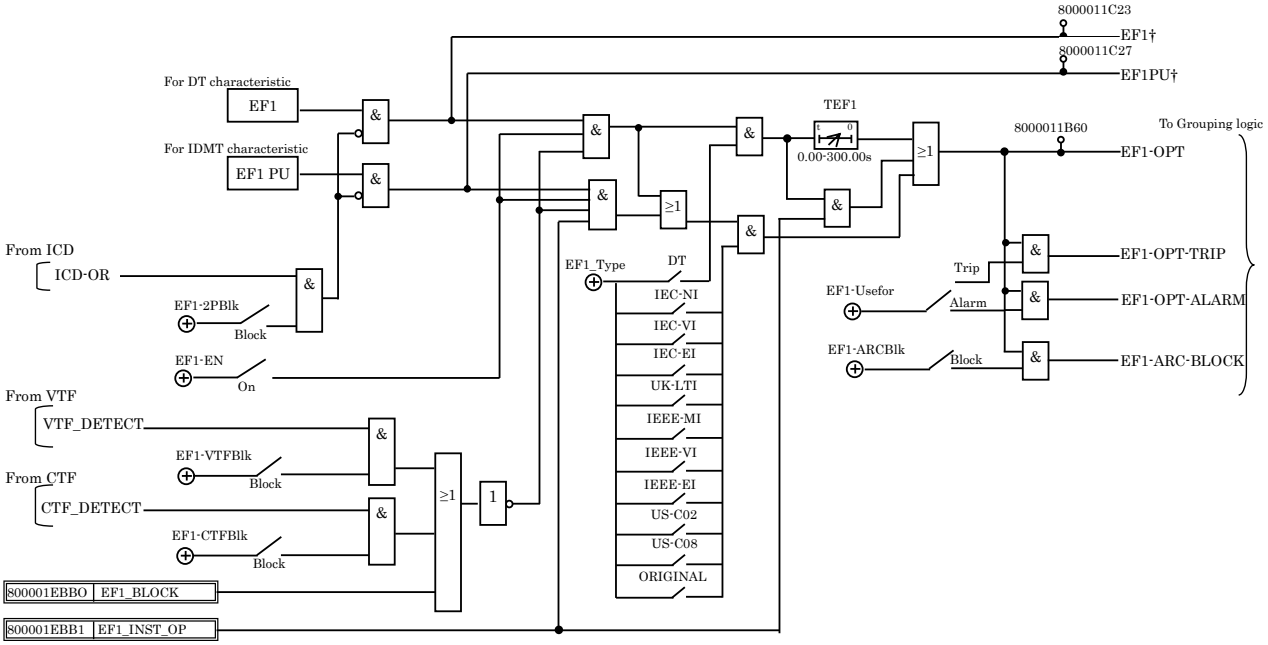


Figure 2.10-6 Scheme logic for the EF1

†Note:The presence of 'EF1' and 'EF1PU' signals depends on the operation characteristic defined with setting [**EF1_Type**], as shown in Table 2.9-7.

Table 2.10-5 Signal behaviors of PLC monitoring points 'EF1' and 'EF1PU'

PLC monitoring points	Setting [**EF1_Type**]	
	DT	**IEC-NT,VI,EI, UK-LTI, IEET-MI,VI,EI, US-CO2,CO8, ORIGINAL**
EF1	①	③
EF1PU	②	④

①: A pick-up signal is generated instantly when the element operates.

②: No signal due that the PU element is killed. Use 'EF1' in place of this.

③: A pick-up signal is generated, but delayed with the IDMT characteristic.

④: A pick-up signal is generated instantly.

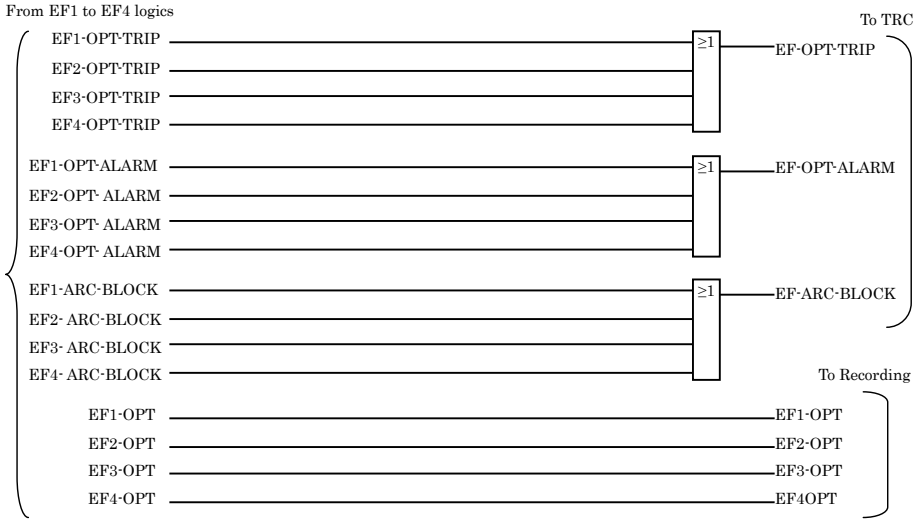


Figure 2.10-7 Grouping logic for TRC/Recording

2.10.7 Setting

Setting of EF(Function ID: 441001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
Common	EF-Vpol	0.5 - 100.0		V	The polarizing voltage level of EF directional characteristic	3.0		
EF1	EF1-EN	Off / On		-	EF1 protection enable	Off		
	EF1-Dir	NonDir / Forward / Reverse		-	EF1 directional characteristic	NonDir		
	EF1-Angle	0 - 180		deg	EF1 directional characteristic angle	45		
	EF1-Type	DT / IEC-NI / IEC-VI / IEC-EI/ UK-LTI / IEEE-MI / IEEE-VI / IEEE-EI / US-CO2 / US-CO8 / Original		-	EF1 delay type	DT		
	EF1-DT	0.02 - 50.00	0.10 - 250.00	A	EF1 threshold (in DT mode)	0.30	1.50	
	EF1-IDMT	0.02 - 5.00	0.10 - 25.00	A	EF1 threshold (in IDMT mode)	0.30	1.50	
	EF1-DPR	10 - 100		%	EF1 drop-out/pick-up ratio	100		
	TEF1	0.00 - 300.00		s	EF1 operating delay time (in DT mode)	1.00		
	EF1-TMS-IEC	0.010 - 50.000		-	EF1 time multiplier of IEC inverse curve	1.000		
	EF1-TMS-UK	0.010 - 50.000		-	EF1 time multiplier of UK inverse curve	1.000		
	EF1-TMS-IEEE	0.010 - 50.000		-	EF1 time multiplier of IEEE inverse curve	1.000		
	EF1-TMS-US	0.010 - 50.000		-	EF1 time multiplier of US inverse curve	1.000		
	EF1-TMS-ORG	0.010 - 50.000		-	EF1 time multiplier of Original inverse curve	1.000		
	EF1-Rtype	DEF / DEP		-	EF1 reset delay type	DEF		
	TEF1R	0.00 - 300.00		s	EF1 definite time reset delay	0.00		
	EF1-RTMS-IEEE	0.010 - 50.000		-	EF1 dependent reset time multiplier of IEEE inverse curve	1.000		
	EF1-RTMS-US	0.010 - 50.000		-	EF1 dependent reset time multiplier of US inverse curve	1.000		
	EF1-RTMS-ORG	0.010 - 50.000		-	EF1 dependent reset time multiplier of Original inverse curve	1.000		
	EF1-k	0.00000 - 500.00000		-	EF1 user original curve coefficient	0.00000		
	EF1-a	0.00000 - 10.00000		-	EF1 user original curve coefficient	0.00000		
	EF1-c	0.00000 - 10.00000		-	EF1 user original curve coefficient	0.00000		
	EF1-kr	0.00000 - 500.00000		-	EF1 user original curve coefficient	0.00000		
	EF1-b	0.00000 - 10.00000		-	EF1 user original curve coefficient	0.00000		
	EF1-2fBlk	Non / Block		-	EF1 operation block by 2f-detection	Non		
	EF1-VTFBlk	Non / Block		-	EF1 operation block by VTF	Non		
	EF1-CTFBlk	Non / Block		-	EF1 operation block by CTF	Non		
	EF1-UseFor	Trip / Alarm		-	EF1 used for trip or alarm	Trip		
	EF1-ARCBlk	Non / Block		-	Autoreclose block by EF1	Block		
EF2	EF2-EN	Off / On		-	EF2 protection enable	Off		
	EF2-Dir	NonDir / Forward / Reverse		-	EF2 directional characteristic	NonDir		
	EF2-Angle	0 - 180		deg	EF2 directional characteristic angle	45		
	EF2-Type	DT / IEC-NI / IEC-VI / IEC-EI / UK-LTI / IEEE-MI / IEEE-VI / IEEE-EI / US-CO2 / US-CO8 / Original		-	EF2 delay type	DT		
	EF2-DT	0.02 - 50.00	0.10 - 250.00	A	EF2 threshold (in DT mode)	0.30	1.50	

Setting of EF(Function ID: 441001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
		EF2-IDMT	0.02 - 5.00	0.10 - 25.00	A	EF2 threshold (in IDMT mode)	0.30	1.50	
		EF2-DPR	10 - 100		%	EF2 drop-out/pick-up ratio	100		
		TEF2	0.00 - 300.00		s	EF2 operating delay time (in DT mode)	1.00		
		EF2-TMS-IEC	0.010 - 50.000		-	EF2 time multiplier of IEC inverse curve	1.000		
		EF2-TMS-UK	0.010 - 50.000		-	EF2 time multiplier of UK inverse curve	1.000		
		EF2-TMS-IEEE	0.010 - 50.000		-	EF2 time multiplier of IEEE inverse curve	1.000		
		EF2-TMS-US	0.010 - 50.000		-	EF2 time multiplier of US inverse curve	1.000		
		EF2-TMS-ORG	0.010 - 50.000		-	EF2 time multiplier of Original inverse curve	1.000		
		EF2-Rtype	DEF / DEP		-	EF2 reset delay type	DEF		
		TEF2R	0.00 - 300.00		s	EF2 definite time reset delay	0.00		
		EF2-RTMS-IEEE	0.010 - 50.000		-	EF2 dependent reset time multiplier of IEEE inverse curve	1.000		
		EF2-RTMS-US	0.010 - 50.000		-	EF2 dependent reset time multiplier of US inverse curve	1.000		
		EF2-RTMS-ORG	0.010 - 50.000		-	EF2 dependent reset time multiplier of Original inverse curve	1.000		
		EF2-k	0.00000 - 500.00000		-	EF2 user original curve coefficient	0.00000		
		EF2-a	0.00000 - 10.00000		-	EF2 user original curve coefficient	0.00000		
		EF2-c	0.00000 - 10.00000		-	EF2 user original curve coefficient	0.00000		
		EF2-kr	0.00000 - 500.00000		-	EF2 user original curve coefficient	0.00000		
		EF2-b	0.00000 - 10.00000		-	EF2 user original curve coefficient	0.00000		
		EF2-2fBlk	Non / Block		-	EF2 operation block by 2f-detection	Non		
		EF2-VTFBlk	Non / Block		-	EF2 operation block by VTF	Non		
		EF2-CTFBlk	Non / Block		-	EF2 operation block by CTF	Non		
		EF2-UseFor	Trip / Alarm		-	EF2 used for trip or alarm	Trip		
		EF2-ARCBlk	Non / Block		-	Autoreclose block by EF2	Block		
	EF3	EF3-EN	Off / On		-	EF3 protection enable	Off		
		EF3-Dir	NonDir / Forward / Reverse		-	EF3 directional characteristic	NonDir		
		EF3-Angle	0 - 180		deg	EF3 directional characteristic angle	45		
		EF3-Type	DT / IEC-NI / IEC-VI / IEC-EI / UK-LTI / IEEE-MI / IEEE-VI / IEEE-EI / US-CO2 / US-CO8 / Original		-	EF3 delay type	DT		
		EF3-DT	0.02 - 50.00	0.10 - 250.00	A	EF3 threshold (in DT mode)	0.30	1.50	
		EF3-IDMT	0.02 - 5.00	0.10 - 25.00	A	EF3 threshold (in IDMT mode)	0.30	1.50	
		EF3-DPR	10 - 100		%	EF3 drop-out/pick-up ratio	100		
		TEF3	0.00 - 300.00		s	EF3 operating delay time (in DT mode)	1.00		
		EF3-TMS-IEC	0.010 - 50.000		-	EF3 time multiplier of IEC inverse curve	1.000		
		EF3-TMS-UK	0.010 - 50.000		-	EF3 time multiplier of UK inverse curve	1.000		
		EF3-TMS-IEEE	0.010 - 50.000		-	EF3 time multiplier of IEEE inverse curve	1.000		
		EF3-TMS-US	0.010 - 50.000		-	EF3 time multiplier of US inverse curve	1.000		

Setting of EF(Function ID: 441001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
		EF3-TMS-ORG	0.010 - 50.000		-	EF3 time multiplier of Original inverse curve	1.000		
		EF3-Rtype	DEF / DEP		-	EF3 reset delay type	DEF		
		TEF3R	0.00 - 300.00		s	EF3 definite time reset delay	0.00		
		EF3-RTMS-IEEE	0.010 - 50.000		-	EF3 dependent reset time multiplier of IEEE inverse curve	1.000		
		EF3-RTMS-US	0.010 - 50.000		-	EF3 dependent reset time multiplier of US inverse curve	1.000		
		EF3-RTMS-ORG	0.010 - 50.000		-	EF3 dependent reset time multiplier of Original inverse curve	1.000		
		EF3-k	0.00000 - 500.00000		-	EF3 user original curve coefficient	0.00000		
		EF3-a	0.00000 - 10.00000		-	EF3 user original curve coefficient	0.00000		
		EF3-c	0.00000 - 10.00000		-	EF3 user original curve coefficient	0.00000		
		EF3-kr	0.00000 - 500.00000		-	EF3 user original curve coefficient	0.00000		
		EF3-b	0.00000 - 10.00000		-	EF3 user original curve coefficient	0.00000		
		EF3-2fBlk	Non / Block		-	EF3 operation block by 2f-detection	Non		
		EF3-VTFBlk	Non / Block		-	EF3 operation block by VTF	Non		
		EF3-CTFBlk	Non / Block		-	EF3 operation block by CTF	Non		
		EF3-UseFor	Trip / Alarm		-	EF3 used for trip or alarm	Trip		
		EF3-ARCBlk	Non / Block		-	Autoreclose block by EF3	Block		
	EF4	EF4-EN	Off / On		-	EF4 protection enable	Off		
		EF4-Dir	NonDir / Forward / Reverse		-	EF4 directional characteristic	NonDir		
		EF4-Angle	0 - 180		deg	EF4 directional characteristic angle	45		
		EF4-Type	DT / IEC-NI / IEC-VI / IEC-EI/ UK-LTI / IEEE-MI / IEEE-VI / IEEE-EI / US-CO2 / US-CO8 / Original		-	EF4 delay type	DT		
		EF4-DT	0.02 - 50.00	0.10 - 250.00	A	EF4 threshold (in DT mode)	0.30	1.50	
		EF4-IDMT	0.02 - 5.00	0.10 - 25.00	A	EF4 threshold (in IDMT mode)	0.30	1.50	
		EF4-DPR	10 - 100		%	EF4 drop-out/pick-up ratio	100		
		TEF4	0.00 - 300.00		s	EF4 operating delay time (in DT mode)	1.00		
		EF4-TMS-IEC	0.010 - 50.000		-	EF4 time multiplier of IEC inverse curve	1.000		
		EF4-TMS-UK	0.010 - 50.000		-	EF4 time multiplier of UK inverse curve	1.000		
		EF4-TMS-IEEE	0.010 - 50.000		-	EF4 time multiplier of IEEE inverse curve	1.000		
		EF4-TMS-US	0.010 - 50.000		-	EF4 time multiplier of US inverse curve	1.000		
		EF4-TMS-ORG	0.010 - 50.000		-	EF4 time multiplier of Original inverse curve	1.000		
		EF4-Rtype	DEF / DEP		-	EF4 reset delay type	DEF		
		TEF4R	0.00 - 300.00		s	EF4 definite time reset delay	0.00		
		EF4-RTMS-IEEE	0.010 - 50.000		-	EF4 dependent reset time multiplier of IEEE inverse curve	1.000		
		EF4-RTMS-US	0.010 - 50.000		-	EF4 dependent reset time multiplier of US inverse curve	1.000		
		EF4-RTMS-ORG	0.010 - 50.000		-	EF4 dependent reset time multiplier of Original inverse curve	1.000		
		EF4-k	0.00000 - 500.00000		-	EF4 user original curve coefficient	0.00000		
		EF4-a	0.00000 - 10.00000		-	EF4 user original curve coefficient	0.00000		

Setting of EF(Function ID: 441001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
		EF4-c	0.00000 - 10.00000		-	EF4 user original curve coefficient	0.00000		
		EF4-kr	0.00000 - 500.00000		-	EF4 user original curve coefficient	0.00000		
		EF4-b	0.00000 - 10.00000		-	EF4 user original curve coefficient	0.00000		
		EF4-2fBlk	Non / Block		-	EF4 operation block by 2f-detection	Non		
		EF4-VTFBlk	Non / Block		-	EF4 operation block by VTF	Non		
		EF4-CTFBlk	Non / Block		-	EF4 operation block by CTF	Non		
		EF4-UseFor	Trip / Alarm		-	EF4 used for trip or alarm	Trip		
		EF4-ARCBlk	Non / Block		-	Autoreclose block by EF4	Block		

2.10.8 Data ID

◆ Signal monitoring point

EF(Function ID: 441001)

Element ID	Name	Description
8000011C23	EF1	EF1 relay element operated
8000011C27	EF1PU	EF1 relay operation level pick up
8000011B60	EF1-OPT	EF1 protection operated
8100021C23	EF2	EF2 relay element operated
8100021C27	EF2PU	EF2 relay operation level pick up
8100021B60	EF2-OPT	EF2 protection operated
8200031C23	EF3	EF3 relay element operated
8200031C27	EF3PU	EF3 relay operation level pick up
8200031B60	EF3-OPT	EF3 protection operated
8300041C23	EF4	EF4 relay element operated
8300041C27	EF4PU	EF4 relay operation level pick up
8300041B60	EF4-OPT	EF4 protection operated

◆ Connection point on PLC logic

EF(Function ID: 440001)

Element ID	Name	Description
800001EBB0	EF1_BLOCK	EF1 protection block command
810002EBB0	EF2_BLOCK	EF2 protection block command
820003EBB0	EF3_BLOCK	EF3 protection block command
830004EBB0	EF4_BLOCK	EF4 protection block command
800001EBB1	EF1_INST_OP	EF1 protection instantaneous operation command
810002EBB1	EF2_INST_OP	EF2 protection instantaneous operation command
820003EBB1	EF3_INST_OP	EF3 protection instantaneous operation command
830004EBB1	EF4_INST_OP	EF4 protection instantaneous operation command

2.11 Negative sequence overcurrent protection (OCN)

Negative-sequence overcurrent protection (OCN) function has both time characteristic and directional elements. Two stages (elements) are available in the OCN function. The user can select various features using the scheme switches provided. The elements are named OCN1 and OCN2; and they operate independently.

To simplify the description, only OCN1 is discussed but is applicable to the OCN2; hence, read the expression for OCN1 as OCN2 unless a special explanation or instruction has been provided.

Note: The number of relay elements depends on the IED model. To know the number in respective IED models, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.11-1 Comparative table in respective ordering numbers

Features	Ordering No. at "G&T"				
	10	11	13	19	22
Non-directional/directional definite time OCN protection	NA	✓	✓	(✓)	✓
Number of stages	–	2	2	2	2

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, THM, BCD, CBF, SOTF-OC, OV, OVS, UV, UVS, FRQ/DFRQ, FS, VTF, CTF, ARC, VCHK.

2.11.1 Relay polarity

The user can choose either non-directional OCN or directional OCN for each OCN stage. In addition, the user can further select either the forward or the direction for each of the directional OCN elements selected.

(i) Characteristic of a non-directional OCN

The characteristic of the non-directional type (non-directional OCN) is a circle at the origin. A setting and a scheme switch is used to configure each non-directional OCN element; i.e., the user can set the threshold value of non-directional OCN element for state 1 using setting [**OCN1-DT**], provided time characteristic is required for define time delay (DT) described in section 2.11.2(i). **NonDir** is set for the scheme switch [**OCN1-Dir**].

(ii) Characteristic of directional OCN in the forward

As shown in Figure 2.11-1, the characteristic of the directional-OCN elements in the forward direction is a semi-circle based upon the border-line; the hatched area shows the operating region of the directional-OCN.

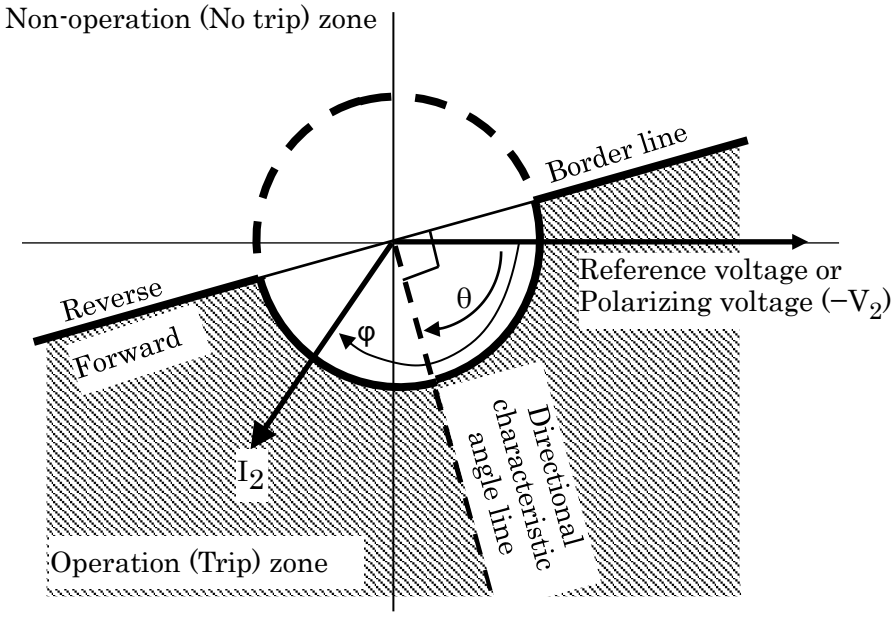


Figure 2.11-1 Characteristic of the directional-OCN element in the forward direction

Note: Directional characteristic angle (θ) forms the angle between the reference quantity and the directional characteristic angle line. The half plane represents the zone of operation bordered on one side by the border line and extending in the direction that contains both the reference (polarizing) and operating quantities.

A setting and a scheme switch, as well as the non-directional OCN element, provide the settings for the directional OCN element: for example, the user can set the threshold value

(I_{OCN}) for stage 1 with the setting [**OCN1-DT**] and **Forward** can be set for the scheme switch [**OCN1-Dir**]. Setting of the sensing angle (θ) is configured by the setting [**OCN1-Angle**] with the value of θ in the range of 0–180°. Figure 2.11-2 shows an example of an angle and a characteristic using the θ.

The operation decision of OCN uses the following equation:

$$I_2 \geq I_{OCN} \quad (2.11\text{-}1)$$

$$I_2 \times \cos(\varphi - \theta) \geq 0 \quad (2.11\text{-}2)$$

$$V_2 \geq OCN_Vpol \quad (2.11\text{-}3)$$

where

I_2 = Negative phase sequence current
V_2 = Negative phase sequence voltage
$-V_2$ = reference voltage (or polarizing voltage)
Φ = lagging angle
θ = OCN setting angle ([**OCN1-Angle**])
I_{OCN} = Setting value of OCN ([**OCN1-DT**] and the others])
OCN_Vpol = Setting value of the polarizing voltage ([**OCN-Vpol**])

Note: The phase angle in the event of an internal fault is equal to the angle of the zero-sequence impedance of the system; this value ranges approximately from 50° to 90°. The θ of OCN can be set from 0° to 180°. The minimum voltage necessary to maintain directionality can be set from 0.5 to 180 V.

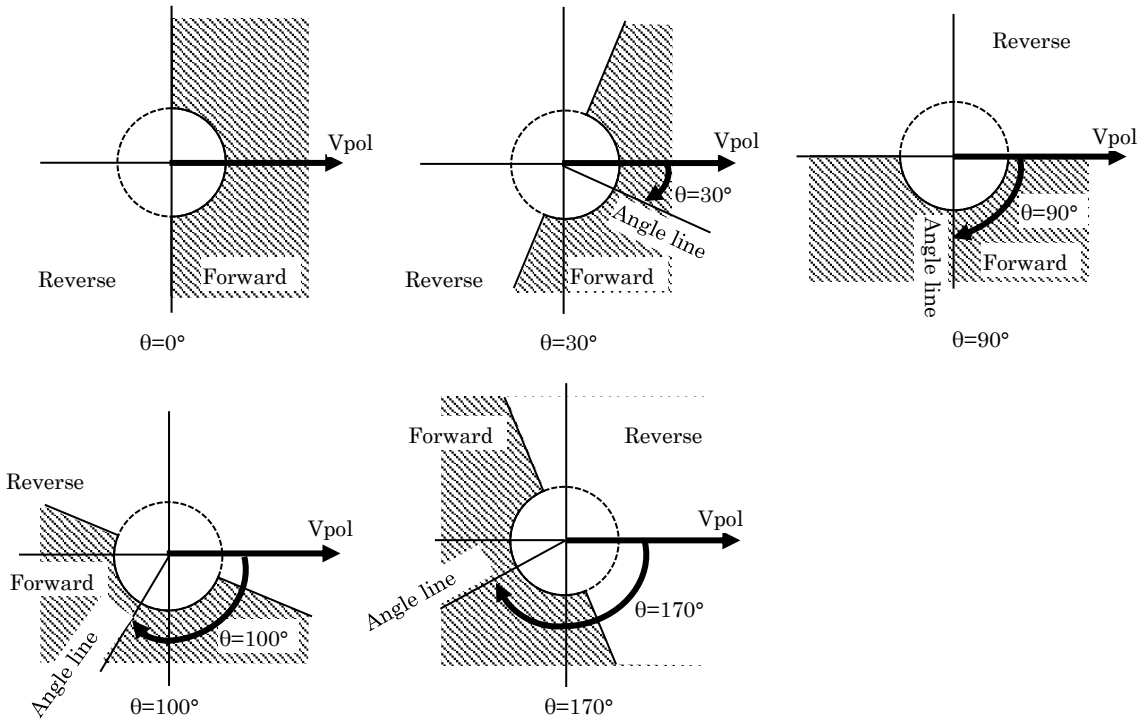


Figure 2.11-2 Examples of directional characteristic angle (θ)

(iii) Characteristic of directional OCN in the reverse

The reverse characteristic is a mirror image of the forward characteristic. The setting and the scheme switch, in addition to providing the setting of the directional OCN element in the forward direction, provides the setting of the directional EF element in the reverse direction: for example, **Reverse** is set for the scheme switch [**OCN1-Dir**] when the direction of the OCN element for stage 1 is considered.

2.11.2 Inverse time and definite time delay characteristic

The OCN element monitors the negative-sequence current; when the negative-sequence current is beyond the threshold for the operation, the OCN element will operate within a period that is defined by the time characteristic feature. The user can choose the one of the operate time delay characteristics: (i) dependent (inverse) time characteristic delay (i.e., IDMT) or (ii) independent (definite) time characteristic delay (i.e., DT). The operate time of the IDMT depends upon the level of the negative-sequence current, whereas the operate time in the DT is a constant.

For the reset time delay in the IDMT, either inverse (dependent)-time-reset or definite(independent)-time-reset is characterized by the setting.

The user can select which characteristic will be applied to each stage of the OCN element using scheme switches. We shall see the scheme switches later.

(i) DT characteristic

The operate time in the DT characteristic will be a constant time; it is not affected by the level of the negative-sequence current. The reset time is set to zero so that resetting is performed immediately. The user can set the operate time using a setting; it is discussed in sections (iv).

(ii) IDMT characteristic

The operate time in the IDMT characteristic is inversely proportional to the level of the fault current. The user can choose the operate time from a preset curve. Ten characteristic curves are available; i.e. nine pre-installed curves covering IEC, IEEE, US and UK standard characteristic curves and one original (user programmable) characteristic curve for which the user can set the equation parameters. The IDMT curve equation and parameters will be explained in section (iii).

The reset time of the IDMT is also user-selectable; either inverse-time-reset or definite-time-reset is selected. For the inverse-time-rest, the user can choose the reset time for the preset characteristic from six characteristic curves; i.e. IEEE and US standard five pre-

installed characteristic curves and one user-original characteristic carver where the user can set the equation parameters. The inverse-time-reset curve equation and parameters will be discussed in section (v).

(iii) Operate time of IDMT

The dependent time in the IDMT is defined by Equation (2.11-4). (ref IEC 60255-151):

$$t(I) = TMS \times \left\{ \left[\frac{k}{\left({}^{I}/_{I_s} \right)^{\alpha} - 1} \right] + c \right\} \qquad (2.11\text{-}4)$$

where:

t = operating time for constant current I (seconds),

I = energizing current (amperes),

Is = earth fault current setting (amperes),

TMS = time multiplier setting,

k, α, c = constants defining curve.

The nine pre-programmed standard characteristic curve are tabulated in Table 2.11-2; additionally, one original (user-programmable) curve can be applied. One curve can be chosen for each OCN stage by setting. Figure 2.11-3 illustrates these characteristic curves. For example, the user should set one for the scheme switch [**OCN1-Type**]: "**IEC-NI**" for IEC Normal Inverse, "**IEC-VI**" for IEC Very Inverse, "**IEC-EI**" for IEC Extremely Inverse, "**UK-LTI**" for UK Long Time Inverse, "**IEEE-MI** " for IEEE Moderately Inverse, "**IEEE-VI**" for IEEE Very Inverse, "**IEEE-EI**" for IEEE Extremely Inverse, "**US-CO2**" for US CO2 short time inverse, "**US-CO8**" for US CO8 inverse, and "**Original**" for user-programmable characteristic.

In the IDMT operation, the user can also program the characteristic using time-multiplier-setting (TMS) for the required operate time. For example, when the IEC characteristic is selected, the user can set the TMS value using the setting [**OCN1-TMS-IEC**] (incidentally, the default value of the TMS is 1.00). The other TMSs are also available by the [**OCN1-TMS-UK**], [**OCN1-TMS-IEEE**], [**OCN1-TMS-US**] and [**OCN1-TMS-ORG**].

Table 2.11-2 Constants for IDMT

Curve type (IEC 60255-151)	Curve Description	k	α	c
A	IEC Normal Inverse (IEC-NI)	0.14	0.02	0
B	IEC Very Inverse (IEC-VI)	13.5	1	0
C	IEC Extremely Inverse (IEC-EI)	80	2	0
-	UK Long Time Inverse (UK-LTI)	120	1	0
D	IEEE Moderately Inverse (IEEE-MI)	0.0515	0.02	0.114
E	IEEE Very Inverse (IEEE-VI)	19.61	2	0.491
F	IEEE Extremely Inverse (IEEE-EI)	28.2	2	0.1217
-	US CO8 inverse (US-CO8)	5.95	2	0.18
-	US CO2 short time inverse (US-CO2)	0.02394	0.02	0.01694

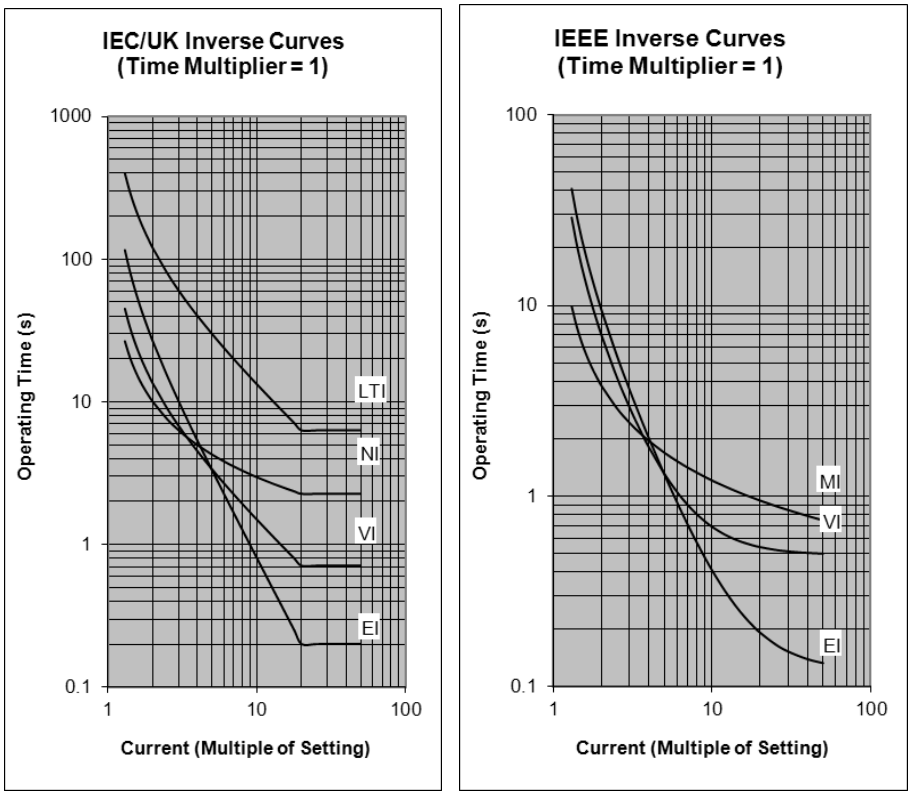


Figure 2.11-3 IDMT Characteristics curves

(iv) Operate time of DT

The operate time in the DT is a constant.

(iv)-1 Time characteristic

The user should set **DT** for the scheme switch [**OCN1-Type**]. The value of the required operate time is set for the setting [**TOCN1**] in the range 0.00–300.00s.

(iv)-2 Instantaneous activation

The instantaneous operation characteristic is achieved by setting zero for the [**TOCN1**], but the instantaneous one can be also obtained when the logic signal "1 (High)" is programmed to be injected at PLC connection point "OCN1_INST_OP".

(v) Reset time of IDMT

Programming the reset time characteristic is available for the IEEE standard, US standard and original (user-programmable) dependent time characteristic†. In the IEEE standard, for example, the user should set **DEP** for the scheme switch [**OCN1-Rtype**]. The following equation defines the reset time for the inverse-time-reset characteristic (ref. IEC 60255-151):

$$t(\mathrm{I}) = RTMS \times \left[\frac{\mathrm{kr}}{1 - \left({}^{\mathrm{I}}/_{\mathrm{I_s}} \right)^{\beta}} \right] \qquad (2.11\text{-}2)$$

where:

t = time required for the element to reset fully after complete operation (seconds),

I = energizing current (amperes),

Is = earth fault current setting (amperes),

kr = time required to reset fully after complete operation when the energizing current is zero

RTMS = time multiplier setting for resetting.

ß = constants defining curve.

For setting the RTMS for the IEEE standard, the user can use setting [**OCN1-RTMS-IEEE**] (incidentally, the default value is 1.000). Similarly, settings [**OCN1-RTMS-US**] and [**OCN1-RTMS-ORG**] are provided for the US standard and the original, respectively (For more information w.r.t the values for kr and ß, see Table 2.11-3; Figure 2.11-4 shows the characteristic curves).

Table 2.11-3 Constants for inverse-time-reset characteristics

Curve Type IEC 60255-151	Curve Description	kr (sec)	ß
A	IEC Normal Inverse (IEC-NI‡)	N/A	N/A
B	IEC Very Inverse (IEC-VI‡)	N/A	N/A
C	IEC Extremely Inverse (IEC-EI‡)	N/A	N/A
-	UK Long Time Inverse (UK-LTI‡)	N/A	N/A
D	IEEE Moderately Inverse (IEEE-MI)	4.85	2
E	IEEE Very Inverse (IEEE-VI)	21.6	2
F	IEEE Extremely Inverse (IEEE-EI)	29.1	2
-	US CO8 inverse (US-CO8)	5.95	2
-	US CO2 short time inverse (US-CO2)	2.261	2

†Note: The user can set **DEF** for scheme switch [**OCN1-Rtype**] when the definite-time-reset characteristic is preferred. The definite-reset-time characteristic is available in all IDMT characteristics (see Table 2.11-4). After that, the user should set an intentional delay reset time for the setting [**TOCN1R**].

‡Note: The user should set **DEF** is for scheme switch [**OCN1-Rtype**] when the IEC and the UK standards are selected.

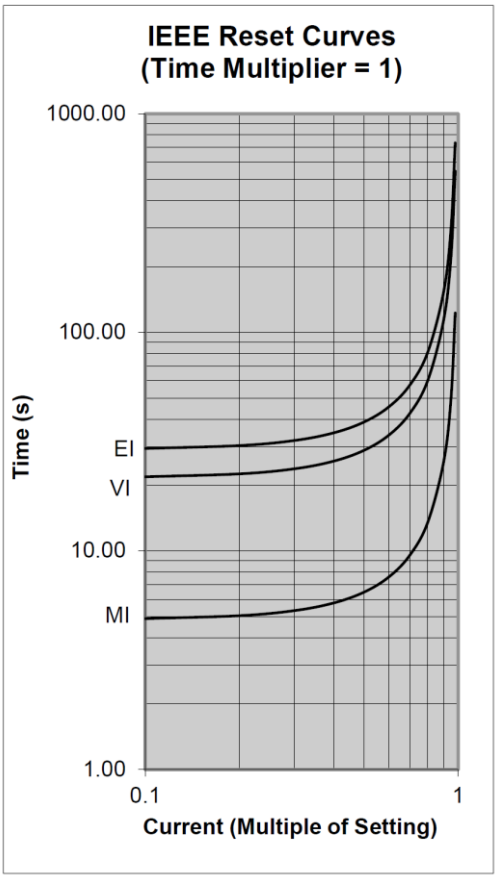


Figure 2.11-4 Inverse-time-reset characteristics curves

Figure 2.11-5 illustrates the effect of invers-time-reset on the internal time delay counter. An object current (I), where I is greater than a setting (I_S) provides an energizing quantity for the function which continues to flow for a cumulative period causing the operation of the function. If the operating quantity falls below the value of the I_S, the function will return to its reset state after time t(I), which is calculated using Equation (2.11-2).

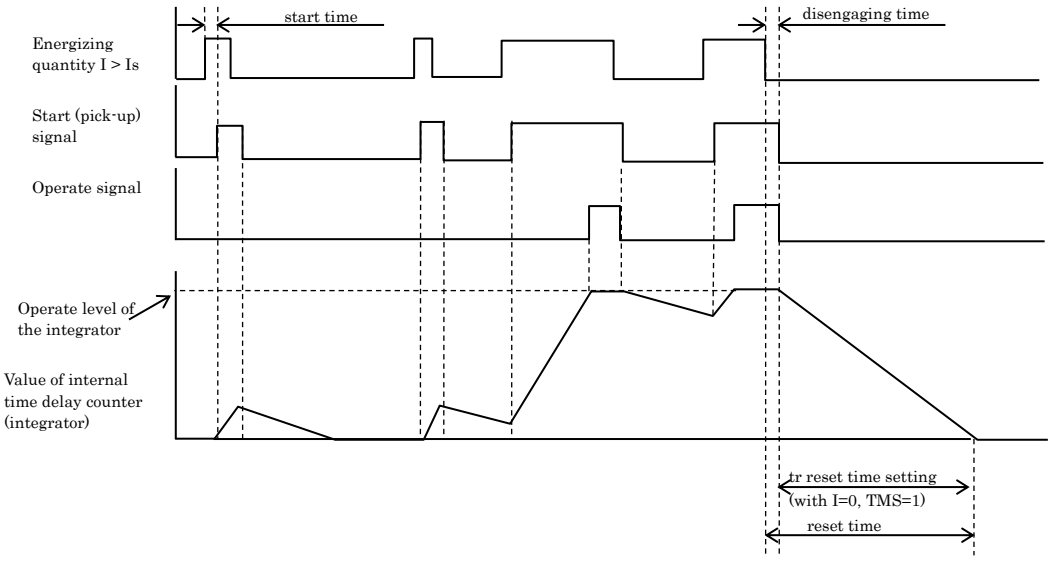


Figure 2.11-5 Inverse-time-reset characteristics

(vi) Reset time of DT

In the DT characteristic, the reset time is designed to be instant. Thus, the user has no points for the settings [**OC1-Rtype**] and [**TOC1R**].

(vii) Summary of OCN operation

Table 2.11-4 shows a summary for OCN operation.

Table 2.11-4 Type and standard board in the OCN1 (A tick represents a selectable function)

Characteristics		DT	IDMT									
			IEC-NI	IEC-VI	IEC-EI	UK-LTI	IEEE-MI	IEEE-VI	IEEE-EI	US-CO2	US-CO8	Original
Scheme switch [OCN1-Type]	DT	✓										
	IEC-NI		✓									
	IEC-VI			✓								
	IEC-EI				✓							
	UK LTI					✓						
	IEEE-MI						✓					
	IEEE-VI							✓				
	IEEE-EI								✓			
	US-CO2									✓		
	US-CO8										✓	
	Original											✓
Scheme switch [OCN1-Rtype]	DEF	N.A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	DEP	N.A					✓					
		N.A						✓				
		N.A							✓			
		N.A								✓		
		N.A									✓	
		N.A										✓

2.11.3 Threshold value

The value of threshold current at which the OCN (I_2) element will pick-up is configured by settings; the settings [**OCN1-IDMT**] and [**OCN1-DT**] are provided for both the IDMT and the DT characteristic. Note that the settings of the threshold levels are allowed to have distinct values in the respective OCN elements. A rating current for the input is defined either 1A or 5A; the input rating is defined on a VCT. (For more information about the VCT, see Chapter *Technical description: Transformer module for AC analogue input*).

2.11.4 Reset Ratio

The ratio of the threshold current for pick-up to reset is applied using a setting; for example, the ratio for the OCN1 element is set using the setting [**OCN1-DPR**]. The reset ratios for the other OCN elements are also provided.

2.11.5 Miscellaneous functions

(i) Harmonic detection

The operation of each OCN element can be blocked using a scheme switch, if the ICD function detects a second harmonic current caused by the magnetizing inrush current phenomenon when a transformer is energized. For example, for the OCN1 element, the scheme switch [**OCN1-2fBlk**] is provided, and **Block** should be set when the user wishes to block the OCN1 element when the second harmonic associated with magnetizing inrush is present. **Non** is set for the scheme switch [**OCN1-2fBlk**] as the default setting. For more information about the ICD function, see Chapter *Relay application: Inrush current detection function*.

(ii) Blocking OCN by VTF

The operation of the OCN element can be blocked by the voltage transformer failure (VTF) function via a scheme switch. For example, **Block** is set for the scheme switch [**OCN1-VTFBlk**] to block the operation of the OCN1 element during a VTF condition. **Non** is set for the scheme switch [**OCN1-VTFBlk**] as a default. For more information about the VTF, see Chapter *Relay application: VT failure detection*.

(iii) Blocking OCN by CTF

The operation of the OCN element can be blocked by the current transformer failure (CTF) function via a scheme switch. For example, **Block** should be set for the scheme switch [**OCN1-CTFBlk**] to block the operation of the OCN1 element during a CTF condition. **Non** is set for the scheme switch [**OCN1-CTFBlk**] as a default. For more information about the CTF, see Chapter *Relay application: CT failure detection*.

(iv) OCN operation for autoreclose

The OCN element activates the auto-reclose (ARC) function. However, if ARC is not required, **Block** is set for the scheme switch [**OCN1-ARCBlk**]. **Block** is set for the scheme switch [**OCN1-ARCBlk**] as a default.

(v) Signal of OCN trip

When a user requires an alarm signal in place of the trip signal; for example, set **Alarm** for the scheme switch [**OCN1-UseFor**]. **Trip** is set for the scheme switch [**OCN1-UseFor**] for the normal trip operation.

2.11.6 Scheme logic

The scheme logic of both the non-directional and the directional OCN1 is illustrated in Figure 2.11-6; Figure 2.11-7 shows grouping commands for the trip circuit (TRC). The OCN1 signal is generated when the pickup current exceeds a threshold, and then trip signals are injected into the TRC. (For more information, see Chapter *Relay application: Trip circuit function*)

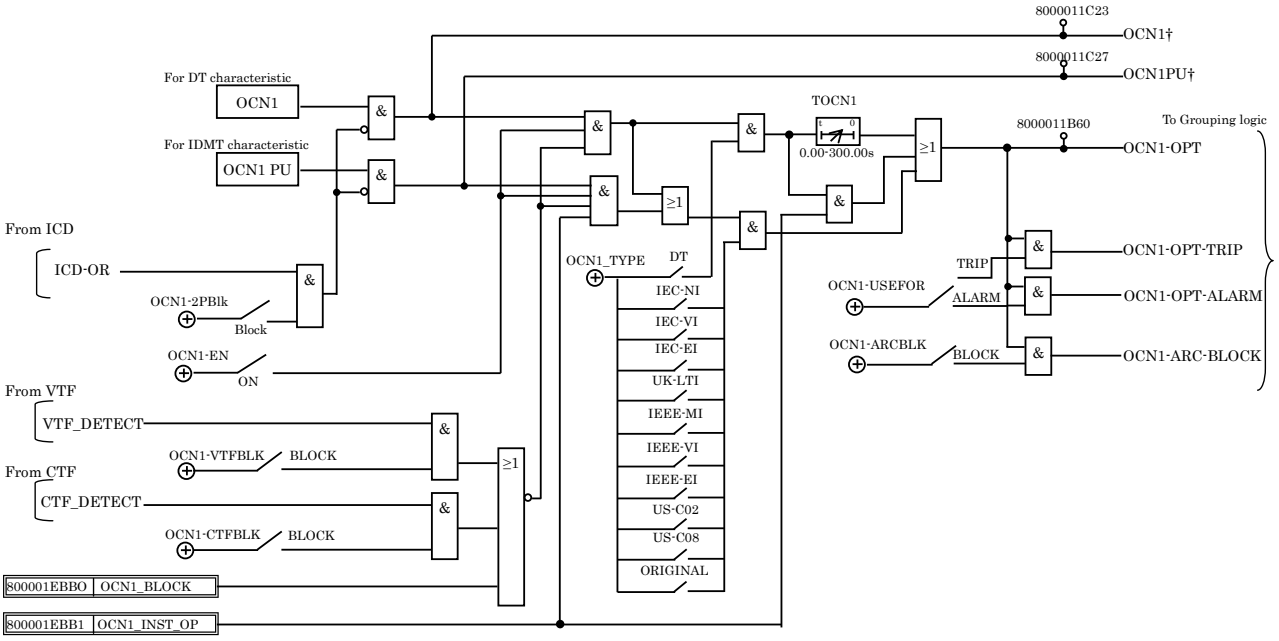


Figure 2.11-6 Scheme logic of OCN1

†Note:The presence of 'OCN1' and 'OCN1PU' signals depends on the operation characteristic defined with setting [**OCN1_Type**], as shown in Table 2.9-7.

Table 2.11-5 Signal behaviors of PLC monitoring points 'OCN1' and 'OCN1PU'

PLC monitoring points	Setting [**OCN1_Type**]	
	DT	**IEC-NT,VI,EI, UK-LTI, IEET-MI,VI,EI, US-CO2,CO8, ORIGINAL**
OCN1	①	③
OCN1PU	②	④

①: A pick-up signal is generated instantly when the element operates.

②: No signal due that the PU element is killed. Use 'OCN1' in place of this.

③: A pick-up signal is generated, but delayed with the IDMT characteristic.

④: A pick-up signal is generated instantly.

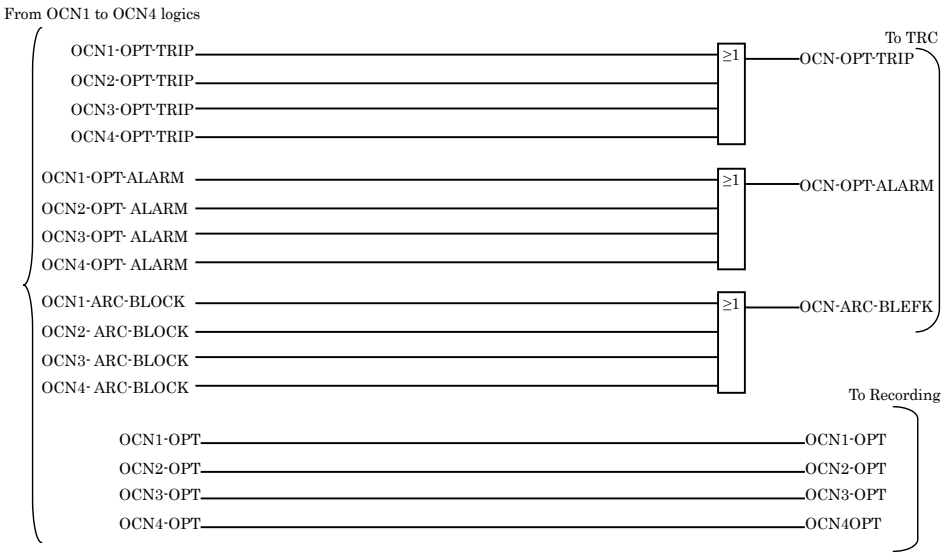


Figure 2.11-7 Grouping logic for TRC/Recording

2.11.7 Setting

Setting of OCN(Function ID:443001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A	5A	
Common		OCN-Vpol	0.5 - 25.0		V	The polarizing voltage level of OCN directional characteristic	3.0		
	OCN1	OCN1-EN	Off / On		-	OCN1 protection enable	Off		
		OCN1-Dir	NonDir / Forward / Reverse		-	OCN1 directional characteristic	NonDir		
		OCN1-Angle	0 - 180		deg	OCN1 directional characteristic angle	45		
		OCN1-Type	DT / IEC-NI / IEC-VI / IEC-EI / UK-LTI / IEEE-MI / IEEE-VI / IEEE-EI / US-CO2 / US-CO8 / Original		-	OCN1 delay type	DT		
		OCN1-DT	0.02 - 50.00	0.10 - 250.00	A	OCN1 threshold (in DT mode)	0.40	2.00	
		OCN1-IDMT	0.02 - 5.00	0.10 - 25.00	A	OCN1 threshold (in IDMT mode)	0.40	2.00	
		OCN1-DPR	10 - 100		%	OCN1 drop-out/pick-up ratio	100		
		TOCN1	0.00 - 300.00		s	OCN1 operating delay time	1.00		
		OCN1-TMS-IEC	0.010 - 50.000		-	OCN1 time multiplier of IEC inverse curve	1.000		
		OCN1-TMS-UK	0.010 - 50.000		-	OCN1 time multiplier of UK inverse curve	1.000		
		OCN1-TMS-IEEE	0.010 - 50.000		-	OCN1 time multiplier of IEEE inverse curve	1.000		
		OCN1-TMS-US	0.010 - 50.000		-	OCN1 time multiplier of US inverse curve	1.000		
		OCN1-TMS-ORG	0.010 - 50.000		-	OCN1 time multiplier of Original inverse curve	1.000		
		OCN1-Rtype	DEF / DEP		-	OCN1 reset delay type	DEF		
		TOCN1R	0.00 - 300.00		s	OCN1 definite time reset delay	0.00		
		OCN1-RTMS-IEEE	0.010 - 50.000		-	OCN1 dependent reset time multiplier of IEEE inverse curve	1.000		
		OCN1-RTMS-US	0.010 - 50.000		-	OCN1 dependent reset time multiplier of US inverse curve	1.000		
		OCN1-RTMS-ORG	0.010 - 50.000		-	OCN1 dependent reset time multiplier of Original inverse curve	1.000		
		OCN1-k	0.00000 - 500.00000		-	OCN1 user original curve coefficient	0.00000		
		OCN1-a	0.00000 - 10.00000		-	OCN1 user original curve coefficient	0.00000		
		OCN1-c	0.00000 - 10.00000		-	OCN1 user original curve coefficient	0.00000		
		OCN1-kr	0.00000 - 500.00000		-	OCN1 user original curve coefficient	0.00000		
		OCN1-b	0.00000 - 10.00000		-	OCN1 user original curve coefficient	0.00000		
		OCN1-2fBlk	Non / Block		-	OCN1 operation block by 2f-detection	Non		
		OCN1-VTFBlk	Non / Block		-	OCN1 operation block by VTF	Non		
		OCN1-CTFBlk	Non / Block		-	OCN1 operation block by CTF	Non		
		OCN1-UseFor	Trip / Alarm		-	OCN1 used for trip or alarm	Trip		
		OCN1-ARCBlk	Non / Block		-	Autoreclose block by OCN1	Block		
	OCN2	OCN2-EN	Off / On		-	OCN2 protection enable	Off		
		OCN2-Dir	NonDir / Forward / Reverse		-	OCN2 directional characteristic	NonDir		
		OCN2-Angle	0 - 180		deg	OCN2 directional characteristic angle	45		

Setting of OCN(Function ID:443001)

Setting item	Range		Units	Contents	Default setting value		Notes
	1A rating	5A rating			1A	5A	
OCN2-Type	DT / IEC-NI / IEC-VI / IEC-EI / UK-LTI / IEEE-MI / IEEE-VI / IEEE-EI / US-CO2 / US-CO8 / Original		-	OCN2 delay type	DT		
OCN2-DT	0.02 - 50.00	0.10 - 250.00	A	OCN2 threshold (in DT mode)	0.40	2.00	
OCN2-IDMT	0.02 - 5.00	0.10 - 25.00	A	OCN2 threshold (in IDMT mode)	0.40	2.00	
OCN2-DPR	10 - 100		%	OCN2 drop-out/pick-up ratio	100		
TOCN2	0.00 - 300.00		s	OCN2 operating delay time	1.00		
OCN2-TMS-IEC	0.010 - 50.000		-	OCN2 time multiplier of IEC inverse curve	1.000		
OCN2-TMS-UK	0.010 - 50.000		-	OCN2 time multiplier of UK inverse curve	1.000		
OCN2-TMS-IEEE	0.010 - 50.000		-	OCN2 time multiplier of IEEE inverse curve	1.000		
OCN2-TMS-US	0.010 - 50.000		-	OCN2 time multiplier of US inverse curve	1.000		
OCN2-TMS-ORG	0.010 - 50.000		-	OCN2 time multiplier of Original inverse curve	1.000		
OCN2-Rtype	DEF / DEP		-	OCN2 reset delay type	DEF		
TOCN2R	0.00 - 300.00		s	OCN2 definite time reset delay	0.00		
OCN2-RTMS-IEEE	0.010 - 50.000		-	OCN2 dependent reset time multiplier of IEEE inverse curve	1.000		
OCN2-RTMS-US	0.010 - 50.000		-	OCN2 dependent reset time multiplier of US inverse curve	1.000		
OCN2-RTMS-ORG	0.010 - 50.000		-	OCN2 dependent reset time multiplier of Original inverse curve	1.000		
OCN2-k	0.00000 - 500.00000		-	OCN2 user original curve coefficient	0.00000		
OCN2-a	0.00000 - 10.00000		-	OCN2 user original curve coefficient	0.00000		
OCN2-c	0.00000 - 10.00000		-	OCN2 user original curve coefficient	0.00000		
OCN2-kr	0.00000 - 500.00000		-	OCN2 user original curve coefficient	0.00000		
OCN2-b	0.00000 - 10.00000		-	OCN2 user original curve coefficient	0.00000		
OCN2-2fBlk	Non / Block		-	OCN2 operation block by 2f-detection	Non		
OCN2-VTFBlk	Non / Block		-	OCN2 operation block by VTF	Non		
OCN2-CTFBlk	Non / Block		-	OCN2 operation block by CTF	Non		
OCN2-UseFor	Trip / Alarm		-	OCN2 used for trip or alarm	Trip		
OCN2-ARCBlk	Non / Block		-	Autoreclose block by OCN2	Block		

2.11.8 Data ID

◆ Signal monitoring point

OCN(Function ID: 443001)

Element ID	Name	Description
8000011C23	OCN1	OCN1 relay element operated
8000011C27	OCN1PU	OCN1 relay operation level pick up
8000011B60	OCN1-OPT	OCN1 protection operated
8100021C23	OCN2	OCN2 relay element operated
8100021C27	OCN2PU	OCN2 relay operation level pick up
8100021B60	OCN2-OPT	OCN2 protection operated

◆ Connection point on PLC logic

OCN(Function ID: 443001)

Element ID	Name	Description
800001EBB0	OCN1_BLOCK	OCN1 protection block command
800001EBB1	OCN1_INST_OP	OCN1 protection instant operation command
810002EBB0	OCN2_BLOCK	OCN2 protection block command
810002EBB1	OCN2_INST_OP	OCN2 protection instant operation command

2.12 Thermal overload function (THM)

Apparatus such as cables, transformers, generators and others can become overheated when overloaded beyond their respective design limits due to excessive demands being placed on the system. The thermal overload function (THM) works by determining the temperature rise in an item of primary equipment by monitoring the current in order to detect the thermal overload of the apparatus.

THM has an exponential characteristics in accordance with the IEC 60255-149 standard. THM determines both the I^2R loss and the cooling effect of the coolant simultaneously; THM also determines the pre-load condition and signals a trip signal when an overload condition arises.

THM issues a trip signal in accordance with an alarm stage that reflects the temperature of the thermal overload condition. The alarm stage is configured using a setting; hence, the user should determine the appropriate setting so that a trip signal can be issued before the apparatus is overheated

---

Note: Several IED models do not have thermal overload features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.12-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
THM	Thermal overload protection	NA	✓	✓	(✓)	✓

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, OCN, BCD, CBF, SOTF-OC, OV, OVS, UV, UVS, FRQ/DFRQ, FS, VTF, CTF, ARC, VCHK.

2.12.1 Thermal state determination

THM simulates the change of thermal state using an algorithm; THM can detect an overload condition. Thermal state (θ) is determined with the following equation:

$$\theta = \frac{I^2}{I_{AOL}^2}\left(1 - e^{-t/\tau}\right) \times 100 \ (\%) \qquad (2.12\text{-}1)$$

where I is the load current applied; I_{AOL} is the allowable overload current; τ is the thermal time constant. The value of τ is set using setting [**TTHM**].

Thermal state 0% is the cold state, whereas 100% reflects the thermal limit—which is the point at which no further temperature rise can be tolerated safely and the system should be disconnected. The thermal limit for any given system is subject to setting [**THM**], which determines the value of overload current. The THM signals a trip when the value of θ is at 100%.

THM determines I using the positive-sequence current (I_1) and negative-sequence current (I_2) using Equation (2.12-2); and operates according to the characteristics defined in IEC 60255-149† when the user has set scheme switch [**THM-Ieq**] **On**.

$$I = \sqrt{I_1^2 + q \times I_2^2} \qquad (2.12\text{-}2)$$

where,

q: Unbalance factor; the unbalance factor is used for motor/generator protection; the user should set q=0 when setting [**THM-q**] except when it is applied to motor/generator protection.

†Note: If the user prefers to use the thermal characteristic for the THM function specified in IEC 60255-8, set **Off** for the scheme switch [**THM-Ieq**]. In this case, THM is determined using the largest of the three-phase currents.

The period of time for a trip to occur depends not only on the degree of overload, but also on the degree of load current as far as reaching the overload state. The period of the trip, that is, depends on whether the overload is applied from 'cold' or 'hot'. THM has thresholds for alarm and trip; hence, the two thresholds exist independently.

2.12.2 Thermal characteristic

THM characteristics are determined with two equations. Equation (2.12-3) is used to define the cold state. Equation (2.12-4) is used to define the hot state:

$$t = \tau \cdot \mathrm{Ln}\left[\frac{I^2}{I^2 - I_{AOL}^2}\right] \qquad (2.12\text{-}3)$$

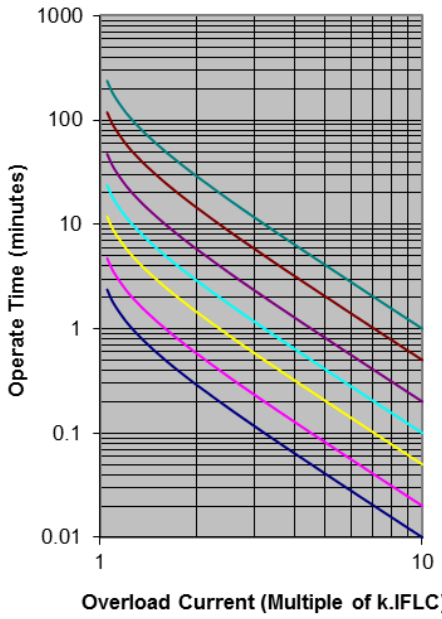
$$t = \tau \cdot \mathrm{Ln}\left[\frac{I^2 - I_P^2}{I^2 - I_{AOL}^2}\right] \qquad (2.12\text{-}4)$$

where t is time to trip for a constant overload current of I (minutes), I is the overload current (largest phase current in amperes), I_{AOL} is the permitted overload current (amperes), Ip is the pre-load current (amperes), τ is the thermal time constant (minutes), and Ln is the natural logarithm.

In Equation (2.12-3), cold curves are special versions of the hot curves where Ip is zero, catering for the situation where a cold system is switched onto an immediate overload.

Figure 2.12-1.a shows the cold state where an overload has been switched onto a previously un-loaded system. Figure 2.12-1.b shows the hot state where an overload is switched onto a system that has previously been loaded to 90% of its capacity. The figures are in conformity with the IEC 60255-149 curves, and these curves are drawn in a range of settings of the time constant (τ).

a.Thermal Curves (Cold Curve - no prior load)



b. Thermal Curves (Hot Curve - 90% prior load))

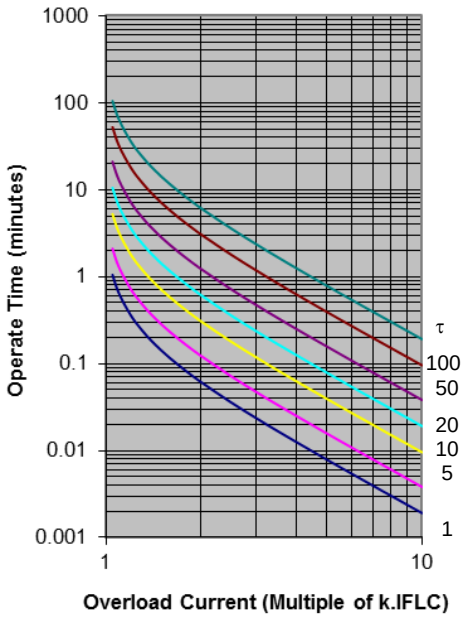


Figure 2.12-1 Thermal curves

2.12.3 Scheme logic

Figure 2.12-2 shows the scheme logic for THM. THM has two thresholds; threshold "A" is used for alarming, threshold "T" for tripping. The name of the output signal for the alarm is termed THM-OPT-ALARM and that of the output signal for tripping is termed "THM-OPT-TRIP".

The threshold level for the alarm is set using setting [**THM-Alarm**] as a percentage of the tripping threshold. The alarm signal is disabled when **Off** is set for scheme switch [**THMA-EN**]. The trip signal is prevented when **Off** is set for scheme switch [**THMT-EN**]. PLC signals THMA_BLOCK and THMT_BLOCK are used to block the operation of THM.

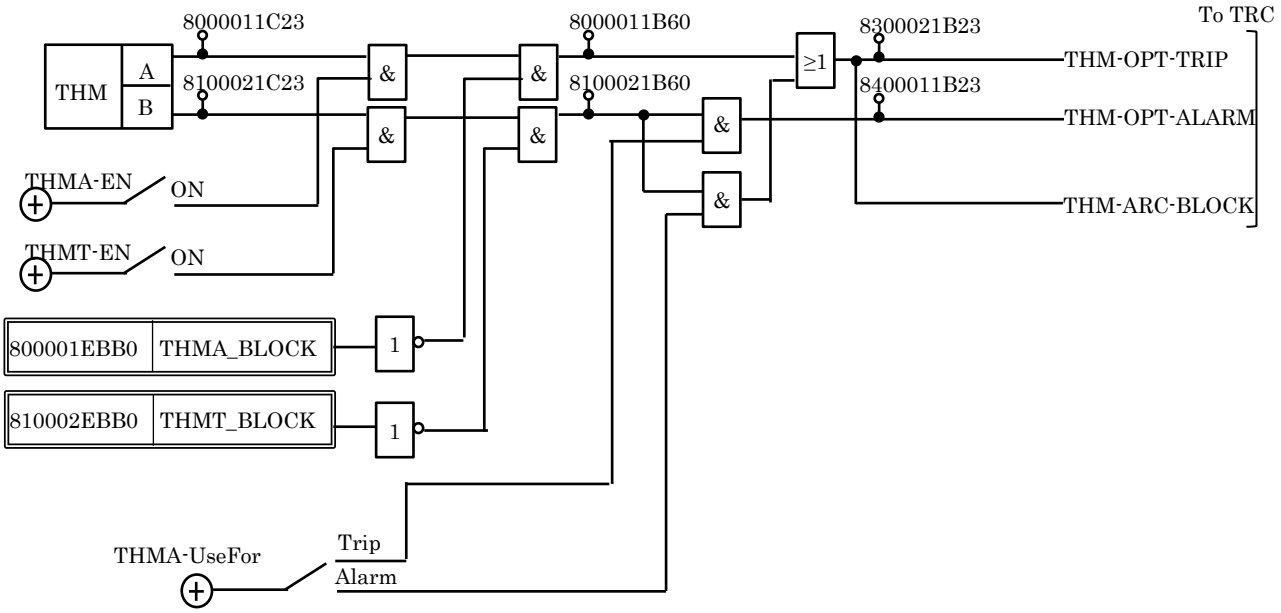


Figure 2.12-2 THM Logic

When wishing to have a test about pre-load current (Ip), the user should set a test value for the setting [**THM-IP**] followed by setting [**THM-Test**]=**On**.

2.12.4 Setting

Setting of THM(Function ID: 451001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
Thermal setting	THMT-EN	Off / On		-	Thermal protection enable	Off		
	THMA-EN	Off / On		-	Thermal alarm enable	Off		
	THM	0.4 – 2.0	2.0 – 10.0	A	Thermal overload current	1.0	5.0	
	TTHM	0.5 – 500.0		min	Thermal time constant	10.0		
	THM-Alarm	50 – 100		%	Thermal alarm level multiplier (Percentage of [THM] setting)	80		
	THM-q	0 – 10		-	Thermal unbalance factor from I2	0		
	THM-Ieq	Off / On		-	Thermal equivalent heating current used	On		
	TFM-UseFor	Trip / Alarm		-	THM used for trip or alarm	Trip		
Test setting	THM-Test	Off / On		-	To utilize the setting[THM-IP], and To change the reset delay to instantaneous reset	Off		
	THM-IP	0.00 - 1.00	0.00 - 5.00	A	Previous load current for thermal testing	0.00/0.00		

2.12.5 Data ID

◆ Signal monitoring point

THM(Function ID: 451001)

Element ID	Name	Description
8000011C23	THM-A	THM relay element operated (Alarm)
8000011B60	THM-ALARM	THM protection Alarm signal
8400011B23	THM-OPT-ALARM	THM protection operated (Alarm)
8300021B23	THM-OPT-TRIP	THM protection operated (Trip)
8100021C23	THM-T	THM relay element operated (Trip)
8100021B60	THM-TRIP	THM protection Trip signal

◆ Connection point on PLC logic

THM(Function ID: 451001)

Element ID	Name	Description
800001EBB0	THMA_BLOCK	THM protection for Alarm block command
810002EBB0	THMT_BLOCK	THM protection for Trip block command

2.13 Broken conductor protection (BCD)

A series fault or an open circuit fault can be caused by circuit breaker contact failure, the operation of fuses, and false operation of single-phase switchgear. IEC60050 defines a series fault as having impedances in each of three-phases that are not equal; hence, the series fault is typified by the interruption of one or two phases, as a rule. The function of broken conductor protection (BCD) is to detect series faults and signal a trip signal to the trip circuit.

Note: Several IED models do not have broken conductor protection feature. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.13-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
BCD	Broken conductor protection	NA	✓	✓	(✓)	✓

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, OCN, BCD, CBF, SOTF-OC, OV, OVS, UV, UVS, FRQ/DFRQ, FS, VTF, CTF, ARC, VCHK.

2.13.1 Equivalent circuit for a one-phase series fault

Figure 2.13-1 shows the sequence diagram of the network connection when a single-phase series fault occurs. We can represent the series fault by the positive sequence, negative sequence and zero sequence impedances; the impedances are distributed to the left and right as shown in the diagram of the primary circuit below. The ratio of the left to the right is determined by the fault location such as k1:1-k1, k2:1-k2, and k0:1-k0.

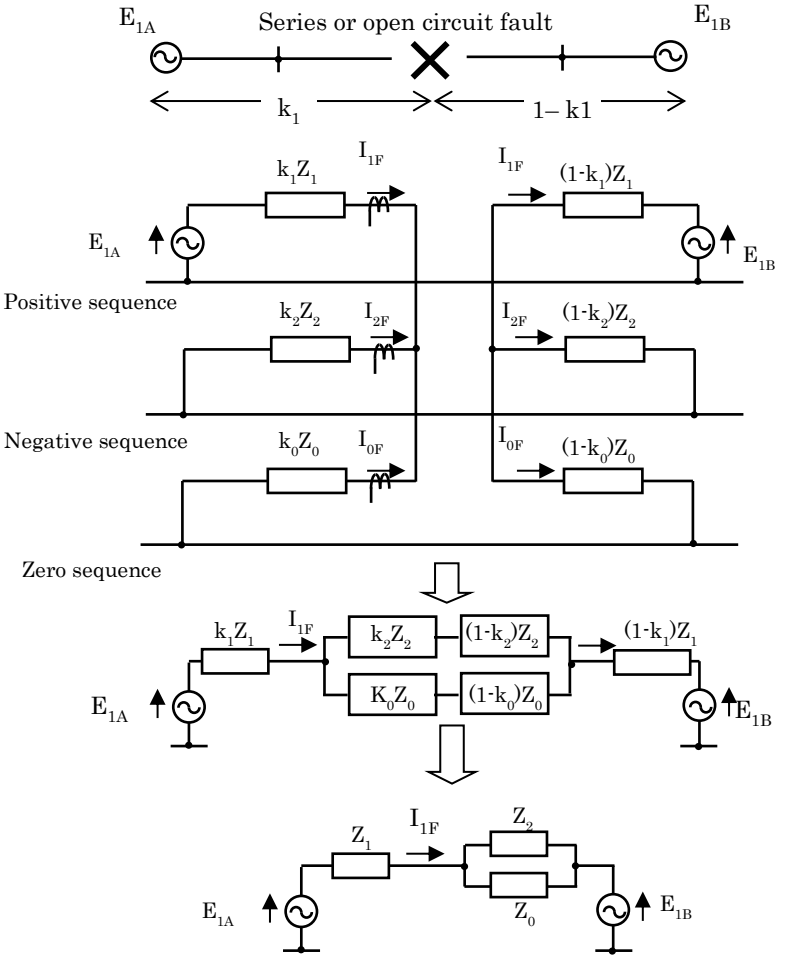


Figure 2.13-1 Equivalent circuit for a single-phase fault

The series fault results in positive sequence current (I_{1F}), negative sequence current (I_{2F}) and zero phase sequence current (I_{0F}) in the single-phase. These are given by

$$I_{1F} + I_{2F} + I_{0F} = 0 \quad (2.13\text{-}1)$$

$$Z_{2F}I_{2F} \cdot Z_{0F}I_{0F} = 0 \quad (2.13\text{-}2)$$

$$E_{1A} \cdot E_{1B} = Z_{1F}I_{1F} \cdot Z_{2F}I_{2F} \quad (2.13\text{-}3)$$

where,

E_{1A}, E_{1B}: power source voltage

Z_1: positive sequence impedance

Z_2: negative sequence impedance

Z_0: zero sequence impedance

From Equation (2.13-1), (2.13-2), and (2.13-3), the following equations are derived:

$$I_{1F} = \frac{Z_2 + Z_0}{Z_1Z_2 + Z_1Z_0 + Z_2Z_0}(E_{1A} - E_{1B}) \quad (2.13\text{-}4)$$

$$I_{2F} = \frac{-Z_0}{Z_1Z_2 + Z_1Z_0 + Z_2Z_0}(E_{1A} - E_{1B}) \quad (2.13\text{-}5)$$

$$I_{0F} = \frac{-Z_2}{Z_1Z_2 + Z_1Z_0 + Z_2Z_0}(E_{1A} - E_{1B}) \quad (2.13\text{-}6)$$

The magnitude of the fault current depends on the impedance across the system, the difference in phase angle, and the magnitude between the power source voltages behind both ends.

As noted earlier, the BCD element detects the presence of a fault by measuring the ratio between the negative sequence current and the positive sequence current (I_{2F}/I_{1F}). The ratio is obtained from the negative sequence impedance (Z_2) and the zero sequence impedance (Z_0); hence, the equation of the ratio is expressed as follows:

$$\frac{I_{2F}}{I_{1F}} = \frac{|I_{2F}|}{|I_{1F}|} = \frac{Z_0}{Z_2 + Z_0} \quad (2.13\text{-}7)$$

A ratio value of 0.5 or higher is obtained when the zero sequence impedance is larger than the negative sequence impedance. The ratio, thus, is close to 1.0 if the system is high-impedance earthed or a single-end earthed system.

2.13.2 Characteristic and setting

The hatched area of Figure 2.13-2 illustrates the BCD characteristic; the BCD function will operate when the positive sequence current (I1) is larger than 0.04×In, the negative sequence current (I2) is larger than 0.01×In, and the ratio $|I_2/I_1|$ is higher than setting [**BCD**].

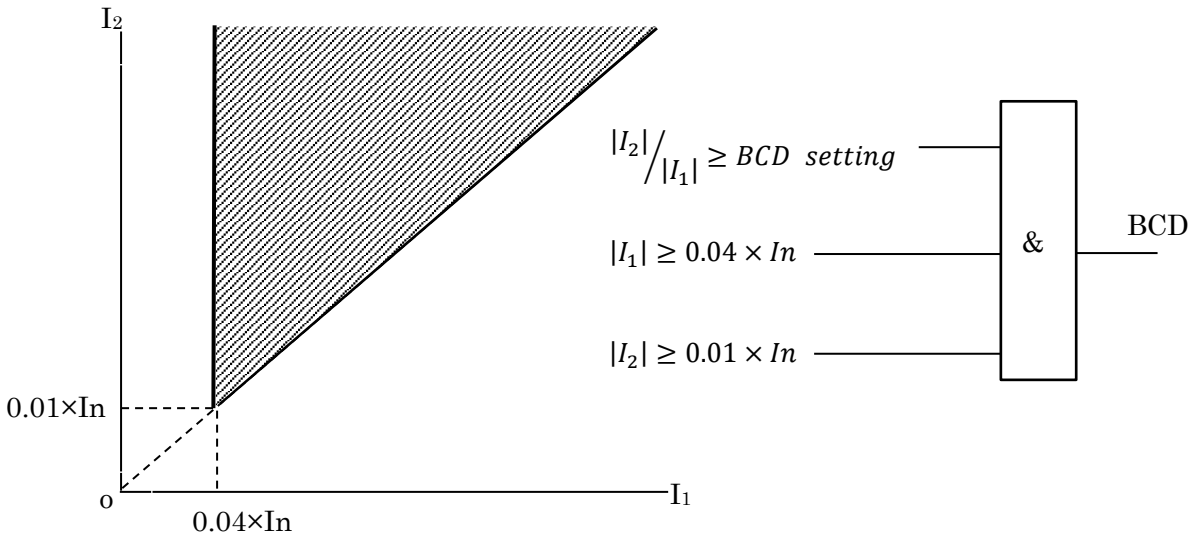


Figure 2.13-2 Characteristic of BCD

2.13.3 Miscellaneous functions

(i) Harmonic detection function

The operation of BCD can be blocked when the IED detects 2nd harmonic caused by the phenomenon of magnetizing inrush current when a transformer is energized. To block the operation of the BCD function during the occurrence of the harmonic, set scheme switch [**BCD-2fBlk**] **Block**.

(ii) Block operation of CTF for BCD

The operation of the BCD function can be blocked by the current transformer failure (CTF) function using a scheme switch. **Block** is set for scheme switch [**BCD-CTFBlk**] if the user wishes to disable the operation of the BCD function when a current transformer failure occurs.

2.13.4 Scheme logic

Figure 2.13-3 shows the scheme logic for the BCD function. The BCD function issues a trip signal through a delayed pick-up timer, the value of which is set for [**TBCD**]. The operation of the BCD function can be disabled using scheme switch [**BCD-EN**] **Off**.

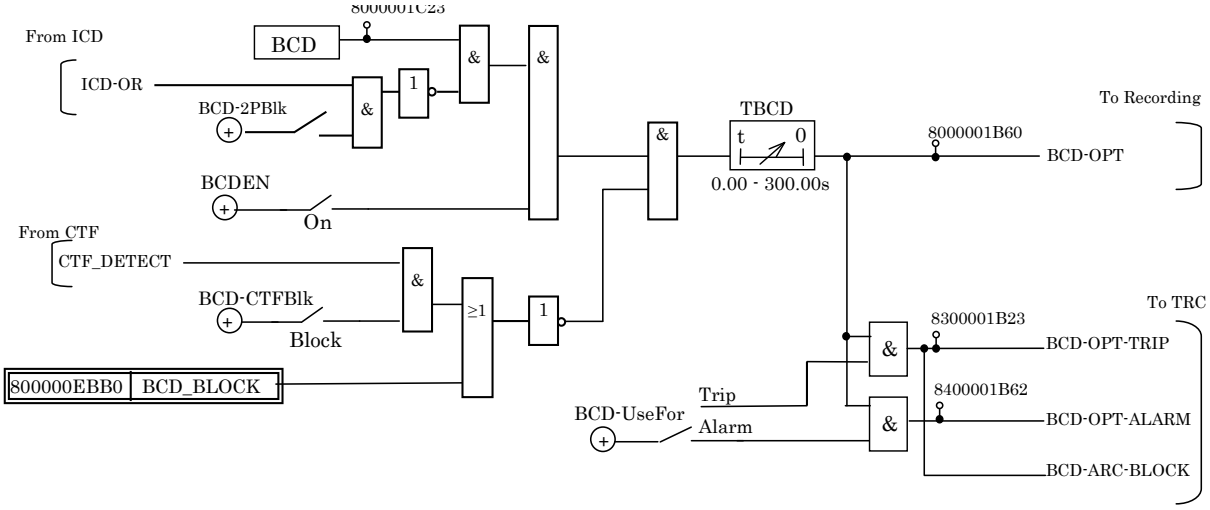


Figure 2.13-3 Broken conductor protection scheme logic

Normal power system levels of negative phase sequence restrict the setting value of [**BCD**]. The BCD function continuously determines the ratio (I_{2F}/I_{1F}). User can check the present ratio along with the maximum value (I_{21} max) that has been examined for 15 minutes ago. We recommend that user should distinguish the present ratio against the value on commissioning stage; and user should set a value for [**BCD**] from 130% to 150% of the ratio has been checked.

Note: The ratio (I_{2F}/ I_{1F}) is displayed only when the current in positive-sequence (or load current) on the secondary circuit is larger than 2% of the rated current on secondary circuit.

2.13.5 Setting

Setting of BCD(Function ID: 452001)

Setting item		Range	Units	Contents	Default setting value	Notes
BCD	BCD-EN	Off / On	-	BCD protection enable	Off	
	BCD	0.10 - 1.00	-	BCD relay operating value (I2/I1)	0.20	
	TBCD	0.00 - 300.00	s	BCD operating delay time	1.00	
	BCD-2fBlk	Non / Block	-	BCD operation block by 2f-detection	Non	
	BCD-CTFBlk	Non / Block	-	BCD operation block by CTF	Non	
	BCD-UseFor	Trip / Alarm	-	BCD used for trip or alarm	Trip	

2.13.6 Data ID

◆ Signal monitoring point

BCD(Function ID: 452001)

Element ID	Name	Description
8000001C23	BCD	BCD relay element operated
8000001B60	BCD-OPT	BCD protection operated

◆ Connection point on PLC logic

BCD(Function ID: 452001)

Element ID	Name	Description
800000EBB0	BCD_BLOCK	BCD1 protection block command

2.14 Circuit breaker fail protection (CBF)

When a circuit breaker (CB) fails to remove a fault as a consequence of the CB failing to open, the function of circuit breaker fail protection (CBF) is to remove the fault by the back-tripping of other CBs. For example, if a fault current continues to flow following the issue of a trip signal, the CBF function determines that a CB failure has occurred and issues another trip signal to the adjacent CB(s) and/or the upstream CB.

Although a trip signal will have been issued by other protection functions, CBF protection has relay elements and timers that are used to detect the continuing presence of a fault following the issuance of a trip signal. The relay elements are termed OCCBF† and EFCBF†, which run as protection functions within CBF.

†Note: The CBF function consists of two stages and their stages are operated independently. Thus, the settings/switches/logics for two stages are provided separately. To simply the description, only settings/switches/logics for the stage 1 are discussed as a representative, but the ones for the stage 2 are applicable in the CBF function; hence the user can read the expression for the stage 1 as for the stage 2 unless a special explanation or instructions has been provided.

Note: Several IED models do not have circuit breaker failure protection features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.14-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
CBF	Circuit breaker failure protection	NA	✓	✓	(✓)	✓

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, OCN, THM, BCD, SOTF-OC, OV, OVS, UV, UVS, FRQ/DFRQ, FS, VTF, CTF, ARC, VCHK.

2.14.1 CBF operation and its elements

The operation of CBF is initiated by the operation of OCCBF and EFCBF, which monitors fault current after the issuance of a trip signal by other protection functions. OCCBF or EFCBF monitor the fault current so that the CBF feature can determine the failure of the CB to operate. For CBF, the respective phase currents in three-phase system are monitored by the OCCBF-A, OCCBF-B and OCCBF-C elements, while the zero-sequence current is monitored by the EFCBF element.

The operation of these elements is reset if the threshold values of currents, applied by the setting of [**OCCBF1**] and [**EFCBF1**], are below 80% of their setting value.

2.14.2 Re-trip feature

Once a CB failure occurs, the CBF protection would normally issue a back-trip signal to the adjacent CB(s) and/or the upstream CB. However, the CBF protection is able to issue a further trip signal to the faulted CB before issuing the back-trip signal. The second trip signal is termed “re-trip”; “re-trip,” confirms the occurrence of a CB failure. In the event of an erroneous CBF operation, the use of “re-trip” has the advantage of avoiding the issue of the back-trip signal to the adjacent CB(s) or the upstream CB. The timing chart for “re-trip” and back-trip are discussed later. (See Figure 2.14-1)

There are two operation modes (internal and external mode) for “re-trip”; the user can select the desired mode using scheme switch [**CBF1-Retrip**]:

- Internal mode

  If **On** is set for scheme switch [**CBF1-Retrip**] the CBF function is armed for issuing a “re-trip” command. OCCBF and EFCBF control the “re-trip” signal along with trip signals coming from other functions.

- External mode

  When **On-T** is set for scheme switch [**CBF1-Retrip**], the CBF function is armed forissuing a “re-trip” following tripping by external protection functions only. The external protection functions can operate using PLC connection points in the TRC function. If external mode is selected, an external CBF start signal must be present continuously for as long as the fault is present.

For the re-trip operation, **On** should be set for both scheme switches [**OCCBF1**] and [**EFCBF1**]. When a delay timer is needed for “re-trip”, a setting [**TCBF1-RE**] is available. A setting time can be chosen between 0 and 300.000sec, the time setting to be applied must be determined in accordance with the response time of the CB. The setting time is addressed later. (section 2.14.5)

One of the benefits of the "re-trip" function is that it can used to avoid accidental tripping of an adjacent CB or an upstream CB. This is particularly requisite during maintenance and testing of the system.

2.14.3 Backup feature

As cited above, "re-trip" issues a further trip signal so that the CB receives an instruction to trip again. If "re-trip" cannot remove the fault, CBF will issue a "back-trip" command. Back-tripping is used as a last resort to remove the fault.

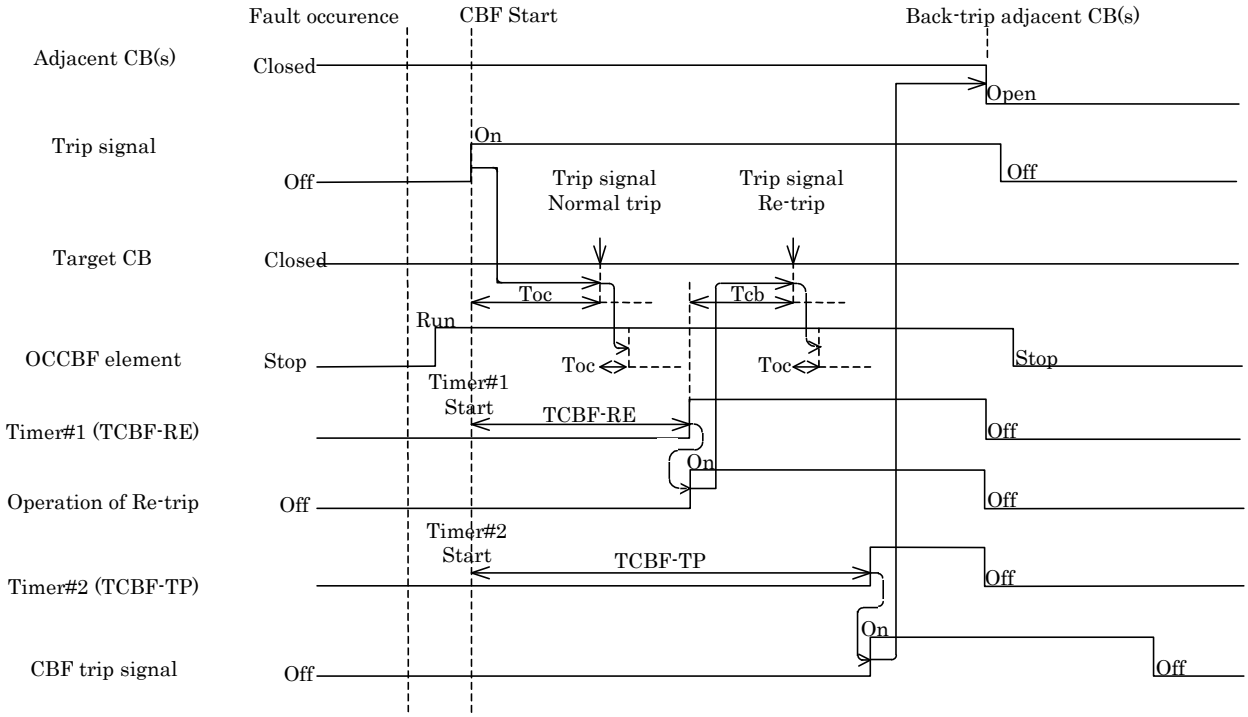


Figure 2.14-1 Timing chart for re-trip and back trip during CBF operation

Figure 2.14-1 is a sequence diagram for the CBF function; the overall sequence illustrated shows a target CB failing to remove a fault with the consequence that back tripping of the adjacent CB(s) is required following operation of the CBF protection to finally clear the fault. The CBF function is initiated via a signal from other protection functions.

If the target CB is tripped normally on receipt of a trip signal so that the fault is removed, both OCCBF and EFCBF will reset before the time settings of timer #1 and timer #2 have elapsed.

Following the issue of the first trip signal, if either OCCBF or EFCBF were to continue to operate and if timer #1 were to time out according to the timer setting value [**TCBF1-RE**], a "re-trip" command would be issued to the target CB. If the target CB were to open to clear the

fault in response to the "re-trip" command, OCCBF and EFCBF would reset and the CBF sequence is stopped.

If the target CB were to fail to remove the fault with the "re-trip" command, and if OCCBF or EFCBF continued to operate and if the timer #2 were to time out in accordance with the setting time applied [**TCBF1-TP**], CBF will issue a trip signal to the adjacent CB(s) to clear the fault, as a last resort.

2.14.4 Scheme logic

Figure 2.14-2 illustrates that the CBF function can issue a trip signal in each phase. A trip signal will be generated in the trip circuit (TRC) when the trip signal is provided for the TRC function.

CBF issues trip signals (CBF1-RETRIP) when OCCBF1 and EFCBF1 operate continuously until expiration of timer settings [**TCBF1-RE**] and [**TCBF1-TP**]. Setting [**TCBF1-RE**] is overridden when **On-AftRe** is set for scheme switch [**CBF1-TRIP**]. When **On** is set for scheme switch [**CBF1-TRIP**], timer setting [**TCBF1-RE**] is bypassed and [**TCBF1-TP**] is applied for backup CBF trip.

Figure 2.14-2 shows that the CBF will operate with OCCBF1, EFCBF1, and PLC signal "EXT.CBF-START" (internal mode).

It is possible to run with PLC signal EXT.CBF1-START only. PLC signal "EXT.CBF1-START" is required. Signal "EXT.CBF1-START" must be present continuously for as long as the fault is present (external mode).

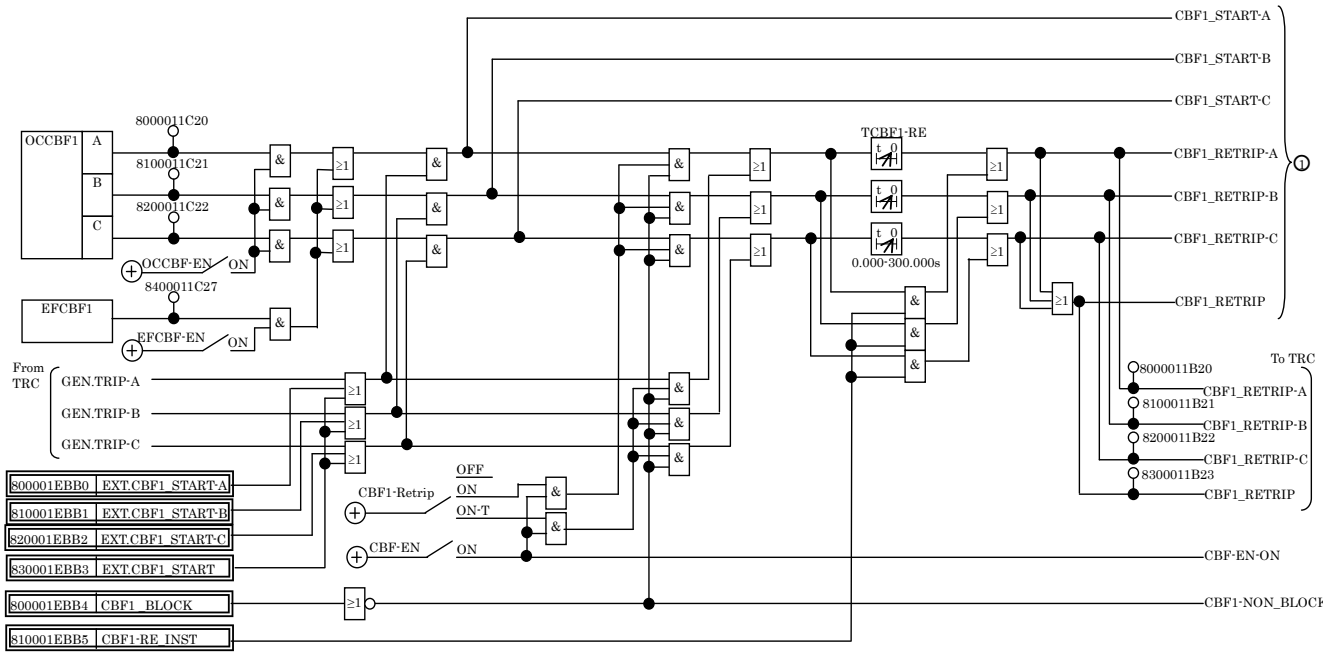


Figure 2.14-2 Elements logic in CBF1

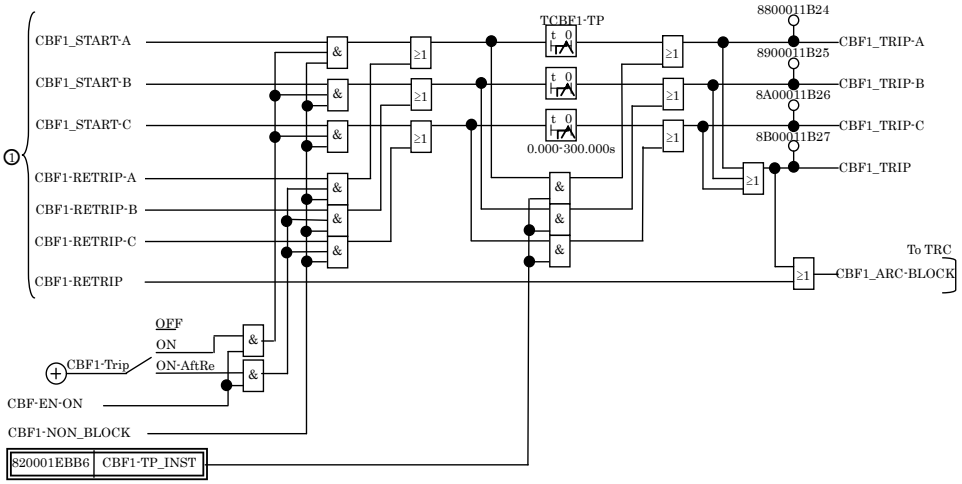


Figure 2.14-3 CBF1 logics (continued from Figure 2.14-2)

2.14.5 Operation timing

The OCCBF and EFCBF elements can check that the target CB has opened normally and that the fault current has disappeared completely. Because load current is usually present, the OCCBF and EFCBF settings should be account for between 10% and 200% of the rated current.

The time settings [**TCBF1-RE**] and [**TCBF1-TP**] are determined in relation to the opening time of the target CB and the reset time of the OCCBF or EFCBF elements (see Toc and Tcb in Figure 2.14-1). The following description illustrates a setting calculation example when "re-trip" is used:

Setting of TCBF-RE =Breaker opening time + OCCBF/EFCBF reset time + Margin
=40ms + 10ms + 20ms
=70ms

Setting of TCBF-TP =TCBF-RE + Output relay operating time + Breaker opening time + OCCBF/EFCBF reset time + Margin
=70ms + 10ms + 40ms + 10ms + 10ms
=140ms

2.14.6 Setting

Setting of CBF(Function ID: 453001)

Setting item			Range	Units	Contents	Default setting value	Notes
CBF	Common	CBF-EN	Off / On	-	CBF protection enable	Off	
		OCCBF-EN	Off / On	-	Current flow is judged by OC relay operation	On	
		EFCBF-EN	Off / On	-	Current flow is judged by EF relay operation	Off	
	CBF1	OCCBF1	0.02 - 5.00/0.10 - 25.00	A	OCCBF relay operating level (Current flow judgment)	1.00/5.00	
		EFCBF1	0.02 - 5.00/0.10 - 25.00	A	EFCBF relay operating level (Current flow judgment)	1.00/5.00	
		CBF1-Retrip	Off / On / On-T	-	CBF retrip operation mode	On	
		TCBF1-RE	0.000 - 300.000	s	CBF retrip timer	0.150	
		CBF1-Trip	Off / On / On-AftRe	-	CBF trip operation mode	On	
		TCBF1-TP	0.000 - 300.000	s	CBF trip timer	0.200	
	CBF2	OCCBF2	0.02 - 5.00/0.10 - 25.00	A	OCCBF relay operating level (Current flow judgment)	1.00/5.00	
		EFCBF2	0.02 - 5.00/0.10 - 25.00	A	EFCBF relay operating level (Current flow judgment)	1.00/5.00	
		CBF2-Retrip	Off / On / On-T	-	CBF retrip operation mode	On	
		TCBF2-RE	0.000 - 300.000	s	CBF retrip timer	0.150	
		CBF2-Trip	Off / On / On-AftRe	-	CBF trip operation mode	On	
		TCBF2-TP	0.000 - 300.000	s	CBF trip timer	0.200	

2.14.7 Data ID

◆ Signal monitoring points

CBF(Function ID: 453001)

Element ID	Name	Description
8000011C20	OCCBF1-A	OCCBF1 relay element operated (phase-A)
8100011C21	OCCBF1-B	OCCBF1 relay element operated (phase-B)
8200011C22	OCCBF1-C	OCCBF1 relay element operated (phase-C)
8400011C27	EFCBF1	EFCBF1 relay element operated
8000011B20	CBF1_RETRIP-A	OCCBF1 Retrip (phase-A)
8100011B21	CBF1_RETRIP-B	OCCBF1 Retrip (phase-B)
8200011B22	CBF1_RETRIP-C	OCCBF1 Retrip (phase-C)
8300011B23	CBF1_RETRIP	OCCBF1 Retrip
8800011B24	CBF1_TRIP-A	OCCBF1 trip (phase-A)
8900011B25	CBF1_TRIP-B	OCCBF1 trip (phase-B)
8A00011B26	CBF1_TRIP-C	OCCBF1 trip (phase-C)
8B00011B27	CBF1_TRIP	OCCBF1 trip
8000011BB0	EXT.CBF1_START-A	External CBF1 start(phase-A)
8100011BB1	EXT.CBF1_START-B	External CBF1 start(phase-B)
8200011BB2	EXT.CBF1_START-C	External CBF1 start(phase-C)
8300011BB3	EXT.CBF1_START	External CBF1 start
8000021C20	OCCBF2-A	OCCBF2 relay element operated (phase-A)
8100021C21	OCCBF2-B	OCCBF2 relay element operated (phase-B)
8200021C22	OCCBF2-C	OCCBF2 relay element operated (phase-C)
8400021C27	EFCBF2	EFCBF2 relay element operated
8000021B20	CBF2_RETRIP-A	OCCBF2 Retrip (phase-A)
8100021B21	CBF2_RETRIP-B	OCCBF2 Retrip (phase-B)
8200021B22	CBF2_RETRIP-C	OCCBF2 Retrip (phase-C)
8300021B23	CBF2_RETRIP	OCCBF2 Retrip
8800021B24	CBF2_TRIP-A	OCCBF2 trip (phase-A)
8900021B25	CBF2_TRIP-B	OCCBF2 trip (phase-B)
8A00021B26	CBF2_TRIP-C	OCCBF2 trip (phase-C)
8B00021B27	CBF2_TRIP	OCCBF2 trip
8000021BB0	EXT.CBF2_START-A	External CBF2 start(phase-A)
8100021BB1	EXT.CBF2_START-B	External CBF2 start(phase-B)
8200021BB2	EXT.CBF2_START-C	External CBF2 start(phase-C)
8300021BB3	EXT.CBF2_START	External CBF2 start

◆ Connection point in PLC logic

CBF(Function ID: 453001)

Element ID	Name	Description
800001EBB0	EXT.CBF1_START-A	External CBF1 start(phase-A)
810001EBB1	EXT.CBF1_START-B	External CBF1 start(phase-B)
820001EBB2	EXT.CBF1_START-C	External CBF1 start(phase-C)
830001EBB3	EXT.CBF1_START	External CBF1 start
800001EBB4	CBF1_BLOCK	CBF1 protection block command
810001EBB5	CBF1-RE_INST	CBF1 instantaneous retrip
820001EBB6	CBF1-TP_INST	CBF1 instantaneous trip

◆ Connection point in PLC logic

CBF(Function ID: 453001)

Element ID	Name	Description
800002EBB0	EXT.CBF2_START-A	External CBF2 start(phase-A)
810002EBB1	EXT.CBF2_START-B	External CBF2 start(phase-B)
820002EBB2	EXT.CBF2_START-C	External CBF2 start(phase-C)
830002EBB3	EXT.CBF2_START	External CBF2 start
800002EBB4	CBF2_BLOCK	CBF2 protection block command
810002EBB5	CBF2-RE_INST	CBF2 instantaneous retrip
820002EBB6	CBF2-TP_INST	CBF2 instantaneous trip

2.15 Overvoltage protection for phase-to-neutral (OV)

The over voltage protection function for phase (OV) detects an over voltage condition that phase-to-neutral voltage is larger than a setting and operates accordingly. The OV function has two stages (elements; OV1 and OV2), which operate independently. The OV element has a time delay characteristic; and the user can select either (1) independent (definite) time characteristic delay or (2) dependent (inverse) time characteristic delay. The OV element is configured both the setting of a pickup voltage (PU) and the setting of a drop-off voltage (DO).

To simplify the description, only OV1 is discussed, but the expression is applicable to the OV2; hence, read the expression for OV1 as the OV2 unless a special explanation or instruction has been provided.

Note: Several IED models do not have phase over-voltage protection features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.15-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
OV	Phase over-voltage protection	NA	✓	✓	(✓)	✓

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, OCN, THM, BCD, CBF, SOTF-OC, OVS, UV, UVS, FRQ/DFRQ, FS, VTF, CTF, ARC, VCHK.

2.15.1 Drop-off and pickup characteristic

Figure 2.15-1 shows the characteristic of the OV element. The outer circle shows the threshold of pick-up threshold voltage (PU), whereas the inner dotted circle shows drop-off voltage point (DO). The hatched area shows the operation area of the OV.

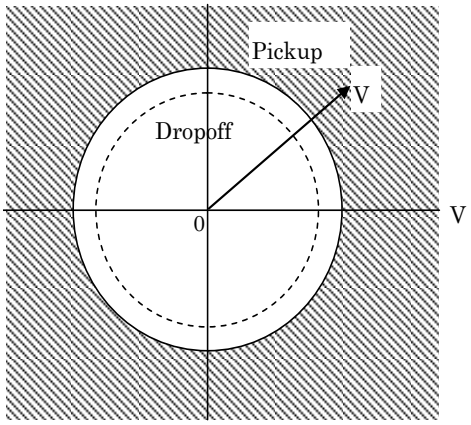


Figure 2.15-1 Characteristic of OV element

For example, with regard to the OV1 element, suppose the user sets a pick-up value in P.U for setting [**OV1**]. Then the user should set a drop-off value using setting [**OV1-DPR**], which configures the ratio of the PU to the DO.

2.15.2 Delay for the operation of the OV element

The OV element has a delay timer for the operation. For the OV1 element, the user can set a delay time using setting [**TOV1**]. The user can find the delay timer in the OV function logic. (See section 2.15.5)

2.15.3 Time characteristic

The OV element has two characteristics between a voltage condition and an operation time; hence, the user should select a mode either (i) definite (independent) time characteristic delay or (ii) inverse (dependent) time characteristic delay. For the definite time characteristic delay, the operation time is a constant. In the inverse time characteristic delay, the operation time depends upon the level of the voltage condition.

(i) Definite time characteristic (DT)

To operate the definite (independent) time delay, set scheme switch [**OV1-Type**] **DT**. Resetting the OV element is performed when a voltage falls below the drop-off voltage.

(ii) Invers time characteristic (IDMT)

To operate the dependent (invers) time delay, set scheme switch [**OV1-Type**] **IDMT**.

(ii)-1 Pick-up characteristic

The operate time of the inverse (dependent) time characteristic is inversely proportional to the

level of the voltage condition. Figure 2.15-2 shows the invers time characteristic of the OV element when a multiplier setting [**OV1-TMS**] is used. The OV element uses Equation (2.15-1) to be in conformity to IEC 60255-127:

$$t(G) = TMS \times \left\{ \left[\frac{k}{\left(V/V_s \right)^a - 1} \right] + c \right\} \qquad (2.15\text{-}1)$$

where,

t = operating time (seconds),

V = energizing voltage (voltage),

Vs = pickup voltage setting (voltage), and

TMS = time multiplier setting to adjust a curve

If the user will require a user-programmable (original) curve in the inverse time characteristic, it is provided when the constants of k, a, c are set, as shown in Table 2.15-2. For example, the user-programmable (original) curve in the OV1 element will be acquired when **Original** is set for the scheme switch [**OV1-Type**], and when values of respective constants are set for [**OV1-k**], [**OV1-a**], and [**OV1-C**].

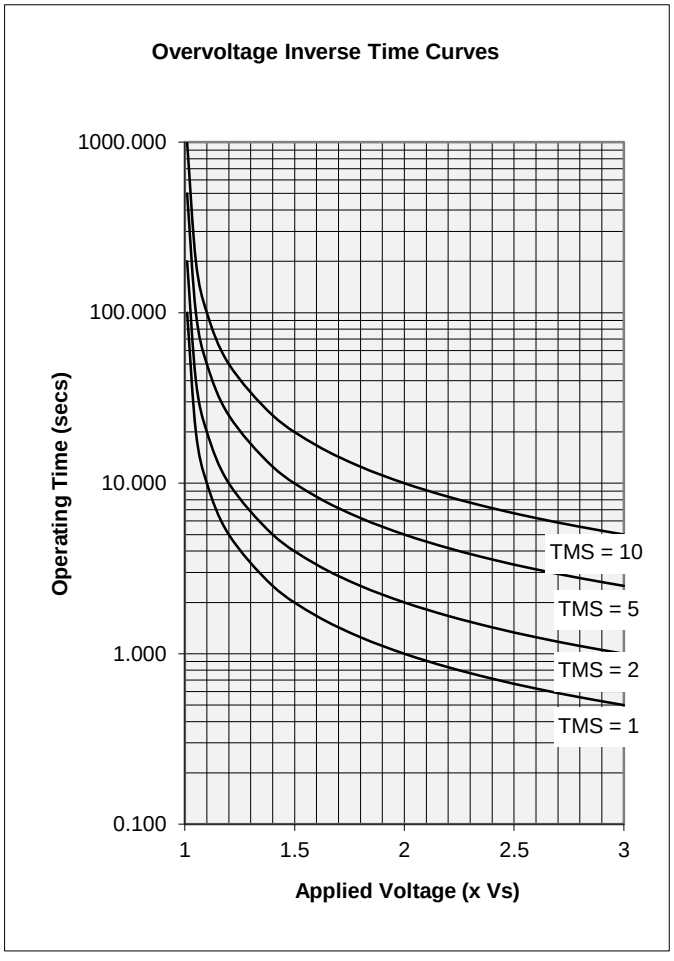


Figure 2.15-2 IDMT characteristic of OV element

Table 2.15-2 Constant value at each setting of IDMT curve

Set item	k	a	C
IDMT	1	1	0
User-programmable (Original)	0.00000 – 500.00000 by 0.00001 step	0.00000 – 10.00000 by 0.00001 step	0.00000 – 10.00000 by 0.00001 step

(ii)-2 Reset feature

The user should set the time for resetting. Figure 2.15-3 shows that examples of the pick-up and the drop-off relevant to both the fault occurrences and the operation time. The value of the time counter furnished in the OV1 element is incremented if faults occur.

As for an intermittent fault (the former in the figure), the time counter will not reach the trip level. In the other words, the operation of the OV1 element is paralyzed in the reset time set by [**TOV1R**].

If a series of fault occurs repeatedly (the latter in the figure), and if the value of the time counter reaches at trip level, the OV1 element will issue a trip signal after a certain delay. After issuing the trip signal, if a series of fault completely disappears after issuing the trip signal, the value of the time counter will be expired after the reset time [**TOV1R**].

When the user requires resetting the operation of the OV1 element immediately, setting zero for the settings [**TOV1R**] is needed. Consequently, when a voltage falls below the reset threshold (drop-off), the operation of the OV1 element is reset promptly.

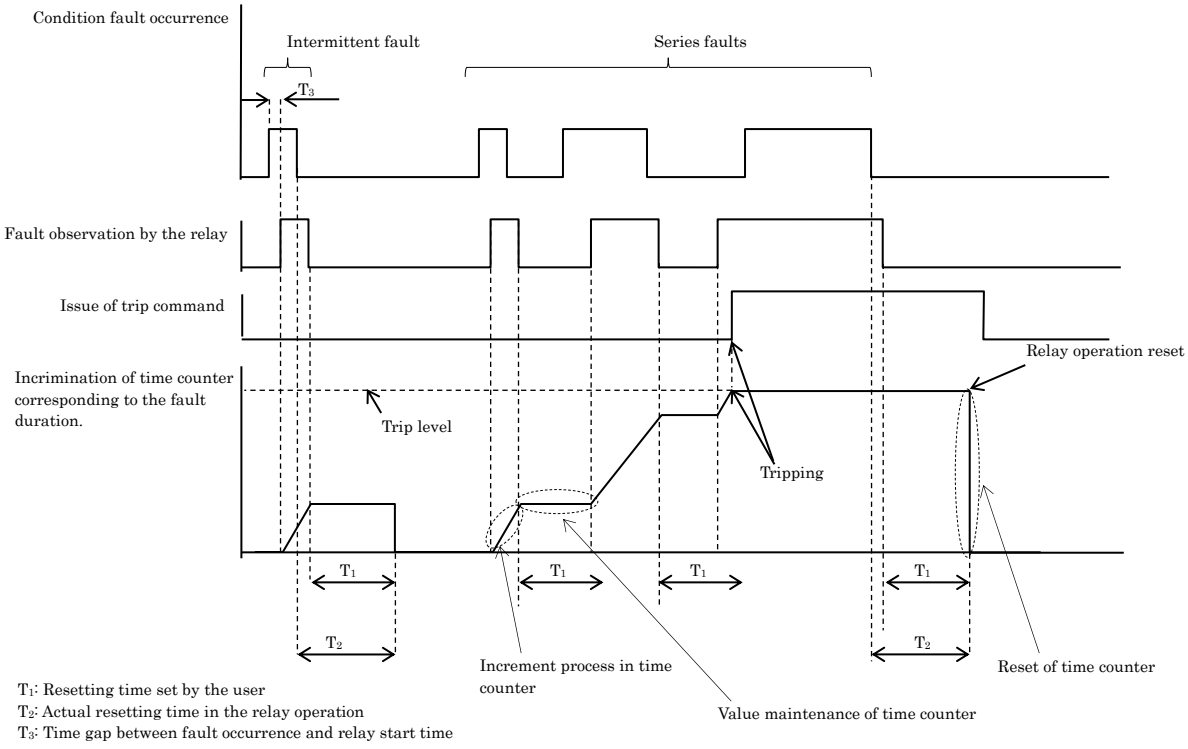


Figure 2.15-3 Faults occurrences and reset operation when IDMT being applied

2.15.4 Miscellaneous functions

(i) OV operation blocked by the occurrence of VT failure

Blocking the OV function may be required when a failure in the voltage transformer occurs. In this case, the user shall set **Block** for scheme switch [**OV1-VTFBlk**]. **Non** (as a default) is set for scheme switch [**OV1-VTFBlk**] in order that the OV function is not blocked by the failure.

(ii) OV trip signal

The OV function issues a trip signal for the trip circuit (TRC†) when **Trip** is set for scheme switch [**OV1-UseFor**] as the normal trip operation. However, when an alarm signal in place of the trip signal is required, the user can set **Alarm** for the scheme switch [**OV1-UseFor**].

†Note: For more information of the trip circuit, see Chapter *Relay application: Trip circuit*.

(iii) Execution of OV function

Set **On** for scheme switch [**OV1-EN**]. Otherwise, set **Off** for the scheme switch [**OV1-EN**] if the OV1 element is not required to operate.

2.15.5 Scheme logic

Figure 2.15-4 shows the OV function logic. Signal connection points "OV*_BLOCK" are provided for the block of the operation of the OV elements. For testing, the OV1-PU element is provided; it generates a pick-up signal when the entering voltage is excesses of the threshold anytime. For example, in the IDMT characteristic, using both monitoring points "8000011C20" and "8000011C24" can facilitate to measure the pickup time after the excess.

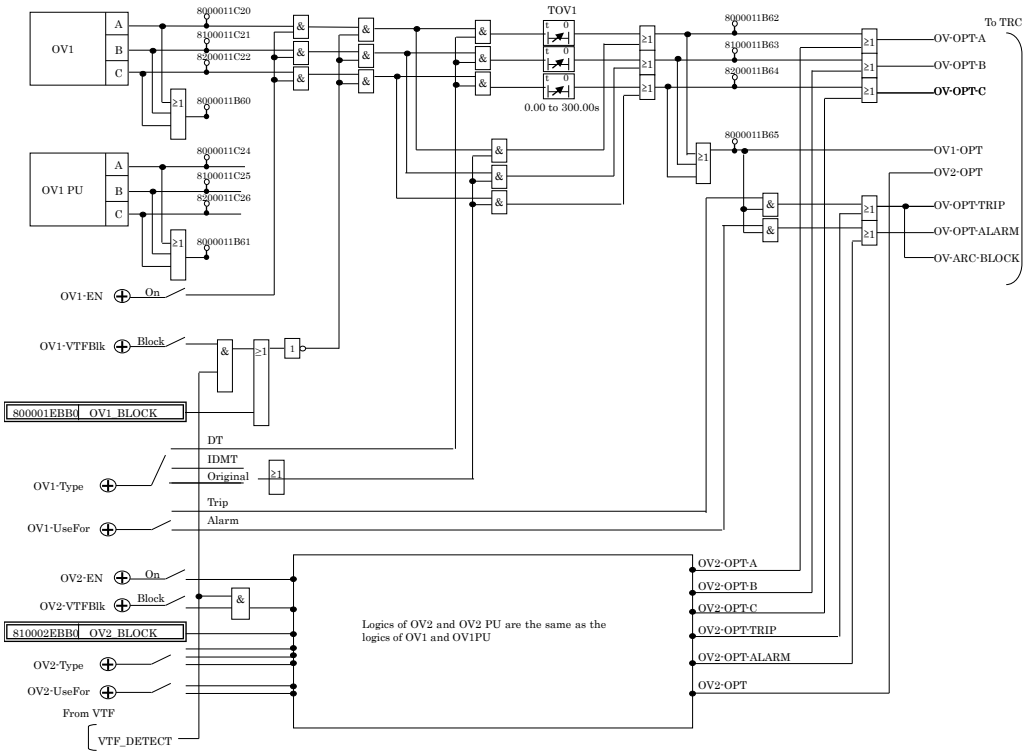


Figure 2.15-4 OV function logics

2.15.6 Setting list

Setting of OV(Function ID: 460001)

Setting item			Range	Unit s	Contents	Default setting value	Notes
		OV1-EN	Off/On		OV1 protection enable	Off	
		OV1-Type	DT/IDMT/Original		OV1 delay type	DT	
		OV1	1.0-220.0	V	OV1 threshold	120.0	
		OV1-DPR	10-100	%	OV1 drop-out/pick-up ratio	100	
		TOV1	0.0-300.0	s	OV1 operating delay time (in DT mode)	1.0	
		OV1-TMS	0.010-100.000		OV1 time multiplier (in IDMT mode)	1.000	
		TOV1R	0.0-300.0	s	OV1 definite time reset delay	0.0	
		OV1-k	0.00000-500.00000		OV1 user original curve coefficient	0.00000	
		OV1-a	0.00000-10.00000		OV1 user original curve coefficient	0.0000	
		OV1-c	0.00000-10.00000		OV1 user original curve coefficient	0.00000	
		OV1-VTFBlk	Non/Block		OV1 operation block by VTF	Non	
		OV1-UseFor	Trip/Alarm		OV1 used for trip or alarm	Trip	
		OV2-EN	Off/On		OV2 protection enable	Off	
		OV2-Type	DT/IDMT/Original		OV2 delay type	DT	
		OV2	1.0-220.0	V	OV2 threshold	120.0	
		OV2-DPR	10-100	%	OV2 drop-out/pick-up ratio	100	
		TOV2	0.0-300.0	s	OV2 operating delay time (in DT mode)	1.0	
		OV2-TMS	0.010-100.000		OV2 time multiplier (in IDMT mode)	1.000	
		TOV2R	0.0-300.0	s	OV2 definite time reset delay	0.0	
		OV2-k	0.00000-500.00000		OV2 user original curve coefficient	0.00000	
		OV2-a	0.00000-10.00000		OV2 user original curve coefficient	0.0000	
		OV2-c	0.00000-10.00000		OV2 user original curve coefficient	0.00000	
		OV2-VTFBlk	Non/Block		OV2 operation block by VTF	Non	
		OV2-UseFor	Trip/Alarm		OV2 used for trip or alarm	Trip	

2.15.7 Data ID

◆ Signal monitoring point

OV(Function ID: 460001)

Element ID	Name	Description
8000011C20	OV1-A	OV1 relay element operated (phase-A)
8100011C21	OV1-B	OV1 relay element operated (phase-B)
8200011C22	OV1-C	OV1 relay element operated (phase-C)
8000011B60	OV1-OR	OV1 relay element operated (3-phases OR)
8000011C24	OV1PU-A	OV1 relay operation level pick up (phase-A)
8100011C25	OV1PU-B	OV1 relay operation level pick up (phase-B)
8200011C26	OV1PU-C	OV1 relay operation level pick up (phase-C)
8000011B61	OV1PU-OR	OV1 relay operation level pick up (3-phases OR)
8000011B62	OV1-OPT-A	OV1 protection operated (phase-A)
8100011B63	OV1-OPT-B	OV1 protection operated (phase-B)
8200011B64	OV1-OPT-C	OV1 protection operated (phase-C)
8000011B65	OV1-OPT	OV1 protection operated
8400021C20	OV2-A	OV2 relay element operated (phase-A)
8500021C21	OV2-B	OV2 relay element operated (phase-B)
8600021C22	OV2-C	OV2 relay element operated (phase-C)
8100021B60	OV2-OR	OV2 relay element operated (3-phases OR)
8400021C24	OV2PU-A	OV2 relay operation level pick up (phase-A)
8500021C25	OV2PU-B	OV2 relay operation level pick up (phase-B)
8600021C26	OV2PU-C	OV2 relay operation level pick up (phase-C)
8100021B61	OV2PU-OR	OV2 relay operation level pick up (3-phases OR)
8400021B62	OV2-OPT-A	OV2 protection operated (phase-A)
8500021B63	OV2-OPT-B	OV2 protection operated (phase-B)
8600021B64	OV2-OPT-C	OV2 protection operated (phase-C)
8100021B65	OV2-OPT	OV2 protection operated

◆ Connection point on PLC logic

OV(Function ID: 460001)

Element ID	Name	Description
800001EBB0	OV1_BLOCK	OV1 protection block command
810002EBB0	OV2_BLOCK	OV2 protection block command

2.16 Overvoltage protection for phase-to-phase (OVS)

The over voltage protection function in phase-to-phase (OVS) detects an over voltage condition that phase-to-neutral voltage is larger than a setting and operates accordingly. The OVS function has two stages (elements; OVS1 and OVS2), which operate independently. The OVS element has a time delay characteristic; and the user can select either (1) independent (definite) time characteristic delay or (2) dependent (inverse) time characteristic delay. The OVS element is configured both the setting of a pickup voltage (PU) and the setting of a drop-off voltage (DO).

To simplify the description, only OVS1 is discussed, but the expression is applicable to OVS2; hence, read the expression for OVS1 as the OVS2 stage unless a special explanation or instruction has been provided.

Note: Several IED models do not have phase-phase over-voltage protection features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.16-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
OVS	Phase-phase over-voltage protection	✓	✓	✓	(✓)	✓

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, OCN, THM, BCD, CBF, SOTF-OC, OV, UV, UVS, FRQ/DFRQ, FS, VTF, CTF, ARC, VCHK.

2.16.1 Drop-off and pickup setting

Figure 2.16-1 shows the characteristic of the OVS element. The outer circle shows the threshold of pick-up threshold voltage (PU), whereas the inner circle shows drop-off voltage point (DO). The hatched area shows the operation area of the OVS.

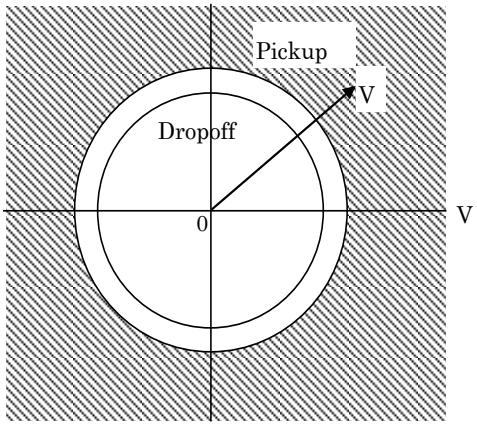


Figure 2.16-1 Characteristic of OVS element

For example, with regard to the OVS1 element, suppose the user sets a pick-up value in P.U for setting [**OVS1**]. Then the user should set a drop-off value using setting [**OVS1-DPR**], which configures the ratio of the PU to the DO.

2.16.2 Delay for the operation of the OVS element

The OVS element has a delay timer for the operation. For the OVS1 element, the user can set a delay time using setting [**TOVS1**]. The user can find the delay timer in the OVS function logic. (See section 2.16.5)

2.16.3 Time characteristic

The OVS element has two characteristics between a voltage condition and an operation time; hence, the user should select a mode either (i) definite (independent) time characteristic delay or (ii) inverse (dependent) time characteristic delay. For the definite time characteristic delay, the operation time is a constant. In the inverse time characteristic delay, the operation time depends upon the level of the voltage condition.

(i) Definite time characteristic (DT)

To operate the definite (independent) time delay, set scheme switch [**OVS1-Type**] **DT.** Resetting the OVS element is performed when a voltage falls below the drop-off voltage.

(ii) Invers time characteristic (IDMT)

To operate the dependent (invers) time delay, set scheme switch [**OVS1-Type**] **IDMT**.

(ii)-1 Operation feature

The operate time of the inverse (dependent) time characteristic is inversely proportional to the level of the voltage condition. Figure 2.16-2 shows the invers time characteristic of the OVS element when a multiplier setting is used. The OVS element uses Equation (2.16-1) to be in

conformity to IEC 60255-127:

$$t(G) = TMS \times \left\{ \left[\frac{k}{\left(V/V_s \right)^a - 1} \right] + c \right\} \qquad (2.16\text{-}1)$$

where,

t = operating time (seconds),

V = energizing voltage (voltage),

Vs = pickup voltage setting (voltage), and

TMS = time multiplier setting to adjust a curve

If the user will require a user-programmable (original) curve in the inverse time characteristic, it is provided when the constants of k, a, c are set, as shown in Table 2.16-2. For example, the user-programmable (original) curve in the OVS1 element will be acquired when **Original** is set for the scheme switch [**OVS1-Type**], and when values of respective constants are set for [**OVS1-k**], [**OVS1-a**], and [**OVS1-C**].

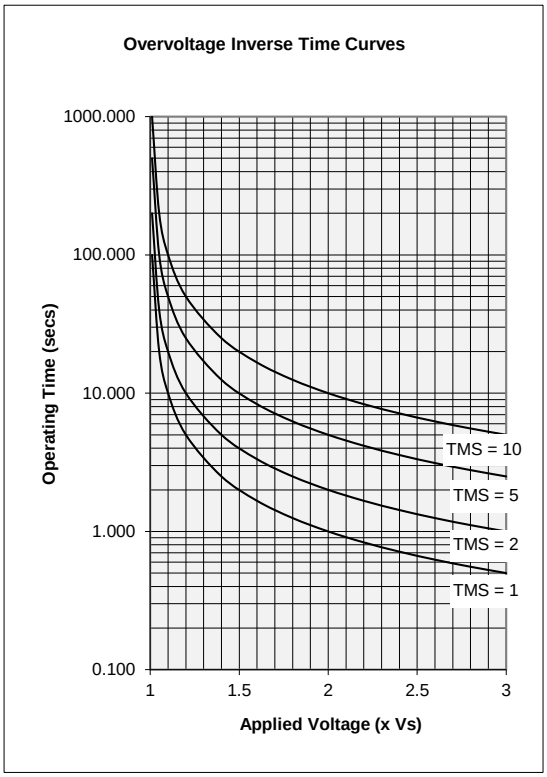


Figure 2.16-2 IDMT characteristic of OVS element

Table 2.16-2 Constant value at each setting of IDMT curve

Set item	k	a	C
IDMT	1	1	0
User-programmable (Original)	0.00000 – 500.00000 by 0.00001 step	0.00000 – 10.00000 by 0.00001 step	0.00000 – 10.00000 by 0.00001 step

(ii)-2 Reset feature

The user should set the time for resetting. Figure 2.16-3 shows that examples of the pick-up and the drop-off relevant to both the fault occurrences and the operation time. The value of the time counter furnished in the OVS1 element is incremented if faults occur.

As for an intermittent fault (the former in the figure), the time counter will not reach the trip level. In the other words, the operation of the OVS1 element is paralyzed in the reset time set by [**TOVS1R**].

If a series of fault occurs repeatedly (the latter in the figure), and if the value of the time counter reaches at trip level, the OVS1 element will issue a trip signal after a certain delay. After issuing the trip signal, if a series of fault completely disappears after issuing the trip signal, the value of the time counter will be expired after the reset time [**TOVS1R**].

When the user requires resetting the operation of the OVS1 element immediately, setting zero for the settings [**TOVS1R**] is needed. Consequently, when a voltage falls below the reset threshold (drop-off), the operation of the OVS1 element is reset promptly.

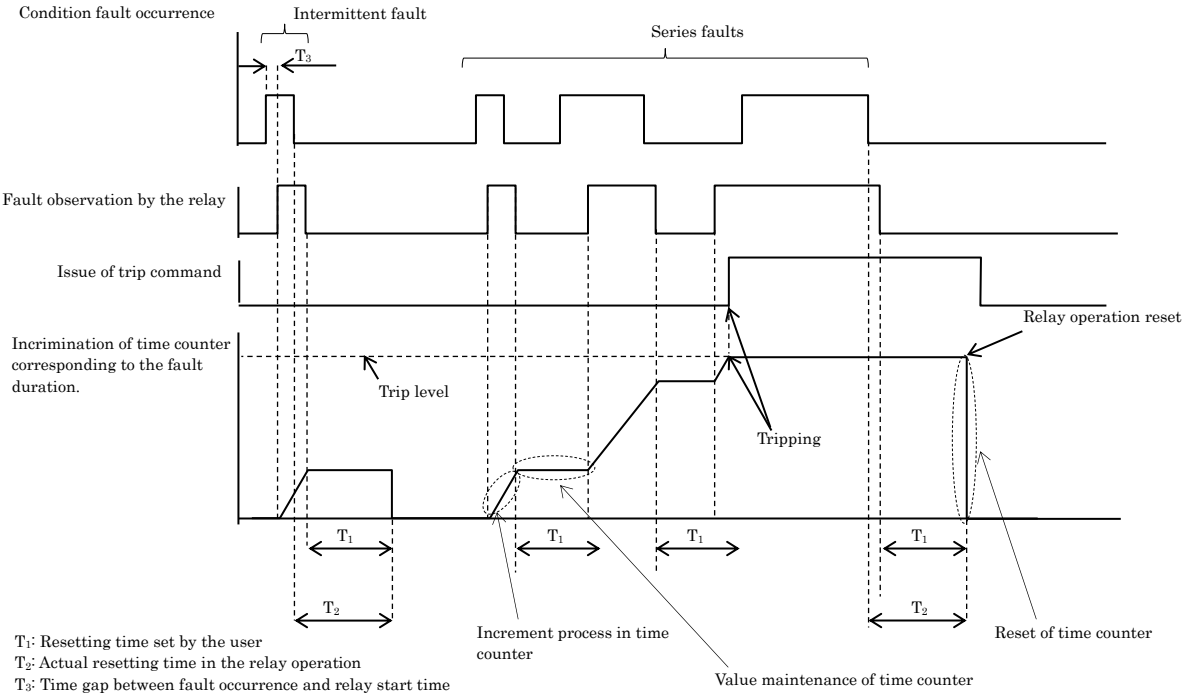


Figure 2.16-3 Faults occurrences and reset operation when IDMT being applied

2.16.4 Miscellaneous functions

(i) OVS operation blocked by the occurrence of VT failure

Blocking the OVS function may be required when a failure in the voltage transformer occurs. In this case, the user shall set **Block** for scheme switch [**OVS1-VTFBlk**]. **Non** (as a default) is set for scheme switch [**OVS1-VTFBlk**] in order that the OVS function is not blocked by the

failure.

(ii) Switch of OVS trip signal

The OVS function issues a trip signal for the trip circuit (TRC†) when **Trip** is set for scheme switch [**OVS1-UseFor**] as the normal trip operation. However, when an alarm signal in place of the trip signal is required, the user can set **Alarm** for the scheme switch [**OVS1-UseFor**].

†Note: For more information of the trip circuit, see Chapter *Relay application: Trip circuit*.

(iii) Execution of OVS function

Set **On** for scheme switch [**OVS1-EN**]. Otherwise, set **Off** for the scheme switch [**OVS1-EN**] if the OVS1 element is not required to operate.

2.16.5 Scheme logic

Figure 2.16-4 shows the OVS function logic. Signal connection points "OVS*_BLOCK" are provided for the block of the operation of the OVS elements. For testing, the OVS1-PU element is provided; it generates a pick-up signal when the entering voltage is excesses of the threshold anytime. For example, in the IDMT characteristic, using both monitoring points "8000011C20" and "8000011C24" can facilitate to measure the pickup time after the excess.

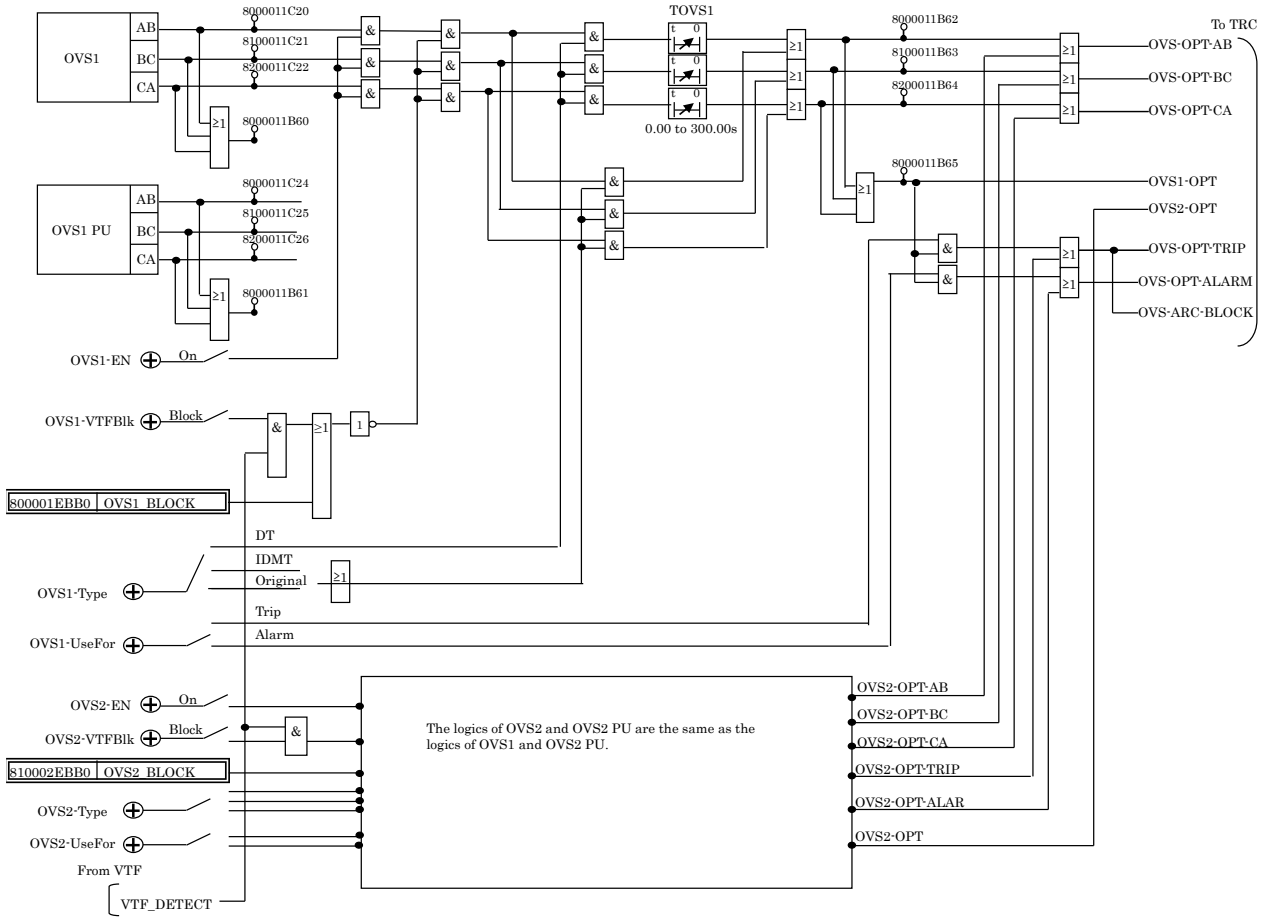


Figure 2.16-4 OVS function logics

2.16.6 Setting list

Setting of OVS(Function ID: 461001)

Setting item			Range	Unit s	Contents	Default setting value	Notes
	OVS1	OVS1-EN	Off/On	-	OVS1 protection enable	Off	
		OVS1-Type	DT/IDMT/Original	-	OVS1 delay type	DT	
		OVS1	1.0-220.0	V	OVS1 threshold	120.0	
		OVS1-DPR	10-100	%	OVS1 drop-out/pick-up ratio	100	
		TOVS1	0.00-300.00	s	OVS1 operating delay time (in DT mode)	1.00	
		OVS1-TMS	0.010-100.000	-	OVS1 time multiplier (in IDMT mode)	1.000	
		TOVS1R	0.0-300.0	s	OVS1 definite time reset delay	0.0	
		OVS1-k	0.00000-500.00000	-	OVS1 user original curve coefficient	0.00000	
		OVS1-a	0.00000-10.00000	-	OVS1 user original curve coefficient	0.00000	
		OVS1-c	0.00000-10.00000	-	OVS1 user original curve coefficient	0.00000	
		OVS1-VTFBlk	Non/Block	-	OVS1 operation block by VTF	Non	
		OVS1-UseFor	Trip/Alarm	-	OVS1 used for trip or alarm	Trip	
	OVS2	OVS2-EN	Off/On	-	OVS2 protection enable	Off	
		OVS2-Type	DT/IDMT/Original	-	OVS2 delay type	DT	
		OVS2	1.0-220.0	V	OVS2 threshold	120.0	
		OVS2-DPR	10-100	%	OVS2 drop-out/pick-up ratio	100	
		TOVS2	0.00-300.00	s	OVS2 operating delay time (in DT mode)	1.00	
		OVS2-TMS	0.010-100.000	-	OVS2 time multiplier (in IDMT mode)	1.000	
		TOVS2R	0.0-300.0	s	OVS2 definite time reset delay	0.0	
		OVS2-k	0.00000-500.00000	-	OVS2 user original curve coefficient	0.00000	
		OVS2-a	0.00000-10.00000	-	OVS2 user original curve coefficient	0.00000	
		OVS2-c	0.00000-10.00000	-	OVS2 user original curve coefficient	0.00000	
		OVS2-VTFBlk	Non/Block	-	OVS2 operation block by VTF	Non	
		OVS2-UseFor	Trip/Alarm	-	OVS2 used for trip or alarm	Trip	

2.16.7 Data ID

◆ Signal monitoring point

OVS(Function ID: 461001)

Element ID	Name	Description
8000011C20	OVS1-AB	OVS1 relay element operated (phase-AB)
8100011C21	OVS1-BC	OVS1 relay element operated (phase-BC)
8200011C22	OVS1-CA	OVS1 relay element operated (phase-CA)
8000011B60	OVS1-OR	OVS1 relay element operated (3-phases OR)
8000011C24	OVS1PU-AB	OVS1 relay operation level pick up (phase-AB)
8100011C25	OVS1PU-BC	OVS1 relay operation level pick up (phase-BC)
8200011C26	OVS1PU-CA	OVS1 relay operation level pick up (phase-CA)
8000011B61	OVS1PU-OR	OVS1 relay operation level pick up (3-phases OR)
8000011B62	OVS1-OPT-AB	OVS1 protection operated (phase-AB)
8100011B63	OVS1-OPT-BC	OVS1 protection operated (phase-BC)
8200011B64	OVS1-OPT-CA	OVS1 protection operated (phase-CA)
8000011B65	OVS1-OPT	OVS1 protection operated
8400021C20	OVS2-AB	OVS2 relay element operated (phase-AB)
8500021C21	OVS2-BC	OVS2 relay element operated (phase-BC)
8600021C22	OVS2-CA	OVS2 relay element operated (phase-CA)
8100021B60	OVS2-OR	OVS2 relay element operated (3-phases OR)
8400021C24	OVS2PU-AB	OVS2 relay operation level pick up (phase-AB)
8500021C25	OVS2PU-BC	OVS2 relay operation level pick up (phase-BC)
8600021C26	OVS2PU-CA	OVS2 relay operation level pick up (phase-CA)
8100021B61	OVS2PU-OR	OVS2 relay operation level pick up (3-phases OR)
8400021B62	OVS2-OPT-AB	OVS2 protection operated (phase-AB)
8500021B63	OVS2-OPT-BC	OVS2 protection operated (phase-BC)
8600021B64	OVS2-OPT-CA	OVS2 protection operated (phase-CA)
8100021B65	OVS2-OPT	OVS2 protection operated

◆ Connection point on PLC logic

OVS(Function ID: 461001)

Element ID	Name	Description
800001EBB0	OVS1_BLOCK	OVS1 protection block command
810002EBB0	OVS2_BLOCK	OVS2 protection block command

2.17 Phase under-voltage protection (UV)

The under-voltage protection function for phase-to-earth (UV) consists of two stages (elements) independently: UV1 and UV2. The time characteristic of the UV element is configured either definite time (DT) or inverse definite minimum time (IDMT) using settings.

Each UV stage (element) detects the under-voltage condition of phase-to-earth. The user can set a threshold and the ratio of a drip-out voltage (DO) to a pick-up voltage (PU) in the UV element. To simplify the description, only the UV1 element is described, but the expression is applicable to the UV2; hence, read the expression for the UV1 element as the UV2 unless a special explanation or instruction has been provided.

Note: Several IED models do not have phase under-voltage protection features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.17-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
UV	Phase under-voltage protection	NA	✓	✓	(✓)	✓

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, OCN, THM, BCD, CBF, SOTF-OC, OV, OVS, UVS, FRQ/DFRQ, FS, VTF, CTF, ARC, VCHK.

2.17.1 Drop-off and pick-up characteristic

Figure 2.17-1 shows the UV characteristic as hatched area with concentric circles. The pick-up threshold voltage (PU) is represented the outer circle; the drop-off voltage point (DO) is represented the dotted circle. The PU voltage of the UV1 element is set using [**UV1**]. The DO voltage of the UV1 element is set using [**UV1-DPR**].

The inner circle shows the area in which the UV function is blocked when the value of the block voltage is set for [**UVBLK**]. Setting [**TUVBLK**] is also provided so that the user can delay blocking the UV1 and UV2 elements using the setting.

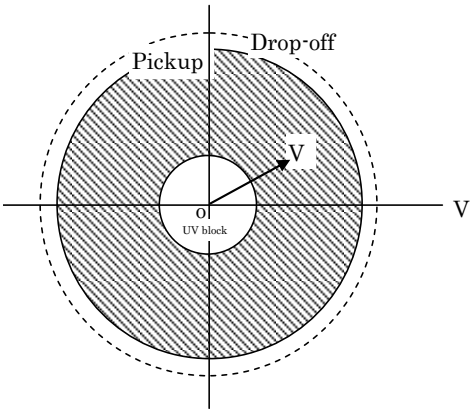


Figure 2.17-1 UV1 element characteristic

2.17.2 Time characteristic

The UV element has the relationship between an input voltage and an operation time; the relationship is divided into two time characteristics: (i) the definite time (DT) and (ii) the inverse definite minimum time (IDMT).

(i) Definite time characteristic (DT)

(i)-1 Setting pick-up operation

The user is required to set **DT** for scheme switch [**UV1-Type**] when the UV1 element should operate in the DT characteristic. The UV1 element has a delay timer for the pick-up operation; the user can set a delay time using setting [**TUV1**]. The user can find the delay timer in the UV function logic. (See section 2.17.4)

(i)-2 Setting drop-off operation

Resetting the UV1 element is performed instantly when a voltage exceeds over the drop-off voltage.

(ii) Inverse definite minimum time (IDMT) characteristic

To operate the IDMT characteristic in the UV1 element, set scheme switch [**UV1-Type**] **IDMT.**

(ii)-1 Setting pick-up operation

The IDMT characteristic is applied when the operation of the UV1 element is required inversely in accordance with the level of input voltage. The IDMT characteristic curve is illustrated in Figure 2.17-2 using a value of time multiplier is set for [**UV1-TMS**]. It is followed to Equation (2.17-1) in conformed in IEC 60255-127

$$t(G) = TMS \times \left\{ \left[\frac{k}{1 - \left({}^{V}/_{V_s} \right)^{a}} \right] + c \right\} \qquad (2.17\text{-}1)$$

where,

t = operating time (seconds),

V = energizing voltage (voltage),

Vs = pickup voltage setting (voltage),

TMS = time multiplier setting.

Except for pre-programmed characteristics, the user can have a user-programmable (original) characteristic curve. The user-programmable (original) curve is obtained when the constants of k, a, c, as shown in Table 2.17-2, are set, and when **Original** is set for scheme switch [**UV1-Type**]. The constants are set with settings [**UV1-k**], [**UV1-a**], and [**UV1-C**].

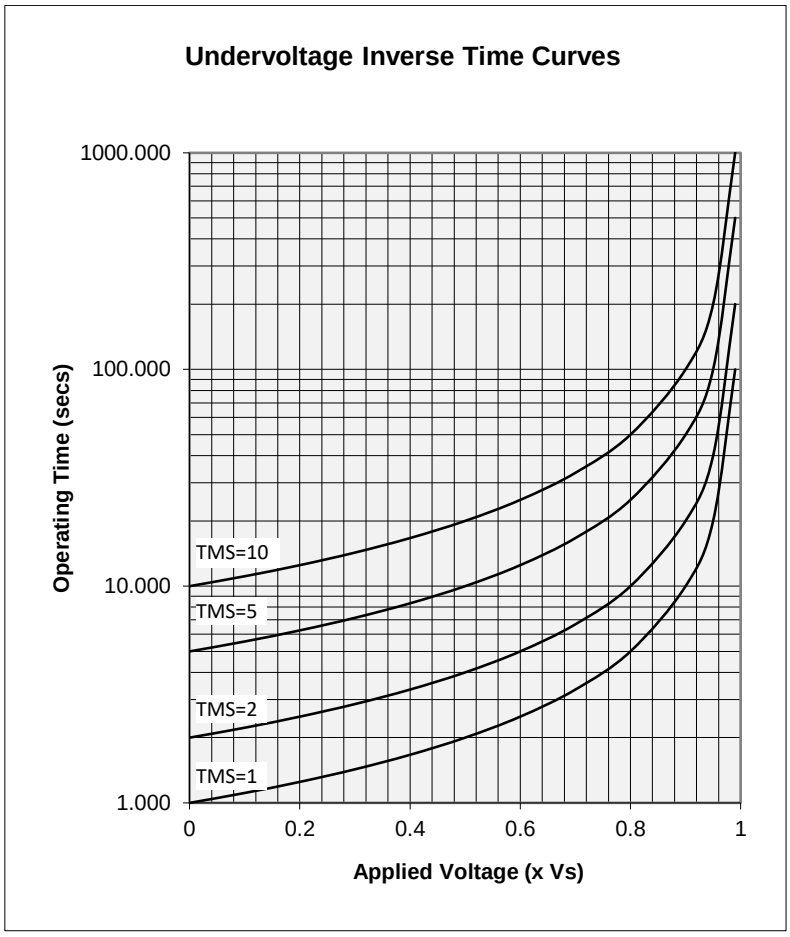


Figure 2.17-2 IDMT characteristics curves depending on TMS

Table 2.17-2 Values k, a, c for pre-programmable IDMT and user-programmable IDMT

Set item	k	a	C
IDMT	1	1	0
User-programmable (Original)	0.00000 – 500.00000 by 0.00001 step	0.00000 – 10.00000 by 0.00001 step	0.00000 – 10.00000 by 0.00001 step

(ii)-2 Setting drop-off operation

The user should set the time for resetting in the IDMT characteristic. Figure 2.17-3 shows examples of the pick-up and the drop-off relevant to both the fault occurrences and the operation time. The UV1 element has a time counter that increases in response to the fault occurrence and duration. This figure also shows the increment degree of the time counter for the fault occurrences.

As for an intermittent fault (the former in the figure), the time counter does not reach the trip level. In the other word, the UV1 element will be paralyzed in the reset time [**TUV1R**].

If a series of fault occurs, the time counter increase corresponding to the duration of series faults. When the time counter reaches the trip level, then the UV1 element issues a trip signal after a certain delay. After issuing the trip signal, if a series of fault disappears completely, the operation of the UV1 element is expired after the reset time [**TUV1R**].

When the user requires resetting the operation of the UV1 element immediately, setting zero for the settings [**TUV1R**] is needed. Consequently, when a voltage is recovered over the reset threshold (drop-off), the operation of the UV1 element is reset promptly.

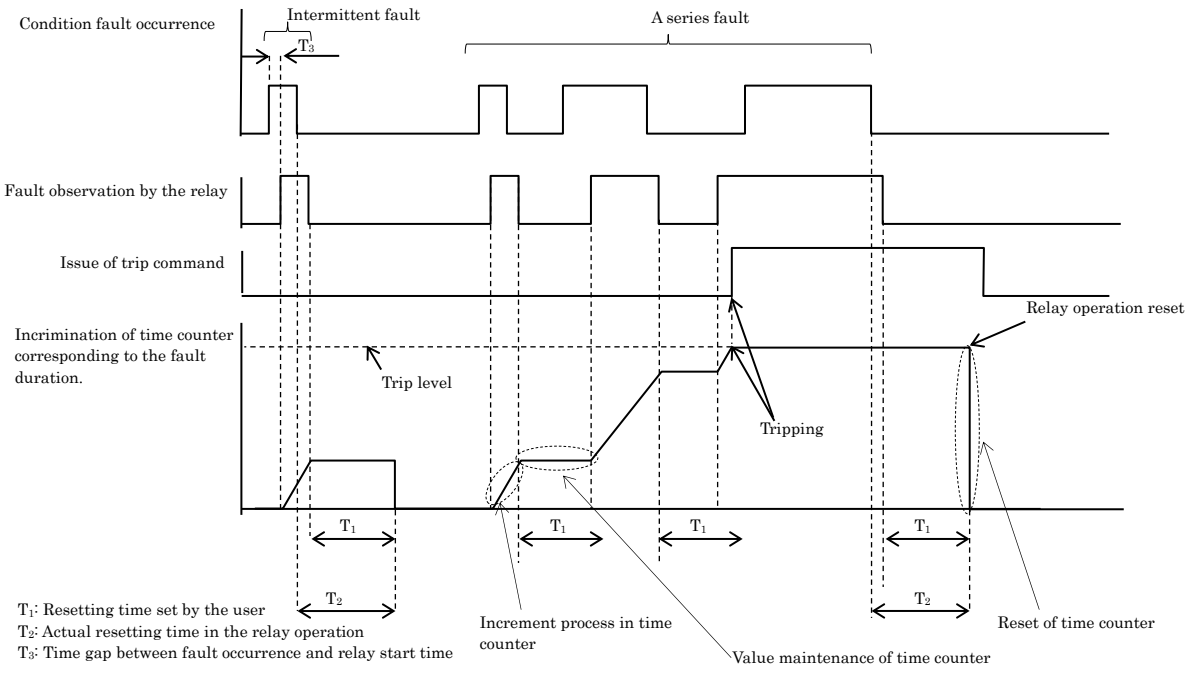


Figure 2.17-3 Faults occurrences and reset operation when IDMT being applied

2.17.3 Miscellaneous functions

(i) Blocking UV operation

Blocking the UV function may be required when a failure in the voltage transformer occurs. In this case, the user shall set **Block** for scheme switch [**UV1-VTFBlk**]. **Non** (as a default) is set for scheme switch [**UV1-VTFBlk**] in order that the UV function is not blocked by the failure.

(ii) UV trip signal

The UV1 element issues a trip signal for the trip circuit (TRC†) when **Trip** is set for scheme switch [**UV1-UseFor**] as the normal tripping. However, when an alarm signal in place of the trip signal is required, the user can set **Alarm** for the scheme switch [**UV1-UseFor**].

†Note:For more information about tripping, see Chapter *Relay application: Trip circuit*.

(iii) Operation of UV element

The user should set **On** for scheme switch [**UV1-EN**] for the operation of the UV1 element. Otherwise, set **Off** for the scheme switch if the UV1 element is not required to operate.

(iv) Under voltage test

Setting [**UV-Test**] =**On** is not to operate UV blocking element (UVBLK) for testing.

2.17.4 Scheme logic

Figure 2.17-4 show the logic of the UV function. PLC connection points “UV*_BLOCK” are provided for blocking the operation of the UV elements. Other PLC connection points “CB_*PH_OPEN” are provided so that the UV function can determine its operation using the open/closed information of a circuit breaker (CB). For testing, the UV1-PU element is provided; it generates a pick-up signal when the entering voltage is below the threshold anytime. For example, in the IDMT characteristic, using both PLC monitoring points “8000011B20” and “8000011B24” can facilitate to measure the pickup time after the deficiency. (2.50.1

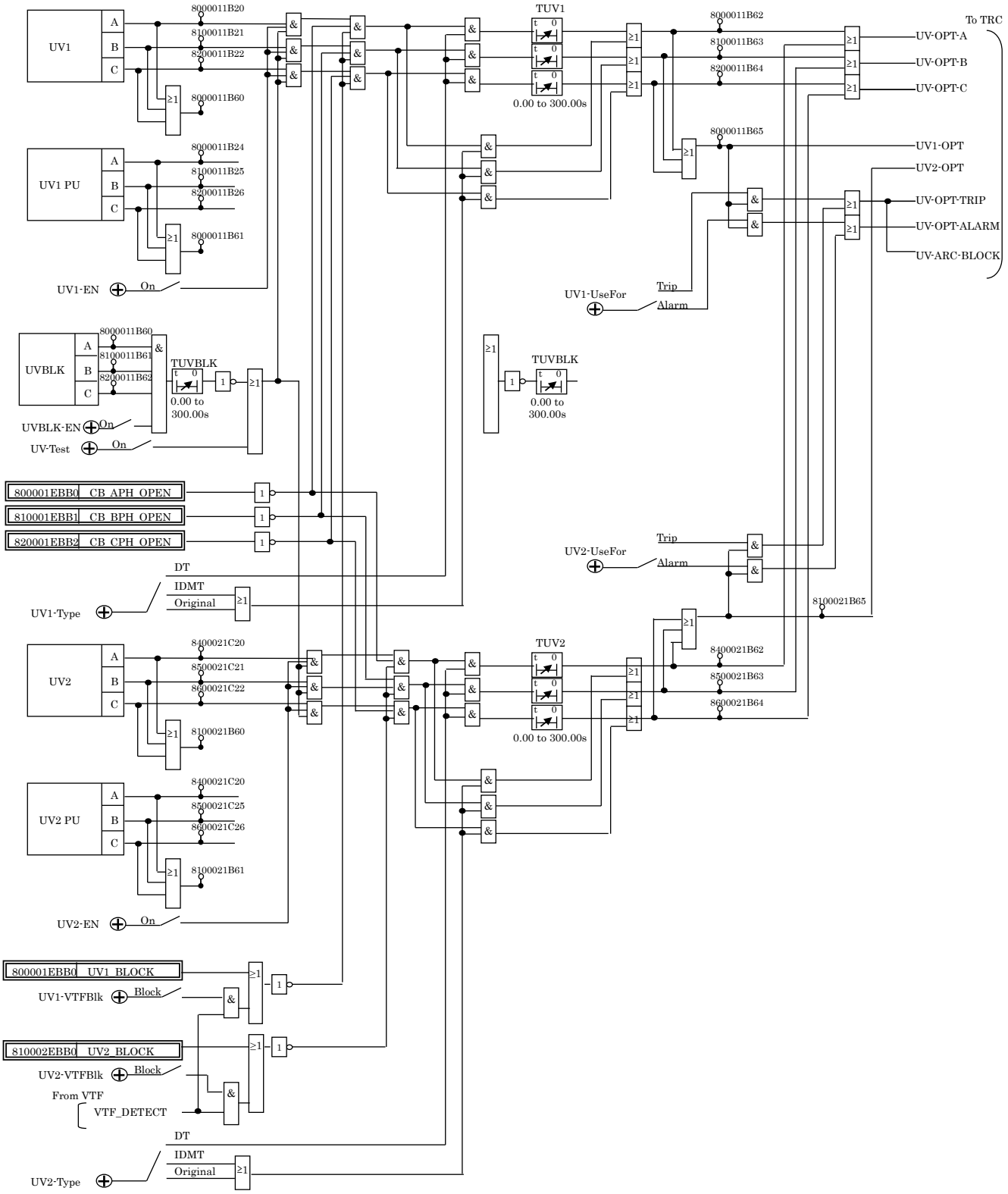


Figure 2.17-4 Scheme logic of UV function

2.17.5 Setting

Setting of UV(Function ID: 470001)

Setting item			Range	Unit s	Contents	Default setting value	Notes
		UVBLK-EN	Off/On	-	UV block function enable	Off	
		UVBLK	5.0-20.0	V	UV block threshold	10.0	
		TUVBLK	0.00-300.00	s	UV block delay time	10.00	
		UV-Test	Off/On	-	Not to execute UV block function	Off	
	UV1	UV1-EN	Off/On	-	UV1 protection enable	Off	
		UV1-Type	DT/IDMT/Original	-	UV1 delay type	DT	
		UV1	5.0-130.0	V	UV1 threshold	60.0	
		UV1-DPR	100-120	%	UV1 drop-out/pick-up ratio	100	
		TUV1	0.00-300.00	s	UV1 operating delay time (in DT mode)	1.00	
		UV1-TMS	0.010-100.00	-	UV1 time multiplier (in IDMT mode)	1.000	
		TUV1R	0.0-300.0	s	UV1 definite time reset delay	0.0	
		UV1-k	0.00000-500.00000	-	UV1 user original curve coefficient	0.00000	
		UV1-a	0.00000-10.00000	-	UV1 user original curve coefficient	0.00000	
		UV1-c	0.00000-10.00000	-	UV1 user original curve coefficient	0.00000	
		UV1-VTFBlk	Non/Block	-	UV1 operation block by VTF	Non	
		UV1-UseFor	Trip/Alarm	-	UV1 used for trip or alarm	Trip	
	UV2	UV2-EN	Off/On	-	UV2 protection enable	Off	
		UV2-Type	DT/IDMT/Original	-	UV2 delay type	DT	
		UV2	5.0-130.0	V	UV2 threshold	60.0	
		UV2-DPR	100-120	%	UV2 drop-out/pick-up ratio	100	
		TUV2	0.00-300.00	s	UV2 operating delay time (in DT mode)	1.00	
		UV2-TMS	0.010-100.00	-	UV2 time multiplier (in IDMT mode)	1.000	
		TUV2R	0.0-300.0	s	UV2 definite time reset delay	0.0	
		UV2-k	0.00000-500.00000	-	UV2 user original curve coefficient	0.00000	
		UV2-a	0.00000-10.00000	-	UV2 user original curve coefficient	0.00000	
		UV2-c	0.00000-10.00000	-	UV2 user original curve coefficient	0.00000	
		UV2-VTFBlk	Non/Block	-	UV2 operation block by VTF	Non	
		UV2-UseFor	Trip/Alarm	-	UV2 used for trip or alarm	Trip	

2.17.6 Data ID

◆ Signal monitoring point

UV(Function ID: 470001)

Element ID	Name	Description
8000011C20	UV1-A	UV1 relay element operated (phase-A)
8100011C21	UV1-B	UV1 relay element operated (phase-B)
8200011C22	UV1-C	UV1 relay element operated (phase-C)
8000011B60	UV1-OR	UV1 relay element operated (3-phases OR)
8000011C24	UV1PU-A	UV1 PU relay operation level pick up (phase-A)
8100011C25	UV1PU-B	UV1 PU relay operation level pick up (phase-B)
8200011C26	UV1PU-C	UV1 PU relay operation level pick up (phase-C)
8000011B61	UV1PU-OR	UV1 PU relay operation level pick up (3-phases OR)
8000011B62	UV1-OPT-A	UV1 protection operated (phase-A)
8100011B63	UV1-OPT-B	UV1 protection operated (phase-B)
8200011B64	UV1-OPT-C	UV1 protection operated (phase-C)
8000011B65	UV1-OPT	UV1 protection operated (3-phases OR)
8400021C20	UV2-A	UV2 relay element operated (phase-A)
8500021C21	UV2-B	UV2 relay element operated (phase-B)
8600021C22	UV2-C	UV2 relay element operated (phase-C)
8100021B60	UV2-OR	UV2 relay element operated (3-phases OR)
8400021C24	UV2PU-A	UV2 relay operation level pick up (phase-A)
8500021C25	UV2PU-B	UV2 relay operation level pick up (phase-B)
8600021C26	UV2PU-C	UV2 relay operation level pick up (phase-C)
8100021B61	UV2PU-OR	UV2 relay operation level pick up (3-phases OR)
8400021B62	UV2-OPT-A	UV2 protection operated (phase-A)
8500021B63	UV2-OPT-B	UV2 protection operated (phase-B)
8600021B64	UV2-OPT-C	UV2 protection operated (phase-C)
8100021B65	UV2-OPT	UV2 protection operated (3-phases OR)
8000001B60	UVBLK-A	UVBLK relay operation level pick up (phase-A)
8100001B61	UVBLK-B	UVBLK relay operation level pick up (phase-B)
8200001B62	UVBLK-C	UVBLK relay operation level pick up (phase-C)

◆ Connection point in PLC logic

UV(Function ID: 470001)

Element ID	Name	Description
800001EBB0	UV1_BLOCK	UV1 protection block command
810002EBB0	UV2_BLOCK	UV2 protection block command
800000EBB0	CB_APH_OPEN	Circuit Breaker detection (phase-A)
810000EBB1	CB_BPH_OPEN	Circuit Breaker detection (phase-B)
820000EBB2	CB_CPH_OPEN	Circuit Breaker detection (phase-C)

2.18 Phase-to-phase under-voltage protection (UVS)

The under-voltage protection function for phase-to-phase (UVS) consists of two stages (elements) independently: UVS1 and UVS2. The time characteristic of the UVS element is configured either definite time (DT) or inverse definite minimum time (IDMT) using settings.

Each UVS element detects the under-voltage condition of phase-to-phase. The user can set a threshold and the ratio of a drip-out voltage (DO) to a pick-up voltage (PU) in the UVS element. To simplify the description, only the UVS1 element is described, but the expression is applicable to the UVS2; hence, read the expression for the UVS1 element as the UVS2 unless a special explanation or instruction has been provided.

Note: Several IED models do not have phase-phase under-voltage protection features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.18-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
UVS	Phase-phase under-voltage protection	NA	✓	✓	(✓)	✓

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, OCN, THM, BCD, CBF, SOTF-OC, OV, OVS, UV, FRQ/DFRQ, FS, VTF, CTF, ARC, VCHK.

2.18.1 Drop-off and pick-up characteristic

Figure 2.18-1 shows the UVS characteristic as hatched area with concentric circles. The pick-up threshold voltage (PU) is represented the outer circle; the drop-off voltage point (DO) is represented the dotted circle. The PU voltage of the UVS1 element is set using [**UVS1**]. The DO voltage of the UVS1 element is set using [**UVS1-DPR**].

The inner circle shows the area in which the UVS function is blocked when the value of the block voltage is set for [**UVSBLK**]. Setting [**TUVSBLK**] is also provided so that the user can delay blocking the UVS1 and UVS2 elements using the setting.

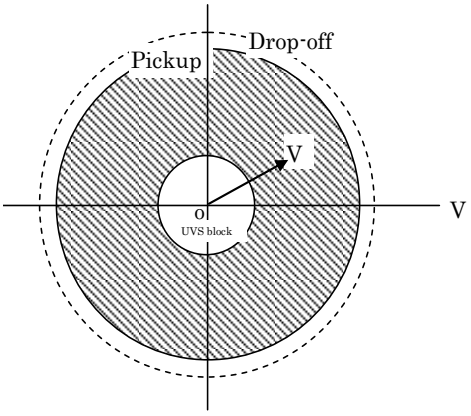


Figure 2.18-1 UVS1 element characteristic

2.18.2 Time characteristic

The UVS element has the relationship between an input voltage and an operation time; the relationship is divided into two time characteristics: (i) the definite time (DT) and (ii) the inverse definite minimum time (IDMT).

(i) Definite time characteristic (DT)

(i)-1 Setting pick-up operation

The user is required to set **DT** for scheme switch [**UVS1-Type**] when the UVS1 element should run in the DT characteristic. The UVS1 element has a delay timer for the operation; the user can set a delay time using setting [**TUVS1**]. The user can find the delay timer in the UVS function logic. (See section 2.18.4)

(i)-2 Setting drop-off operation

Resetting the UVS1 element is performed instantly when a voltage exceeds over the drop-off voltage.

(ii) Inverse definite minimum time (IDMT) characteristic

To operate the inverse definite minimum time (IDMT), set scheme switch [**UVS1-Type**] **IDMT.**

(ii)-1 Pick-up characteristic

The IDMT characteristic is applied when the operation of the UVS1 element is required inversely in accordance with the level of input voltage. The IDMT characteristic curve is illustrated in Figure 2.18-2 using a value of time multiplier is set for [**UV1-TMS**]. It is followed to Equation (2.18-1) in conformed in IEC 60255-127

$$t(G) = TMS \times \left\{ \left[\frac{k}{1 - \left({}^{V}/_{V_s} \right)^{a}} \right] + c \right\} \qquad (2.18\text{-}1)$$

where,

t = operating time (seconds),

V = energizing voltage (voltage),

Vs = pickup voltage setting (voltage),

TMS = time multiplier setting.

Except for pre-programmed characteristics, the user can have a user-programmable (original) characteristic curve. The user-programmable (original) curve is obtained when the constants of k, a, c, as shown in Table 2.18-2, are set, and when **Original** is set for scheme switch [**UVS1-Type**]. The constants are set with settings [**UVS1-k**], [**UVS1-a**], and [**UVS1-C**].

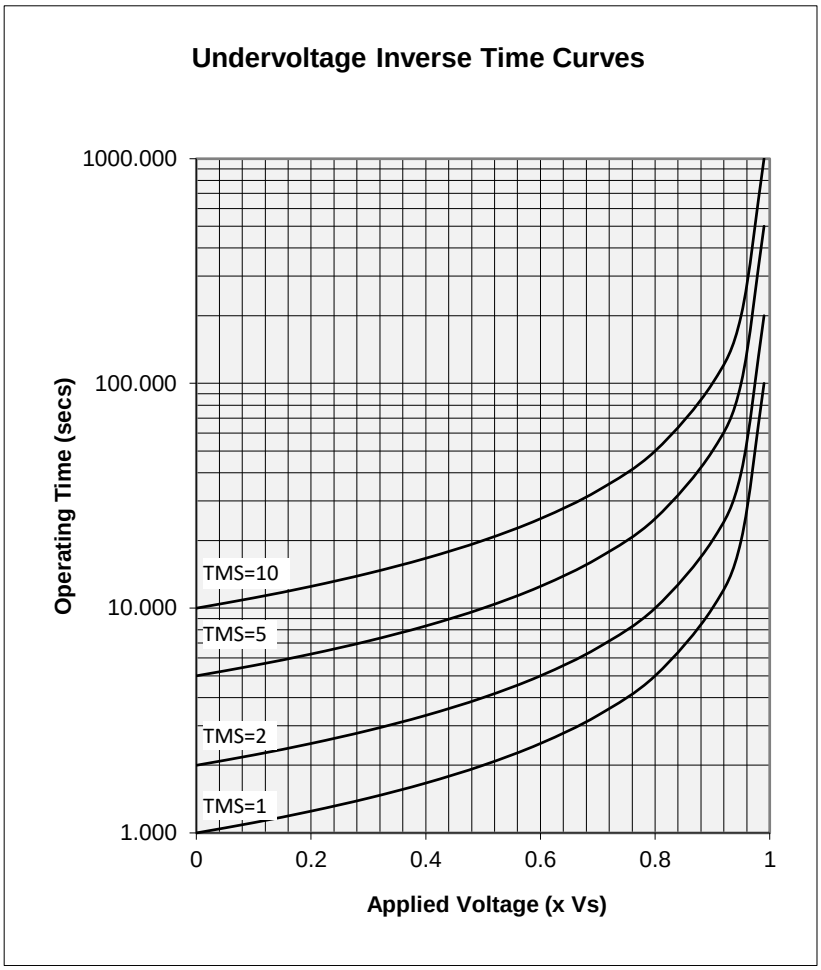


Figure 2.18-2 IDMT characteristics curves depending on TMS

Table 2.18-2 Values k, a, c for pre-programmable IDMT and user-programmable IDMT

Set item	k	a	C
IDMT	1	1	0
User-programmable (Original)	0.00000 – 500.00000 by 0.00001 step	0.00000 – 10.00000 by 0.00001 step	0.00000 – 10.00000 by 0.00001 step

(ii)-2 Drop-off characteristic

The user should set the time for resetting in the IDMT characteristic. Figure 2.18-3 shows examples of the pick-up and the drop-off relevant to both the fault occurrences and the operation time. The UVS1 element has a time counter that increases in response to the fault occurrence and duration. This figure also shows the increment degree of the time counter for the fault occurrences.

As for an intermittent fault (the former in the figure), the time counter does not reach the trip level. In the other word, the UVS1 element will be paralyzed in the reset time [**TUVS1R**]. If a series of fault occurs, the time counter increase corresponding to the duration of series faults. When the time counter reaches the trip level, then the UVS1 element issues a trip signal after a certain delay. After issuing the trip signal, if a series of fault disappears completely, the operation of the UVS1 element is expired after the reset time [**TUVS1R**].

When the user requires resetting the operation of the UVS1 element immediately, setting zero for the settings [**TUVS1R**] is needed. Consequently, when a voltage is recovered over the reset threshold (drop-off), the operation of the UVS1 element is reset promptly.

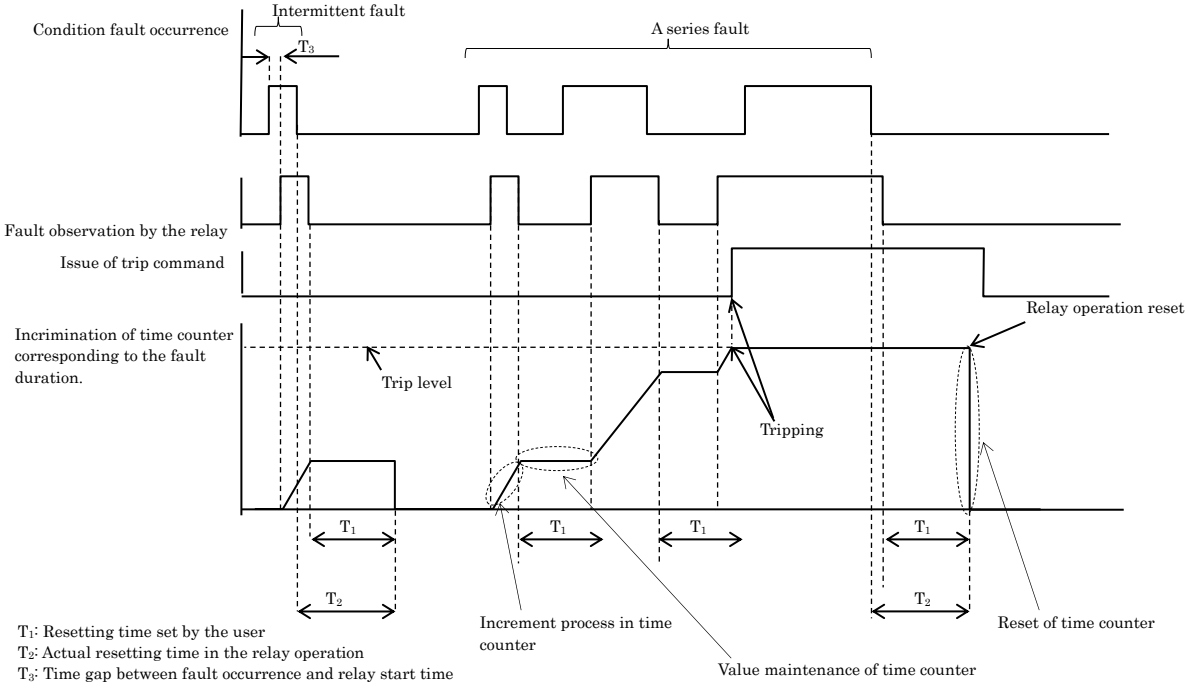


Figure 2.18-3 Faults occurrences and reset operation when DT being applied

2.18.3 Miscellaneous functions

(i) Block of UVS operation

Blocking the UVS function may be required when a failure in the voltage transformer occurs. In this case, the user shall set **Block** for scheme switch [**UVS1-VTFBlk**]. **Non** (as a default) is set for scheme switch [**UVS1-VTFBlk**] in order that the UVS function is not blocked by the failure.

(ii) UVS trip signal

The UVS1 element issues a trip signal for the trip circuit (TRC†) when **Trip** is set for scheme switch [**UVS1-UseFor**] as the normal tripping. However, when an alarm signal in place of the trip signal is required, the user can set **Alarm** for the scheme switch [**UVS1-UseFor**].

†Note:For more information about tripping, see Chapter *Relay application: Trip circuit*.

(iii) Operation of UVS function

Set **On** for scheme switch [**UVS1-EN**]. Otherwise, set **Off** for the scheme switch [**UVS1-EN**] if the UVS1 element is not required to operate.

(iv) Under voltage test

Setting [**UVS-Test**] =**On** is not to operate UVS blocking element (UVSBLK) for testing.

2.18.4 Scheme logic

Figure 2.18-4 show the logic of the UVS function. PLC connection points “UVS*_BLOCK” are provided for blocking the operation of the UVS elements. Other PLC connection points “CB_*PH_OPEN” are provided so that the UVS function can determine its operation using the open/closed information of a circuit breaker (CB). For testing, the UVS1-PU element is provided; it generates a pick-up signal when the entering voltage is below the threshold anytime. For example, in the IDMT characteristic, using both PLC monitoring points “8000011B20” and “8000011B24” can facilitate to measure the pickup time after the deficiency.

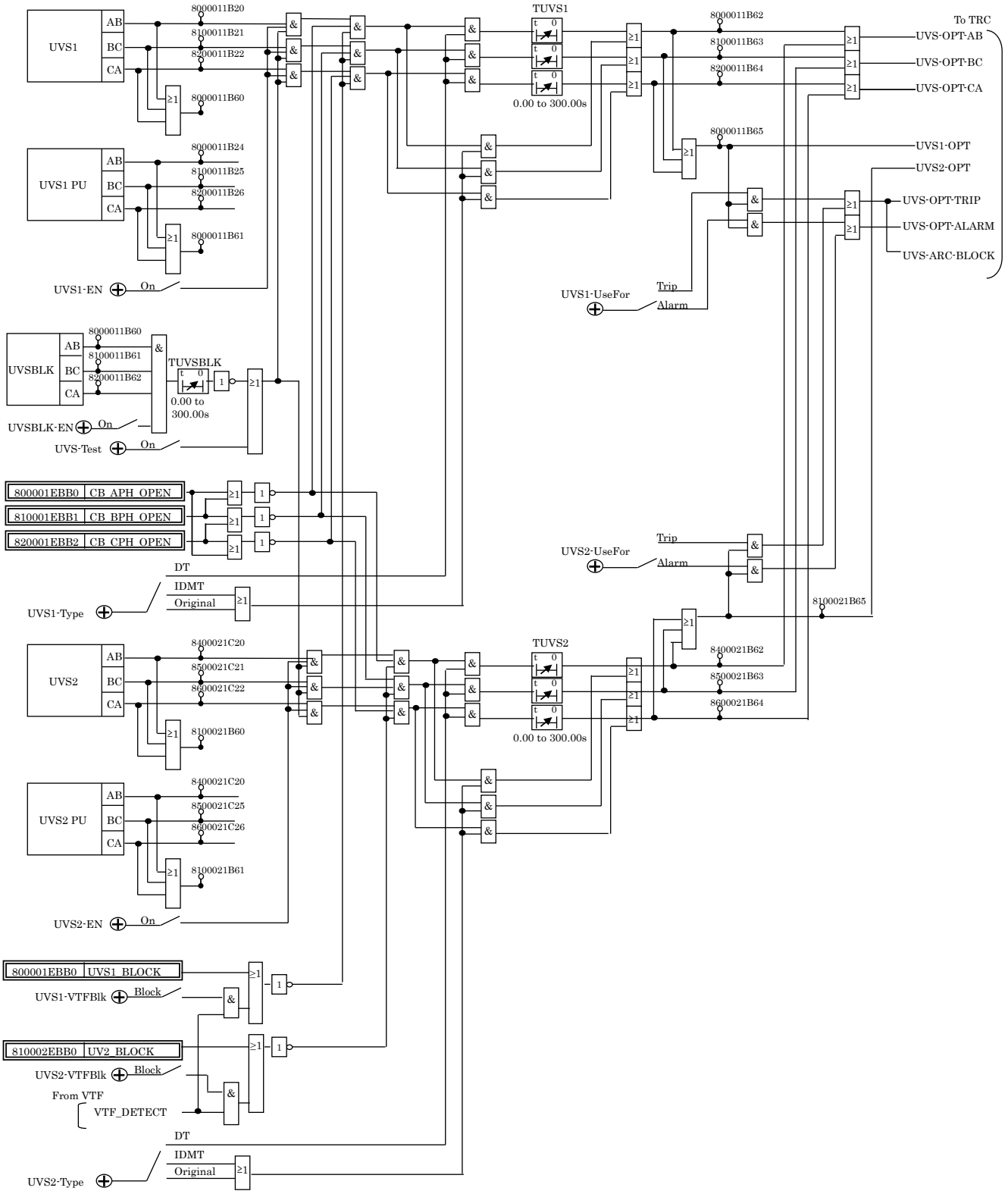


Figure 2.18-4 Scheme logic of UVS function

2.18.5 Setting

Setting of UVS(Function ID: 471001)

Setting item		Range	Units	Contents	Default setting value	Notes
	UVSBLK-EN	Off/On		UVS block function enable	Off	
	UVSBLK	5.0-20.0	V	UVS block threshold	10.0	
	TUVSBLK	0.00-300.00	s	UVS block delay time	10.00	
	UVS-Test	Off/On		Not to execute UVS block function	Off	
UVS1	UVS1-EN	Off/On		UVS1 protection enable	Off	
	UVS1-Type	DT/IDMT/Original		UVS1 delay type	DT	
	UVS1	5.0-130.0	V	UVS1 threshold (in DT mode)	60.0	
	UVS1-DPR	100-120	%	UVS1 drop-out/pick-up ratio	100	
	TUVS1	0.00-300.00	s	UVS1 operating delay time (in DT mode)	1.00	
	UVS1-TMS	0.010-100.00		UVS1 time multiplier (in IDMT mode)	1.000	
	TUVS1R	0.0-300.0	s	UVS1 definite time reset delay	0.0	
	UVS1-k	0.00000-500.00000		UVS1 user original curve coefficient	0.00000	
	UVS1-a	0.00000-10.00000		UVS1 user original curve coefficient	0.00000	
	UVS1-c	0.00000-10.00000		UVS1 user original curve coefficient	0.00000	
	UVS1-VTFBlk	Non/Block		UVS1 operation block by VTF	Non	
	UVS1-UseFor	Trip/Alarm		UVS1 used for trip or alarm	Trip	
UVS2	UVS2-EN	Off/On		UVS2 protection enable	Off	
	UVS2-Type	DT/IDMT/Original		UVS2 delay type	DT	
	UVS2	5.0-130.0	V	UVS2 threshold (in DT mode)	60.0	
	UVS2-DPR	100-120	%	UVS2 drop-out/pick-up ratio	100	
	TUVS2	0.00-300.00	s	UVS2 operating delay time (in DT mode)	1.00	
	UVS2-TMS	0.010-100.00		UVS2 time multiplier (in IDMT mode)	1.000	
	TUVS2R	0.0-300.0	s	UVS2 definite time reset delay	0.0	
	UVS2-k	0.00000-500.00000		UVS2 user original curve coefficient	0.00000	
	UVS2-a	0.00000-10.00000		UVS2 user original curve coefficient	0.00000	
	UVS2-c	0.00000-10.00000		UVS2 user original curve coefficient	0.00000	
	UVS2-VTFBlk	Non/Block		UVS2 operation block by VTF	Non	
	UVS2-UseFor	Trip/Alarm		UVS2 used for trip or alarm	Trip	

2.18.6 Data ID

◆ Signal monitoring point

UVS(Function ID: 471001)

Element ID	Name	Description
8000011C20	UVS1-AB	UVS1 relay element operated (phase-AB)
8100011C21	UVS1-BC	UVS1 relay element operated (phase-BC)
8200011C22	UVS1-CA	UVS1 relay element operated (phase-CA)
8000011B60	UVS1-OR	UVS1 relay element operated (3-phases OR)
8000011C24	UVS1PU-AB	UVS1 PU relay operation level pick up (phase-AB)
8100011C25	UVS1PU-BC	UVS1 PU relay operation level pick up (phase-BC)
8200011C26	UVS1PU-CA	UVS1 PU relay operation level pick up (phase-CA)
8000011B61	UVS1PU-OR	UVS1 PU relay operation level pick up (3-phases OR)
8000011B62	UVS1-OPT-AB	UVS1 protection operated (phase-AB)
8100011B63	UVS1-OPT-BC	UVS1 protection operated (phase-BC)
8200011B64	UVS1-OPT-CA	UVS1 protection operated (phase-CA)
8000011B65	UVS1-OPT	UVS1 protection operated
8400021C20	UVS2-AB	UVS2 relay element operated (phase-AB)
8500021C21	UVS2-BC	UVS2 relay element operated (phase-BC)
8600021C22	UVS2-CA	UVS2 relay element operated (phase-CA)
8100021B60	UVS2-OR	UVS2 relay element operated (3-phases OR)
8400021C24	UVS2PU-AB	UVS2 relay operation level pick up (phase-AB)
8500021C25	UVS2PU-BC	UVS2 relay operation level pick up (phase-BC)
8600021C26	UVS2PU-CA	UVS2 relay operation level pick up (phase-CA)
8100021B61	UVS2PU-OR	UVS2 relay operation level pick up (3-phases OR)
8400021B62	UVS2-OPT-AB	UVS2 protection operated (phase-AB)
8500021B63	UVS2-OPT-BC	UVS2 protection operated (phase-BC)
8600021B64	UVS2-OPT-CA	UVS2 protection operated (phase-CA)
8100021B65	UVS2-OPT	UVS2 protection operated
8000001B60	UVSBLK-AB	UVSBLK relay operation level pick up (phase-AB)
8100001B61	UVSBLK-BC	UVSBLK relay operation level pick up (phase-BC)
8200001B62	UVSBLK-CA	UVSBLK relay operation level pick up (phase-CA)

◆ Connection point in PLC logic

UVS(Function ID: 471001)

Element ID	Name	Description
800001EBB0	UVS1_BLOCK	UVS1 protection block command
810002EBB0	UVS2_BLOCK	UVS2 protection block command
800000EBB0	CB_APH_OPEN	A phase CB open
810000EBB1	CB_BPH_OPEN	B phase CB open
820000EBB2	CB_CPH_OPEN	C phase CB open

2.19 Frequency protection (FRQ/DFRQ)

The frequency protection (FRQ and DFRQ) functions have six frequency elements (stages) to detect frequency-deviations and frequency-changes, respectively. If the deviations or changes are appeared, the FRQ and DFRQ function can issue a trip signal (or an alarm signal) in response to the degree of the frequency-deviation and the frequency-change.

With respect to monitoring the frequency-deviation, either an under-frequency element (UF) or an over-frequency element (OF) is used to monitor a frequency. The user can set the degree of frequency deviation at each frequency. Generally, the UF element is applied to monitor the balance between the power generation capability and the loads. The OF element is used monitor the frequency to be within the normal range by load shedding; the OF element is used to protect synchronous machines from possible damage owing to over-frequency conditions.

With respect to monitoring the frequency-changes, either a frequency-rise element (RISE) or a frequency-down element (DOWN) is used to monitor the frequency-change. To monitor the frequency-change, the user should select either the RISE element or the DOWN element at respective frequencies. The DFRQ is used to ensure the operation of load shedding promptly when the change of frequency is very rapid.

To simplify the description, only stage 1 is discussed, but is applicable to the other stages; hence, read the express for stage 1 as the other stages unless a special explanation or instruction has been produced.

Note: Several IED models do not have frequency protection features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.19-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
FRQ/DFRQ	Frequency protection	NA	✓	✓	(✓)	✓

✓: Applicable NA: Not applicable

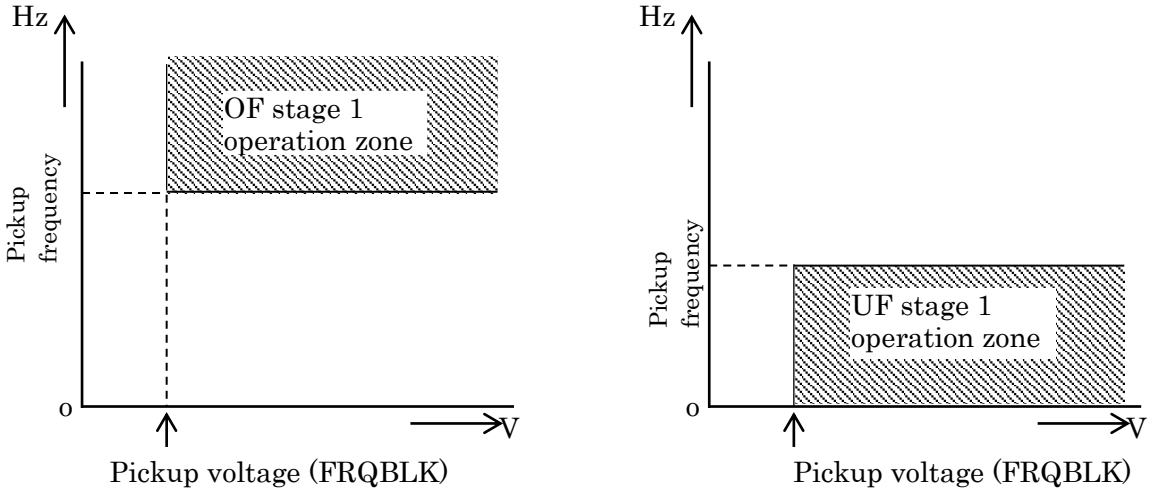
(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, OCN, THM, BCD, CBF, SOTF-OC, OV, OVS, UV, UVS, FS, VTF, CTF, ARC, VCHK.

2.19.1 FRQ features and characteristics

(i) UF/OF characteristic

The UF and OF elements check the frequency every 5msec; they determines the frequency-deviations whether the frequency is in under-frequency or over-frequency. Figure 2.19-1(a) shows the UF characteristic; Figure 2.19-1(b) shows the OF characteristic; hatched area reflects operation zone of the UF and the OF elements.

The user can select the stage 1 to detect either over-frequency state or under-frequency state using scheme switch [**FRQ1-Chara**]. For example, If **OverFrq** is set for the scheme switch [**FRQ1-Chara**], the stage 1 determines the over-frequency state when an over frequency is observed (Figure 2.19-1(a)); the user can set the threshold value into [**FRQ1**]. Conversely, if **UnderFrq** is set for the scheme switch, the stage 1 determines the under-frequency state when an under frequency is observed (Figure 2.19-1(b)). The user can use a delay timer to postpone to issue a trip signal using setting [**TFRQ1**].



a. Over frequency element at Stage 1 b. Under frequency element at Stage 1

Figure 2.19-1 Characteristics of UF and OF elements (e.g. Stage 1 of FRQ)

Regarding the operation of the UF and OF elements, the user should notice the element not to pick-up when the measured voltage is below the threshold value set with the [**FRQBLK**] in positive sequence. Any operation of the FRQ function is blocked when an acquired voltage is smaller than the pickup voltage to be set.

(ii) Enabling FRQ function

The user should set **On** to enable the FRQ function using scheme switch [**FRQ1-EN**]. If the user do not require the FRQ operation, **Off** should be set for the scheme switch.

(iii) FRQ trip signal

The FRQ can issue a trip signal for the function of trip circuit (TRC) when **Trip** is set for scheme switch [**FRQ1-UseFor**]. However, when an alarm signal is required in place of the trip signal, the user should set **Alarm** for scheme switch [**FRQ1-UseFor**]. The TRC function is discussed separately. (See Chapter *Relay application: Trip circuit.*)

(iv) UF/OF scheme logic

Figure 2.19-2 shows the scheme logic for the UF and OF functions. Each stage operates independently. PLC connection point "FRQ1-BLOCK" is provided to block the stage1 when blocking is required by an external signal. The user can connect the PLC connection point with an external signal using PLC function. (For more information of PLC function, see Chapter *PLC function*)

The under-voltage block (FRQBLK) element is used to block the FRQ operation, as mentioned earlier (section 2.19.1(i)).

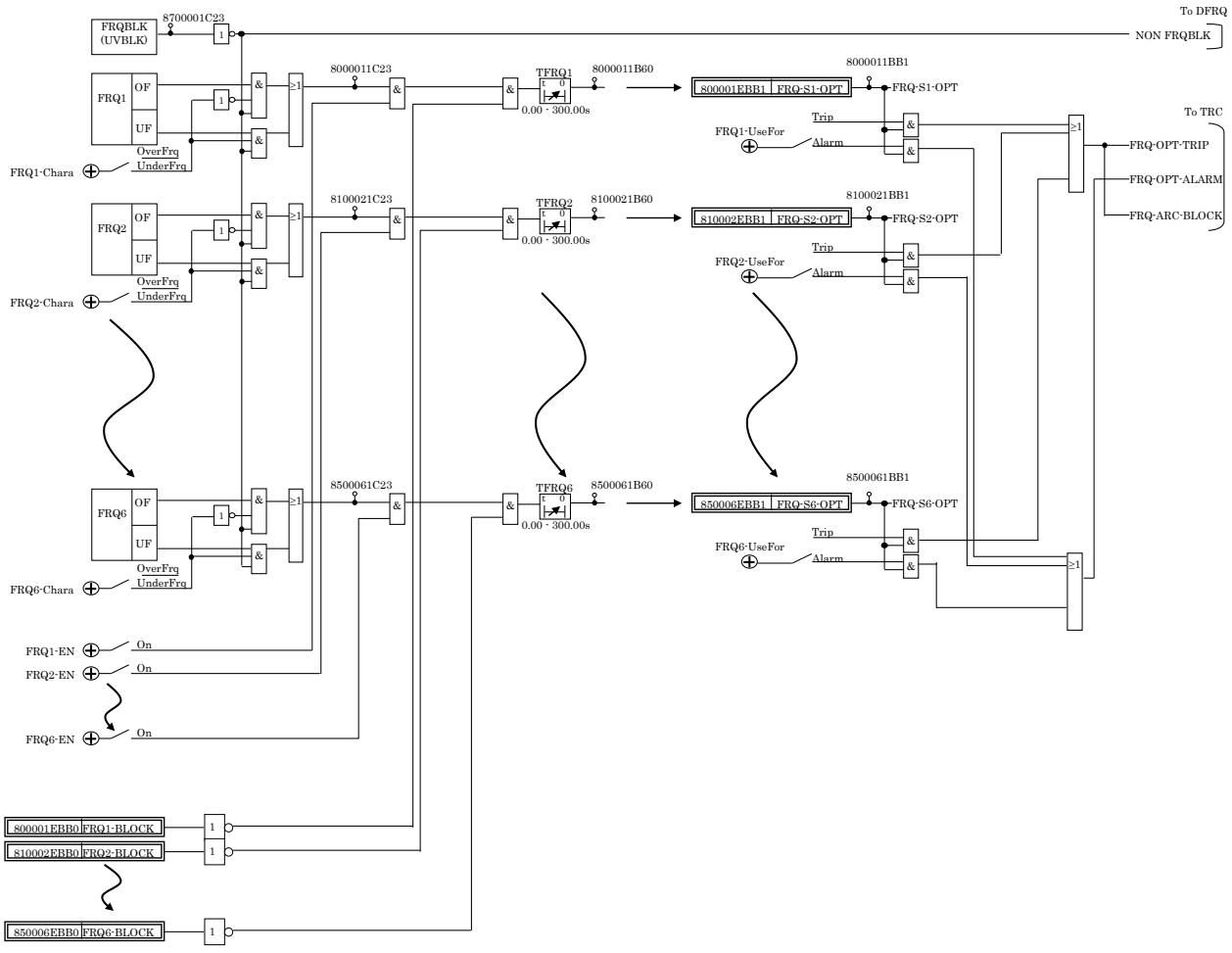


Figure 2.19-2 Scheme logic for FRQ function

2.19.2 DFRQ features and characteristics

(i) RISE/DOWN characteristic

The RISE and DOWN elements calculate the gradient of frequency-change (Δf/Δt) every 5msec. Figure 2.19-3 shows how to calculate the gradient using Δf and Δt: the change of frequency (Δf) over a time interval and Δt equals to 100ms. Six elements are provided for the DFRQ function; each element can operate independently. Each stage of the DFRQ function issues a trip signal if Δf exceeds the setting value of 50 consecutive times.

The user can set the state 1 to detect whether a frequency to be rising or to be descending using scheme switch [**DFRQ1-Chara**]. For example, when **Rise** is set for the scheme switch [**DFRQ1-Chara**], the DFRQ examines the gradient of frequency-change (Δf/Δt) in up. Conversely, when **Down** is set for the scheme switch, the DFRQ examines the gradient of frequency-change (Δf/Δt) in down. Setting [**DFREQ1**] is used to configure an operation threshold; the operation threshold is configured with Hertz per second.

The operation of the RISE/DOWN elements is blocked when the FRQBLK element runs. That is, if an obtained voltage is below the setting [**FRQBLK**], any operation of the DFRQ function is blocked. The FRQBLK element is discussed in section 2.19.1(i).

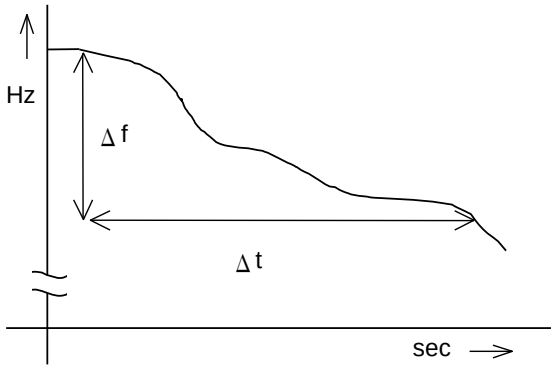


Figure 2.19-3 Gradient of frequency rate-of-change

(ii) Enabling DFRQ function

The user should set On to enable the DFRQ function using scheme switch [**DFRQ1-EN**]. If the user is not to operate the DFRQ function, Off should be set for the scheme switch.

(iii) DFRQ trip signal

The DFRQ can issue a trip signal for the function of trip circuit (TRC) when **Trip** is set for scheme switch [**DFRQ1-UseFor**]. However, when an alarm signal is required in place of the trip signal, the user should set **Alarm** for scheme switch [**DFRQ1-UseFor**]. The TRC function is discussed separately. (See Chapter *Relay application: Trip circuit*)

(iv) DFRQ scheme logic

Figure 2.19-4 shows the scheme logic of the DFRQ function. Each stage operates independently. PLC connection point "DFRQ1-BLOCK" is provided to block the stage1; hence the user can connect an external signal to this PLC connection point when the external signal is provided to block the stage 1. (For more information of PLC function, see Chapter PLC function)

The signal of the under-voltage block (FRQBLK) element is provided from the FRQ logic.

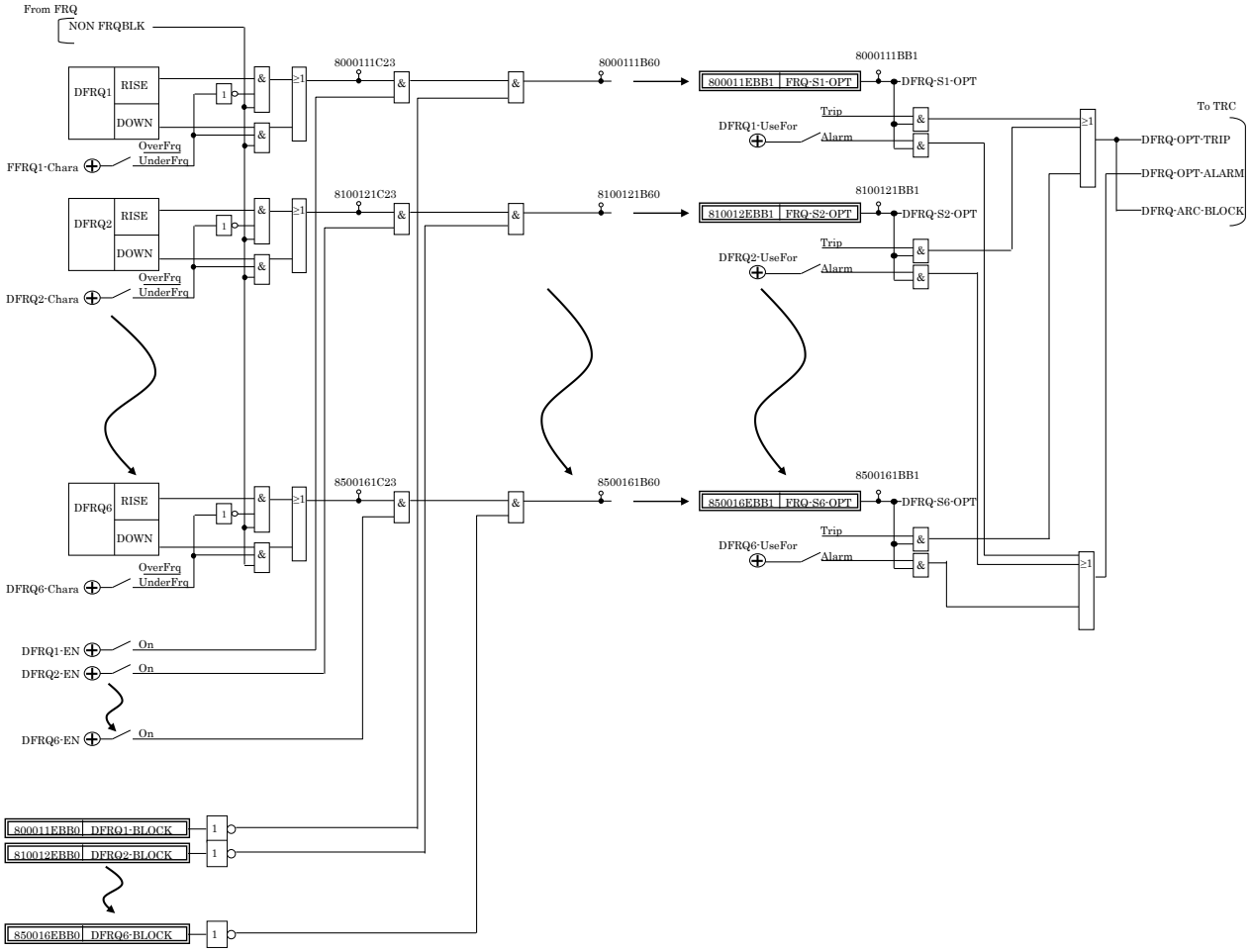


Figure 2.19-4 Scheme Logic of Frequency Rate-of-change Protection

(2.53.1)

2.19.3 Setting

Setting of FRQ(Function ID: 475001)

Setting item			Range	Unit s	Contents	Default setting value	Notes
	Common	FRQBLK	40.0 to 100.0	V	Set for blocking in positive sequence	40.0	
	FRQ1	FRQ1-EN	Off/On	–	FRQ1 protection enable	Off	
		FRQ1-Chara	OverFrq/UnderFrq	–	The selection of FRQ1 character	UnderFrq	
		FRQ1	-10.00 to 10.00	Hz	FRQ1 threshold	-1.00	
		TFRQ1	0.00 to 300.00	S	FRQ1 operating delay time	1.00	
		FRQ1-UseFor	Trip/Alarm	–	FRQ1 used for trip or alarm	Trip	
	FRQ2	FRQ2-EN	Off/On	–	FRQ1 protection enable	Off	
		FRQ2-Chara	OverFrq/UnderFrq	–	The selection of FRQ1 character	UnderFrq	
		FRQ2	-10.00 to 10.00	Hz	FRQ1 threshold	-1.00	
		TFRQ2	0.00 to 300.00	S	FRQ1 operating delay time	1.00	
		FRQ2-UseFor	Trip/Alarm	–	FRQ1 used for trip or alarm	Trip	
	FRQ3	FRQ3-EN	Off/On	–	FRQ1 protection enable	Off	
		FRQ3-Chara	OverFrq/UnderFrq	–	The selection of FRQ1 character	UnderFrq	
		FRQ3	-10.00 to 10.00	Hz	FRQ1 threshold	-1.00	
		TFRQ3	0.00 to 300.00	S	FRQ1 operating delay time	1.00	
		FRQ3-UseFor	Trip/Alarm	–	FRQ1 used for trip or alarm	Trip	
	FRQ4	FRQ4-EN	Off/On	–	FRQ1 protection enable	Off	
		FRQ4-Chara	OverFrq/UnderFrq	–	The selection of FRQ1 character	UnderFrq	
		FRQ4	-10.00 to 10.00	Hz	FRQ1 threshold	-1.00	
		TFRQ4	0.00 to 300.00	S	FRQ1 operating delay time	1.00	
		FRQ4-UseFor	Trip/Alarm	–	FRQ1 used for trip or alarm	Trip	
	FRQ5	FRQ5-EN	Off/On	–	FRQ1 protection enable	Off	
		FRQ5-Chara	OverFrq/UnderFrq	–	The selection of FRQ1 character	UnderFrq	
		FRQ5	-10.00 to 10.00	Hz	FRQ1 threshold	-1.00	
		TFRQ5	0.00 to 300.00	S	FRQ1 operating delay time	1.00	
		FRQ5-UseFor	Trip/Alarm	–	FRQ1 used for trip or alarm	Trip	
	FRQ6	FRQ6-EN	Off/On	–	FRQ1 protection enable	Off	
		FRQ6-Chara	OverFrq/UnderFrq	–	The selection of FRQ1 character	UnderFrq	
		FRQ6	-10.00 to 10.00	Hz	FRQ1 threshold	-1.00	
		TFRQ6	0.00 to 300.00	S	FRQ1 operating delay time	1.00	
		FRQ6-UseFor	Trip/Alarm	–	FRQ1 used for trip or alarm	Trip	
	DFRQ1	DFRQ1-EN	Off/On	–	DFRQ1 protection enable	Off	
		DFRQ1-Chara	Rise/Down	–	The selection of DFRQ1 character	Down	
		DFRQ1	0.1 to 15.0	Hz /s	DFRQ1 threshold	0.5	
		DFRQ1-UseFor	Trip/Alarm	–	DFRQ1 used for trip or alarm	Trip	
	DFRQ2	DFRQ2-EN	Off/On	–	DFRQ2 protection enable	Off	
		DFRQ2-Chara	Rise/Down	–	The selection of DFRQ2 character	Down	
		DFRQ2	0.1 to 15.0	Hz /s	DFRQ2 threshold	0.5	
		DFRQ2-UseFor	Trip/Alarm	–	DFRQ2 used for trip or alarm	Trip	
	DFRQ3	DFRQ3-EN	Off/On	–	DFRQ3 protection enable	Off	
		DFRQ3-Chara	Rise/Down	–	The selection of DFRQ3 character	Down	
		DFRQ3	0.1 to 15.0	Hz /s	DFRQ3 threshold	0.5	
		DFRQ3-UseFor	Trip/Alarm	–	DFRQ3 used for trip or alarm	Trip	
	DFRQ4	DFRQ4-EN	Off/On	–	DFRQ4 protection enable	Off	
		DFRQ4-Chara	Rise/Down	–	The selection of DFRQ4 character	Down	
		DFRQ4	0.1 to 15.0	Hz /s	DFRQ4 threshold	0.5	
		DFRQ4-UseFor	Trip/Alarm	–	DFRQ4 used for trip or alarm	Trip	
	DFRQ5	DFRQ5-EN	Off/On	–	DFRQ5 protection enable	Off	
		DFRQ5-Chara	Rise/Down	–	The selection of DFRQ5 character	Down	
		DFRQ5	0.1 to 15.0	Hz /s	DFRQ5 threshold	0.5	

Setting of FRQ(Function ID: 475001)

Setting item			Range	Units	Contents	Default setting value	Notes
	DFRQ6	DFRQ5-UseFor	Trip/Alarm	–	DFRQ5 used for trip or alarm	Trip	
		DFRQ6-EN	Off/On	–	DFRQ6 protection enable	Off	
		DFRQ6-Chara	Rise/Down	–	The selection of DFRQ6 character	Down	
		DFRQ6	0.1 to 15.0	Hz /s	DFRQ6 threshold	0.5	
		DFRQ6-UseFor	Trip/Alarm	–	DFRQ6 used for trip or alarm	Trip	

2.19.4 Data ID

◆ Signal monitoring point

FRQ(Function ID: 475001)

Element ID	Name	Description
8000011C23	FRQ1	FRQ1 relay element operated
8000111C23	DFRQ1	DFRQ1 relay element operated
8000011B60	FRQ1-OPT	FRQ1 element operated
8000111B60	DFRQ1-OPT	DFRQ1 element operated
8000011BB1	FRQ-S1-OPT	FRQ1 protection operated
8000111BB1	DFRQ-S1-OPT	DFRQ1 protection operated
8100021C23	FRQ2	FRQ2 relay element operated
8100121C23	DFRQ2	DFRQ2 relay element operated
8100021B60	FRQ2-OPT	FRQ2 element operated
8100121B60	DFRQ2-OPT	DFRQ2 element operated
8100021BB1	FRQ-S2-OPT	FRQ2 protection operated
8100121BB1	DFRQ-S2-OPT	DFRQ2 protection operated
8200031C23	FRQ3	FRQ3 relay element operated
8200131C23	DFRQ3	DFRQ3 relay element operated
8200031B60	FRQ3-OPT	FRQ3 element operated
8200131B60	DFRQ3-OPT	DFRQ3 element operated
8200031BB1	FRQ-S3-OPT	FRQ3 protection operated
8200131BB1	DFRQ-S3-OPT	DFRQ3 protection operated
8300041C23	FRQ4	FRQ4 relay element operated
8300141C23	DFRQ4	DFRQ4 relay element operated
8300041B60	FRQ4-OPT	FRQ4 element operated
8300141B60	DFRQ4-OPT	DFRQ4 element operated
8300041BB1	FRQ-S4-OPT	FRQ4 protection operated
8300141BB1	DFRQ-S4-OPT	DFRQ4 protection operated
8400051C23	FRQ5	FRQ5 relay element operated
8400151C23	DFRQ5	DFRQ5 relay element operated
8400051B60	FRQ5-OPT	FRQ5 element operated
8400151B60	DFRQ5-OPT	DFRQ5 element operated
8400051BB1	FRQ-S5-OPT	FRQ5 protection operated
8400151BB1	DFRQ-S5-OPT	DFRQ5 protection operated
8500061C23	FRQ6	FRQ6 relay element operated
8500161C23	DFRQ6	DFRQ6 relay element operated
8500061B60	FRQ6-OPT	FRQ6 element operated
8500161B60	DFRQ6-OPT	DFRQ6 element operated
8500061BB1	FRQ-S6-OPT	FRQ6 protection operated
8500161BB1	DFRQ-S6-OPT	DFRQ6 protection operated
8700001C23	FRQBLK	FRQBLK relay element operated

◆ Connection point in PLC logic

FRQ(Function ID: 475001)

Element ID	Name	Description
800011EBB1	DFRQ-S1-OPT	DFRQ1 protection operated
810012EBB1	DFRQ-S2-OPT	DFRQ2 protection operated

◆ Connection point in PLC logic

FRQ(Function ID: 475001)

Element ID	Name	Description
820013EBB1	DFRQ-S3-OPT	DFRQ3 protection operated
830014EBB1	DFRQ-S4-OPT	DFRQ4 protection operated
840015EBB1	DFRQ-S5-OPT	DFRQ5 protection operated
850016EBB1	DFRQ-S6-OPT	DFRQ6 protection operated
800011EBB0	DFRQ1_BLOCK	DFRQ1 protection block command
810012EBB0	DFRQ2_BLOCK	DFRQ2 protection block command
820013EBB0	DFRQ3_BLOCK	DFRQ3 protection block command
830014EBB0	DFRQ4_BLOCK	DFRQ4 protection block command
840015EBB0	DFRQ5_BLOCK	DFRQ5 protection block command
850016EBB0	DFRQ6_BLOCK	DFRQ6 protection block command
800001EBB1	FRQ-S1-OPT	FRQ1 protection operated
810002EBB1	FRQ-S2-OPT	FRQ2 protection operated
820003EBB1	FRQ-S3-OPT	FRQ3 protection operated
830004EBB1	FRQ-S4-OPT	FRQ4 protection operated
840005EBB1	FRQ-S5-OPT	FRQ5 protection operated
850006EBB1	FRQ-S6-OPT	FRQ6 protection operated
800001EBB0	FRQ1_BLOCK	FRQ1 protection block command
810002EBB0	FRQ2_BLOCK	FRQ2 protection block command
820003EBB0	FRQ3_BLOCK	FRQ3 protection block command
830004EBB0	FRQ4_BLOCK	FRQ4 protection block command
840005EBB0	FRQ5_BLOCK	FRQ5 protection block command
850006EBB0	FRQ6_BLOCK	FRQ6 protection block command

2.20 Out of step tripping by voltage (OSTV)

Certain power disturbance may cause the loss of synchronism between terminal ends. When the loss occurs, the disturbance should be separated from the power system promptly. The function of out-of-step-tripping by voltage (OSTV) can detect such fault; and the detection is done by comparing the voltages at the terminals.

Note: Several IED models do not have out of step tripping features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.20-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
OSTV	Out of step tripping by voltage (56V)	NA	✓	✓	✓	✓

✓: Applicable NA: Not applicable

2.20.1 Operation characteristic

Two elements are provided to detect an out-of-step condition. Figure 2.20-1 shows the operation principle of the OSTV function. Reference voltage (V_A) is acquired in IED A at terminal A; and a corresponding voltage (V_B) is acquired in IED B at terminal B. Using the telecommunication[1] voltage data at both terminals are provided to the respective opposite terminals. Electrical center is located at which the respective impedances for respective terminals are equal.

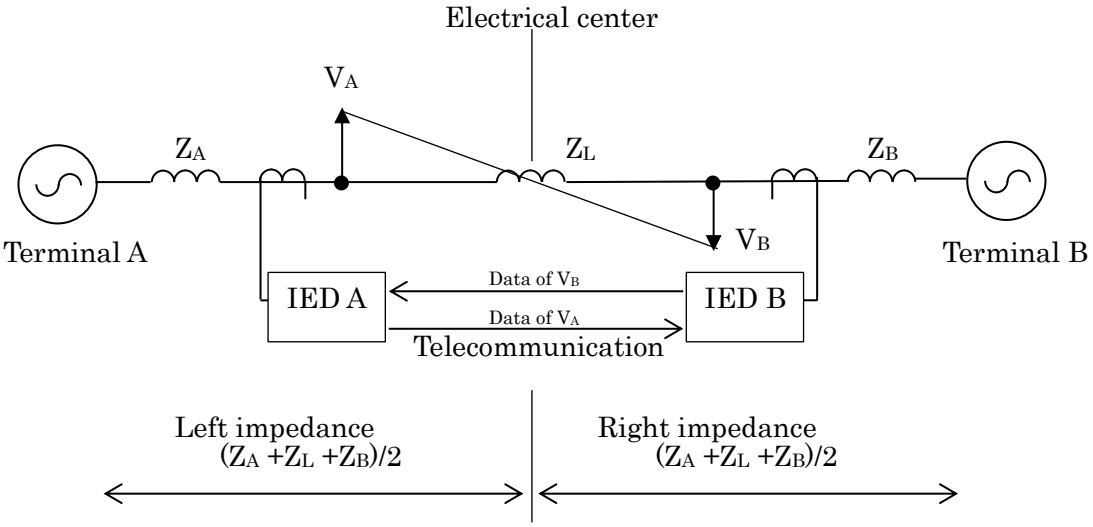


Figure 2.20-1 Typical impedance and electrical center

[1]Note: The data is transferred by the function of 'Communication application'. For more information, see Chapter *Relay application: Communication application*.

Figure 2.20-2 is the characteristic of the OSTV-1 element. Phasor V_B will exist in the second quadrant (α-zone) or the third quadrant (ß-zone) if the out-of-step state is appeared. This is because a reference voltage is obtained at terminal A.

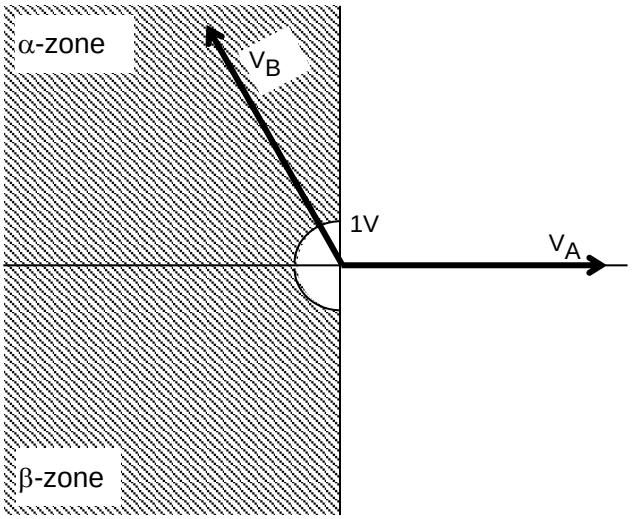


Figure 2.20-2 Voltage phase comparison between terminal A and terminal B (OSTV-1)

Another OSTV element (OSTV-2) is provided when the protection is carried out by three IEDs. The characteristic of the OSTV-2 element is the same as the characteristic of the OSTV-1 element.

Note that to detect the state of out-of-step, phasor V_B should stay at each quadrant for the setting time (1.5 cycles). This is because that the influence of any VT transient should be cancelled. The voltages in positive-sequence are used for the calculation of the OSTV function; and when amplitudes are larger than 1V, the operation of the OSTV function is valid.

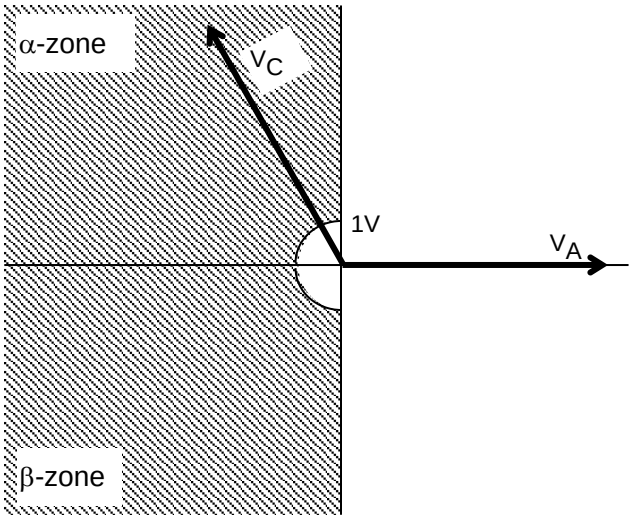


Figure 2.20-3 Voltage phase comparison between terminal A and terminal C (OSTV-2)

2.20.2 Scheme logic and settings

Figure 2.20-4 shows the scheme logic of the OSTV function. The user should set scheme switch [**OSTV-EN**] **On** when the OSTV function is required to operate. The user should note that the OSTV function should operate together multi-level overcurrent elements (OCMFS), which is provided in the Failsafe function (FS. For more information of FS, see Chapter *Relay application: Fail safe*).

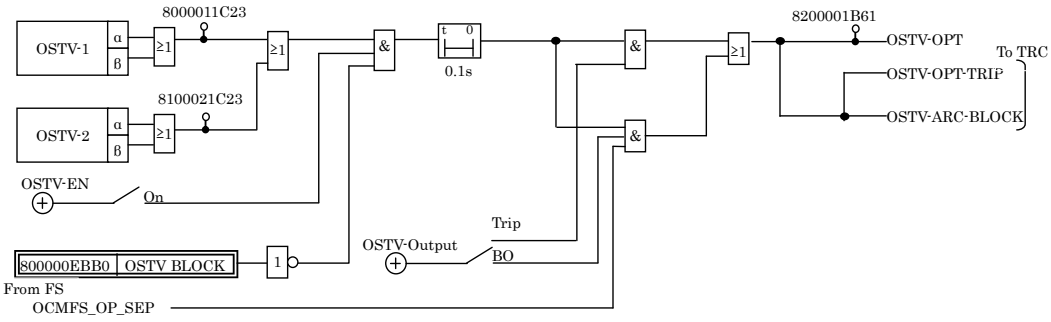


Figure 2.20-4 OSTV logic

The signal output of the OSTV function is directed by the scheme switch [**OSTV-Output**]. When **BO** is set for [**OSTV-Output**], the OSTV signal is issued for the binary output circuit of binary IO modules (BIO[1]). Conversely, when **Trip** is set for the [**OSTV-Output**], the OSTV signal is issued for the trip circuit (TRC[2]).

[1]Note: For more information about the binary output circuit, see Chapter *Technical description: Binary IO module*.

[2]Note: The TRC function is discussed separately. See Chapter *Relay application: Trip circuit*.

The can use PLC connection point 'OSTV_BLOCK' to program blocking the operation of the OSTV function, if the user wishes to stop the operation by receiving an external signal.

2.20.3 Setting

Setting of OSTV(Function ID: 479001)

Setting item		Range	Units	Contents	Default setting value	Notes
OSTV	OSTV-EN	Off / On	-	OSTV protection enable	Off	
	OSTV-Output	Trip / BO	-	OSTV trip signal output position	Trip	

2.20.4 Data ID

◆ Signal monitoring point

OSTV(Function ID: 479001)

Element ID	Name	Description
8000011C23	OSTV-1	OSTV-1 relay element operated
8100021C23	OSTV-2	OSTV-2 relay element operated
8200001B61	OSTV-OPT	OSTV protection block command

◆ Connection point on PLC logic

OSTV(Function ID: 479001)

Element ID	Name	Description
800000EBB0	OSTV BLOCK	OSTV detect block

2.21 Inrush current detection function (ICD)

When a current transformer (CT) is first energized, an inrush current flows into the CT transiently to establish the magnetic field. The magnitude of the inrush current can greater than the full load current so much; thus, the protection function can issue trip signals falsely. That is, the inrush current is required to detected and the protection functions shall not operate during CT energizing. Inrush current detection (ICD) function is designed to detect a second harmonic inrush current. This is because, the inrush current has all order of harmonics, but the second harmonics is the greatest†. Signals generated in the ICD function are transferred to other protection functions to block their operations.

†Note:The second harmonic current is present all inrush currents in three-phases. The proportion of the second harmonic current varies with the degree of the energizing, but the ratio of the second harmonic current to the fundamental current can be about 20% or greater during energizing.

Note: Several IED models do not have Inrush current detection features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.21-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
ICD	Inrush current detection function (ICD)	✓	✓	✓	✓	✓

✓: Applicable NA: Not applicable

2.21.1 Operation and characteristic

The ICD function examines the ratio of a second harmonic current (I2f) to the fundamental current (I1f) in each phase. If the ratio$|I_{2f}|/|I_{1f}|$ is larger than the setting [**ICD-2f**], the ICD function is able to identify the presence of inrush currents. Figure 2.21-1 illustrates the characteristic; the operation region is designated by the hatched area; the operation threshold is set with the [**ICD-OC**].

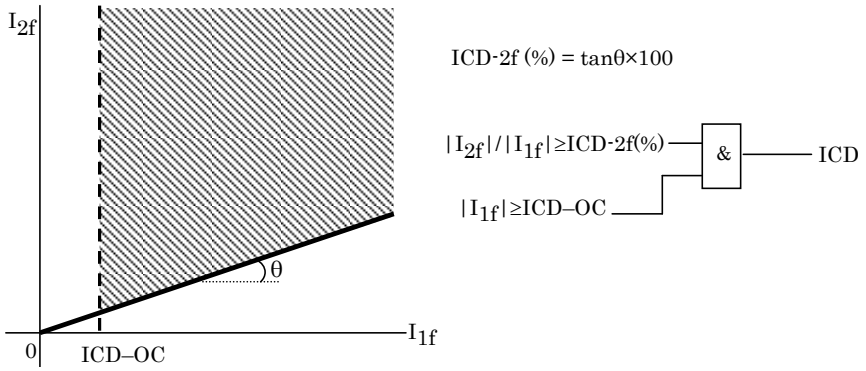


Figure 2.21-1 ICD characteristic and operation region

As shown in Figure 2.21-1, the user should set both the [**ICD-2f**] and [**ICD-OC**] when the second harmonic inrush current should be detected. The user should set **On** for the scheme switch [**ICD-EN**] to enable the ICD operation.

2.21.2 Scheme logic

Figure 2.21-2 illustrates the ICD logic. When second harmonic inrush current is detected, the ICD signal will be received by other protection functional elements.

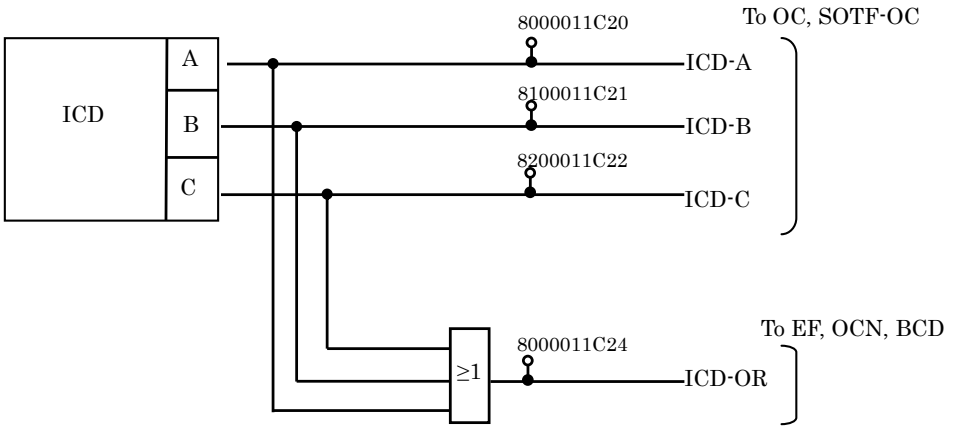


Figure 2.21-2 ICD logic

2.21.3 Setting

Setting of ICD(Function ID: 480001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
	ICD-EN	On /Off		–	ICD function enable			
	ICD-2f	10 – 50		%	Second harmonic detection	15%		
	ICD-OC	0.10 – 5.00	0.5 – 25.0	0.01A / 0.1 A	ICD threshold setting	0.10A	0.5A	

2.21.4 Data ID

◆ Signal monitoring point

ICD(Function ID: 480001)

Element ID	Name	Description
8000001C20	ICD-A	ICD relay element operated (phase-A)
8100001C21	ICD-B	ICD relay element operated (phase-B)
8200001C22	ICD-C	ICD relay element operated (phase-C)
8300001C23	ICD-OR	ICD relay element operated (3-phases OR)

2.22 Fail safe (FS)

Various protection functions are connected to trip function, which opens circuit breakers. The operation of the trip function should be reliable enough to function correctly, for which the function of fail-safe (FS) is provided. The Fail safe function includes overcurrent element (OCFS), phase current change detector element (OCDFS), earth fault element (EFF), multi-level overcurrent element (OCMF), under-voltage element for phase-to-ground (UVF), under-voltage element for phase-to-phase fault (UVSF), and under-voltage change detection element (UVDF). Each element has a scheme switch, and the scheme switch disables the element independently. As a rule, the FS uses the OCFS. However, for the function of out of step tripping (OST), the FS can use the OCMF. The OST is discussed separately. (See Chapter Relay application: *Out of step tripping*)

Note: Several IED models do not have fail-safe features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.22-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
FS	Fail-safe function (FS)	NA	✓	✓	(✓)	✓

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, OCN, THM, BCD, CBF, SOTF-OC, OV, OVS, UV, UVS, FRQ/DFRQ, VTF, CTF, ARC, VCHK.

2.22.1 Overcurrent element (OCFS)

This function consists of overcurrent elements for the three-phases, that is, OCFS-A, OCFS-B, and OCFS-C. The pickup value of the OCFS is set by setting [**OCFS**]; the OCFS can operate by setting **On** for the scheme switch [**OCFS-EN**].

2.22.2 Phase current change detector element (OCDFS)

This function is used to detect the change in current per phase, and the OCDFS consists elements for the three-phases, that is, OCDFS-A, OCDFS-B, and OCDFS-C. As shown in Figure 2.22-1, the OCDFS operates when the vectorial difference between currents I_M and I_N observed is one cycle apart which is larger than the setting [**OCDFS**]. Therefore, the quiescent load current does not affect the operating sensitivity of the OCDFS element, and the OCDFS can detect a fault current precisely.

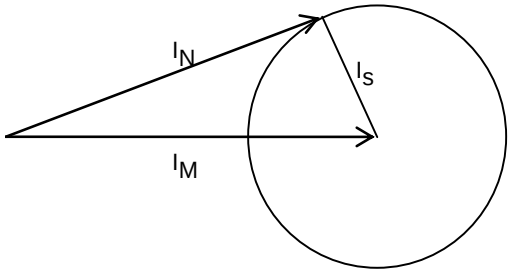


Figure 2.22-1 Current change detection

The operation is based on the following equation.

$$|I_M - I_N| \geq I_S \qquad (2.22\text{-}1)$$

where,

I_M = present current
I_N = current one cycle before
Is = setting [**OCDFS**]

The setting of the OCDFS is set by setting [**OCDFS**]; the OCDFS can operate by setting **On** for the scheme switch [**OCDFS-EN**]. Additionally, the OCDFS has off-delay timers and setting [**TOCDFS**] is provided to adjust the timers.

2.22.3 Earth fault current element (EFFS)

The EFFS measures the residual current, and when the residual current exceeds a setting level, the EFFS signals the detection of earth fault. The setting level of the EFFS is set by setting [**EFFS**]. The EFFS operates when **On** is set for the scheme switch [**EFFS-EN**].

If the earth fault current is significant, because of unbalance in the network, the scheme

switch [**EFFS-EN**] should disable the operation of the EFFS.

2.22.4 Multi-level overcurrent elements (OCMFS)

(i) Characteristic of OCMFS

As a current may fluctuate during out of step conditions, seven overcurrent elements are provided for the FS, and are placed at multiple levels.

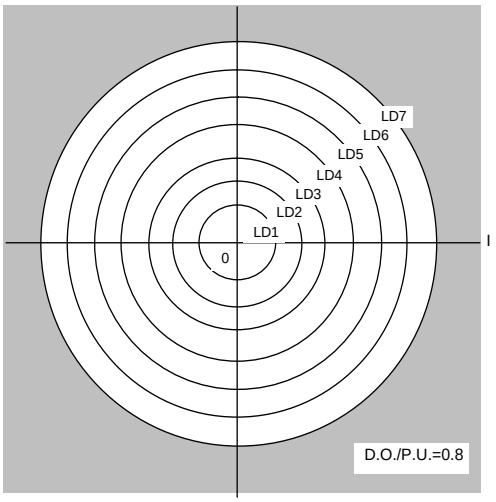


Figure 2.22-2 OCMF characteristics

As shown in Figure 2.22-2, the OCMFS has seven current level detectors (LDs). The Table 2.22-2 shows the threshold between operation and resetting of seven detectors, and these thresholds are fixed. The overcurrent elements (level detector LD1 to LD7) operate when a current exceeds operation threshold and resets when the current falls below 80% of the operation threshold.

Table 2.22-2 Level Detector Settings

	1A rating		5A rating	
Detector	Operate (A)	Reset (A)	Operate (A)	Reset (A)
LD1	0.10	0.08	0.50	0.40
LD2	0.16	0.13	0.80	0.65
LD3	0.26	0.21	1.30	1.05
LD4	0.41	0.33	2.05	1.65
LD5	0.66	0.53	3.30	2.65
LD6	1.05	0.84	5.25	4.20
LD7	1.68	1.34	8.40	6.70

The OCMFS operates in five seconds when any of the level detectors operate and reset without time delay when all the level detectors reset, as shown in the Figure 2.22-4.

(ii) Setting of OCMF

As described earlier, the signal of the OCMF is usually used for the trip function. However, with scheme switch [**OCMFS-EN**], the OCMF can feed its signal to the OST exclusively. When **On-T** is set for the scheme switch [**OCMFS-EN**], the OCMF operates the trip function, whereas the OCMF activates for the OST when **On-S** is set for the scheme switch [**OCMSF-EN**]. If the OCMF has to be disabled, **Off** is set for the scheme switch [**OCMSF-EN**].

2.22.5 Under-voltage element for phase-to-earth (UVFS)

The UVFS measures a phase-to-earth voltage and its sensitivity is set with setting [**UVFS**]. The operation of the UVFS is initiated when the phase-to-earth voltage drops below the setting and **On** is set for the setting [**UVFS-EN**].

2.22.6 Under-voltage element for phase-to-phase (UVSFS)

In UVSFS, when a phase-to-phase voltage is below setting [UVSFS], the UVSFS is initiated. The setting [**UVSFS**] is enabled when **On** is set for the setting [**UVSFS-EN**].

2.22.7 Under-voltage change detection element (UVDFS)

This element operates if a voltage drops below a setting voltage compared to that of the previous cycle. The sensitivity of the UVDFS is configured by setting [**UVDFS**]. In addition, the UVDF has off-delay timers and setting [**TUVDFS**] is provided to adjust the timers.

2.22.8 Scheme logic

Figure 2.22-3 and Figure 2.22-4 show the scheme logic of the FS. As described earlier, each element has a scheme switch that can either enable or disable the operation. To disable FS, **Off** is set for the scheme switch [**FS-EN**], then the trip circuit can operate regardless of the result of the FS.

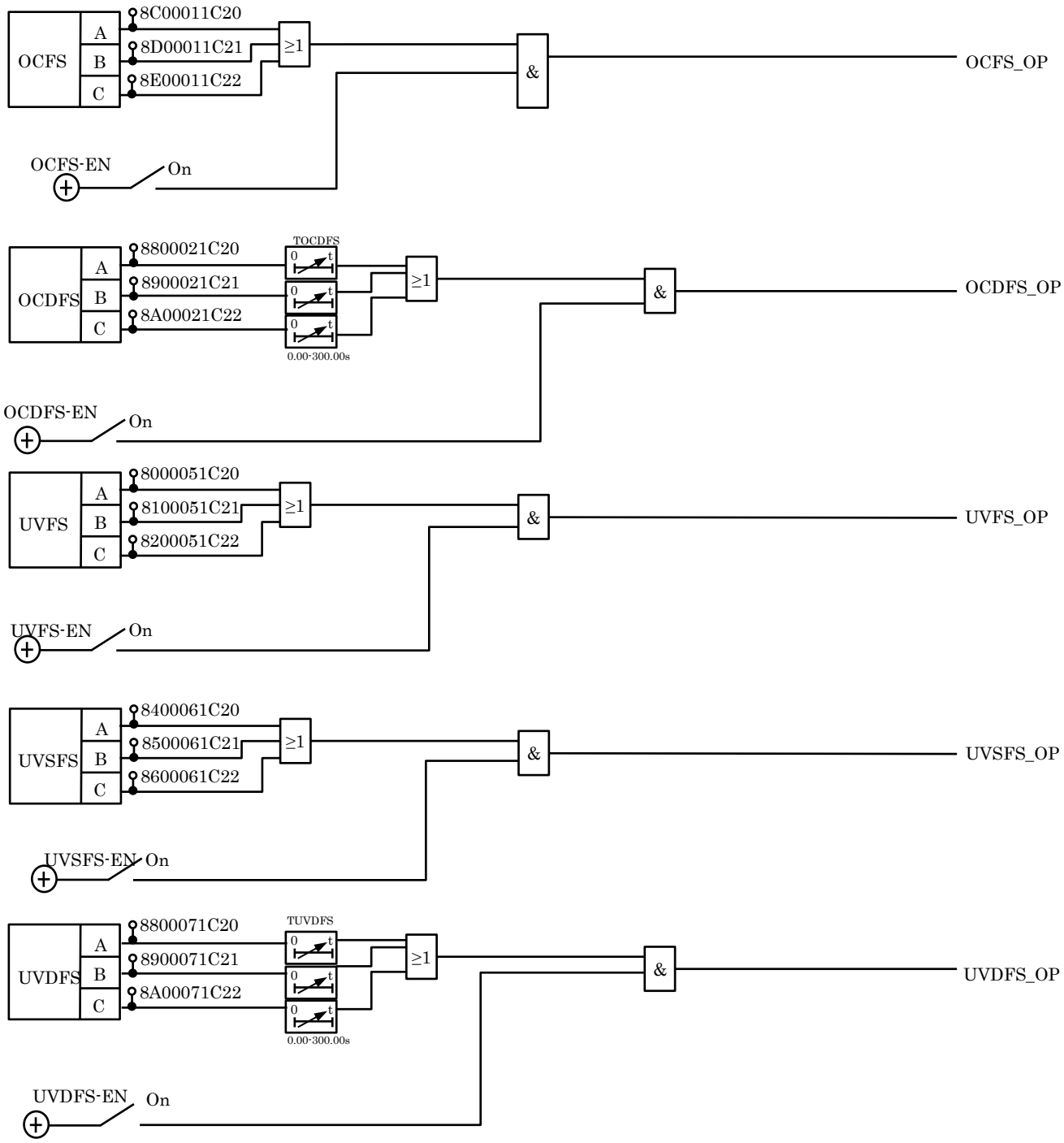


Figure 2.22-3 Soft fail scheme logic (1)

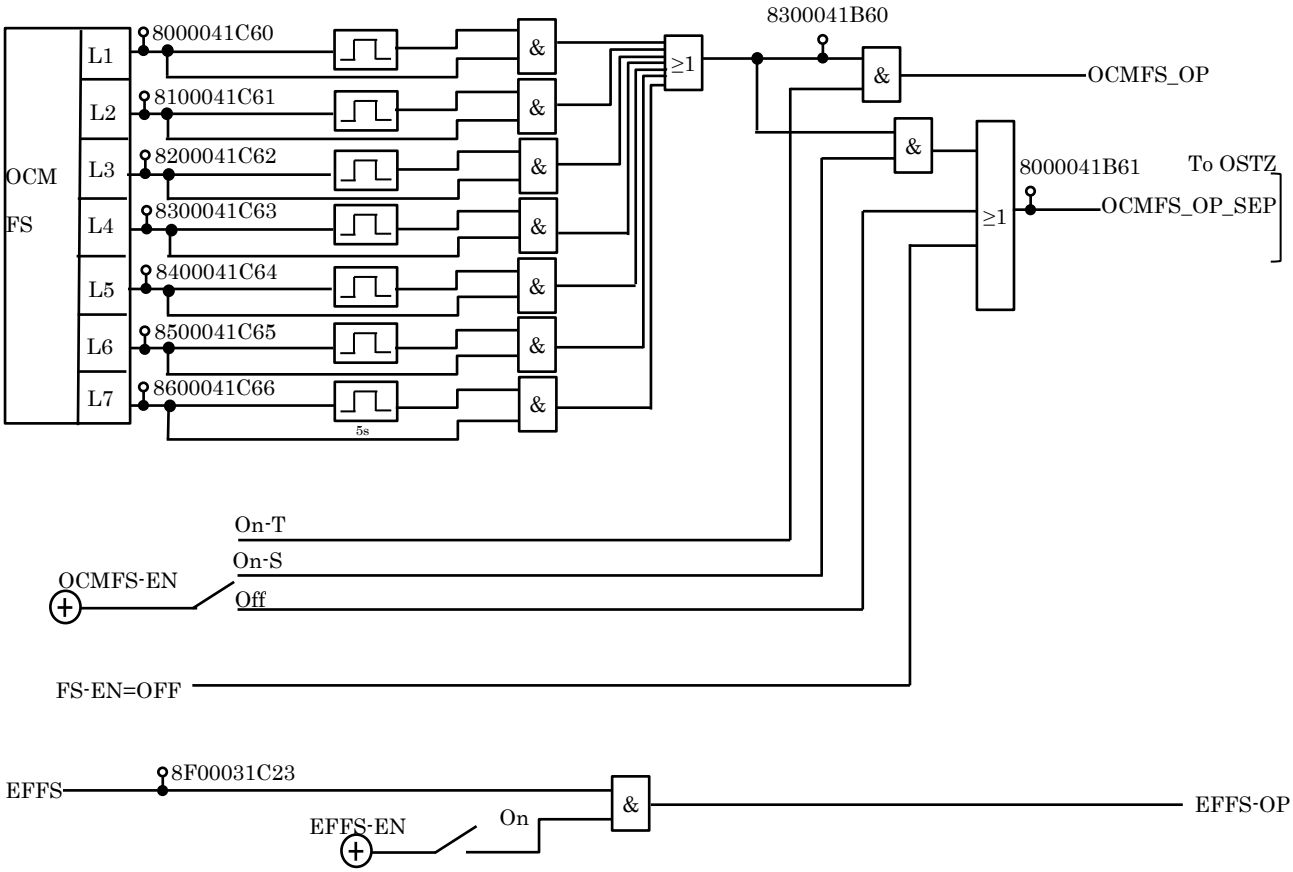


Figure 2.22-4 Soft fail scheme logic (2)

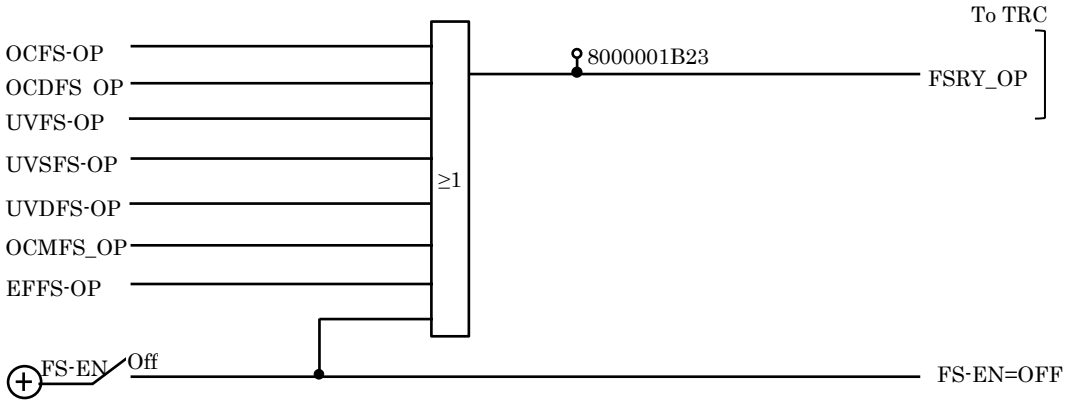


Figure 2.22-5 Output signal of the FS

(2.60.1)

2.22.9 Setting

Setting of FS(Function ID: 48B001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
Failsafe	FS-EN	Off / On		-	Fail safe enable	Off		
	OCFS-EN	Off / On		-	Fail safe OCFS enable	On		
	OCFS	0.10 - 50.00	0.50 - 250.00	A	OCFS relay operating value	1.00	5.00	
	OCDFS-EN	Off / On		-	Fail safe OCDFS enable	On		
	OCDFS	0.05 - 0.20	0.25 - 1.00	A	OCDFS relay operating value	0.10	0.50	
	TOCDFS	0.00 - 300.00		s	Extended time of OCDFS operating	10.10		
	EFFS-EN	Off / On		-	Fail safe EFFS enable	On		
	EFFS	0.10 - 50.00	0.50 - 250.00	A	EFFS relay operating value	0.20	1.00	
	OCMFS-EN	Off / On-T / On-S		-	Fail safe OCMFS enable	On-T		
	UVFS-EN	Off / On		-	Fail safe UVFS enable	On		
	UVFS	5.0 - 130.0		V	UVFS relay operating value	46.0		
	UVSFS-EN	Off / On		-	Fail safe UVSFS enable	On		
	UVSFS	5.0 - 130.0		V	UVSFS relay operating value	80.0		
	UVDFS-EN	Off / On		-	Fail safe UVDFS enable	On		
	UVDFS	1 - 20		V	UVDFS relay operating value	5		
	TUVDFS	0.00 - 300.00		s	Extended time of UVDFS operating	10.10		

2.22.10 Data ID list

◆ Signal monitoring point

FS(Function ID: 48B001)

Element ID	Name	Description
8C00011C20	OCFS-A	OCFS relay element operated (phase-A)
8D00011C21	OCFS-B	OCFS relay element operated (phase-B)
8E00011C22	OCFS-C	OCFS relay element operated (phase-C)
8800021C20	OCDFS-A	OCDFS relay element operated (phase-A)
8900021C21	OCDFS-B	OCDFS relay element operated (phase-B)
8A00021C22	OCDFS-C	OCDFS relay element operated (phase-C)
8F00031C23	EFFS	EFFS relay element operated
8000041C60	OCMFS-L1	OCFS relay element operated (phase-L1)
8100041C61	OCMFS-L2	OCFS relay element operated (phase-L2)
8200041C62	OCMFS-L3	OCFS relay element operated (phase-L3)
8300041C63	OCMFS-L4	OCFS relay element operated (phase-L4)
8400041C64	OCMFS-L5	OCFS relay element operated (phase-L5)
8500041C65	OCMFS-L6	OCFS relay element operated (phase-L6)
8600041C66	OCMFS-L7	OCFS relay element operated (phase-L7)
8000051C20	UVFS-A	UVFS relay element operated (phase-AB)
8100051C21	UVFS-B	UVFS relay element operated (phase-BC)
8200051C22	UVFS-C	UVFS relay element operated (phase-CA)
8400061C20	UVSFS-AB	UVSFS relay element operated (phase-A)
8500061C21	UVSFS-BC	UVSFS relay element operated (phase-B)
8600061C22	UVSFS-CA	UVSFS relay element operated (phase-C)
8800071C20	UVDFS-A	UVDFS relay element operated (phase-A)
8900071C21	UVDFS-B	UVDFS relay element operated (phase-B)
8A00071C22	UVDFS-C	UVDFS relay element operated (phase-C)
8000001B23	FSRY_OP	Fail Safe Relay open signal by Fail Safe
8300041B60	OCMFS-OR	OCMFS relay element operated (7-phase OR)
8000041B61	OCMFS_OP_SEP	Fail Safe Relay open signal by OCMFS

2.23 VT failure detection (VTF)

If a failure occurs on the secondary circuit in the voltage transformer (VT), the operation in relays cannot be obtained properly because the relays do not measure voltages correctly. Therefore, the VT failure detection (VTF) function is provided to block operating the relays upon occurrence of the VT failure. Accordingly, if a VT failure is detected by the VTF function, an alarm signal is issued for the relays upon occurrence of the VT failure. Accordingly, an alarm signal is issued if a VT failure is detected by the VTF function; a detection signal by the VTF function blocks operating the relay for the voltage monitor [1].

After the disappearance of the VT failure, the VTF function can take account of the VT secondary circuit being in healthy condition in the three-phase; the operation of the VTF function is reset[2]. Thus, the blocked relays are allowed to operate again. Incidentally, issuing the VTF alarm is automatically removed and then the user can find resetting the VTF alarm.

[1]Note: The VTF function can block the operation in several relays, but it does not block the operation in other relays. To know the blocking, refer sections of the respective protection functions.

[2]Note: The user can programmable the operation using the setting and the PLC signals.

(2.62.0)

Note: Several IED models do not have VTF detection features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.23-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
VTF	VTF detection (VTF)	✓	✓	✓	(✓)	✓

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, OCN, THM, BCD, CBF, SOTF-OC, OV, OVS, UV, UVS, FRQ/DFRQ, FS, CTF, ARC, VCHK.

2.23.1 VTF features

The VTF function has three relay elements in order to decide the failure in the VT; hence two criterions (i.e., for VTF1 and VTF2) exist to detect the failure in the VT.

(i) Phase-to-earth under voltage element (UVVTF)

For the VTF1 function, the under-voltage element (UVVTF) monitors the under voltage. The threshold of the UVVTF relay is set using the [**UVVTF**].

(ii) Earth fault overcurrent element (EFVTF)

For the VTF2 function, the earth fault overcurrent element (EFVTF) monitors the overcurrent in zero-sequence. The threshold of the EFVTF relay is set using the [**EFVTF**].

(iii) Earth fault overvoltage element (OVGVTF)

For the VTF2 function, the earth fault overvoltage element (OVGVTF) monitors the over voltage in zero-sequence. The threshold of the OVGVTF relay is set the using [**OVGVTF**].

(iv) Detection criterion for the VTF1

The criterion for the VTF1 function is defined when the UVVTF relay operates whereas the OCD relay does not operate.

(v) Detection criterion for the VTF2

The criterion for the VTF2 function is defined when both the EFVTF relay and the OCD relay are not operated whereas the OVGVTF relay is operated.

2.23.2 Operation for the VTF function

When the VTF function detects the failure, issuing the VTF1_DETECT signal is continuing regardless of the operation of the OCD relay, provided **On** is set for both the [**VTF1EN**] and the [**VTF2EN**]. Issuing the VTF2_DETECT signal is also continuing regardless of the operation of both the OCD and the EFVTF relays. Note that issuing the VTF_DETECT signal is cleared when the operations of the UVVTF relay and the OVGVTF relay are reset.

However, nonetheless the OCD/EFVTF relay is still running after the VTF detection, issuing the VTF_DETECT signal is cleared, provided **OPT-On** is set for the settings [**VTF1-EN**] and the [**VTF2EN**].

When issuing the VTF_DETECT signal continues longer than ten seconds, the signal VTF_DETCT clears to generate the VTF_ALARM signal.

2.23.3 VTF Logic

Figure 2.23-1 shows the logics of the VTF function. As described earlier, the VT failure is grouped into the VTF1 criterion (VTF1_DETECT) and the VTF2 criterion (VTF2_DETECT). When we consider the VTF1 criterion, the upper logic in Figure 2.23-1 is used; whereas we consider the VTF2 criterion, lower one is used.

The user can select either the VTF1 or VTF2 criteria using the using the scheme switch [**VTF1EN**] or [**VTF2EN**].

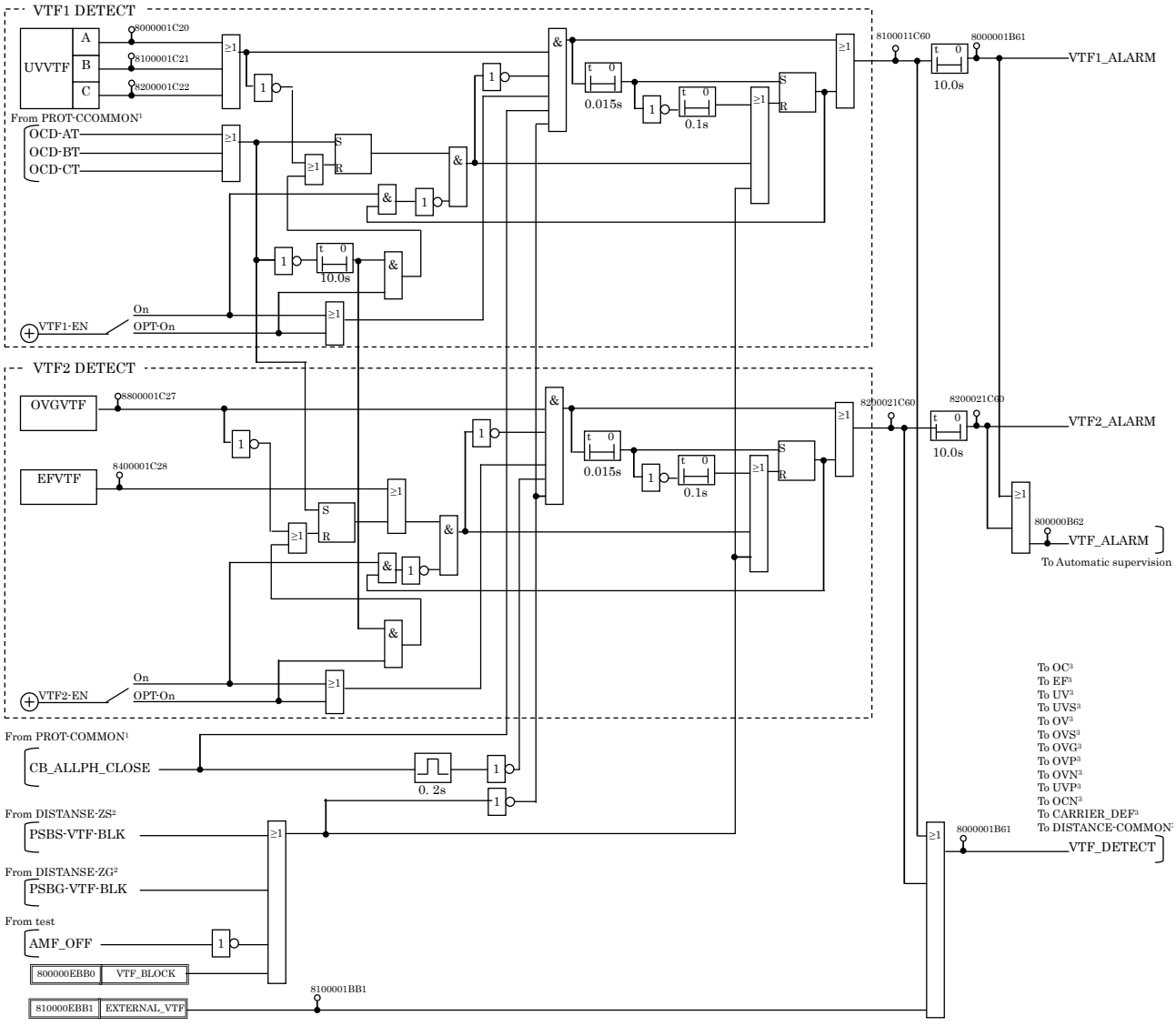


Figure 2.23-1 Scheme logic in the VTF function

[1]Note: Signal CB_ALLPH_CLOSE is provided from Protection common function (PROT_COMMON). The OCD relay is used for both the VTF1 DETECT and the VTF2 DETECT. For more information, see Chapter *Relay application: Protection common*.

[2]Note: Entering signals coming from distance protections (ZS/ZG) are available if the ZS/ZG protections are provided in the IED. For more information with regard to

the ZS/ZG protections, see Chapter *Relay application: Distance protection,* when available.

[3]Note: Output signals are provided for respective relays when the relays are available. See *Appendix: Ordering* whether the relays are supplied into the IED.

[4]Note: AMF feature is used for the test. To generate the AMF signal, see chapter *User interface: test-submenu*.

If a PLC signal is injected at the PLC connection point "VTF_BLOCK", the operation of the VTF function is blocked. The user can program to inject an external signal for the failure detection using the PLC connection point EXTERNAL_VTF; the VTF_DETECT signal is generated when the signal is injected at the EXTERNAL_VTF. (2.62.1)

2.23.4 Setting

Setting of VTF(Function ID: 490001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
VTF	VTF 1	VTF1-EN	Off / On / OPT-On		-	VTF1 enable	On		
		UVVTF	1.0 - 220.0		V	Phase under voltage level for VTF1 detection	20.0		
	VTF 2	VTF2-EN	Off / On / OPT-On		-	VTF2 enable	On		
		OVGVTF	1.0 - 220.0		V	Zero phase over voltage level for VTF2 detection	20.0		
		EFVTF	0.10 - 50.00	0.50 - 250.00	A	Zero phase over current level for VTF2 detection block	0.20	1.00	

2.23.5 Data ID

◆ Signal monitoring point

VTF(Function ID: 490001)

Element ID	Name	Description
8400001C2B	EFVTF	EFVTF relay element operated
8100001BB1	EXTERNAL VTF	External VTF receive
8800001C27	OVGVTF	OVGVTF relay element operated
8000001C20	UVVTF-A	UVVTF relay element operated(Phase-A)
8100001C21	UVVTF-B	UVVTF relay element operated(Phase-B)
8200001C22	UVVTF-C	UVVTF relay element operated(Phase-C)
8000001B62	VTF ALARM	VTF alarm (VTF1 ALARM/VTF2 ALARM OR)
8000001B61	VTF DETECT	VTF detected (VTF1 DET/VTF2 DET OR)
8100011C61	VTF1 ALARM	VTF1 alarm (10s timer)
8100011C60	VTF1 DET	VTF1 detected
8200021C61	VTF2 ALARM	VTF2 alarm (10s timer)
8200021C60	VTF2 DET	VTF2 detected

◆ Connection point on PLC logic

VTF(Function ID: 490001)

Element ID	Name	Description
800000EBB0	VTF BLOCK	VTF block signal
810000EBB1	EXTERNAL VTF	External VTF receive

2.24 CT failure detection (CTF)

If a failure occurs on the secondary circuit in the current transformer (CT), the operation in relays cannot be obtained properly because the relays do not measure incoming currents correctly. Therefore, the CT failure detection (CTF) function is provided to block operating the relays[1] upon occurrence of the CT failure. Accordingly, an alarm signal is issued if a CT failure is detected by the CTF function; a detection signal by the CTF function blocks operating the relay for the current monitor[1].

After the disappearance of the CT failure, the CTF function can take account of the CT secondary circuit being in healthy condition in the three-phase; the operation of the CTF function is reset[2]. Thus, the blocked relays are allowed to operate again. Incidentally, issuing the CTF alarm is automatically removed and then the user can find resetting the CTF alarm.

[1]Note: The CTF function can block the operation in several relays, but it does not block the operation in other relays. To know the blocking, refer sections of the respective protection functions.

[2]Note: The user can programmable the operation using the setting and the PLC signals.

(2.63.0)

Note: Several IED models do not have CTF detection features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.24-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
CTF	CTF detection (CTF)	✓	✓	✓	(✓)	✓

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, OCN, THM, BCD, CBF, SOTF-OC, OV, OVS, UV, UVS, FRQ/DFRQ, FS, VTF, ARC, VCHK.

2.24.1 CTF features

The CTF function has two relay elements in order to decide the failure in the CT; hence two criterions exist to detect the failure in the CT in the CTF function.

(i) Earth fault overcurrent element (EFCTF)

The earth fault overcurrent element (EFCTF) monitors the zero-sequence current for the failure in the CT. The threshold of the EFCTF element is set using the [**EFCTF**].

(ii) Earth fault overvoltage element (OVGCTF)

The earth fault overvoltage element (OVGCTF) monitors the zero-sequence voltage for the failure in the CT. The OVGCTF element is set using the [**OVGCTF**].

(iii) Detection criterion (CTF_DETECT)

When the EFCTF element operates whereas the OVGCTF element does not operate, the detection criterion (CTF_DETECT) is applied.

2.24.2 Operation for the CTF function

When the CTF function detects the failure, issuing the CTF_DETECT signal is continuing regardless of the operation of the OVGCTF relay, provided **On** is set for the scheme switch [**CTF-EN**]. Issuing the CTF _DETECT is continued until the operation of the EFCTF relay is reset.

However, nonetheless the OVGCTF relay is still running after the CTF detection, issuing the CTF_DETECT signal is cleared, provided **OPT-On** is set for the scheme switch [**CTF-EN**].

When issuing the CTF_DETECT signal continues longer than ten seconds, the signal CTF_DETECT clears to generate the CTF_ALARM signal.

2.24.3 Scheme logic

Figure 2.24-1 shows the logic of the CTF function. CTF_DET signal is issued when the EFCTF element is running and the OVGCTF element is not running.

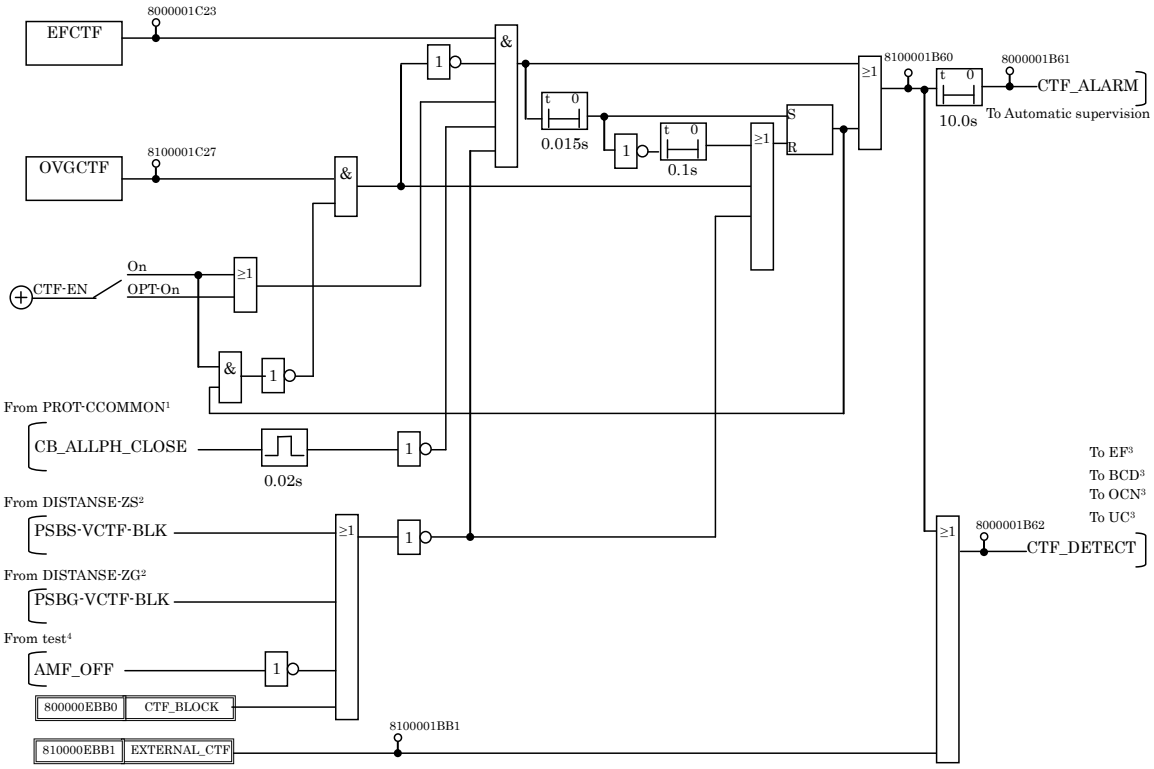


Figure 2.24-1 Scheme logic in the CTF function

[1]Note: Signal CB_ALLPH_CLOSE is provided from Protection common function (PROT_COMMON). For more information, see Chapter *Relay application: Protection common*.

[2]Note: Entering signals come from distance protections (ZS/ZG) when the ZS/ZG are available in the IED. For more information, see Chapter *Relay application: Distance protection*.

[3]Note: Output signals are provided for respective relays when the relays are available. See *Appendix: Ordering* whether the relays are supplied into the IED.

[4]Note: AMF feature is used for the test. To generate the AMF signal, see chapter *User interface: test-submenu*.

If a PLC signal is injected at the PLC connection point "CTF_BLOCK", the operation of the CTF function is blocked. The user can program to inject an external signal for the failure detection using the PLC connection point EXTERNAL_CTF; the CTF_DETECT signal is generated when the signal is injected at the EXTERNAL_CTF.

2.24.4 Setting

Setting of CTF(Function ID: 491001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
CTF	CTF-EN	Off / On / OPT-On		-	CTF enable	On		
	EFCTF	0.10 - 50.00	0.50 - 250.00	A	Zero phase over current level for CTF detection	0.20	1.00	
	OVGCTF	1.0 - 220.0		V	Zero phase over voltage level for CTF detection block	20.0		

2.24.5 Data ID

◆ Signal monitoring point

CTF(Function ID: 491001)

Element ID	Name	Description
8000001B61	CTF ALARM	CTF alarm operated
8100001B60	CTF DET	CTF det
8000001B62	CTF DETECT	CTF detect
8000001C23	EFCTF	EFCTF relay element operated
8100001BB1	EXTERNAL CTF	External CTF receive
8100001C27	OVGCTF	OVGCTF relay element operated

◆ Connection point in PLC logic

CTF(Function ID: 491001)

Element ID	Name	Description
800000EBB0	CTF BLOCK	CTF block signal
810000EBB1	EXTERNAL CTF	External CTF receive

2.25 Multi-end fault locator (FL-A and FL-Z)

The function of multi-end fault locator (FL) can determine a fault location on lines with high reliability; it is useful in case of power system failure. The following two calculations run in the FL; then the FL selects one of the calculation results to provide a fault location.

(1) *FL calculation with data at a local-terminal and remote-terminals*

(2) *FL calculation with data at a local-terminal only*

Note: Several IED models do not have fault locator features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.25-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
FL	Fault locator (21FL)	✓	✓	✓	✓	✓
FL	Fault locator (FL)	✓	✓	✓	✓	✓

✓: Applicable NA: Not applicable

2.25.1 FL calculation with data at a local-terminal and remote-terminals

When considering the ***FL calculation with data at a local-terminal and remote-terminals***, user should note the computation requires minimum two-cycles of fault continuing time. The FL result includes calculation errors: fixed error and proportional error. The fixed error is because of the arithmetic error, but the proportional error is because of the settings in Segregated-current-differential protection[1] (DIFL) function. The proportional error corresponds to the setting[2] [**DIFL-I1**], but this error is inversely proportional to the differential current[2] (Id).

The FL calculation requires data of voltages and currents at a local-terminal and remote-terminals. The FL does not calculate for a switch-onto-fault or for a fault when the line energizes from one terminal and the other terminal is out-of-service.

When user considers the FL calculation in three-terminal application, if one of the three-terminal is out-of-service, and when a fault arises between the junction and the out-of-service terminal, the FL calculation assumes this fault being at the junction.

[1]Note: For more information of the DIFL, see Chapter *Relay application: Segregated current differential protection*

[2]Note: Setting [**DIFL-I1**] and differential current (Id) are discussed in the DIFL.

(i) Calculation Principle

(i)-1 Calculation on two-terminal application

Figure 2.25-1 shows two IEDs exist at the end of the line GH. Voltages due to the fault are calculated by Equation (2.25-1) and Equation (2.25-2).

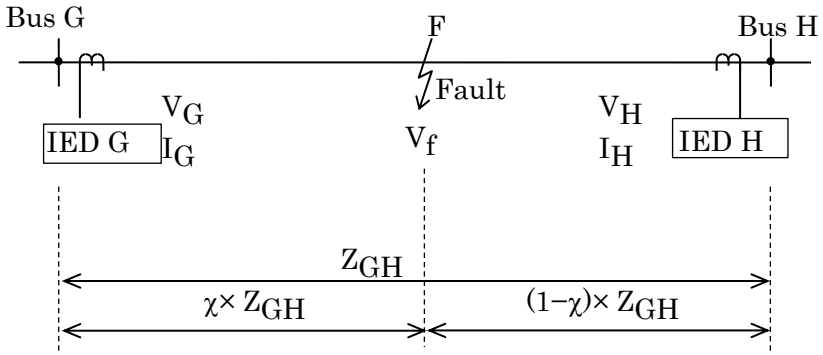


Figure 2.25-1 IED G and IED H on line GH

$$V_G - \chi \cdot Z_{GH} \cdot I_G = V_f \qquad (2.25\text{-}1)$$

$$V_H - (1-\chi) \cdot Z_{GH} \cdot I_H = V_f \qquad (2.25\text{-}2)$$

where,

V_G: Voltage at IED G

I_G: Current at IED G

V_H: Voltage at IED H

I_H: Current at IED H

χ: Distance ratio of GF to GH

V_f: Voltage at fault point

Z_{GH}[1]: Impedance on line GH

Substituting Equation (2.25-1) for Equation (2.25-2) gives,

$$\chi = \frac{V_G - V_H + Z_{GH} \cdot I_H}{Z_{GH} \cdot (I_G + I_H)} \qquad (2.25\text{-}3)$$

The distance ratio (χ) is also calculated with the differential current (Id) because the net currents at the IED G and the IED H are equal to the differential current ($Id = I_G + I_H$):

$$\chi = \frac{V_G - V_H + Z_{GH} \cdot I_H}{Z_{GH} \cdot I_d} \qquad (2.25\text{-}4)$$

[1]Note: User should set the Z_{GH} into Line1_Element. For further information, see section 2.25.5(ii). For setting methods, see section 2.25.6(iii).

(i)-2 Calculation on three-terminal application

The principle mentioned above is also applicable for the operation of three terminals, as shown in Figure 2.25-2. Note that one of three calculations (Calc. 1 to 3) determines the fault location.

The three calculations are in sequence performed and a calculation result is selected from them:

(Calc. 1) Calculation for a fault being as far as the junction (a fault on line GJ)
(Calc. 2) Calculation for a fault being beyond the junction (a fault on line JH)
(Calc. 3) Calculation for a fault being beyond the junction (a fault on line JS)

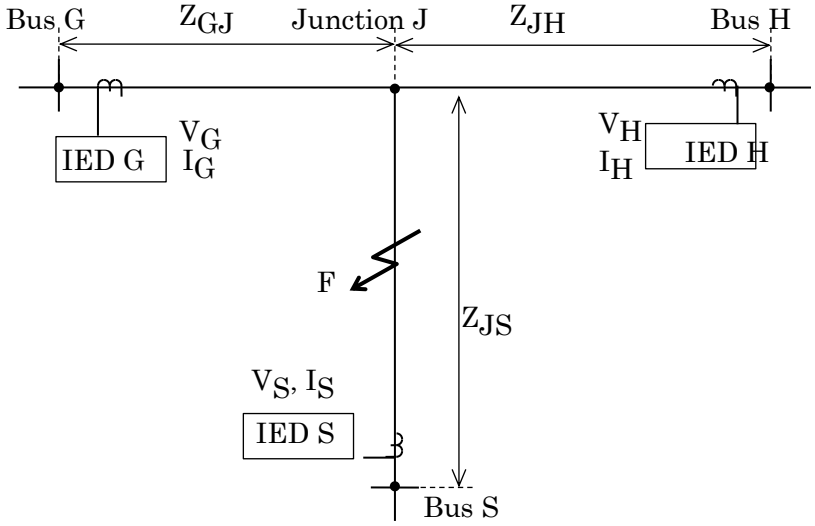


Figure 2.25-2 IED G, H, and S on lines with a junction and a fault on line JS

The FL in IED G makes calculation with the following equations:

$$\chi_{GJ} = \frac{V_G - V_H + Z_{GJ}(I_H + I_S) + Z_{JH} \cdot I_H}{Z_{GJ} \cdot I_d} \quad (2.25\text{-}5)$$

$$\chi_{JH} = \frac{V_G - V_H + Z_{JH} \cdot I_H - Z_{GJ} \cdot I_G}{Z_{JH} \cdot I_d} \quad (2.25\text{-}6)$$

$$\chi_{JS} = \frac{V_G - V_S + Z_{JS} \cdot I_S - Z_{GJ} \cdot I_G}{Z_{JS} \cdot I_d} \quad (2.25\text{-}7)$$

$$I_d = I_G + I_H + I_S \quad (2.25\text{-}8)$$

where,

V_G, V_H, V_S: Voltage at IED G, IED H, and IED S
I_G, I_H, I_S: Current at IED G, IED H, and IED S
χ_{GJ}: Distance ratio of GF to GJ when a fault (F) arises on line GJ
χ_{JH}: Distance ratio of JF to JH when a fault (F) arises on line JH
χ_{JS}: Distance ratio of JF to JS when a fault (F) arises on line JS
Z_{GJ}: Section impedance[2] on line GJ
Z_{JH}: Section impedance[2] on line JH
Z_{JS}: Section impedance[2] on line JS

[2]Note: User should set the values of each section impedances into each Line_Element. For the consideration of the section and their Line_Element, see section 2.25.5(i) and section 2.25.6(iii).

For instance, the IED G makes calculation in the following sequences:

- At the outset, the IED G makes calculation of the equation (2.25-5) assuming that the fault arises on line GJ.

- If the calculation result is not identical to the input data from a line, then the IED G makes calculation with Equation (2.25-6) assuming that the fault arises on line JH.

- Then, the IED G makes calculation with Equation (2.25-7), when both Equation (2.25-5) and Equation (2.25-6) do not hold true for the input data from a line, and finally the IED G decides that the fault arises on line JS, as shown in Figure 2.25-2.

(i)-3 Equations by symmetrical components

In practice, the FL calculation is carried out in symmetrical components; hence, Equations (2.25-4) to (2.25-7) are converted to symmetrical equations in the FL.

For example, in Figure 2.25-1, the distance ratio (χ) can be expressed in symmetrical components when we substitute symmetrical components† for Equation (2.25-4).

$$\chi = \frac{V_{1G} - V_{1H} + (Z_{11} \cdot I_{1H} + Z_{12} \cdot I_{2H} + Z_{10} \cdot I_{0H})}{Z_{11} \cdot I_{1d} + Z_{12} \cdot I_{2d} + Z_{10} \cdot I_{0d}} \qquad (2.25\text{-}9)$$

where,

V1G:	Positive-sequence voltage at IED G
V1H:	Positive-sequence voltage at IED H
I1H, I2H and I0H:	Current (IH) at IED H represented by positive-sequence, negative-sequence, and zero-sequence
I1d, I2d and I0d:	Differential current (Id) represented by positive-sequence, negative-sequence, and zero-sequence
Z11, Z12 and Z10‡	Line impedance (ZGH) represented by positive-sequence, negative-sequence, and zero-sequence

†Note: When we can assume that the respective mutual-impedances are equal ($Z_{ab}=Z_{bc}$, $Z_{bc}=Z_{ca}$, and $Z_{ca}=Z_{ab}$), symmetrical components (Z_{11}, Z_{12} and Z_{10}) are obtained from the following Equations (2.25-10) to (2.25-12):

$$Z_{11} = \frac{Z_{aa} + Z_{bb} + Z_{cc} - (Z_{ab} + Z_{bc} + Z_{ca})}{3} \quad (2.25\text{-}10)$$

$$Z_{12} = \frac{Z_{aa} + a^2 \cdot Z_{bb} + a \cdot Z_{cc} + 2(a \cdot Z_{ab} + Z_{bc} + a^2 \cdot Z_{ca})}{3} \quad (2.25\text{-}11)$$

$$Z_{10} = \frac{Z_{aa} + a \cdot Z_{bb} + a^2 \cdot Z_{cc} - (a^2 \cdot Z_{ab} + Z_{bc} + a \cdot Z_{ca})}{3} \quad (2.25\text{-}12)$$

where, “a” and “a2” are represented as

$$a = 1\angle 120°, a^2 = 1\angle 240°$$

‡Note: When we suppose that all the self-impedance and all the mutual-impedance are identical ($Z_{aa}=Z_{bb}=Z_{cc}$ and $Z_{ab}=Z_{bc}=Z_{ca}$), we can see that both Z_{12} and Z_{10} are represented as zero when Z_{10} is identical to Z_{GH}.

Note: To run the FL, user should set either the symmetrical components (Z_{11}, Z_{12} and Z_{10}) or the self-impedance (Z_{aa}, Z_{bb} and Z_{cc}) and mutual-impedance (Z_{ab}, Z_{bc} and Z_{ca}). For example, the value of Z_{11} is placed for setting [**FL_1R1**] and [**FL_1X1**] when symmetrical setting is selected. If symmetrical setting is not selected, user should set the value of the Z_{aa} for setting [**FL_1Raa**] and [**FL_1Xaa**]. For more information, see section 2.25.6(iii).

(ii) Data recording trigger and calculation trigger

The calculation is stated by signals; and following protection functions provide the trigger signals:

(a) Current differential protection (DIFL)
(b) External protection

With regard to the trigger signal of the external protection function, user can program the trigger signal for recording data and calculation by using Element IDs (PLC connection points), as shown in Table 2.25-2.

Table 2.25-2 Element IDs of recording data and calculation

Element ID	Name	Description
310022EC64	FLAZ_RecF	Trigger for data recording
310022EC66	FLAZ_LocF	Trigger for calculation

Note: Element IDs are also listed in section 2.25.8.

(ii)-1 Trigger signal for data recording

Figure 2.25-3 shows a trigger signal for data recording. If elements operate and switches are closed, the FL records the data of current and voltage. It is also possible that the FL starts to record these data when the PLC[1] signal is appeared.

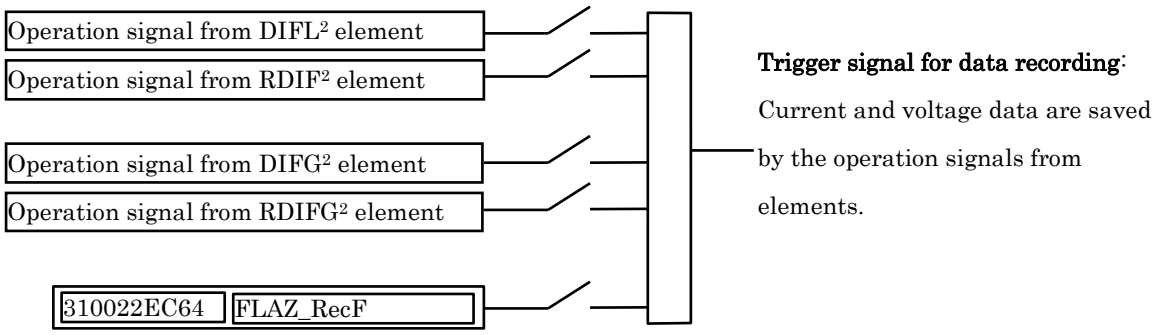


Figure 2.25-3 Data recording trigger from the DIFL and the PLC

[1]Note: User can configure a signal with the PLC logic. For more information on the PLC, see Chapter *PLC function*.

[2]Note: Respective switches in the above figure are closed when respective elements operate. After that, data recording is provided for the FL. Elements and characteristics (DIFL, RDIF, DIFG, and RDIFG) are discussed in the DIFL. See Chapter *Relay application: Segregated current differential protection*.

(ii)-2 Trigger signal for FL calculation

Figure 2.25-4 shows a calculation trigger; the calculation is carried out when the FL receives the result signals of the DIFL and the DIFG. The calculation also starts by the PLC signal.

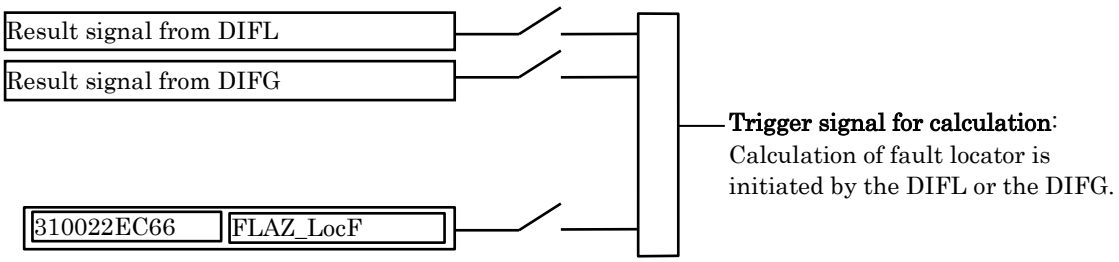


Figure 2.25-4 Calculation trigger from the DIF function and PLC

(iii) Calculation error

User should note that the calculation error might be larger when a setting value is far from the actual data of line impedance. For example, if abnormal settings[1] are done, the calculation error will be appeared notably.

[1]Note: Abnormal settings can be exist when values are far from actual impedance data of transmission line. For example, resistance value is so larger then reactance value,

and so on.

(iii)-1 Calculation error in two-terminal-ends operation

The nominal measurement error can be with in ±1km when the following conditions are applied:

- The line length (L) is shorter than 100km.
- The setting value [**DIFL-I1**] is lower than a half of the rated current[2] ($0.5 \times I_n$).
- The differential current (Id) is larger than double of the rated current[2] ($2 \times I_n$).

In other words, the calculation error can be with in ±1% when the following conditions are applied:

- The line length (L) is shorter than 100km.
- The setting value [**DIFL-I1**] setting is lower than a half of the rated current[2] ($0.5 \times I_n$).
- The differential current (Id) is larger than double of the rated current[2] ($2 \times I_n$).

(iii)-2 Calculation error in three-terminal-ends operation

The nominal measurement error can be with in ±2km when the following conditions are applied:

- The line length (L) is shorter than 100km.
- The setting value [**DIFL-I1**] is larger than a quarter of the rated current[2] ($0.25 \times I_n$).
- The reactance per unit length ($X1/L$) is smaller than the value ($0.05/I_n$).
- The reactance per unit length ($X1/L$) is lower than the value ($6.0/I_n$).
- The differential current (Id) is larger than double of the rated current[2] ($2 \times I_n$).

On the other hand, the calculation error can be with in ±2% when the following conditions are applied:

- The line length (L) is shorter than 100km.
- The setting value [**DIFL-I1**] is lower than a quarter of the rated current[2] ($0.25 \times I_n$).
- The reactance per unit length ($X1/L$) is larger than the value ($0.05/I_n$).
- The reactance per unit length ($X1/L$) is smaller than the value ($6.0/I_n$).
- The differential current (Id) is larger than double of the rated current2 ($2 \times I_n$).

[2]Note: Rated current (In) is described separately. (See Chapter *Technical description: Transformer module*)

2.25.2 FL calculation with data at a local-terminal only

When considering the **FL calculation with data at a local-terminal only**, user should note the time of this calculation is longer than the time of **FL calculation with data at a local-terminal and remote-terminals**[1]. This FL calculation requires data of the reference current, which is obtained by measuring the change in current before and after the fault occurrence. The reference current is used to remove the influence of load voltage and arc voltage.

[1]Note: In the ***FL calculation with data at a local-terminal only***, more calculation time—that are longer than three-cycles as fault continuing time—is required. Conversely, minimum two-cycles as fault continuing time are required in the ***FL calculation with data at a local-terminal and remote-terminals***.

If a phase-to-phase fault occurs, ***Calculation principle for phase-to-phase fault*** is used with data of the reference current (Iß"), which is obtained by measuring the change in current before and after the fault occurrence.

If an earth fault occurs, ***Calculation principle for earth fault*** is used with another reference current (Iα"), which is similarly obtained by measuring the change in the current before and after the fault.

In order to maintain the measurement accuracy, the compensation factors for impedance imbalance are considered in the calculation when the variation of the impedance in each phase is large.

(i) Calculation principle for phase-to-phase fault

(i)-1 Equations for the calculation in the case of phase-b-to-phase-c fault

We suppose the occurrence of a phase-b-to-phase-c fault. The fault distance (χ) is calculated with the following Equations (2.25-13) to (2.25-16). Equation (2.25-16) is a general expression when lines are treated as having lumped constants; and this expression is sufficient for lines within 100km.

$$I_{bc} = I_{\mathrm{b}} - I_{\mathrm{c}} \tag{2.25-13}$$

$$V_{bc} = V_{\mathrm{b}} - V_{\mathrm{c}} \tag{2.25-14}$$

$$I_{\beta}{}' = I_{\mathrm{bc}} - (I_{Lb} - I_{Lc}) \tag{2.25-15}$$

$$\chi = \frac{I_m\left(V_{bc} \cdot I_{\beta}{}''\right) \times \mathrm{L}}{\left\{I_m\left(R_1 \cdot I_{bc} \cdot I_{\beta}{}''\right) + R_e\left(X_1 \cdot I_{bc} \cdot I_{\beta}{}''\right)\right\} \times K_{bc}} \tag{2.25-16}$$

where,

Ib, Ic: Line-to-neutral currents when a phase-bc fault arises
Ibc: Line-to-line currents when a phase-bc fault arises (=Ib−Ic)
Vbc: Line-to-line voltages when a phase-bc fault arises (=Vb−Vc)
ILb: Load-current in phase-b before the fault
ILc: Load-current in phase-c before the fault
Iß': Load-current change before and after the fault (=(Ib−Ic)−(ILb−ILc))
Iß": Complex conjugate of Iß'
R1: Resistance component of line impedance1 in positive-sequence
X1: Reactance component of line impedance1 in positive-sequence
Kbc: Compensation factor2 for imbalance impedance
L: Line length3 in the kilometer or mile
Im( ): Expression of imaginary part when a value is placed in parentheses
Re( ): Expression of real part when a value is placed in parentheses
• : Symbol of Vector product

[1]Note: For example, user should set the R_1 and the X_1 with settings [**FL_1R1**] and setting [**FL_1X1**] respectively, when the impedance of line GJ is considered in symmetrical components, as shown in Figure 2.25-2. For further information, see section 2.25.6(iii).

[2]Note: User should set the K_{ab}, K_{bc} and K_{ca} with settings [**FL_Kab**], [**FL_Kbc**], and [**FL_Kca**], when the imbalance impedance is considered. For further information, see section 2.25.6(vi).

[3]Note: User should set the line length for settings [**FL_1line_km**] when the length of line GJ is considered and when the unit of length is represented by kilometer, as shown in Figure 2.25-2. For further information, see section 2.25.6(v).

(i)-2 Compensation for long line

When the line length is beyond 100km, the result of Equation (2.25-16) requires compensation. Equation (2.25-17) is used to find the compensated distance (χ") with respect to the fault distance (χ) which is the result of Equation (2.25-16):

$$\chi'' = \chi - k^2 \times \frac{\chi^3}{3} \qquad (2.25\text{-}17)$$

where,

k: Propagation constant fixed of the line ($0.001 km^{-1}$)

(ii) Calculation principle for earth fault

(ii)-1 Equations

When we suppose the occurrence of an earth fault in phase-a, the fault distance (χ) is

determined with Equations (2.25-18) to (2.25-23):

$$I_{\alpha} = \frac{2I_a - I_b - I_c}{3} \quad (2.25\text{-}18)$$

$$I_{\alpha}' = \frac{2I_a - I_b - I_c}{3} - \frac{2I_{La} - I_{Lb} - I_{Lc}}{3} \quad (2.25\text{-}19)$$

$$\boldsymbol{V} = V_a \cdot I_{\alpha}'' \quad (2.25\text{-}20)$$

$$\boldsymbol{R} = R_1 \cdot I_{\alpha} \cdot I_{\alpha}'' + R_0 \cdot I_{0s} \cdot I_{\alpha}'' + R_{0m} \cdot I_{0m} \cdot I_{\alpha}'' \quad (2.25\text{-}21)$$

$$\boldsymbol{X} = X_1 \cdot I_{\alpha} \cdot I_{\alpha}'' + X_0 \cdot I_{0s} \cdot I_{\alpha}'' + X_{0m} \cdot I_{0m} \cdot I_{\alpha}'' \quad (2.25\text{-}22)$$

$$\chi = \frac{\mathrm{Im}(\boldsymbol{V}) \times L}{\{\mathrm{Im}(\boldsymbol{R}) + \mathrm{Re}(\boldsymbol{X})\} \times K_a} \quad (2.25\text{-}23)$$

where,

Va:Fault voltage (Va=Va0)

Iα: Fault current (=(2Ia−Ib−Ic)/3)

Iα': Current change before and after the fault (=(2Ia−Ib−Ic)/3−(2ILa−ILb−ILc)/3)

Iα": Complex conjugate of Iα'

Ia, Ib, Ic: Fault currents in phase-a, phase-b, and phase-c

ILa, ILb, ILc: Load-current in phase-a, phase-b, and phase-c before the fault

I0s: Current in zero-sequence at local terminal

I0m: Adjacent-line current in zero-sequence in parallel lines

R1: Resistance component of line impedance1 in positive-sequence

X1: Reactance component of line impedance1 in positive-sequence

R0: Resistance component of line impedance2 in zero-sequence

X0: Reactance component of line impedance2 in zero-sequence

R0m: Mutual resistance3 between parallel lines in zero-sequence

X0m: Mutual reactance3 between parallel lines in zero-sequence

Ka: Compensation factor4 for imbalance impedance

Im( ): Expression of imaginary part when a value is placed in parentheses

Re( ): Expression of real part when a value is placed in parentheses

L: Line length5 in the kilometer or mile

・: Symbol of Vector product

[1]Note: For example, user should set the R_1 and the X_1 with settings [**FL_1R1**] and setting [**FL_1X1**] respectively, when the impedance of line GJ is considered in

symmetrical components, as shown in Figure 2.25-2. For further information, see section 2.25.6(iii).

[2]Note: In the calculation of earth fault, user is required to set the R_0 and the X_0 with settings [**FL_1R0**] and setting [**FL_1X0**] respectively, when the impedance of line GJ is considered in symmetrical components.

[3]Note: When the mutual impedance of line GJ is considered , and when parallel lines are applied, user should set the R_{0m} and the X_{0m} with settings [**FL_1R0m**] and setting [**FL_1X0m**] respectively,. If a single line is considered, user are not required to set these settings.

[4]Note: User should set the K_a, K_b and K_c with settings [**FL_Ka**], [**FL_Kb**], and [**FL_Kc**], when the imbalance impedance is considered. For further information, see section 2.25.6(vi).

[5]Note: User should set the line length for settings [**FL_1line_km**] when the length of line GJ is considered and when the unit of length is represented by kilometer, as shown in Figure 2.25-2. For further information, see section 2.25.6(v).

(ii)-2 Compensation

Consider the influence of the distributed capacitance in Equation (2.25-23), likewise section 2.25.2(i)-2. When the line length is beyond 100km, the result of Equation (2.25-23) requires compensation. Thus, Equation (2.25-17) is used to find the compensated distance (χ″) with respect to the fault distance (χ) which Equation (2.25-23) calculates. The setting procedures are discussed later. (See section 2.25.6(iii)-2)

(iii) Data recording trigger and calculation trigger

The calculation is started by signals; and following protection functions provide the trigger signals:

(a) Distance protection[1] (ZS/ZG)
(b) Over current protection[2] (OC)
(c) Current differential protection (DIFL)
(d) External protection[3]

[1]Note: For more information of the ZS/ZG, see Chapter *Relay application: Distance protection*.

[2]Note: For more information of the OC, see Chapter *Relay application: Overcurrent protection*.

[3]Note: With regard to the trigger signal from the external protection function, user can program this trigger signal by using Element IDs (PLC connection points), as shown in Table 2.25-3, which are also listed in section 2.25.8.

Table 2.25-3 Element IDs for data recording and calculation

Element ID	Name	Description
310022EC60	FLZ_RecF	Trigger for data save
310022EC61	FLZ_RecR	Trigger for data save
310022EC62	FLZ_LocF	Trigger for calculation
310022EC63	FLZ_LocR	Trigger for calculation

(iii)-1 Trigger signal for Data recording

Figure 2.25-5 shows a trigger signal for data recording. Respective elements of protective functions (ZS/ZG, OC, and DIFL) output their operation signals when respective elements operate; and then, these signals are summarized to the trigger signal by a logic "OR". In response to scheme switch [**FL-Dir**], the FL can record the data of current and voltage if the fault occurs in either forward or reverse.

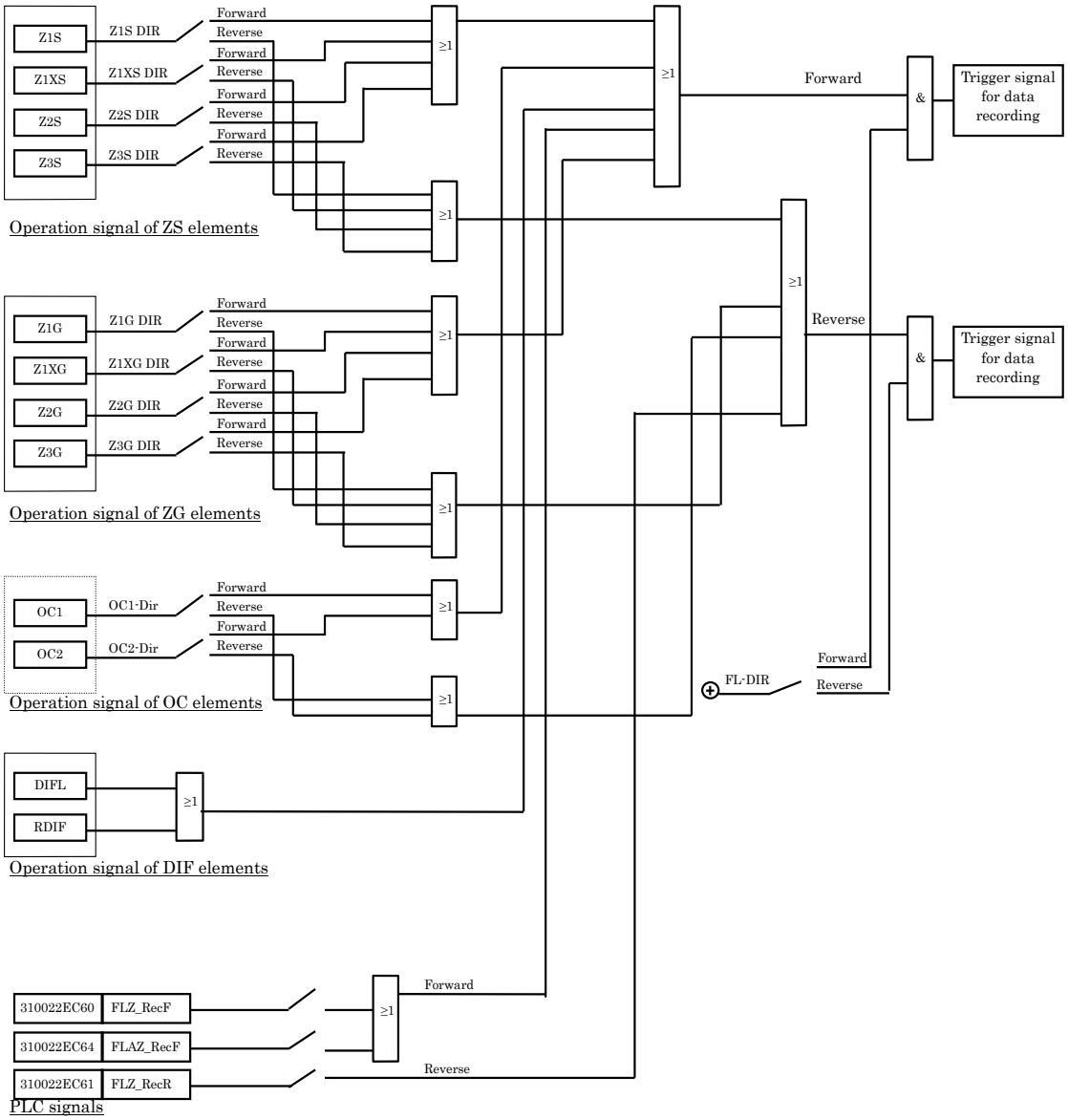


Figure 2.25-5 Data recording trigger from functions and PLC

Note: In the FL, user should verify the direction between the FL function and the other protection function. For example, if **Forward** is set for the scheme switch [**FL-Dir**], user should set **Forward** for the respective scheme switches [**Z*S-DIR**], [**Z*G-DIR**] and [**OC*-DIR**]. If contradiction is found, the FL does not operate. For further information, see section 2.25.6(iii).

(iii)-2 Trigger signal for FL calculation

Figure 2.25-6 shows trigger signals for FL calculation. Result signals[1] from the respective protection functions are summarized by logic "OR", which provides the trigger signal.

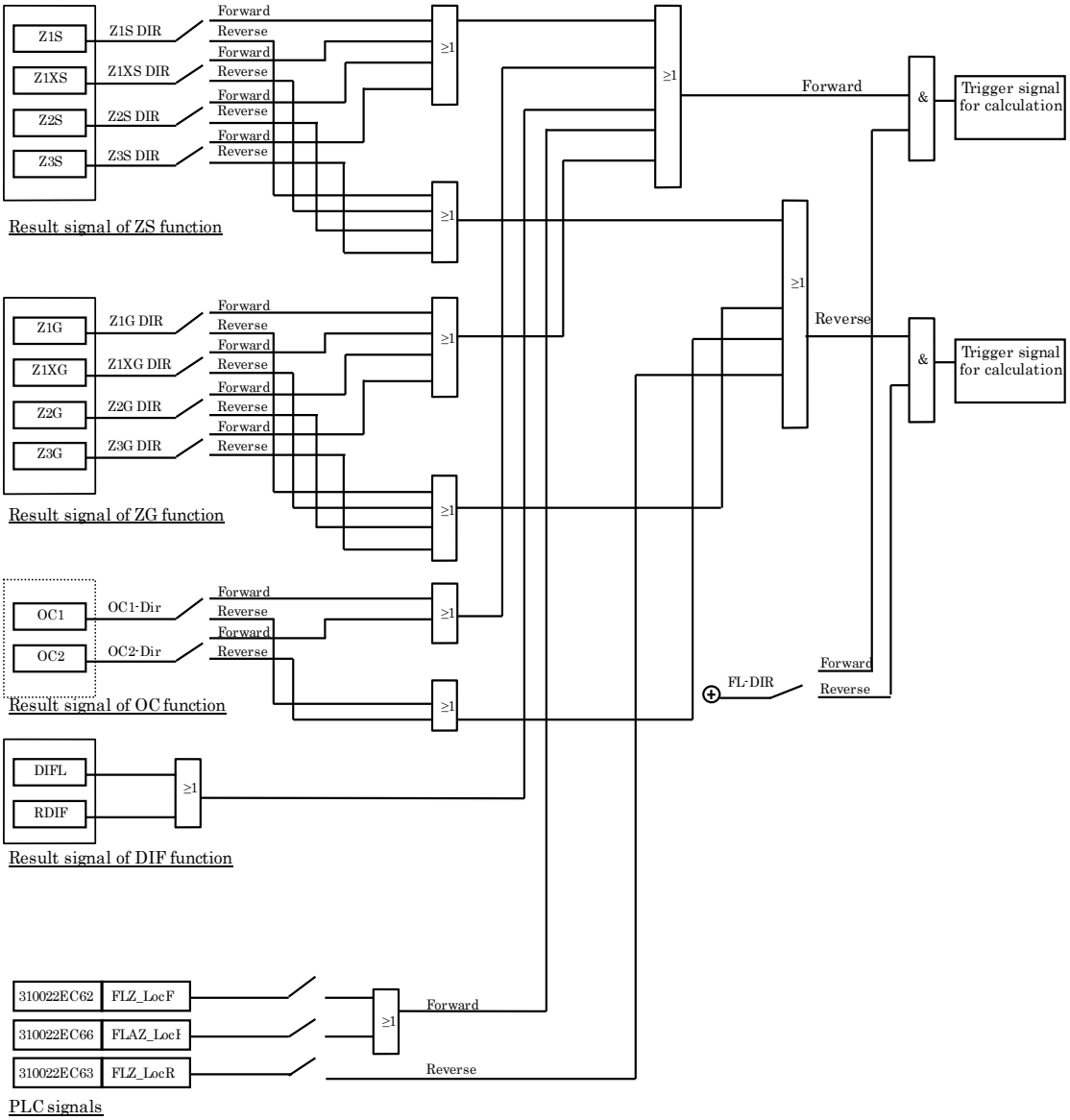


Figure 2.25-6 Calculation trigger from functions and PLC

[1]Note: The result signals can start the FL calculation, but the result signals are not the same as the operation signals of

Figure 2.25-5.

(iv) Calculation error

User should note that the calculation error could be larger when a setting value is far from actual line impedance. For example, if abnormal settings[1] are done, the calculation error will be appeared notably.

The calculation error can be with in ± 2.5 km when the following conditions are applied:

- A fault is assumed to arise up to 100 km distance.
- The fault current is larger than double of the rated current[2] ($2 \times I_n$).
- The reactance[3] per unit length ($^{X1}/_{L}$) is longer than a value ($^{0.05}/_{I_n}$).

In other words, this calculation error can be with in ±2.5% when the following conditions are applied:

- The line length (L) is shorter than 100km.
- The reactance per unit length ($^{X1}/_{L}$) is larger than a value ($^{0.05}/_{I_n}$).
- The fault current is larger than double of the rated current[2] ($2 \times I_n$).

[1]Note: Abnormal settings can be exist when values are far from actual impedance data of transmission line. For example, resistance value is so larger then reactance value, and so on.

[2]Note: Rated current (In) is described separately. (See Chapter *Technical description: Transformer module*)

[3]Note: The term X1 is the reactance component of line impedance.

2.25.3 Selection of calculation results

At the outset, we discuss that the FL calculation consist of two groups: (1) **FL calculation with data at a local-terminal and remote-terminals** and (2) **FL calculation with data at a local-terminal only**. Hence, either (1) or (2) is selected as a calculation result in accordance with a fault condition. The FL selects the result of (2) **FL calculation with data at a local-terminal only** when the FL finds the following conditions after the calculations:

- The calculation results are less than 20% of the line length (L).
- The result difference between (1) and (2) is within 5% of the line length (L).
- The calculation result is less than 40km.

2.25.4 Screen of FL output

Although the IED screen is shown separately in Chapter *Recording function*, the IED screen of the fault determination is discussed here because the screen of fault determination is unique compared with others. Thus, we brief the IED screen of the fault determination, as shown in Figure 2.25-7.

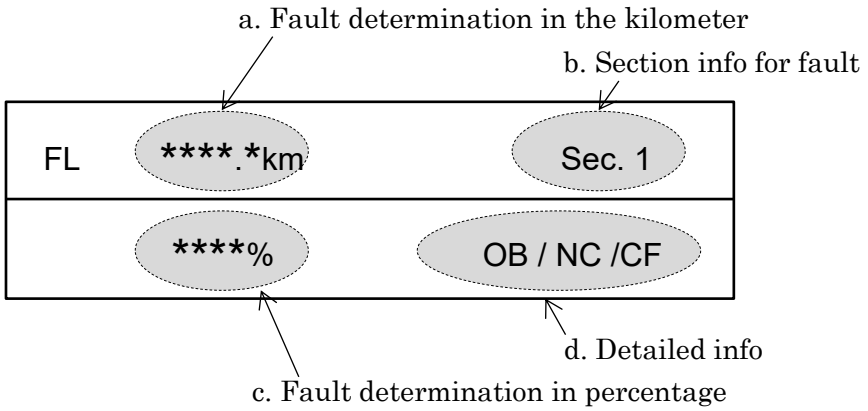


Figure 2.25-7 IED screen of FL calculation in the kilometer and percentage

(i) Fault determination in kilometer or mile

The fault location is referred as a fault determination (fault distance), and the fault determination is displayed in kilometer, as shown in Figure 2.25-8 (shaded portion a). If the information of the line length includes an error, the screen is displayed with "—" (dash sign) and the calculation dose not start. The fault determination is not shown when the trigger is not provided for the FL.

As shown in Figure 2.25-8, if the IED at local-terminal runs along with other IEDs, the IED at local-terminal displays the distance value from the local IED to the fault point.

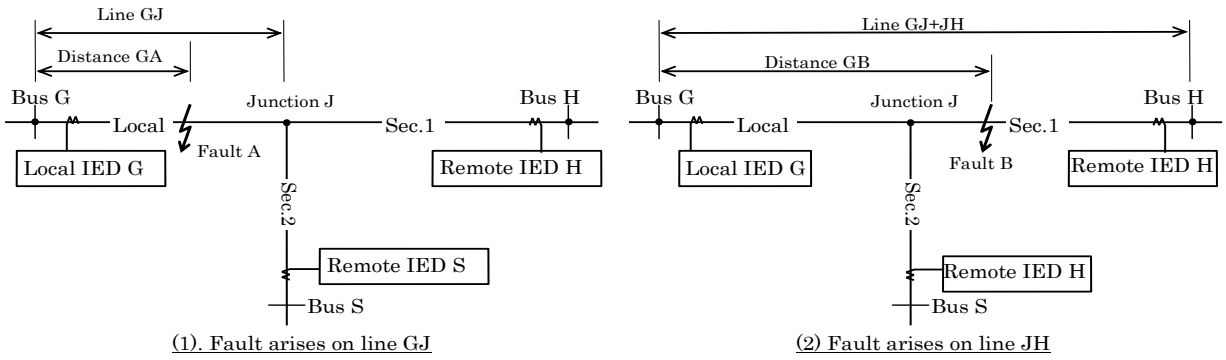


Figure 2.25-8 Fault determination when three IEDs are applied

The fault determination (fault distance) is displayed in mile or kilometer. To display the fault distance in mile, user should change the setting, which is discussed later. (See

section2.25.6(v))

(ii) Fault determination in percentage

Figure 2.25-7 (shaded portion c) shows the result of the fault determination in percentage. The screen is displayed as "—" (dash sign) when the result of the fault determination has an error.

As shown in Figure 2.25-7, when the IED at local-end (IED G) runs along with the other IEDs (IED H and IED S), user should notice that the screen difference is appeared with fault occurrence between (1) a fault arises on the line GJ and (2) a fault arises on the line JH.

(ii)-1 Fault A arises on the line GJ

As shown in Figure 2.25-8 (1), when a fault A arises on the line GJ, the following equation determines the result of fault determination in percentage:

$$\text{Fault determination (\%)} = \frac{\text{Distance to fault A (GA)}}{\text{lenght of Line GJ (GJ)}} \times 100 \qquad (2.25\text{-}24)$$

(ii)-2 Fault B arises on the line JH

As shown in Figure 2.25-8 (2), when a fault B arises on the line JH, the following equation determines the result of fault determination in percentage:

$$\text{Fault determination (\%)} = \frac{\text{Distance to fault B (GB)}}{\text{lenght of Line GH (GJ + JH)}} \times 100 \qquad (2.25\text{-}25)$$

(iii) Fault section information

When a junction exists on the line, and when the FL runs in the IED G at local-terminal, the section information is useful. Figure 2.25-7 (shaded portion b) show the section information displayed on the IED screen at the IED G when the IED H and the IED S run at remote-terminals. Table 2.25-4 shows section notations. If a fault occurs, one of the section notations is displayed on the IED screen. Note that no section information is shown when a junction does not exist on the line.

Table 2.25-4 Section notation when a fault arises

Section notation[1]	Meaning	Correspondent line	Correspondent setting[2]
Local	A fault arises from the local terminal to a junction.	Line GJ	Line1_Element
Sec. 1	A fault arises from a junction to remote end #1.	Line JH	Line2_Element
Sec. 2	A fault arises from a junction to remote end #2.	Line JS	Line3_Element
Junc.	A fault arises near a junction.	Junction	N.A

[1]Note: Section notation and correspondent settings are relevant to communication ports. For detail, section 2.25.5(i).

[2]Note: User can find the setting means in section 2.25.6(iii).

(iv) Detail information

As shown in Figure 2.25-7 (shaded portion d), the detail information is displayed along with the fault determination, which is simplified with notations, Table 2.25-5 summarizes the notations of fault determination.

Table 2.25-5 Notation of fault information for screen

Fault info. Notation	Meaning	Comment
OB	Over boundary	Fault location is assumed over the boundary.In the case of three-terminal application, the boundary means the sum of the two line length.
OJ	Over junction	Fault location is assumed over the junction; this information is applied only for the ***FL calculation with data at a local-terminal only***. If the results of the ***FL calculation with data at a local-terminal and remote-terminals*** assumed over the junction, the section notation will appear instead like "Sec.1" or "Sec.2".
NC	Not converged.	Since a number of calculation results are scattered, the FL chooses one of the result value in order that the scattering turns to be small.
CF	Communication failure	Communication failures are risen while data recording; hence the ***FL calculation with data at a local-terminal only*** is brought for the fault determination. Note that the result of the calculation decays.

2.25.5 Preparation and consideration of setting

User should set line impedance for the FL; and these setting points are provided in each Line_element. User should note that the value of the line impedance is represented as secondary circuit of VCT.

(i) Setting in each Line_element when three-terminal being applied

As shown in Figure 2.25-8 and Table 2.25-4, when three IEDs are configured at a local-terminal and the other remote-terminals, the protection sections are divided into three: (1) Local (Line GJ), (2) Sec. 1 (Line JH), and (3) Sec. 2 (Line JS).

User should set impedance values into Line1_Element when the Local (GJ) is subject to setting. As for the Sec.1 (JH), user should set impedance values into Line2_Element. Likewise, as for the Sec. 2 (JS), set impedance values into Line3_Element.[2]

User should notice that the section configurations are decided by the IED communication port[1]; and the section is established when the communication between the IEDs is made. For example, the Sec.1 is decided by the communication port #1 with which the Local IED (IED G) is connected to the remote-IED (IED H). On the other hand, the Sec. 2 is decided by the communication port #2 with which the Local IED is connected to the remote-IED (IED S).

[1]Note: The configuration for the communication port is discussed separately. (See Chapter *Relay application: Transmission control function*)

[2]Note: The "Line1_Element", "Line2_Element", and "Line3_Element" are discussed in the setting procedure. See section 2.25.6(iii).

(ii) Setting in Line1_Element when two-terminal being applied

The setting items in "Line1_Element" are only used when two IEDs are configured.

(iii) Setting for a signle IED configulation

The setting items in "Line1_Element" are only used when a single IED is configured. In this case, the FL calculation with data at a local-terminal only is only applicable.

(iv) Computation of impedance when variation being found in respective phases

When variation of the impedance in respective phases is found, user should get an impedance in positive-sequence by Equation (2.25-26), an impedance in zero-sequence by Equation (2.25-27), and a mutual impedance in zero-sequence by Equation (2.25-28).

$$Z_1 = \frac{Z_{aa} + Z_{bb} + Z_{cc} - (Z_{ab} + Z_{bc} + Z_{ca})}{3} \qquad (2.25\text{-}26)$$

$$Z_0 = \frac{Z_{aa} + Z_{bb} + Z_{cc} + 2(Z_{ab} + Z_{bc} + Z_{ca})}{3} \quad (2.25\text{-}27)$$

$$Z_{0m} = \frac{Z_{am} + Z_{bm} + Z_{cm}}{3} \quad (2.25\text{-}28)$$

(v) Computation of impedance when imbalance being found

The compensation factors are provided when impedance imbalances are apparent. Equations (2.25-29) to (2.25-34) are provided to calculate these factors, but these factors should be set to 100% when the impedance imbalances can be ignored.

$$K_{ab} = \frac{\frac{Z_{aa} + Z_{bb}}{2} - Z_{ab}}{Z_1} \quad (2.25\text{-}29)$$

$$K_{bc} = \frac{\frac{Z_{bb} + Z_{cc}}{2} - Z_{bc}}{Z_1} \quad (2.25\text{-}30)$$

$$K_{ca} = \frac{\frac{Z_{cc} + Z_{aa}}{2} - Z_{ca}}{Z_1} \quad (2.25\text{-}31)$$

$$K_a = \frac{Z_{aa} - \frac{Z_{ab} + Z_{ca}}{2}}{Z_1} \quad (2.25\text{-}32)$$

$$K_b = \frac{Z_{bb} - \frac{Z_{bc} + Z_{ab}}{2}}{Z_1} \quad (2.25\text{-}33)$$

$$K_c = \frac{Z_{cc} - \frac{Z_{ca} + Z_{ab}}{2}}{Z_1} \quad (2.25\text{-}34)$$

2.25.6 Setting procedure

The FL has a number of operation features and these features are provided with settings, which can be keyed from the IED screen for operation. (See Chapter *User interface: Setting*)

(i) FL execution

The FL calculation is carried out when **On** is set for setting [**FL_EN**]. The two calculation groups (which are described in section2.25.1 and section 2.25.2) are subject to this setting.

(ii) FL direction

Note: Set of FL direction is only available for the ***FL calculation with data at a local-terminal only***.

When considering the fault determination, user can choose the direction in either forward or reverse. When required to respond to the fault in forward, user should select the direction in forward if the forward is selected in the elements of the other protection functions corresponding to the FL; otherwise, the FL calculation fails to start.

The setting [**FL_Dir**] is provided to select the FL direction; and **Forward** is set when a fault is supposed to arise in forward. Inversely, set **Reverse** for it when a fault is supposed to arise in reverse direction. Figure 2.25-9 shows the direction of a fault.

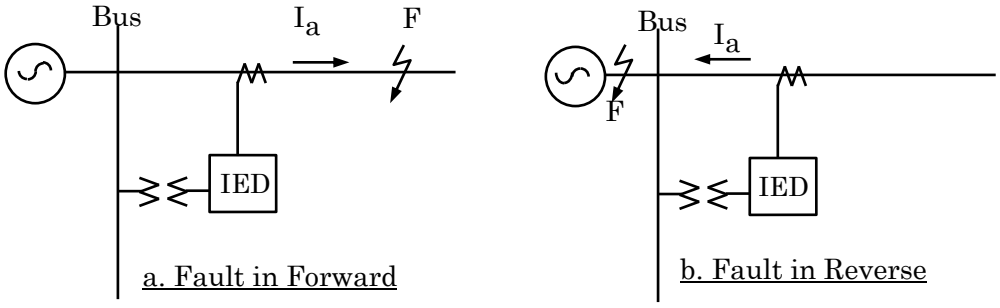


Figure 2.25-9 Forward fault and reverse fault

(iii) Selection of either Matrix or Symmetrical component; and impedance settings

As described in section 2.25.1(i)-3, the FL calculation is carried out in symmetrical component; hence, setting the line impedance in symmetrical components may be required, but user can also set the line impedance in resistive and reactive (matrix) components. Thus, prior to setting of impedance, user should select either **Matrix** or **Symmetrical** with scheme switch [**FL_ImpSet**].

(iii)-1 Impedance setting in Matrix components

Matrix setting is required to set numerical values for both self-impedance (Z_{aa}, Z_{bb} and Z_{cc}) and mutual-impedance (Z_{ab}, Z_{bc} and Z_{ca}).

As shown in Figure 2.25-8, when we consider the three-terminal application, user should key values for each Line_Element. When we consider the two-terminal application, as shown in Figure 2.25-1, user just keys values for Line1_Element setting.

- Setting for Line GJ (Line1_Element)

For instance, consider setting impedance values with respect to the local line (line GJ) in Figure 2.25-8, setting targets are represented as the Line1_Element. The self-impedances are one of the subjects in the matrix setting; hence, user should set the self-impedance values for setting items—that are designated [**FL_1Raa**] to [**FL_1Rcc**] and [**FL_1Xaa**] to [**FL_1Xcc**]. Likewise, the mutual-impedances values are set for the settings [**FL_1Rab**] to [**FL_1Rca**] and [**FL_1Xab**] to [**FL_1Xca**].

- Setting for Line JH (Line2_Element)

On the other hand, considering setting impedance value of line JH, setting targets are represented as the Line2_Element. In a manner similar to that of Setting of Line GJ, user should set the self-impedance values for setting items—that are designated [**FL_2Raa**] to [**FL_2Rcc**] and [**FL_2Xaa**] to [**FL_2Xcc**]. Likewise, the mutual-impedances values are set for the settings [**FL_2Rab**] to [**FL_2Rca**] and [**FL_2Xab**] to [**FL_2Xca**].

- Setting for Line JS (Line3_Element)

For impedance values of line JH, setting targets are represented as the Line3_Element. In a manner similar to that of Setting of Line GJ, user should set the self-impedance values for setting items—that are designated [**FL_3Raa**] to [**FL_3Rcc**] and [**FL_3Xaa**] to [**FL_3Xcc**]. Likewise, the mutual-impedances values are set for the settings [**FL_3Rab**] to [**FL_3Rca**] and [**FL_3Xab**] to [**FL_3Xca**].

(iii)-2 Impedance setting in Symmetrical components

Symmetrical setting is available when each self-impedance is identical to the other ($Z_{aa}=Z_{bb}=Z_{cc}$) and each mutual-impedance is identical to the other ($Z_{ab}=Z_{bc}=Z_{ca}$); and then, set **Symmetrical** for the scheme switch [**FL_ImpSet**]. The method of how to obtain the symmetrical values is discussed earlier with Equations (2.25-10) to (2.25-12).

- Impedance for Line GJ (Line1_Element setting)

The settings [**FL_1R0**], [**FL_1R1**], [**FL_1X0**], and [**FL_1X1**] are subject to setting items when user considers the impedance setting of the Line1_Element.

- Impedance for Line JH (Line2_Element setting)

The settings [**FL_2R0**], [**FL_2R1**], [**FL_2X0**], and [**FL_2X1**] are subject to setting items when user considers the impedance setting of the Line2_Element.

- Impedance for Line GJ (Line3_Element setting)

The settings [**FL_3R0**], [**FL_3R1**], [**FL_3X0**], and [**FL_3X1**] are subject to setting items when user considers the impedance setting of the Line3_Element.

(iv) Compensation setting for earth fault for parallel lines

In order to respond to an earth fault, the FL function operates where the entering current is compensated by the residual current on an adjacent line when the FL function operates for the parallel lines. In the FL function, the compensation is also available for the entering current by the computation using impedance.

As a rule, when the FL function operates in the parallel lines, it is recommended that the entering current should be compensated by the residual current. This is because the measuring elements can detect the earth fault securely. Thus, the user should set **Off** for the scheme switch [**FL-Z0B**]; mutual impedance in the parallel lines should be set for the settings [**FL_R0m**] and [**FL_X0m**].[1]

[1]Note: The user should use Equation (2.25-28) in order to derive mutual impedance when the parallel lines are taken into consideration; the user should set their mutual impedances for the settings [**FL_R0m**] and [**FL_X0m**]. Setting values of the mutual impedance are also found in Equations (2.25-21) and (2.25-22).

If residual current on the parallel line is not provided, the user should set **On** for the scheme switch [**FL-Z0B**]. In this case, settings for impedance looking in reverse are required together with the settings [**FL_R0m**] and [**FL_X0m**]. These impedances looking in reverse are provided with both settings [**FL_Z0B-L**] and [**FL_Z0B-R**]. The setting [**FL_Z0B-L**] is referred an impedance looking in reverse at local-end in zero sequence. The setting [**FL_Z0B-R**] is referred an impedance looking in reverse at remote-end in zero sequence. Table 2.25-6 summarizes their compensation means and settings.

Table 2.25-6 Method and setting in earth fault compensation

Compensation method	Setting objects		Decision of compensation method	Required power quantities for this operation
	Switch [**FL-Z0B**]	Impedance setting		
Residual-current	**Off**	[**FL_R0m**] and [**FL_X0m**]	1. The residual current is available in the parallel line. 2. The single line is considered.	I_{0m}, I_a, I_b, I_c, V_a, V_b, V_c
Impedance looking in reverse	**On**	[**FL_Z0B_L**], [**FL_Z0B_R**], [**FL_R0m**], and [**FL_X0m**]	1. The residual current is not available in the parallel line. 2. The compensation method above is not preferred.	I_a, I_b, I_c, V_a, V_b, V_c

Note: The user should set **Off** for the scheme switch [**FL-Z0B**] when the FL function operates on a single circuit line.

(v) Setting of the unit of length/distance

As shown in Figure 2.25-7, the fault determination is shown in kilometer when user sets **km** for the scheme switch [**FL_Unit**]. On the other hand, if the fault determiantion in the mile is preferred, user should set **mile** for the scheme switch [**FL_Unit**]. The IED screen for the FL computaion are subject to this setting. After that, user can set values for the corresponding settings.

For example, when we consider the Line1_Element setting, if user selects **km** for the scheme switch [**FL_Unit**], setting [**FL_1Line_km**] is used to set the line length value. On the other hand, if user selects **mile** for the scheme switch [**FL_Unit**], setting [**FL_1Line_mile**] is used to set the line length value.

(vi) Setting of compensation factor

As discussed in section 2.25.5(v), if the impedance imbalances are found, user should set the compensation factors for settings [**FL_Kab**], [**FL_Kbc**], [**FL_Kca**], [**FL_Ka**], [**FL_Kb**], and [**FL_Kc**]. In order to find how to obtain these factors, see section 2.25.5(v).

(vii) Computation for overreaching

If the user wishes to obtain the result of the FL computation when the fault occurs beyond the boundary defined with the setting [**FL_Line_km**] or [**FL_Line_mile**], the result can be displayed when **On** is set for setting [**FL_ALL_Zone**]. Note that the fault location will be displayed by **On** being set for the [**FL_ALL_Zone**], but the result for overreaching cannot be guaranteed in the FL computation; thereby, it must be taken carefully.

2.25.7 Setting

Setting of FL-AZ (Function ID: 496001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
Switch	FL_EN	Off / On		—	Fault locator enable	On		
	FL_Dir	Forward / Reverse		—	Selection of the fault location direction	Forward		
	FL_ImpSet	Symmetrical / Matrix		—	Selection in the setting mode of impedance	Symmetrical		
	FL_Z0B	Off/ On		—	Zero sequence compensation of the parallel line	Off		
	FL_Unit	km / mile		—	Selection of line length unit	Km		
Line1_Element	FL_1Line_km	0.0 – 500.0		km	Line1 length (km)	50.0		
	FL_1Line_mile	0.0 – 310.0		miles	Line1 length (mile)	31.0		
	FL_1Xaa	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line1 (Xaa)	10.50	2.10	
	FL_1Xbb	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line1 (Xbb)	10.50	2.10	
	FL_1Xcc	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line1 (Xcc)	10.50	2.10	
	FL_1Xab	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line1 (Xab)	0.50	0.10	
	FL_1Xbc	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line1 (Xbc)	0.50	0.10	
	FL_1Xac	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line1 (Xac)	0.50	0.10	
	FL_1Raa	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line1 (Raa)	1.10	0.21	
	FL_1Rbb	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line1 (Rbb)	1.10	0.21	
	FL_1Rcc	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line1 (Rcc)	1.10	0.21	
	FL_1Rab	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line1 (Rab)	0.10	0.01	
	FL_1Rbc	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line1 (Rbc)	0.10	0.01	
	FL_1Rac	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line1 (Rac)	0.10	0.01	
	FL_1X1	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line1 positive sequence impedance	10.00	2.00	
	FL_1R1	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line1 positive sequence impedance	1.00	0.20	
	FL_1X0	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line zero sequence impedance	34.00	6.80	
	FL_1R0	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line zero sequence impedance	3.50	0.70	
	FL_Kab	50 – 150		%	Impedance imbalance compensation factors	100		
	FL_Kbc	50 – 150		%	Impedance imbalance compensation factors	100		
	FL_Kca	50 – 150		%	Impedance imbalance compensation factors	100		
	FL_Ka	50 – 150		%	Impedance imbalance compensation factors	100		

Setting of FL-AZ (Function ID: 496001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
		FL_Kb	50 – 150		%	Impedance imbalance compensation factors	100		
		FL_Kc	50 – 150		%	Impedance imbalance compensation factors	100		
		FL_R0m	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line mutual zero sequence impedance	1.00	0.20	
		FL_X0m	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line mutual zero sequence impedance	10.00	2.00	
		FL_Z0B_L	0.00 – 1000.00	0.00 – 200.00	ohm	Zero sequence back source impedance at local terminal	10.00	2.00	
		FL_Z0B_R	0.00 – 1000.00	0.00 – 200.00	ohm	Zero sequence back source impedance at remote terminal	10.00	2.00	
	Line2_Element	FL_2Line_km	0.0 – 500.0		km	Line2 length (km)	50.0		
		FL_2Line_mile	0.0 – 310.0		miles	Line2 length (mile)	31.0		
		FL_2Xaa	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line2 (Xaa)	10.50	2.10	
		FL_2Xbb	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line2 (Xbb)	10.50	2.10	
		FL_2Xcc	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line2 (Xcc)	10.50	2.10	
		FL_2Xab	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line2 (Xab)	0.50	0.10	
		FL_2Xbc	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line2 (Xbc)	0.50	0.10	
		FL_2Xac	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line2 (Xac)	0.50	0.10	
		FL_2Raa	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line2 (Raa)	1.10	0.21	
		FL_2Rbb	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line2 (Rbb)	1.10	0.21	
		FL_2Rcc	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line2 (Rcc)	1.10	0.21	
		FL_2Rab	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line2 (Rab)	0.10	0.01	
		FL_2Rbc	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line2 (Rbc)	0.10	0.01	
		FL_2Rac	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line2 (Rac)	0.10	0.01	
		FL_2X1	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line1 positive sequence impedance	10.00	2.00	
		FL_2R1	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line1 positive sequence impedance	1.00	0.20	
	Line3_Element	FL_3Line_km	0.0 – 500.0		km	Line3 length (km)	50.0		
		FL_3Line_mile	0.0 – 310.0		miles	Line3 length (mile)	31.0		
		FL_3Xaa	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line3 (Xaa)	10.50	2.10	
		FL_3Xbb	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line3 (Xbb)	10.50	2.10	
		FL_3Xcc	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line3 (Xcc)	10.50	2.10	

Setting of FL-AZ (Function ID: 496001)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
		FL_3Xab	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line3 (Xab)	0.50	0.10	
		FL_3Xbc	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line3 (Xbc)	0.50	0.10	
		FL_3Xac	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line3 (Xac)	0.50	0.10	
		FL_3Raa	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line3 (Raa)	1.10	0.21	
		FL_3Rbb	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line3 (Rbb)	1.10	0.21	
		FL_3Rcc	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line3 (Rcc)	1.10	0.21	
		FL_3Rab	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line3 (Rab)	0.10	0.01	
		FL_3Rbc	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line3 (Rbc)	0.10	0.01	
		FL_3Rac	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line3 (Rac)	0.10	0.01	
		FL_3X1	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line3 (Xaa)	10.00	2.00	
		FL_3R1	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line3 (Xbb)	1.00	0.20	
		FL_3X0	0.00 – 1000.00	0.00 – 200.00	ohm	Reactance component of line1 positive sequence impedance	10.50	2.10	
		FL_3R0	0.00 – 1000.00	0.00 – 200.00	ohm	Resistance component of line1 positive sequence impedance	10.50	2.10	

2.25.8 Data ID

◆ Signal monitoring point

FL-AZ (Function ID: 496001)

Element ID	Name	Description
4200101340	FltDiskm	Fault distance
4200101347	FltZ	Fault impedance
3100101348	FltLoop	Fault loop
3100101005	FltQuality	Quality of fault locator

◆ Connection point on PLC logic

FL-AZ (Function ID: 496001)

Element ID	Name	Description
310022EC60	FLZ_RecF	Record start signal (Only local end data, forward)
310022EC61	FLZ_RecR	Record start signal (Only local end data, reverse)
310022EC62	FLZ_LocF	Fault locate start signal (Only local end data, forward)
310022EC63	FLZ_LocR	Fault locate start signal (Only local end data, reverse)
310022EC64	FLAZ_RecF	Record start signal (Local and remote end data, forward)
310022EC66	FLAZ_LocF	Fault locate start signal (Local and remote end data, forward)

2.26 Trip circuit (TRC)

The trip circuit (TRC) scheme issues trip commands to the circuit breakers (CB#1, CB#2) when it receives trip signals from the protection functions (which are identified with 'FC1', 'FC2', etc. to represent DIFL, DIFGL relay, etc.). The TRC function is able to receive an alternate trip signal generated by an additional relay external to the IED using PLC connection points via the binary IO module (BIO)†. If the additional relay can provide a check-signal to condition tripping, increased reliability can be achieved within the IED when using the check-signal as an input to the TRC logic (i.e., fail-safe operation is realized by the operation of the additional relay).

Note: The TRC function is feasible in entire models, which can be enumerated in the IED ordering number. For more information, see *Appendix: Ordering*.

Table 2.26-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
–	TRC	✓	✓	✓	✓	✓

✓: Applicable NA: Not applicable

Figure 2.26-1 shows that the function is made with following logics:

Collection: The signals, received from the various protection functions (shown as 'FC18' and others; see Table 2.26-2 and Table 2.26-6), are gathered in the Trip-signal collection logic.

Generation: CB trip signal generation, Sub-signal generation for blocking ARC§, and Alarm-signal generation logics are provided.

A binary output (BO†) circuit must be selected in order to energize the trip coil of the CB#1 and CB#2. That is, the BOs should be made the connection with the CB#1 and CB#2 trip coils; the drive signal should be outputted (i.e., 'TRIP-COMMAND1-A,-B,-C' and 'TRIP-COMMAND2-A,-B,-C'†). The Alarm-signal generation logic operates to provide a trigger signal for the recording function‡.

†Note: The internal connection between the TRC function and the BIO module should be performed using the BIO settings or the PLC programming. The user can program the connection the PLC monitoring point 'TRIP-COMMAND1-A (8000001B20) etc.' with preferred BO circuits using the settings [**Input signal1**] etc. of each BO on the BIO module. The externally wired connection between the BIO module and trip coil circuit is made at the IED terminals. For more information with regard to the BO circuit concerning the Element ID (Data ID), see Chapter *Technical description: Binary IO module*.

§Note: Autoreclose (ARC) and other protection functions are discussed separately. See Chapter *Relay application*, respectively.

‡Note: For information on recording, see *Chapter Recording function*.

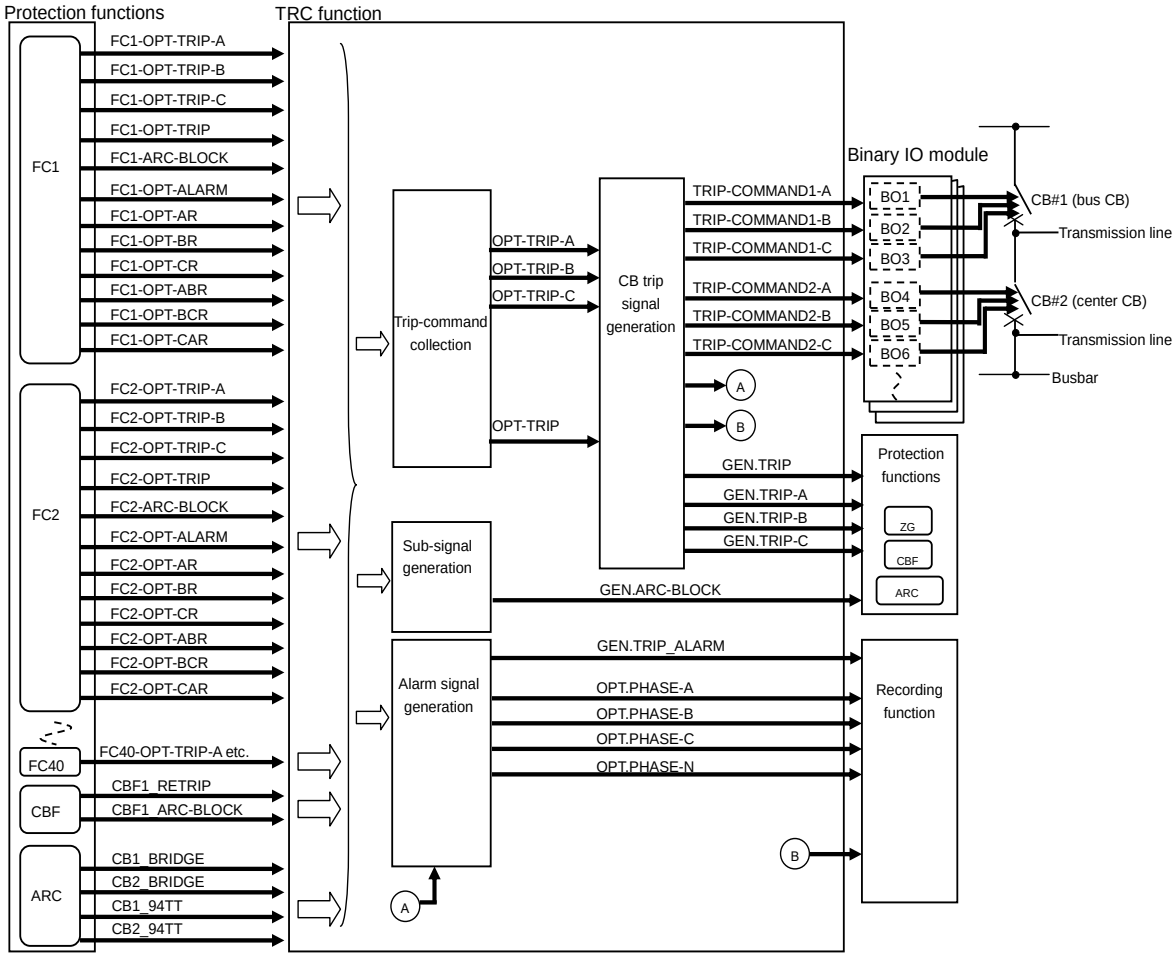


Figure 2.26-1 TRC block diagram

2.26.1 Command for tripping CB and signal to block reclosing CB#1/CB#2

The TRC logic is designed to issue per-phase trip or three-phase trip commands when a fault occurs. Table 2.26-2 shows the receipt of trip signals from the protection functions, which are identified by 'Protection function identification numbers ('*'). Note that an operation block signal for the ARC function is also provided along with the trip signal.

Table 2.26-2 Trip/ARC block signal inputs to the TRC function

Protection functions	ID '*'	Trip and ARC-block signals provided by the protection functions					
		FC*_OPT _TRIP-A	FC*_OPT _TRIP-B	FC*_OPT _TRIP-C	FC*_OPT _TRIP	FC*_OPT_ARC-BLOCK	Note
DIFL	1	X	X	X	–	X	
DIFGL	2	–	–	–	X	X	
OSTV	3	–	–	–	X	X	
DTT	4	–	–	–	X	X	
N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.	
N.A.	6	N.A.	N.A.	N.A.	N.A.	N.A.	
N.A.	7	N.A.	N.A.	N.A.	N.A.	N.A.	
N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.	
ZS	9	–	–	–	X	X	
ZS (SOTF)	10	–	–	–	X	–	
ZG	11	X	X	X	–	X	
ZG (SOTF)	12	–	–	–	X	–	
DISCAR	13	X	X	X	–	X	
DEFCAR	14	X	X	X	–	X	
N.A.	15	N.A.	N.A.	N.A.	N.A.	N.A.	
SOTF-OC	16	–	–	–	X	X	
STUB-OC	17	–	–	–	X	X	
OC	18	–	–	–	X	X	
EF	19	–	–	–	X	X	
OCN	20	–	–	–	X	X	
UC	21	–	–	–	X	X	
THM	22	–	–	–	X	X	
BCD	23	–	–	–	X	X	
N.A.	22	N.A.	N.A.	N.A.	N.A.	N.A.	
OV	25	–	–	–	X	X	
OVS	26	–	–	–	X	X	
N.A.	25	N.A.	N.A.	N.A.	N.A.	N.A.	
N.A.	28	N.A.	N.A.	N.A.	N.A.	N.A.	
OVN	29	–	–	–	X	X	
UV	30	–	–	–	X	X	
UVS	31	–	–	–	X	X	
N.A.	32	N.A.	N.A.	N.A.	N.A.	N.A.	
FRQ	33	–	–	–	X	X	
DFRQ	34	–	–	–	X	X	
N.A.	35	N.A.	N.A.	N.A.	N.A.	N.A.	
N.A.	36	N.A.	N.A.	N.A.	N.A.	N.A.	
N.A.	37	N.A.	N.A.	N.A.	N.A.	N.A.	
N.A.	38	N.A.	N.A.	N.A.	N.A.	N.A.	
N.A.	39	N.A.	N.A.	N.A.	N.A.	N.A.	
N.A.	40	N.A.	N.A.	N.A.	N.A.	N.A.	

Note: 'N.A.' represents 'Not available for the IED', 'X' represents a 'Valid signal received from the protection function', '–' represents that no 'valid signal' received in the

TRC function. '**FC*_OPT_TRIP**' represents a three-pole trip signal. 'ARC-BLOCK' represents a signal used to block the operation of the ARC function; the 'ARC-BLOCK' signal is transferred to the autoreclose function (ARC). Incidentally, the term 'FC*' represents one of the relay elements connected to the TRC function.

Table 2.26-3 and Table 2.26-4 summarize the operation results in the TRC function. Table 2.26-3, shows the correspondents between the input signals (which are signals provided from the protection functions) and their reasons (that is, types of faults). For example, if a fault (1LG in phase A) occurs, 'FC*_OPT_TRIP-A' signal may be provided for the TRC function from a protection function; the TRC function may generates 'TRIP-COMMAN1-A' and 'TRIP-COMMAND2-A' signals when the scheme switch [**TP-MODE**]=**PER-PHASE** (see Table 2.26-4). Note that Table 2.26-3 illustrates generic operation rules concerning fault types; the inputs depend on the practical operation of relay functions. Hence, the user should figure out actual inputs using Table 2.26-2 together with the characteristics of respective protection functions.

Note the TRC outputs will be influenced by the signals generated in the ARC function. That is, when a CB1_BRIDGE or a CB1_94TT signal is generated and it is injected into the TRC function, the TRC function is instructed to output a three-phase tripping (i.e., issuing CB1_94TT following ARC1 FT or TPAR) or the TRC function is instructed to operate unconditionally in three-phase tripping mode (i.e., issuing CB1_BRIDGE following ARC1 UNREADT). We shall see a number of operation settings [**ARC1-MODE**] and [**ARC2-MODE**] in the ARC function.

Table 2.26-3 Trip command and its correspondent fault

Trip phase (Fault type)	Inputs (See Table 2.26-2)	Outputs
	Trip signals coming from protection functions (FC*)	Trip commands
Phase A (1LG)	FC*_OPT_TRIP-A	See Table 2.26-4
Phase B (1LG)	FC*_OPT_TRIP-B	
Phase C (1LG)	FC*_OPT_TRIP-C	
Phase AB (L-L)	FC*_OPT_TRIP-A and FC*_OPT_TRIP-B	
Phase BC (L-L)	FC*_OPT_TRIP-B and FC*_OPT_TRIP-C	
Phase CA (L-L)	FC*_OPT_TRIP-C and FC*_OPT_TRIP-A	
Phases ABC (3PH)	FC*_OPT_TRIP (=FC*_OPT_TRIP-A & B & C)	
No trip (Unfaulted)	No input	No output

Table 2.26-4 Trip commands

Inputs (see Table 2.26-3)	Outputs		
	[TP-MODE]= 1-PHASE†	**[TP-MODE]= 3-PHASE‡**	**[TP-MODE]= PER-PHASE**
FC*_OPT-TRIP-A	TRIP-COMMAND1-A TRIP-COMMAND2-A	TRIP-COMMAND1-A TRIP-COMMAND1-B TRIP-COMMAND1-C TRIP-COMMAND2-A TRIP-COMMAND2-B TRIP-COMMAND2-C	TRIP-COMMAND1-A TRIP-COMMAND2-A
FC*_OPT-TRIP-B	TRIP-COMMAND1-B TRIP-COMMAND2-B		TRIP-COMMAND1-B TRIP-COMMAND2-B
FC*_OPT-TRIP-C	TRIP-COMMAND1-C TRIP-COMMAND2-C		TRIP-COMMAND1-C TRIP-COMMAND2-C
FC*_OPT-TRIP-A **FC*_OPT-TRIP-B**	TRIP-COMMAND1-A TRIP-COMMAND1-B TRIP-COMMAND1-C TRIP-COMMAND2-A TRIP-COMMAND2-B TRIP-COMMAND2-C		TRIP-COMMAND1-A TRIP-COMMAND1-B TRIP-COMMAND2-A TRIP-COMMAND2-B
FC*_OPT-TRIP-B **FC*_OPT-TRIP-C**			TRIP-COMMAND1-B TRIP-COMMAND1-C TRIP-COMMAND2-B TRIP-COMMAND2-C
FC*_OPT-TRIP-C **FC*_OPT-TRIP-A**			TRIP-COMMAND1-C TRIP-COMMAND1-A TRIP-COMMAND2-C TRIP-COMMAND2-A
FC*_OPT-TRIP-A **FC*_OPT-TRIP-B** **FC*_OPT-TRIP-C**			TRIP-COMMAND1-A TRIP-COMMAND1-B TRIP-COMMAND1-C TRIP-COMMAND2-A TRIP-COMMAND2-B TRIP-COMMAND2-C

†Note: the tripping phase does not have the match with the phase of an input signal for **1-PHASE** or **3-PHASE** being set for the scheme switch [**TP-MODE**].

‡Note: Three-phase trip command is issued unconditionally for any fault at **3-PHASE**.

Table 2.26-5 illustrates CBF function can generate a re-trip signal and an ARC-BLOCK signal.

Table 2.26-5 Signals coming from CBF function

Protection function	Signals issued in the CBF		Note
	CBF1_RETRIP	**CBF1_ARC-BLOCK**	
CBF	X	X	

Note: 'X' represents a valid signal for the TRC'. The 'CBF1_ARC-BLOCK' signal is grouped with the 'FC*_OPT_ARC-BLOCK' signal in the Sub-signal generation scheme.

2.26.2 Recording identifiers for respective fault types

Table 2.26-6 shows an identifier signal for the recording function generated when a fault is detected by the protection functions. That is, the identifier is generated in each protection function (relay element) and is transferred to the recording function.

Table 2.26-6 Recording identifiers for relay operating elements for different faults

Protection functions	ID '*'	Fault identifier for relay element operated in each phase						
		FC*_OPT_ALARM	FC*_OPT_AR Phase-A	FC*_OPT_BR Phase-B	FC*_OPT_CR Phase-C	FC*_OPT_ABR Phase-AB	FC*_OPT_BCR Phase-BC	FC*_OPT_CAR Phase-CA
DIFL	1	–	X	X	X	–	–	–
DIFGL	2	–	–	–	–	–	–	–
OSTV	3	–	–	–	–	–	–	–
DTT	4	–	–	–	–	–	–	–
N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
N.A.	6	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
N.A.	7	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
ZS	9	–	–	–	–	X	X	X
ZS (SOTF)	10	–	–	–	–	X	X	X
ZG	11	–	X	X	X	–	–	–
ZG (SOTF)	12	–	X	X	X	–	–	–
DISCAR	13	–	X	X	X	X	X	X
DEFCAR	14	–	X	X	X	–	–	–
N.A.	15	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
SOTF-OC	16	X	X	X	X	–	–	–
STUB-OC	17	–	X	X	X	–	–	–
OC	18	X	X	X	X	–	–	–
EF	19	X	–	–	–	–	–	–
OCN	20	X	–	–	–	–	–	–
UC	21	X	X	X	X	–	–	–
THM	22	X	–	–	–	–	–	–
BCD	23	X	–	–	–	–	–	–
N.A.	24	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
OV	25	X	X	X	X	–	–	–
OVS	26	X	–	–	–	X	X	X
N.A.	36	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
N.A.	28	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
OVN	29	X	–	–	–	–	–	–
UV	30	X	X	X	X	–	–	–
UVS	31	X	–	–	–	X	X	X
N.A.	32	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
FRQ	33	X	–	–	–	–	–	–
DFRQ	34	X	–	–	–	–	–	–
N.A.	35	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
N.A.	36	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
N.A.	37	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
N.A.	38	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
N.A.	39	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
N.A.	40	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Note: 'X' represents a 'Valid signal'. '–' is not 'Valid signal'.

2.26.3 Scheme logic

(i) Trip-signal collection

Trip-signal collection gathers the trip signals provided by each protection function and groups them to the trip operation commands “OPT-TRIP”, “OPT-TRIP-A”, “OPT-TRIP-B”, and “OPT-TRIP-C” for General-trip-signal production, as shown in Figure 2.26-2.

The TRC logic has PLC connection points, which the user can program for issuing the trip command. For example, if the user wishes to trip the CBs using signals generated by external relays, the signals can be connected to the TRC logic using the following PLC connection points: TRIP-A_ADD, TRIP-B_ADD, TRIP-C_ADD and TRIP_ADD.

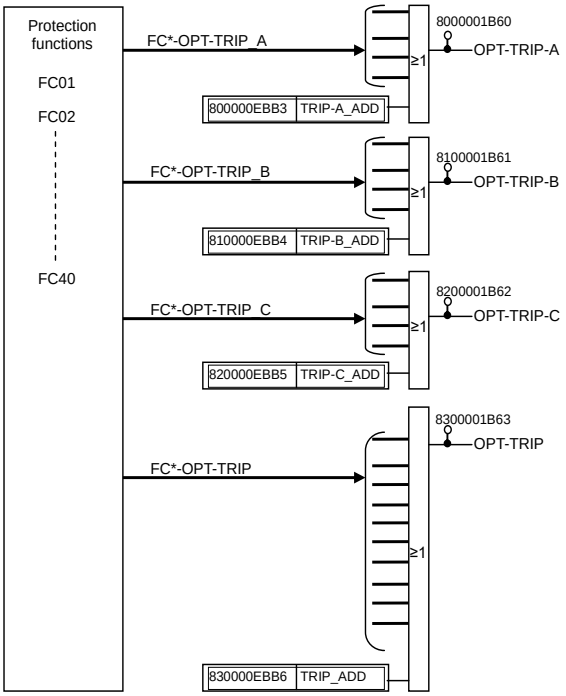


Figure 2.26-2 Scheme logic for Trip-signal collection

(ii) General-trip-signal production

Figure 2.26-3 illustrates the general-trip-signal production logic. The user can program the generation of trip signals using the PLC connection point “ADD_OPT_COM”, when trip signals are not available from the relay functions.

The TRC function has a scheme switch [**TP-MODE**] to determine a trip mode; hence, the user can select either single-phase trip mode (**1-PHASE**) or three-phase trip mode (**3-PHASE**) or per-phase trip mode (**PER-PHASE**) for the CB tripping. Table 2.26-4 has shown the output signals when the TRC function receives the trip signals from the protection functions. Note that the scheme switch [**TP-MODE**] is only applicable when a phase trip mode (**1P**) is set in a protection function (i.e., the user should set trip-phase selectors using [**TPMD**] settings, which some protection functions have. If single-phase trip signals are not generated in the protection

functions, the scheme switch [**TP-MODE**] is useless.

The "GEN.TRIP-A,-B,-C" signals are transferred to the ARC function to initiate the reclose operation of the CBs.

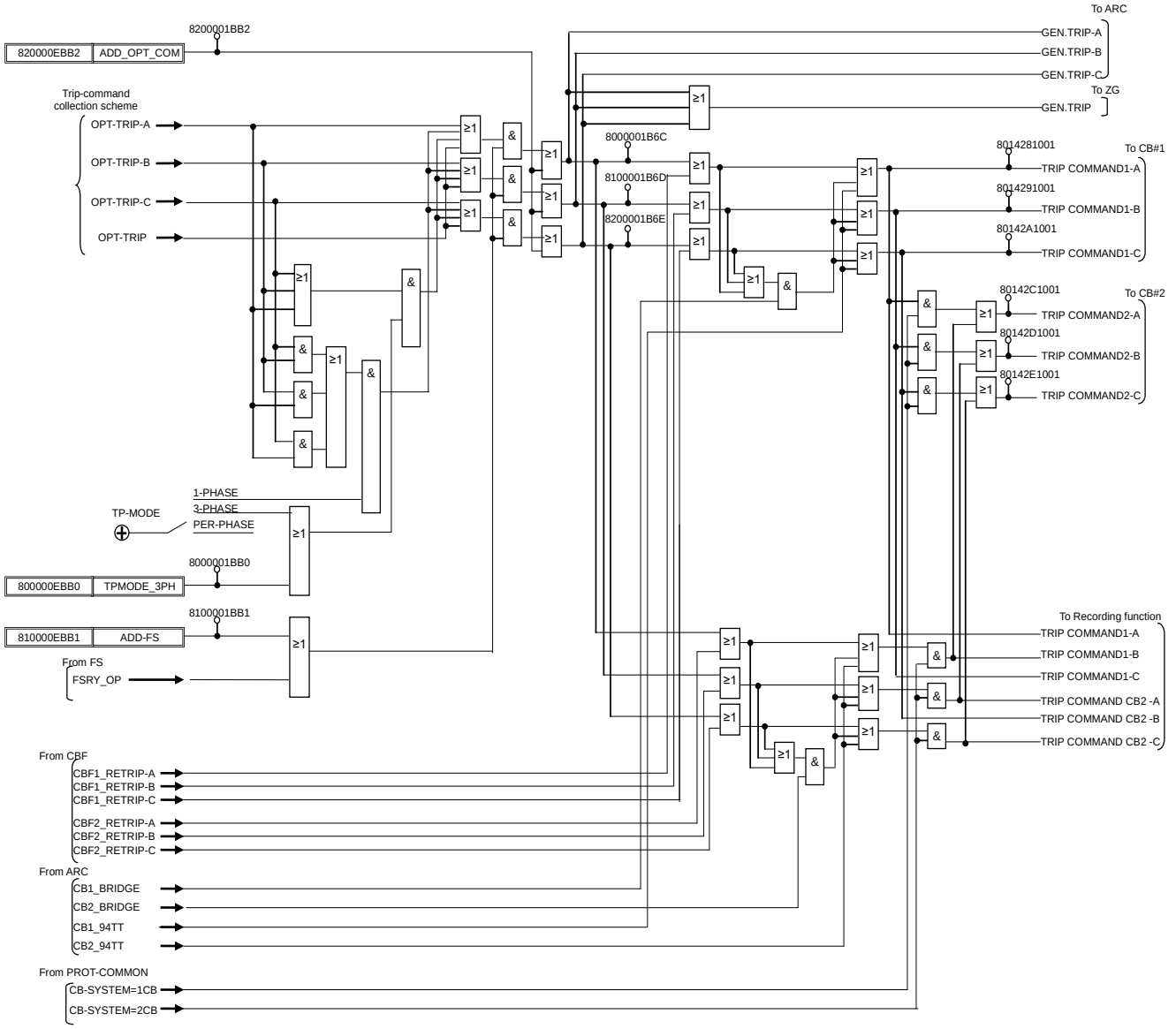


Figure 2.26-3 Logic for general trip and CB trip signals

(ii)-1 Acquisition of fail-safe signal provided externally

If an external relay is available to provide a fail-safe check for the internal operation of the IED, and the user wishes to use the output of the external relay in order to enhance the reliability of tripping further, then the PLC connection points 'ADD-FS' can be used in the Trip-signal generation scheme. That is, the external check signal is connected at the 'ADD-FS' point.

(ii)-2 Acquisition of external trip command

As the PLC connection point 'ADD_OPT_COM' is provided, the TRC function can accept a trip command that is generated externally.

(ii)-3 Provision of trigger signals to Recording functions

The 'TRIP COMMMAND1-A, -B, -C' and 'TRIP COMMMAND2-A, -B, -C' signals are viable to operation of Recording function, which we shall see in Chapter *Recording function*.

(ii)-4 Provision for distance relay

The 'GEN.TRIP' signal is provided to direct the operation of the UVPWI relay in the distance protection function, which we shall see in Chapter *Relay application: Distance protection*.

(iii) CB trip signal production

As illustrated in Figure 2.26-3, the 'TRIP COMMMAND1-A, -B, -C' and 'TRIP COMMMAND2-A, -B, -C' signals are transferred to trip coils of the CB#1 and CB#2 when the signals "OPT-TRIP-A, -B, and -C" or "OPT-TRIP" enter into the TRC function.

(iii)-1 CB trip signals for 1CB system

When the TRC function operates in a single CB (1CB) system; the "TRIP COMMMAND1-A, -B, -C" signals should be connected with BO circuits.

Table 2.26-7 Output signals for single CB#1

Output signals	Usage of signals
TRIP-COMMMAND1-A	CB trip in phase A
TRIP-COMMMAND1-B	CB trip in phase B
TRIP-COMMMAND1-C	CB trip in phase C

(iii)-2 CBs trip signals for 1.5CB system

When the TRC function can operate in a single-and-a-half breaker system (1.5CB); the other "TRIP COMMMAND2-A, -B, -C" signals also should be connected with other BO circuits. Table 2.26-8 summarizes the outputs signals of the TRC function in the 1.5CB system.

Table 2.26-8 Output signals for CB#1 and CB#2 in 1.5CB system

Output signals	Usage of signals
TRIP-COMMMAND1-A	CB#1(Bus CB) trip in phase A
TRIP-COMMMAND1-B	CB#1(Bus CB) trip in phase B
TRIP-COMMMAND1-C	CB#1(Bus CB) trip in phase C
TRIP-COMMMAND2-A	CB#2(Center CB) trip in phase A
TRIP-COMMMAND2-B	CB#2(Center CB) trip in phase B
TRIP-COMMMAND2-C	CB#2(Center CB) trip in phase C

(iv) Sub-signal generation

In a similar way to the Trip-signal collection, the Sub-signal generation groups the blocking signals for ARC operation; it groups them into 'GEN.ARC-BLOCK' signal, as illustrated in Figure 2.26-4. Blocking signal from the CBF function is also integrated into the 'GEN.ARC-BLOCK' signal; then it is transferred to the ARC function.

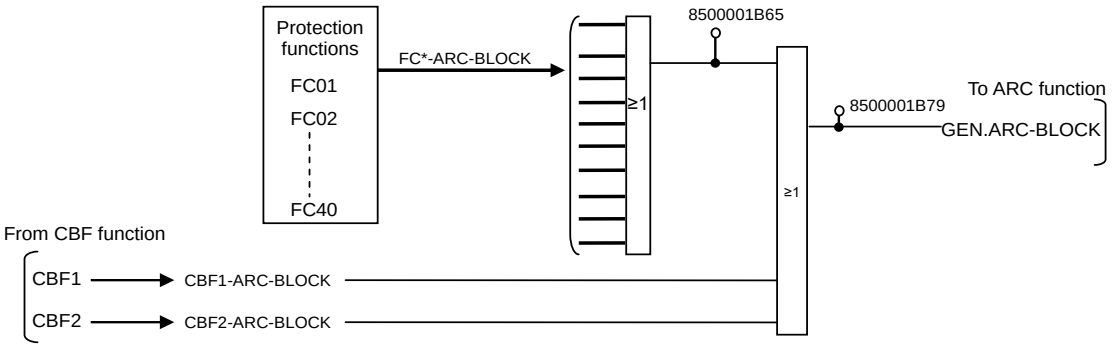


Figure 2.26-4 Scheme logic for Sub-signal generation

(v) Alarm-signal generation

Figure 2.26-5 shows the alarm-signal generation logic. The signals in Table 2.26-6 are collected and grouped into OPT.PHASE-A, OPT.PHASE-B, OPT.PHASE-C, OPT.PHASE-N, and GEN.TRIP_ALARM signals.

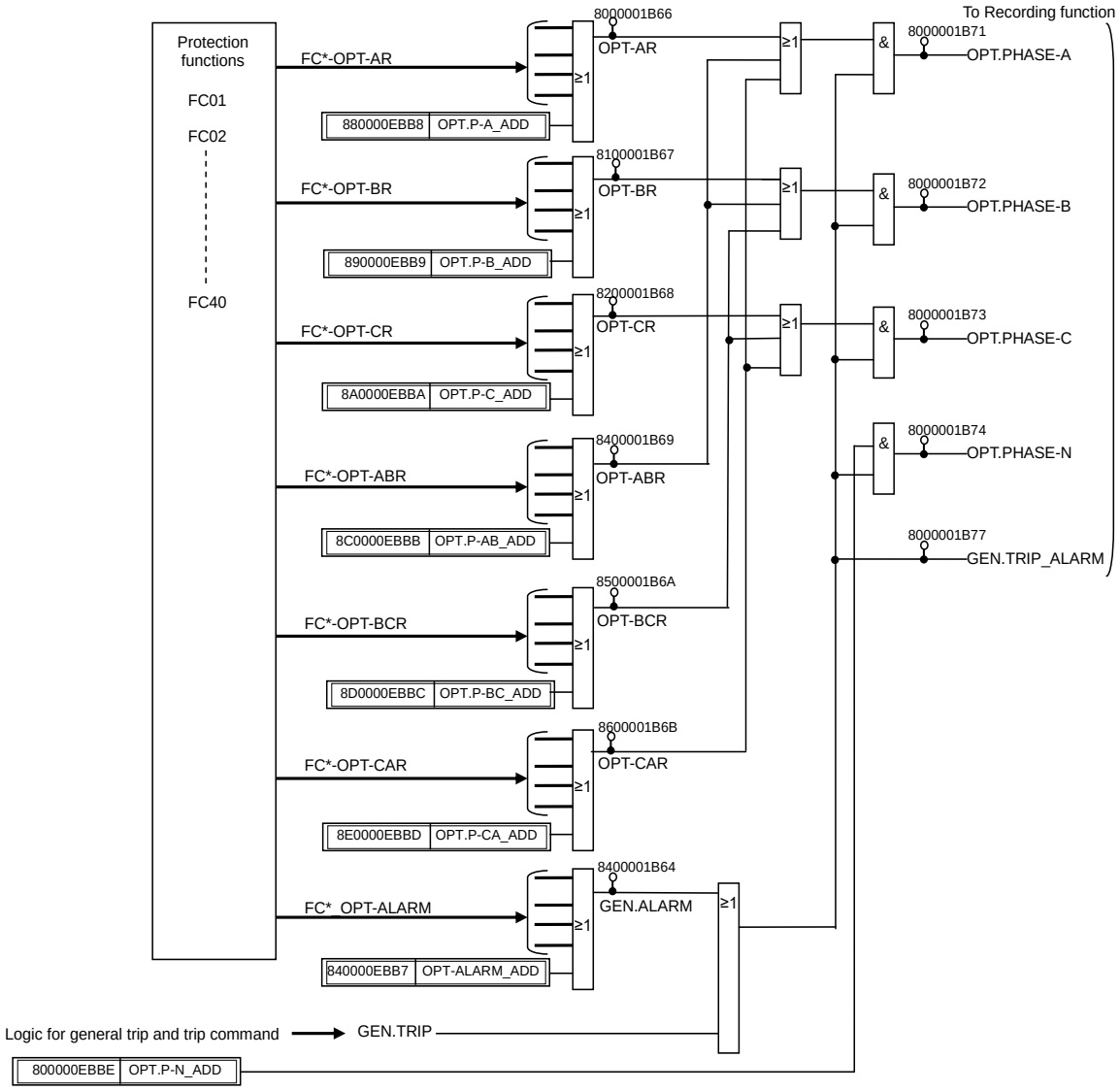


Figure 2.26-5 Scheme logic for Alarm-signal generation

When an alarm signal indicating a Line-to-Line (LL) fault and others is provided externally, the user can also record it as the alarm by the use of PLC connection points 'OPT.P-A_ADD' and others. If the additional relay being designed to operate for a ground fault is available, use the alternative PLC connection point 'OPT.P-N_ADD'.

2.26.4 Setting

Setting of TRC(Function ID: 4A0001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A rating	5A rating	
TRC	TP-MODE	1-Phase / 3-Phase / Per-Phase		-	Trip mode selection	Per-Phase		

2.26.5 Data ID

◆ Signal monitoring point

TRC(Function ID: 4A0001)

Element ID	Name	Description
8400001B64	GEN.ALARM	operation (GEN.ALARM)
8300001B6F	GEN.TRIP	General trip
8000001B6C	GEN.TRIP-A	General trip (Phase-A)
8100001B6D	GEN.TRIP-B	General trip (Phase-B)
8200001B6E	GEN.TRIP-C	General trip (Phase-C)
8000001B77	GEN.TRIP_ALARM	General trip or General alarm
8400001B69	OPT-ABR	operation (ABR)
8000001B66	OPT-AR	operation (AR)
8500001B65	OPT-ARC-BLOCK	operation (ARC-BLOCK)
8500001B6A	OPT-BCR	operation (BCR)
8100001B67	OPT-BR	operation (BR)
8600001B6B	OPT-CAR	operation (CAR)
8200001B68	OPT-CR	operation (CR)
8300001B63	OPT-TRIP	operation (trip)
8000001B60	OPT-TRIP-A	operation (phase-A)
8100001B61	OPT-TRIP-B	operation (phase-B)
8200001B62	OPT-TRIP-C	operation (phase-C)
8000001B71	OPT.PHASE-A	Operating phase-A
8100001B72	OPT.PHASE-B	Operating phase-B
8200001B73	OPT.PHASE-C	Operating phase-C
8300001B74	OPT.PHASE-N	Operating phase-N
8000001B20	TRIP_COMMAND1-A	Trip command 1 (Phase-A)
8100001B21	TRIP_COMMAND1-B	Trip command 1 (Phase-B)
8200001B22	TRIP_COMMAND1-C	Trip command 1 (Phase-C)
8000001B24	TRIP_COMMAND2-A	Trip command 2 (Phase-A)
8100001B25	TRIP_COMMAND2-B	Trip command 2 (Phase-B)
8200001B26	TRIP_COMMAND2-C	Trip command 2 (Phase-C)

◆ Connection point on PLC logic

TRC(Function ID: 4A0001)

Element ID	Name	Description
810000EBB1	ADD_FS	Additional fail-safe command
820000EBB2	ADD_OPT_COM	Additional operation command
840000EBB7	OPT-ALARM_ADD	Additional alarm output command
8C0000EBBB	OPT.P-AB_ADD	Additional operated phase-AB command
880000EBB8	OPT.P-A_ADD	Additional operated phase-A command
8D0000EBBC	OPT.P-BC_ADD	Additional operated phase-BC command
890000EBB9	OPT.P-B_ADD	Additional operated phase-B command
8E0000EBBD	OPT.P-CA_ADD	Additional operated phase-CA command
8A0000EBBA	OPT.P-C_ADD	Additional operated phase-C command
800000EBBE	OPT.P-N_ADD	Additional operated phase-N command
800000EBB0	TPMODE_3PH	3-phases trip permissive command
800000EBB3	TRIP-A_ADD	Additional A-phase trip command

◆ Connection point on PLC logic

TRC(Function ID: 4A0001)

Element ID	Name	Description
810000EBB4	TRIP-B_ADD	Additional B-phase trip command
820000EBB5	TRIP-C_ADD	Additional C-phase trip command

2.27 Autoreclose (ARC)

The basic objective of auto-reclosing is to restore automatically the transmission line back into service, after being tripped by line protection relays, without depending on the operator action. The use of auto-reclosing will improve the system stability and reliability. The choice of the auto-reclosing type, such as, one or more reclosing shots, high speed or delayed, single-phase or multi-phase depends on the characteristics of the transmission and protective system together with the utility practice. The suitability of a particular auto-reclosing scheme may also be established by conducting a transient analysis study of the interconnected electrical network.

Note: Several IED models do not have auto-reclosing features. To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.27-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
ARC	Auto-reclosing	NA	✓	✓	(✓)	✓

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, OCN, THM, BCD, CBF, SOTF-OC, OV, OVS, UV, UVS, FRQ/DFRQ, FS, VTF, CTF, VCHK.

2.27.1 Overview

Table 2.27-2 summarizes the reclosing operations and the modes in the ARC function. The ARC function can operate for both a single CB arrangement and double CBs (1.5CB) arrangement; hence, the ARC function is grouped into two logics: ARC1 for CB#1 and ARC2 for CB#2. Note that multi-shots scheme is only available for 1CB arrangement (CB#1). The 'ORIGINAL' is provided for the user's programing.

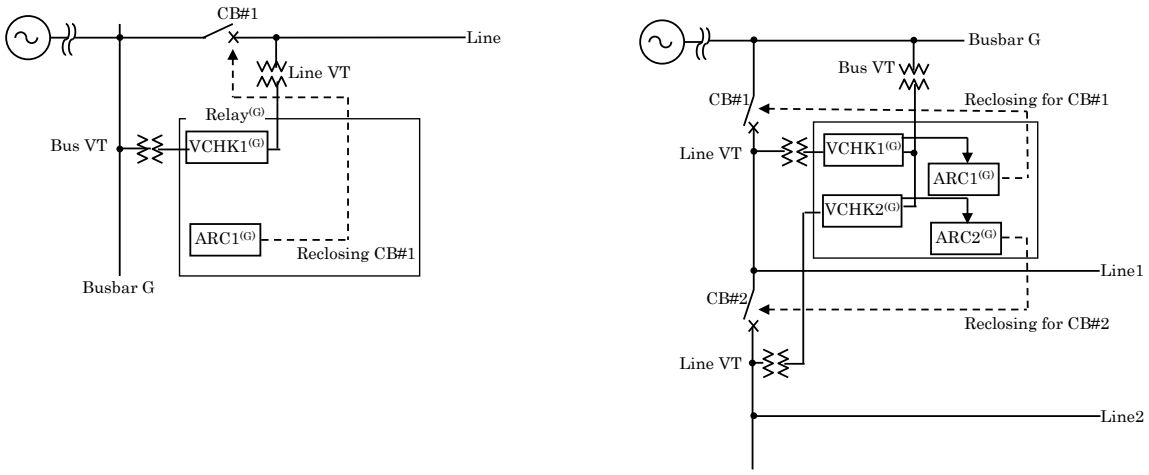
Table 2.27-2 ARC operation modes and shot numbers

Shot number	Reclosing mode	1CB or 1.5CB arrangement			Parallel lines	
		1CB		1.5CB	1CB	2CB
		ARC1	ARC2	ARC1&2	ARC1	ARC1&2
ARC1 SHOT1 or/and ARC2 SHOT	SPAR	X	(N.A)	x	(N.A)	(N.A)
	TPAR	X	(N.A)	x	(N.A)	(N.A)
	SPAR&TPAR	X	(N.A)	x	(N.A)	(N.A)
	MPAR	(N.A)	(N.A)	(N.A)	x	x
	ORIGINAL	X	(N.A)	x	(N.A)	(N.A)
ARC1 SHOT2		X	(N.A)	(N.A)	x	(N.A)
ARC1 SHOT3		X	(N.A)	(N.A)	x	(N.A)
ARC1 SHOT4		X	(N.A)	(N.A)	x	(N.A)
ARC1 SHOT5		X	(N.A)	(N.A)	x	(N.A)

x: Operation is applicable N.A: Operation is not applicable

(i) Breaker system

The ARC function can operate in several breaker systems, as shown in Figure 2.27-1. For the 1.5CB arrangement, the ARC1 and ARC2 logics operate separately; the user can select different reclosing scheme (Figure 2.27-1.b). In parallel lines, the ARC function can take several reclosing schemes when the communication application (COMM_APPL) is available (Figure 2.27-1.c).

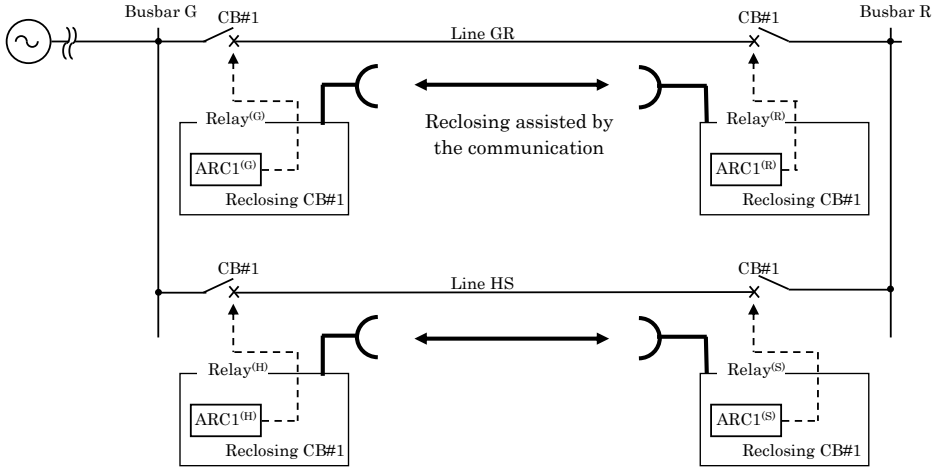


[**ARC1-MODE**]= **FT** / **SPAR** / **TPAR** / **SPAR&TPAR**
[**ARC2-MODE**]= **Off**

a.1CB arrangement system (CB#1)

[**ARC1-MODE**]= **FT** / **SPAR** / **TPAR** / **SPAR&TPAR**
[**ARC2-MODE**]= **FT** / **SPAR** / **TPAR** / **SPAR&TPAR**

b. 1.5 CB arrangement (CB#1 and CB#2)



[**ARC1-MODE**]= **MPAR** [**ARC2-MODE**]= **Off**
[**MPAR-MODE**]= **M2/M3**

c. Parallel lines (CB#1)

Figure 2.27-1 Breaker systems

(ii) Reclosing modes in 1CB and 1.5CB

(ii)-1 Single-phase auto reclose (Setting [**ARC1-MODE**]=**SPAR**)

A faulted phase is tripped by relay applications if a single-phase earth fault occurs; then the ARC function tries to recloses the CB. In the case that the phase-to-phase (or multi-phases) fault occurs, the CB is tripped forcibly in three-phases by the instruction of the ARC function regardless of the fault detection of relay application; the ARC function does not try to reclose the CB. For the SPAR mode, reclosing the CB is performed without the synchronism check and voltage check.

(ii)-2 Three-phase auto reclose (Setting [**ARC1-MODE**]=**TPAR**)

The CB is tripped forcibly in three-phases whether the relay applications detect single-phase fault type or multi-phase fault type; then, the CB will be reclosed by the ARC function. To reclose the CB, the permission signal of the voltage and synchronism check (VCHK†) function is required in the TPAR mode.

†Note: VCHK are automatically applied in the TPAR mode (for ARC1 SHOT1 and ARC2 SHOT). For more information, see Chapter *Relay application: Voltage check for auto reclose*.

(ii)-3 Single- and three-phase auto reclose (Setting [**ARC1-MODE**]=**SPAR&TPAR**)

The CB is tripped in single-phase by the fault detection of relay applications if a single-phase fault occurs; the ARC function tries to reclose the CB. Three-phase tripping is performed if a multi-phase fault occurs; then, the CB will be reclosed by the ARC function. Note that the VCHK permission signal is required to reclose the CB in the three-phase tripping (i.e., TPAR scheme), but the VCHK permission signal is not required in signal-phase tripping (i.e., SPAR scheme).

(ii)-4 Setting selection about SPAR and TPAR modes

Since power can be transmitted through healthy phases even during the dead time, the SPAR mode is convenient for maintaining power system stability. On the other hand, the capacitive coupling effect between the healthy phase and faulty phase may cause a longer de-ionization time when compared to the TPAR mode. That is, a longer dead time is required in the TPAR mode. A shorter dead time can be set in the TPAR mode when compared to the SPAR mode.

For the TPAR mode in the 1.5CB arrangement, synchronism check and voltage check (VCHH) between the bus bar (for bus CB#1) and the line or between the two lines (for center CB#2) are required. The reclosing order between CB#1 and CB#2 can be selected using setting [**ARC-ORDER**]; that is, CB#1 recloses first followed by CB#2 (i.e., [**ARC-ORDER**]=**CB1**)or vice versa (i.e., [**ARC-ORDER**]=**CB2**). Simultaneous closure of CB#1 and CB#2 can also be selected (i.e., [**ARC-ORDER**]=**SIMUL**).

(iii) Reclosing mode in parallel lines (Setting [**ARC1-MODE**]=**MPAR)**

Only the faulted phases are tripped and reclosed, when the terminals of parallel lines are interconnected during the dead time, through at least two or three different phases. The MPAR mode realizes high-speed reclosing for multi-phase faults without synchronism and voltage check (VCHK) and minimizes the possibility of outages in the case of double faults on parallel lines. If the interlinking condition is not satisfied, and reclosing is conditionally permitted based on the result of Link judgment logic. The user has to select a reclosing mode and the number of healthy phases when the fault occurs (i.e., Settings [**ARC-MANOLK**] and [**MPAR-**

MODE]).

(iv) User configurable autoreclose (Setting [**ARC1-MODE**]=**Original)**

In the user configurable auto reclose mode (ORIGINAL), the user can manage the scheme of the ARC procedure and it allows the user program the ARC function by the PLC function.

(v) Number of reclosing shots

(v)-1 Single-shot autoreclose (Setting [**ARC-NUM**]=**S1** in 1CB)

In single-shot autoreclose scheme, autoreclose is performed only once. If the fault cannot be cleared after reclosing, the ARC function reaches final tripping stage (ARC1 FT) and the ARC function instructs the TRC to make three-phase tripping (94CB1_TT). The first shot (ARC1 SHOT1) is just issued when setting [**ARC-NUM**]=**S1**, as described in Table 2.27-2.

(v)-2 Multi-shot autoreclose (Setting [**ARC-NUM**]=**S2/S3/S4/S5** in 1CB)

Any of the two-shot (**S2**) to five-shot (**S5**) reclosing can be selected in multi-shot autoreclose scheme. Successive shots (ARC1 SHOT2 to ARC1 SHOT5) are three-phase tripping and reclosing, if the first shot (ARC1 SHOT1) fails. For 'ARC1 SHOT2' to 'ARC1 SHOT5', which are applied in three-phase reclosure, the user shall introduce a permission signal by PLC programming or the voltage and synchronism check signal. Closing status of the CB main contact can be monitored in the PROT_COMM function; the ARC function can evaluate the successful reclosing-operation after issuing the shots (ARC1 SHOT1 and others). A failure (ARC1 CLOSE FAIL) is signaled if the CB#1 fails to close after issuing the 'ARC1 SHOT1 and others'.

(v)-3 Signle-shot autoreclose (Setting [**ARC-NUM**]=**S1** in 1.5CB)

Note that multi-shot autoreclose will not be applied in the 1.5CB busbar arrangement. The first shot (ARC1 SHOT1/ARC2 SHOT) is just issued for the CB#1 and the CB#2. Closing status of the CB#1 and CB#2 main contacts can be monitored in the PROT_COMM function; the ARC function issues a failure signal (ARC1 CLOSE FAIL or ARC2 CLOSE FAIL) if a CB fails to close after issuing the 'ARC1 SHOT1' or 'ARC2 SHOT'.

(vi) Operation failure in tripping CB

A check is required to determine whether the CB have been tripped to open properly when the relay applications detect the fault. If the CB cannot open within the required time, a failure signal "CB fail to open" is indicated; the ARC function resets the reclose operation of the CB and a shot is not issued.

(vii) Final trip stage

When the ARC function detects the following conditions, the ARC function goes to 'Final trip'

stage, which the ARC issues a three-phase trip signal (CB1_94TT or CB2_94TT) for the TRC function; the ARC function abandons to reclose the CB#1 and CB#2 (ARC1 FT or ARC2 FT).

- CB is not ready for ARC operation
- Failure to issue ARC shot
- ARC block command has come through PLC connection points
- Multi-phase trip in SPAR mode
- Evolving fault (single phase to multiphase) in SPAR and TPAR mode
- No link within parallel lines in MPAR mode; (final trip selected)
- Final trip selected for 3-phase fault (user settable)
- ARC close fail
- Shot number over

2.27.2 Terminology

The terminology and signals outlined below are applicable for single CB#1 system. Signals applicable for CB#2 in a two (2) CB system are similar and are not included for clarity.

(i) Relay operation period

The time interval commencing from the instant of the relay picking-up for the fault current to the instant of the relay dropping-off following the cessation of the fault current.

(ii) Temporary/transient/Arc fault

A transient/temporary fault, the main cause of which is often due to lightning, (an over voltage induced in a line due to the static electricity caused by the lightning may cause a flash over across the insulator string), temporary contact with foreign objects, conductor clashing as a consequence of strong wind.

(iii) Arcing time of CB

When the CB#1 contacts separate during tripping, an arc is produced between the CB#1 contacts; the arc is extinguished by the interrupting medium in the CB#1. The duration of arcing is called the 'Arcing time', which is the time between the instant of separation of the circuit breaker contacts and the instant of the extinction of the fault arc.

(iv) Permanent fault (Signal 'ARC1 FT')

Fallen conductors, tree growth, tree branches that have fallen across lines, as well as other causes, may all produce permanent faults. As the operation of the ARC function is unable to restore power transmission for permanent faults, the ARC function abandons the reclosing of the CB#1, defined as the 'Final trip (ARC1 FT)' stage. If the ARC function gets into the 'ARC1 FT' stage, closing the CB#1 is only possible by the manual operation.

(v) Signal shot scheme (Signal 'ARC1 SHOT1')

The ARC function issues a first auto-reclosing signal 'ARC1 SHOT1' when a 'GEN.TRIP' signal is issued in the trip circuit (TRC†) by the first relay operation. When the user programs the ARC function not to provide subsequent reclosures, this operating sequence provides only one reclosing operation; then, lockout will occur on subsequent tripping, i.e. the 'Final trip (ARC1 FT)' stage.

†Note:For more information, see chapter *Relay application: Trip circuit*.

(vi) Multi shot scheme (Signals 'ARC1 SHOT2–5')

Signals 'ARC1 SHOT2' to 'ARC1 SHOT5' may be issued after the 'ARC1 SHOT1' signal when a persistent fault occurs.

(vii) Dead time (Delay timers TTPAR† and TD_MS2–5)

The dead time is the time interval from relay operation i.e. the initiation of the auto-reclose scheme, to the inception of the 'ARC1 CLOSE COMMAND' used to energize the circuit breaker closing circuit and is provided by delay timer [**TTPAR1**]. A substitute delay timer [**TTPAR1_SUB**] is also available when the user wishes to program the inception of the 'ARC 1SHOT1' signal using the PLC function instead of [**TTPAR1**], this feature is only provided in the event that the user wishes to replace the original logic.

The dead times for sequential operation of the autoreclose scheme 'ARC1 SHOT2' to 'ARC1 SHOT5', are provided by delay timers [**TD_MS2**]–[**TD_MS5**], respectively.

†Note: delay timer [**TTPAR**] is available when the ARC function operates in TPAR mode. For the operation in other SPAR, MPAR, and ORGAR modes, the user should also set values for delay timers [**TSPAR1**], [**TMPAR1**], and [**TORGAR1**].

(viii) Pulse width of 'ARC1 CLOSE COMMAND' (Setting TCCW1)

An 'ARC1 CLOSE COMMAND' signal is issued after the dead time. Setting [**TCCW1**] is used to define the pulse-width of the reclosing commands for respective shots1–5.

(ix) Final trip stage to abandon CB reclosure (Signal 'ARC1 FT' and setting TRR1, TRR_MS2–5)

TRR1 is the time from the ARC1 initiation to abandoning issuing the 'ARC1 SHOT1'. In TPAR† mode the permissive signal 'ARC1-VCHK' must be issued by the VCHK function within the time interval of **TRR1** at the end of the dead time (i.e., **TRR1** has not timed out), otherwise the ARC function abandons the reclosure of CB#1. That is, if **TTPAR1** has timed out and 'ARC1-VCHK' permissive has not been issued within **TRR1** time, TRR1 signal yielded in the TPAR mode ends up 'Final Trip (ARC1 FT)'. Note that the timer setting of the [**TRR1**] timer should be set greater than that applied to the dead time delay timer [**TTPAR1**] to ensure that the dead time has fully expired.

Likewise, for shots 2–5 the timers [**TRR_MS2**] and others issue the signal for 'Final Trip (ARC1 FT)' if the respective shots are not issued within the set time.

†Note: We can see similar ARC behavior in the other SPAR, MPAR, and ORGAR modes.

(x) Reset for tripping failure (Signal 'ARC1 RESET' and setting TRESET)

Subsequent to the reception of the 'GEN.TRIP' signal, a check is required to determine whether the CB#1 has opened. If the CB#1 has not opened within the time setting of timer [**TRESET**], then "CB#1 failing to be opened" is judeged by the 'ARC1 RESET' signal, which also resets the

reclose operation of the CB#1. The duration of the setting applied to the [**TRESET**] timer must be less than the setting applied to the ARC dead time delay timers (e.g. [**TTPAR**] etc.).

(xi) Decision time for successful operation or failure (Setting TARCSUC and signals 'ARC1 CLOSE SUCCESS', 'ARC1 CLOSE FAIL', 'ARC1 SHOT RS')

The [**TARCSUC**] timer provides the following functionality depending on the setting of scheme switch [**ARC-SucChk**].

(xi)-1 Scheme switch [**ARC-SucChk**]=**On**

With [**ARC-SucChk**] set to **On**, timer [**TARCDSUC**] is used to define the checkpoint at which the CB#1 (and #2) are closed successfully after issuing the 'ARC1(or 2) CLOSE COMMAND' signal following which, an 'ARC1(or 2) CLOSE SUCCESS' signal is issued.

If the CB fails to close within the setting of timer [**TARCSUC**],an 'ARC1 CLOSE FAIL' signal is issued and the ARC1 function moves to the 'Final trip (ARC1 FT)' stage.

Successful reclose of the CB (subsequent to fault clearance) is checked by the 'Success check' logic, which checks for the signal 'CB1_ALLPH_CLOSE' provided by the protection common function (PROT_COMMON). Clearing the fault automatically resets the ARC1 operation.

(xi)-2 Scheme switch [**ARC-SucChk**]=**Off**

With [**ARC-SucChk**] set to **Off**, timer [**TARCSUC**] may be used to check for a successful closure following the issue of the 'ARC1 SHOT' command. The 'ARC1 SHOT RS' signal is generated which is used for resetting the ARC function about the CB#1 reclosure.

Note: a CB failure to close condition cannot be detected; the user shall incorporate the check scheme externally.

(xii) Progress of ARC operation (Signals 'ARC1 IN-PROG' and others)

Information regarding the progress of an ARC operation is provided following the reception of the 'GEN.TRIP-A/B/C' signals as follows:

(xii)-1 Entire ARC progress for all shots (signal 'ARC1 IN-PROG')

The 'ARC1 IN-PROG' signal is defined for the time from issuing the first 'GEN.TRIP-A/B/C' to the confirmation of the ARC successful operation or the final trip.

(xii)-2 Respective progress for respective shots (signal 'ARC1-S* IN-PROG/OR')

Respective signals 'ARC1-S* IN-PROG' are defined for the operation of respective shots. A common 'ARC1 IN-PROG OR' is also issued.

(xii)-3 Trigger for the ARC operation (signal 'ARC_START')

The 'ARC_START' signal shows the instant at which 'GEN.TRIP-A/B/C' signals are given from the TRC function. If an external relay can generate the 'ARC_START' signal, the user can use it by programing the binary input circuit (BI) in the PLC function.

(xii)-4 Tripped phases (signals 'TRIP-ANYPH', 'TRIP-1PH', 'TRIP-MPH', 'TRIP-3PH')

Start logic also decides whether the trip mode is single-phase, multi-phase or three-phases. These signals are used for issuing ARC1 SHOT1 in SPAR/TPAR/MPAR modes.

(xiii) Reclaim timer (Setting 'TREADY')

Certain considerations are required to ensure that the ARC function is ready for the next cycle of operation; the reclaim timer 'TREADY' is provided within the ARC function to accommodate this requirement. When a CB is closed for the first time subsequent to the maintenance of a distribution line, the closure would normally be expected to be successful (that is, the CB is closed on to a healthy line). Then the minimum time setting of the [**TREADY**] reclaim timer should be longer than the time required to judge that the CB has closed successfully.

Another consideration required for this setting is that after the CB has gone through a successful ARC cycle; the maximum allowable successive close-open operations are achieved with the setting. In this case, the minimum time delay required before the CB is ready for the next ARC cycle becomes the setting criteria for the [**TREADY**] timer.

Where the incidence of recurrent lightning strikes is experienced, a shorter reclaim time will prevent the ARC function going into an unnecessary lock out. On the other hand, caution is required when considering the exposure of the CB to an excessive number of ARC cycles caused by recurrent faults which will result in an increase in the frequency of the maintenance cycle.

In summary, the time required for the CB to be ready for the next cycle of ARC is the minimum setting that can be applied to the reclaim timer [**TREADY**] in the ARC function.

(xiv) CB bridge (Signal 'CB1_BRIDGE')

The 'CB1_BRIDGE' signal is thrown into the TRC function when the ARC1 logic fails to be 'Ready condition'. The 'CB1_BRIDGE' signal ensures three-phase tripping in the CB#1 when a per-phase trip signal is provided in the TRC function.

(xv) Condition logic (Signals 'ARC1_SPAR_COND', 'ARC1_TPAR_COND')

The 'Condition' logic issues the above signals depending on the setting [**ARC1 MODE**] and the tripped phases (i.e., signal 'TRIP-ANYPH' and others). This logic is available when the setting [**ARC1 MODE**] = **SPAR**, **TPAR**, or **SPAR&TPAR**.

(xvi) Link judgment (setting MPAR-MODE and signals 'MPAR_LINK')

With regard to the power transmission between terminals, the 'Link judgment' logic issues the healthy phases that are left during a fault in parallel lines. This logic is available when the settings [**ARC1 MODE**] = **MPAR** and [**ARC-MANOLK**] = **TPAR** or **SPAR&TPAR**.

2.27.3 Function block diagram

The function diagrams for respective modes are illustrated; they represents the general flow of the logic in the ARC1 function. For simplicity, the function block diagrams are represented for CB1 in a 1CB arrangement in Figure 2.27-2, Figure 2.27-3, and Figure 2.27-4; the logics are similar for CB2 in the 1.5CB arrangement except that only a single shot is permitted in the 1.5CB arrangement. Note that the logics are shown for a two (2) shot scheme for simplicity.

Each functional block diagram is grouped into a number of logic blocks; four typical functional block diagrams are illustrated below:

(i) Issuing 'ARC SHOT1' and 'ARC SHOT2' in 1 CB of the SPAR mode

(ii) Issuing 'ARC SHOT1' and 'ARC SHOT2' in 1 CB of the TPAR mode

(iii) Issuing 'ARC SHOT1' and 'ARC SHOT2' in 1 CB of the SPAR and TPAR mode

(iv) Issuing 'ARC SHOT1' and 'ARC SHOT2' in MPAR of parallel lines

(i) SPAR mode

Figure 2.27-2 illustrates the ARC function when settings of are performed in both Table 2.27-3 and Table 2.27-4.

Table 2.27-3 Block parts in SPAR mode

Block parts	Corresponding logics	Detailed logic
[1]	ARC1-Mode input	**Figure 2.27-11**
[2]	Shot number	**Figure 2.27-13**
[3]	Start	**Figure 2.27-14**
[4]	Initiation	**Figure 2.27-15**
[5]	Shot counter	**Figure 2.27-16**
[6]	Condition	**Figure 2.27-17**
[7]	ARC1 SPAR	**Figure 2.27-18**
[8]	ARC1 SHOT2	**Figure 2.27-21**
[9]	Issuing	**Figure 2.27-22**
[10]	Success check	**Figure 2.27-23**

Table 2.27-4 Setting examples in SPAR mode

Categories	Items	Settings	Corresponding logics
ARC general	ARC1-Mode	SPAR	**Figure 2.27-11**
	ARC2-Mode	Off	**Figure 2.27-12**
	ARC-NUM	S2	**Figure 2.27-13**
ARC1	TREADY	60.0s	**Figure 2.27-15**
	TSPAR1	0.80s	**Figure 2.27-18**
	TSPAR1_SUB	300.00s	**Figure 2.27-18**
	TRR1	2.00s	**Figure 2.27-18**
	TCCW1	0.20s	**Figure 2.27-22**
ARC1 multi-shot	TD_MS2	20.00s	**Figure 2.27-21**
	TRR_MS2	30.00s	**Figure 2.27-21**
ARC misc.	ARC-SucChk	On	**Figure 2.27-23**
	TARCSUC	0.30s	**Figure 2.27-23**
	FT-3pFault	Off	**Figure 2.27-14**
	TRESET	0.30s	**Figure 2.27-15**
	TEVLV	0.30s	**Figure 2.27-17**
	SHOTNUM-TEST	Off	**Figure 2.27-16**
PROT-COMMON	CB-System	1CB	See Protection common function
VCHK	ARC1-VCHK EN	Off	VCHK signal not required
TRC	TP-MODE	Per-Phase	See Trip circuit

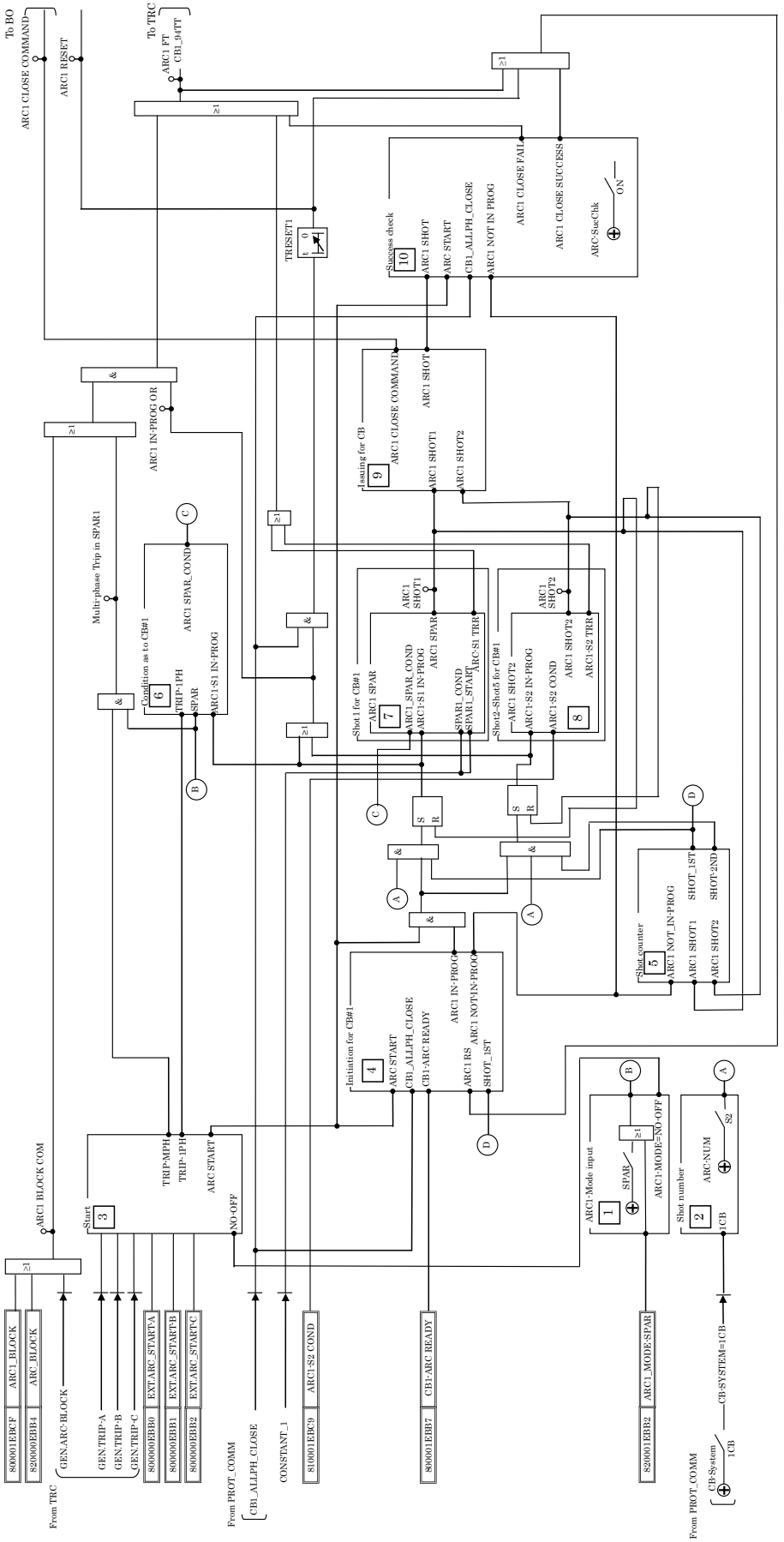


Figure 2.27-2 ARC SHOT1 and SHOT2' in SPAR mode of 1CB system

(ii) TPAR mode

Figure 2.27-3 illustrates the ARC function when settings of are performed in both Table 2.27-5 and Table 2.27-6.

Table 2.27-5 Block parts in TPAR mode

Block parts	Corresponding logics	Detailed logic
[1]	ARC1-Mode input	Figure 2.27-11
[2]	Shot number	Figure 2.27-13
[3]	Start	Figure 2.27-14
[4]	Initiation	Figure 2.27-15
[5]	Shot counter	Figure 2.27-16
[6]	Condition	Figure 2.27-17
[7]	ARC1 TPAR	Figure 2.27-19
[8]	ARC1 SHOT2	Figure 2.27-21
[9]	Issuing	Figure 2.27-22
[10]	Success check	Figure 2.27-23
[11]	Reclose sequence	Figure 2.27-24

Table 2.27-6 Setting examples in TPAR mode

Categories	Items	Settings	Corresponding logics
ARC general	ARC1-Mode	TPAR	Figure 2.27-11
	ARC2-Mode	Off	Figure 2.27-12
	ARC-ORDER	CB1	Figure 2.27-24
	ARC-NUM	S2	Figure 2.27-13
ARC1	TREADY	60.0s	Figure 2.27-15
	TTPAR1	0.60s	Figure 2.27-19
	TTPAR1_SUB	300.00s	Figure 2.27-19
	TRR1	2.00s	Figure 2.27-19
	TCCW1	0.20s	Figure 2.27-22
ARC1 multi-shot	TD_MS2	20.00s	Figure 2.27-21
	TRR_MS2	30.00s	Figure 2.27-21
ARC misc.	ARC-SucChk	On	Figure 2.27-23
	TARCSUC	0.30s	Figure 2.27-23
	FT-3pFault	Off	Figure 2.27-14
	TRESET	0.30s	Figure 2.27-15
	SHOTNUM-TEST	Off	Figure 2.27-16
PROT-COMMON	CB-System	1CB	See Protection common function
VCHK	ARC1-VCHK EN	On	See Voltage check for autoreclose
TRC	TP-MODE	Per-Phase	See Trip circuit

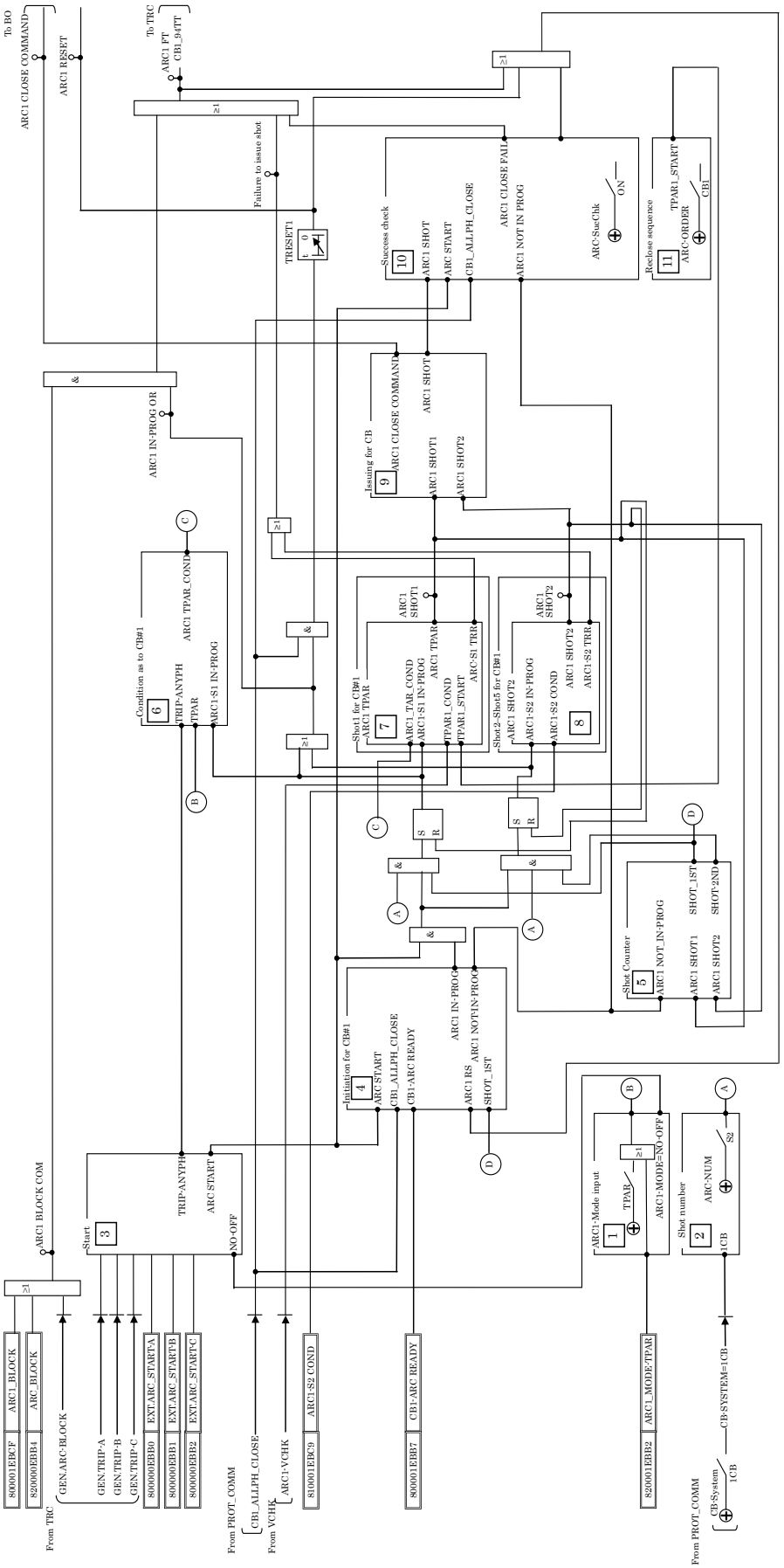


Figure 2.27-3 ARC SHOT1 and SHOT2 in TPAR mode of 1CB system

(iii) SPAR and TPAR mode

Figure 2.27-4 illustrates the ARC function when settings of are performed in both Table 2.27-7 and Table 2.27-8.

Table 2.27-7 Block parts in SPAR and TPAR mode

Block parts	Corresponding logics	Detailed logic
[1]	ARC1-Mode input	Figure 2.27-11
[2]	Shot number	Figure 2.27-13
[3]	Start	Figure 2.27-14
[4]	Initiation	Figure 2.27-15
[5]	Shot counter	Figure 2.27-16
[6]	Condition	Figure 2.27-17
[7]	ARC1 TPAR	Figure 2.27-20
[8]	ARC1 SHOT2	Figure 2.27-21
[9]	Issuing	Figure 2.27-22
[10]	Success check	Figure 2.27-23
[11]	Reclose sequence	Figure 2.27-24

Table 2.27-8 Setting examples in SPAR and TPAR mode

Categories	Items	Settings	Corresponding logics
ARC general	ARC1-Mode	SPAR&TPAR	Figure 2.27-11
	ARC2-Mode	Off	Figure 2.27-12
	ARC-ORDER	CB1	Figure 2.27-24
	ARC-NUM	S2	Figure 2.27-13
ARC1	TREADY	60.0s	Figure 2.27-15
	TSPAR1	0.80s	Figure 2.27-18
	TSPAR1_SUB	300.00s	Figure 2.27-18
	TTPAR1	0.60s	Figure 2.27-20
	TTPAR1_SUB	300.00s	Figure 2.27-20
	TRR1	2.00s	Figure 2.27-20
	TCCW1	0.20s	Figure 2.27-22
ARC1 multi-shot	TD_MS2	20.00s	Figure 2.27-21
	TRR_MS2	30.00s	Figure 2.27-21
ARC misc.	ARC-SucChk	On	Figure 2.27-23
	TARCSUC	0.30s	Figure 2.27-23
	FT-3pFault	Off	Figure 2.27-14
	TRESET	0.30s	Figure 2.27-15
	TEVLV	0.30s	Figure 2.27-17
	SHOTNUM-TEST	Off	Figure 2.27-16
PROT-COMMON	CB-System	1CB	See Protection common function
VCHK	ARC1-VCHK EN	On	See Voltage check for autoreclose
TRC	TP-MODE	Per-Phase	See Trip circuit

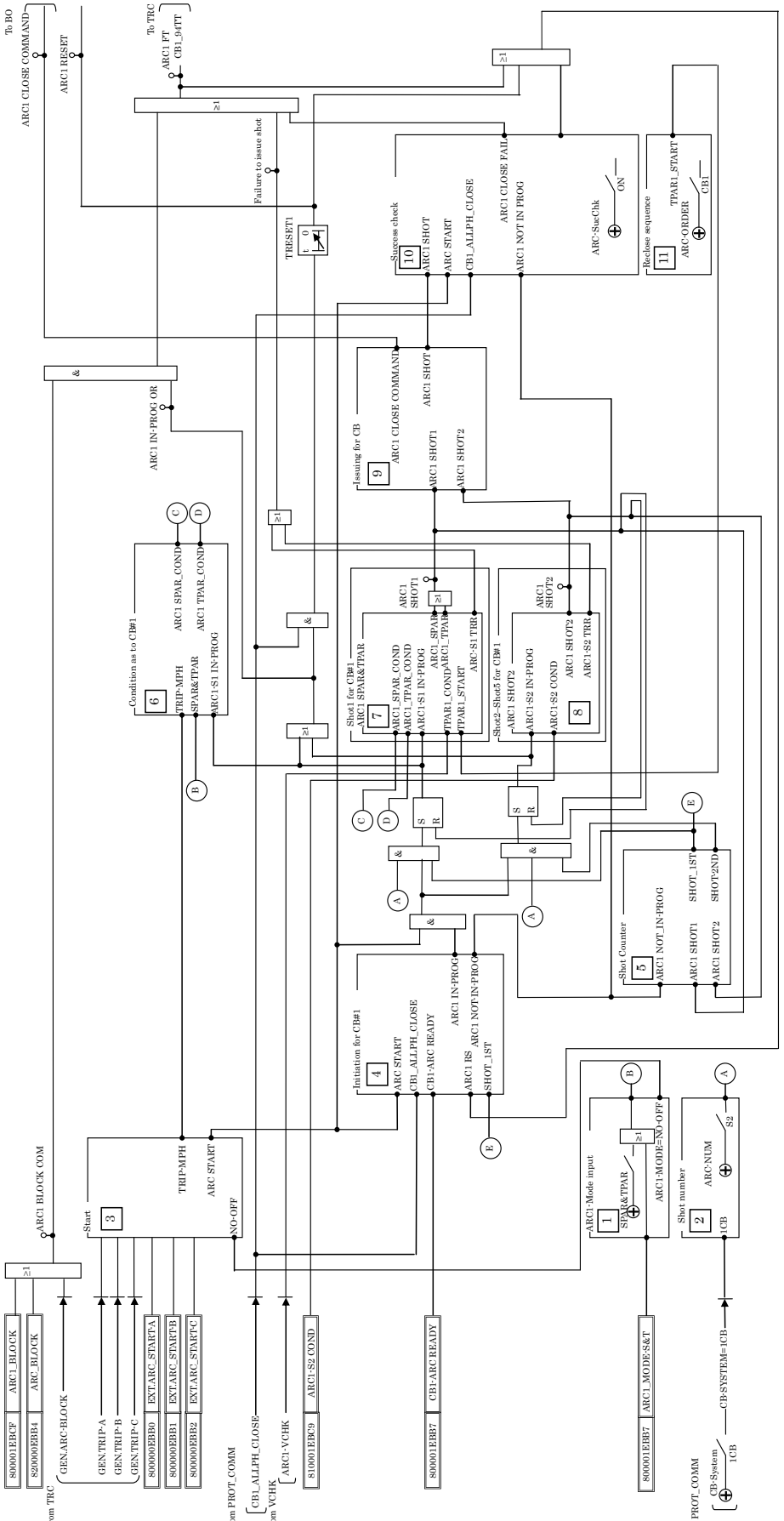


Figure 2.27-4 ARC SHOT1 and SHOT2 in SPAR&TPAR mode of 1CB system

(iv) MPAR mode

Figure 2.27-5 illustrates the ARC function when settings of are performed in both Table 2.27-9 and Table 2.27-10.

Table 2.27-9 Block parts in MPAR mode

Block parts	Corresponding logics	Detailed logic
[1]	ARC1-Mode input	Figure 2.27-11
[2]	Shot number	Figure 2.27-13
[3]	Link judgment	Figure 2.27-28
[4]	Start	Figure 2.27-14
[5]	Initiation	Figure 2.27-15
[6]	Shot counter	Figure 2.27-16
[7]	ARC1 MPAR	Figure 2.27-27
[8]	ARC1 SHOT2	Figure 2.27-21
[9]	Issuing	Figure 2.27-22
[10]	Success check	Figure 2.27-23
[11]	Reclose sequence	Figure 2.27-24

Table 2.27-10 Setting examples in MPAR mode

Categories	Items	Settings	Corresponding logics
ARC general	ARC1-MODE	MPAR	Figure 2.27-11
	ARC2-MOED	Off	Figure 2.27-12
	MPAR-MODE	M2	Table 2.27-13
	ARC-ORDER	CB1	Figure 2.27-24
	ARC-NUM	S2	Figure 2.27-13
ARC1	TREADY	60.0s	Figure 2.27-15
	TSPAR1	0.80s	Figure 2.27-18
	TSPAR1_SUB	300.00s	Figure 2.27-18
	TTPAR1	0.60s	Figure 2.27-20
	TTPAR1_SUB	300.00s	Figure 2.27-20
	TMPAR1	1.00s	Figure 2.27-27
	TMPAR1_SUB	300.00s	Figure 2.27-27
	TRR1	2.00s	Figure 2.27-20
	TCCW1	0.20s	Figure 2.27-22
ARC1 multi-shot	TD_MS2	20.00s	Figure 2.27-21
	TRR_MS2	30.00s	Figure 2.27-21
ARC misc.	ARC-SucChk	On	Figure 2.27-23
	TARCSUC	0.30s	Figure 2.27-23
	FT-3pFault	Off	Figure 2.27-14
	TRESET	0.30s	Figure 2.27-15
	TEVLV	0.30s	Figure 2.27-17
	SHOTNUM-TEST	Off	Figure 2.27-16
PROT-COMMON	CB-System	1CB	See Protection common function
VCHK	ARC1-VCHK EN	On	See Voltage check for autoreclose
TRC	TP-MODE	Per-Phase	See Trip circuit

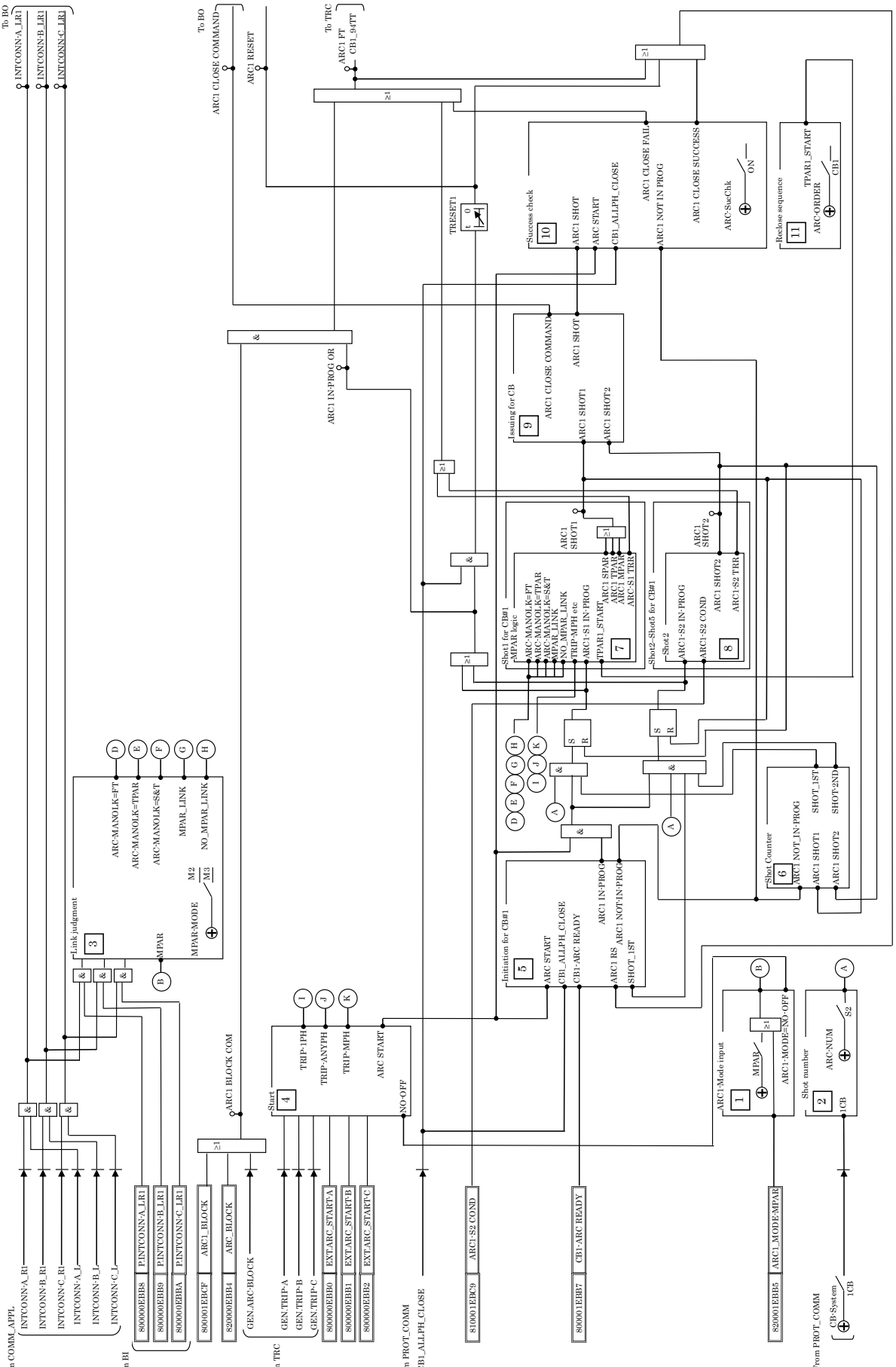


Figure 2.27-5 ARC SHOT and SHOT2 in MPAR mode of parallel lines

2.27.4 Timing diagram

(i) Single shot scheme for an Arcing fault (Shot1 for CB#1 and successful operation in TPAR mode)

Figure 2.27-6 illustrates an example for which the single shot scheme has been selected (i.e. [**ARCNUM**]=S1); an arcing fault is cleared following the operation of the protection relay and the issue of the 'GEN.TRIP-A/B/C' signals for the tripping of the CB#1. The 'GEN.TRIP-A/B/C' also initiates the ARC function and an 'ARC1 CLOSE COMMAND' signal is issued following the expiration of the dead time set for [**TTPAR1**]. When **On** is set for [**ARC-SucChk**], this scheme will determine that the ARC1 was successful when the 'CB1 ALLPH CLOSE' signal is detected following the issuing of the 'ARC1 CLOSE COMMAND' signal; the operation of the ARC function is reset if it operates successfully (i.e., the 'ARC1 IN-PROG' signal is turned off).

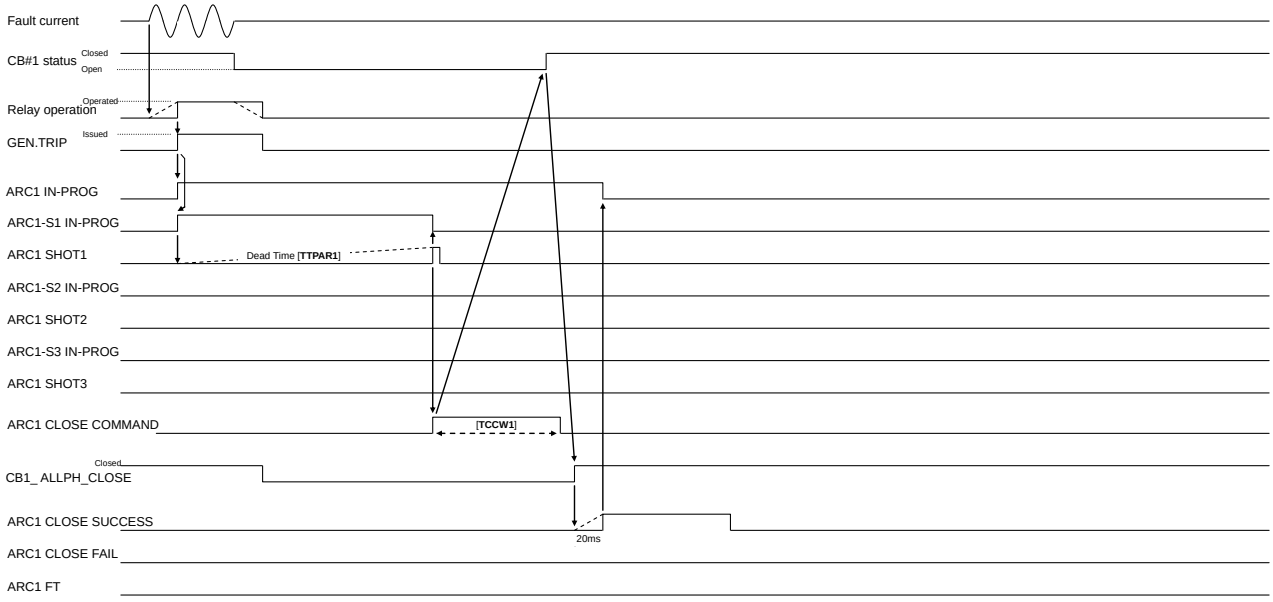


Figure 2.27-6 Single shot scheme [ARC-NUM]=S1 for an Arcing fault; operation is successful

Note: The permissive signal 'ARC1-VCHK' is required in the TPAR mode, but is omitted here for the sake of clarity. The pulse width of the 'ARC1 CLOSE COMMAND' signal is defined using the setting [**TCCW1**].

(ii) Single shot scheme for an Arcing fault; CB#1 fails to reclose

Figure 2.27-7 also shows the single shot scheme. However, the CB#1 fails to reclose on receiving the 'ARC1 CLOSE COMMAND' so that the ARC function initiates the 'ARC1 CLOSE FAIL' signal within the setting time [**TARCDSUC**]. Consequently, the ARC function goes to the final trip (ARC1 FT) stage so that the ARC will not issue another 'ARC1 CLOSE COMMAND' signal hereafter.

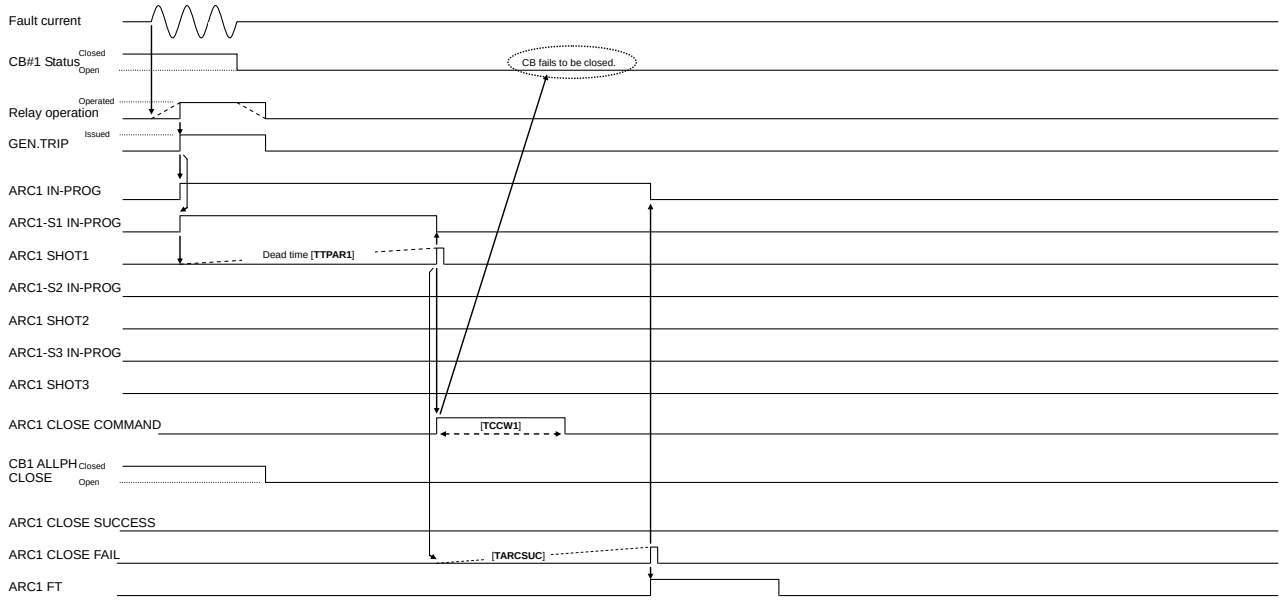


Figure 2.27-7 Single shot scheme [ARC-NUM]=S1 for an Arcing fault; CB#1 fails to reclose

Note: The permissive signal 'ARC1-VCHK' is required in the TPAR mode for the ARC1 SHOT1 operation, but is omitted here for the sake of clarity.

(iii) Single shot scheme for Permanent fault

Figure 2.27-8 illustrates the behavior of the single shot scheme for a permanent fault. Tripping of the CB#1 is executed correctly, but a further trip occurs following the reclosure of the CB#1. Accordingly, the ARC function determines that the ARC1 operation cannot restore power transmission in the single shot scheme; subsequently the ARC function goes to the final trip (ARC1 FT) stage.

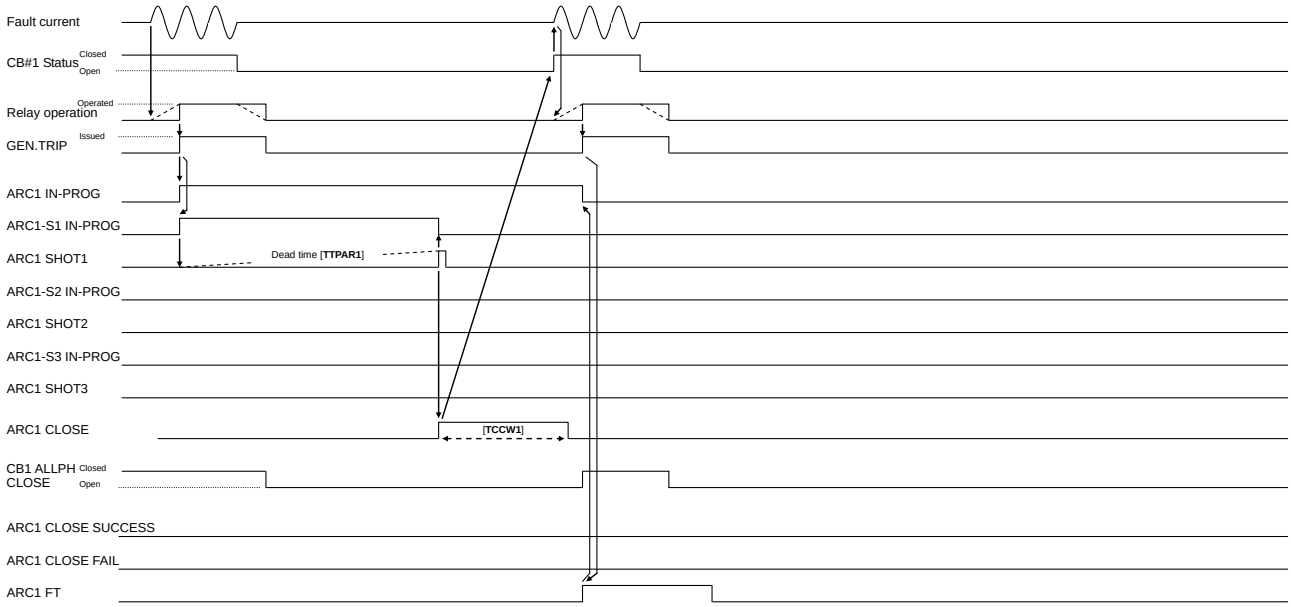


Figure 2.27-8 Single shot ARC scheme [ARC-NUM]=S1 for Permanent fault

Note: The permissive signal 'ARC1-VCHK' is required for the ARC SHOT1 operation, but is omitted here for the sake of clarity.

(iv) Single shot scheme for an Arcing fault; fault removed by a backup CB

Figure 2.27-9 shows the single shot scheme for an Arcing fault, but tripping is not executed due to the failure of the CB#1. Therefore, the operation of the ARC function is reset in the setting time [**TRESET**] before the duration of dead timer [**TTPAR1**] expires. Consequently, the ARC function determines that the local CB#1 cannot be tripped to clear the fault.

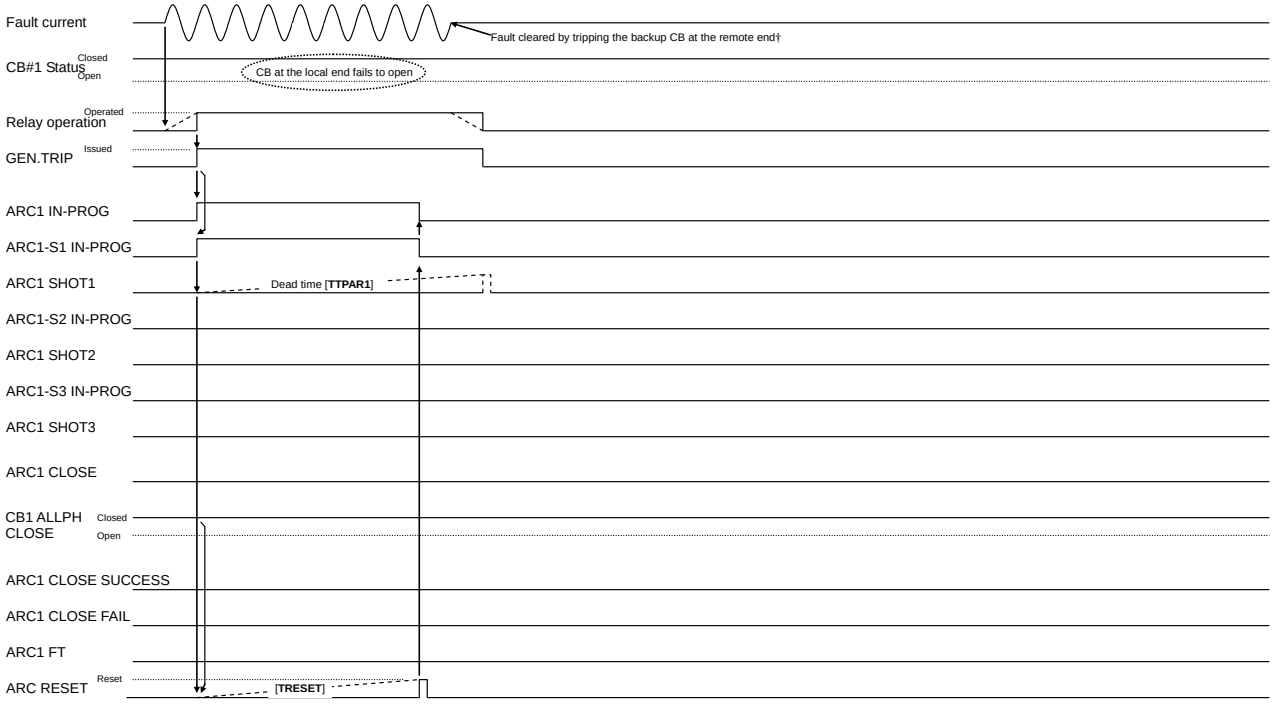


Figure 2.27-9 Single shot scheme [ARC-NUM]=S1 for an Arcing fault; remote CB† tripped

†Note: the fault is removed by the tripping of the CB at the remote end; hence, the fault current will no longer flow.

(v) Multi shot scheme for Permanent fault

Figure 2.27-10 illustrates the multi-shot scheme (**S3**); triple reclosing of the CB#1 by the ARC function is required and executed correctly. However, the ARC function determines that the fault is permanent as the fault persists after the third tripping (i.e. the shot counter logic reaches its maximum value and the fault persists). Consequently, the ARC function moves to the final trip (ARC1 FT) stage so that the ARC will not issue an 'ARC1 CLOSE COMMAND' signal hereafter.

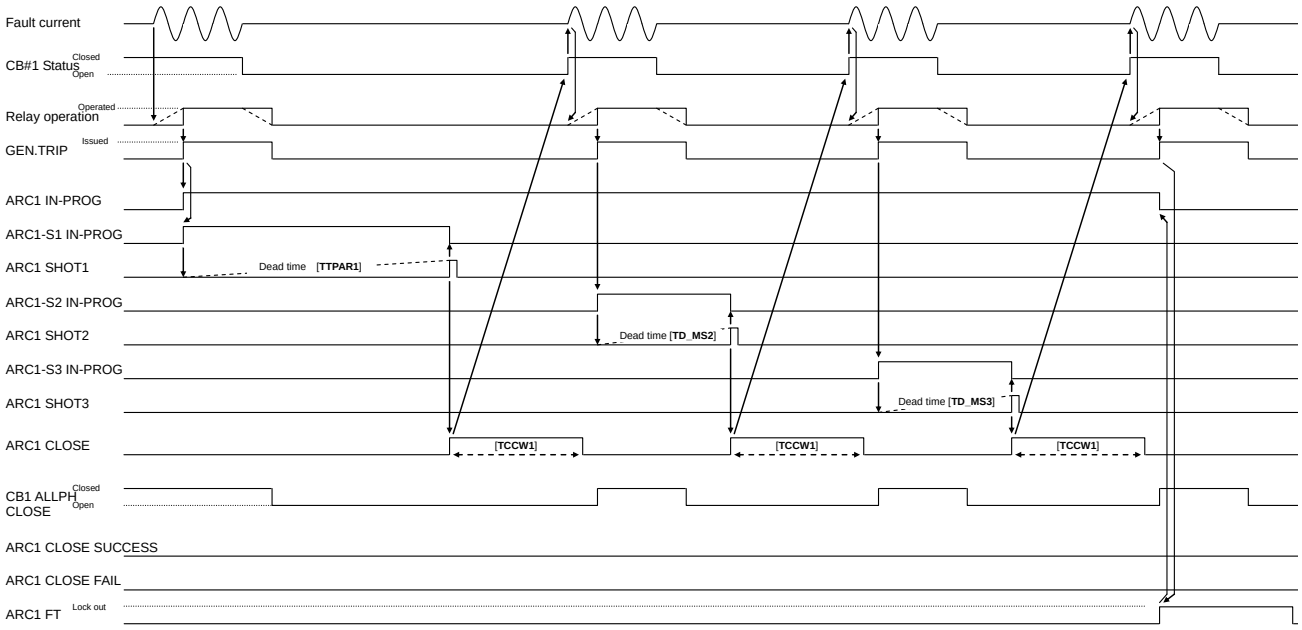


Figure 2.27-10 Multi shot scheme [ARC-NUM]=S3 for a Permanent fault

Note:

1. The permissive signal 'ARC1-VCHK' is required for ARC SHOT1 operation, but has been omitted for clarity in this figure.
2. 'ARC1-VCHK' permissive signal is introduced automatically in the TPAR mode. For ARC-SHOT2 and onwards, the user must introduce the permissive signal from the VCHK function by using PLC programming.

2.27.5 Autoreclosing logics

(i) Setting logic for ARC1 mode – setting (ARC1-MODE)

The ARC1-MODE input setting is illustrated in Figure 2.27-11. The scheme switch [**ARC1-MODE**] has seven setting modes as **OFF**, **FT**, **SPAR**, **TPAR**, **SPAR&TPAR**, **MPAR**, **and Original**.

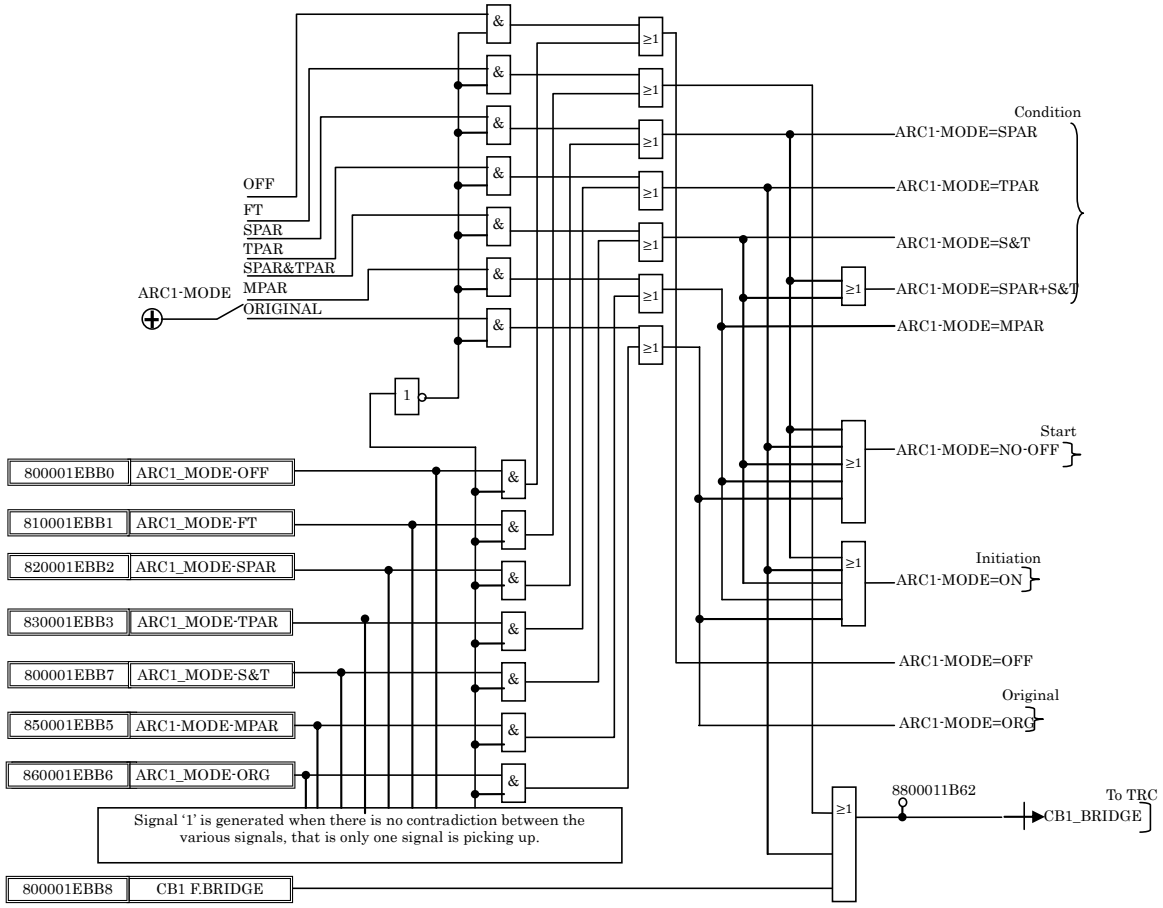


Figure 2.27-11 ARC1-MODE input logic

When **FT** is selected, the ARC function send 'CB1_BRIDGE' signal for the TRC function to be the CB being tripped in three-phases, regardless of the condition of the tripped phase, the operation of respective protection elements, and the ARC settings; the ARC function does not operate (i.e., ARC1-FT).

When **TPAR** is selected, the TRC and the ARC functions operate by the rule that the CB is tripped in three-phases and can be reclosed. That is, 'CB1_BRIDGE' signal is sent for the TRC function so that the CB will be tripped in three-phases forcibly even if a GEN.TRIP-A (TRIP COMMAND-A) signal is only generated in the TRC function (as well as GEN.TRIP-B and GEN.TRIP-C). Note the CB will be tripped in three-phases forcibly, even if a single-phase fault is detected and instructed a single-phase tripping by the relay applications.

(ii) Setting logic for ARC2 mode – setting (ARC2-MODE)

The ARC2-MODE input setting is illustrated in Figure 2.27-12. The scheme switch [**ARC2-MODE**] is provided similar to the [**ARC1-MODE**].

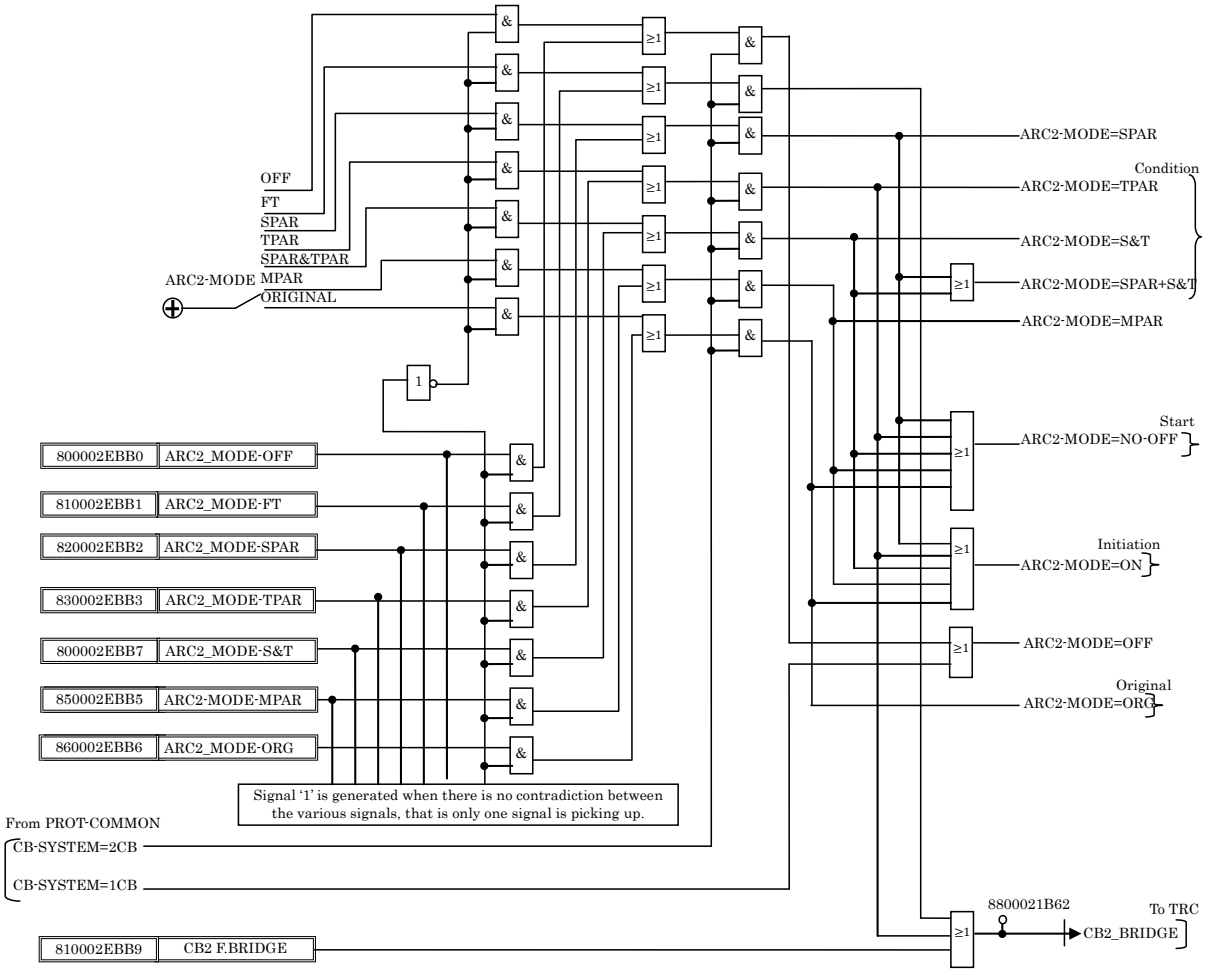


Figure 2.27-12 ARC2-MODE input logic

(iii) Setting logic for shot number – setting (ARC-NUM)

The [**ARC-NUM**] switch is provided to set a number of reclosing CB#1.

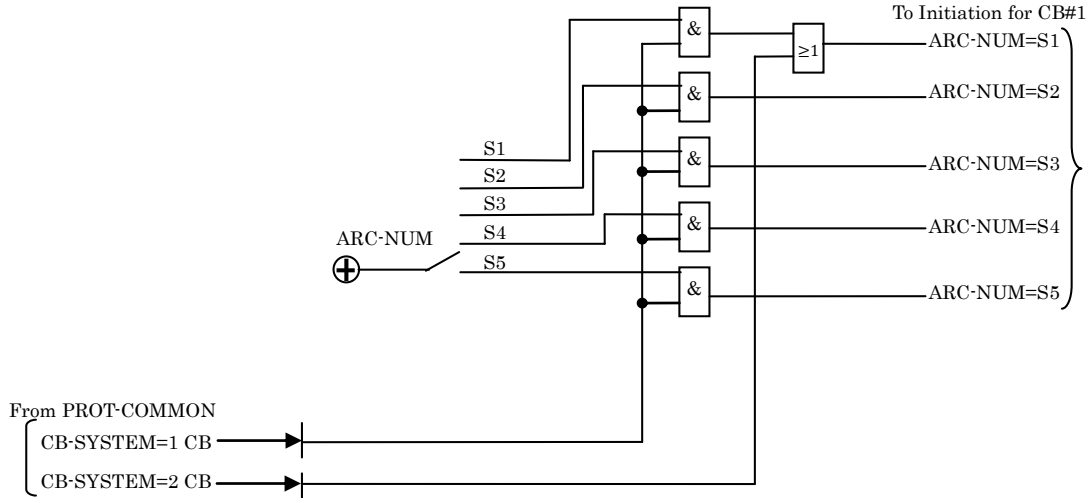


Figure 2.27-13 Shot number

(iv) Start logic – setting (FT-3P FAULT)

Start logic generates 'ARC START' signal when the TRC function has any 'GEN.TRIP-A', '-B', '-C' signals coming from relay functions. The type of tripping (i.e., single-phase-tripping, two-or-three-phase-tripping, or three-phase tripping) is also checked in Start logic. Use PLC connection points 'EXT.ARC_START-A' and others if an external relay is available to start the ARC function.

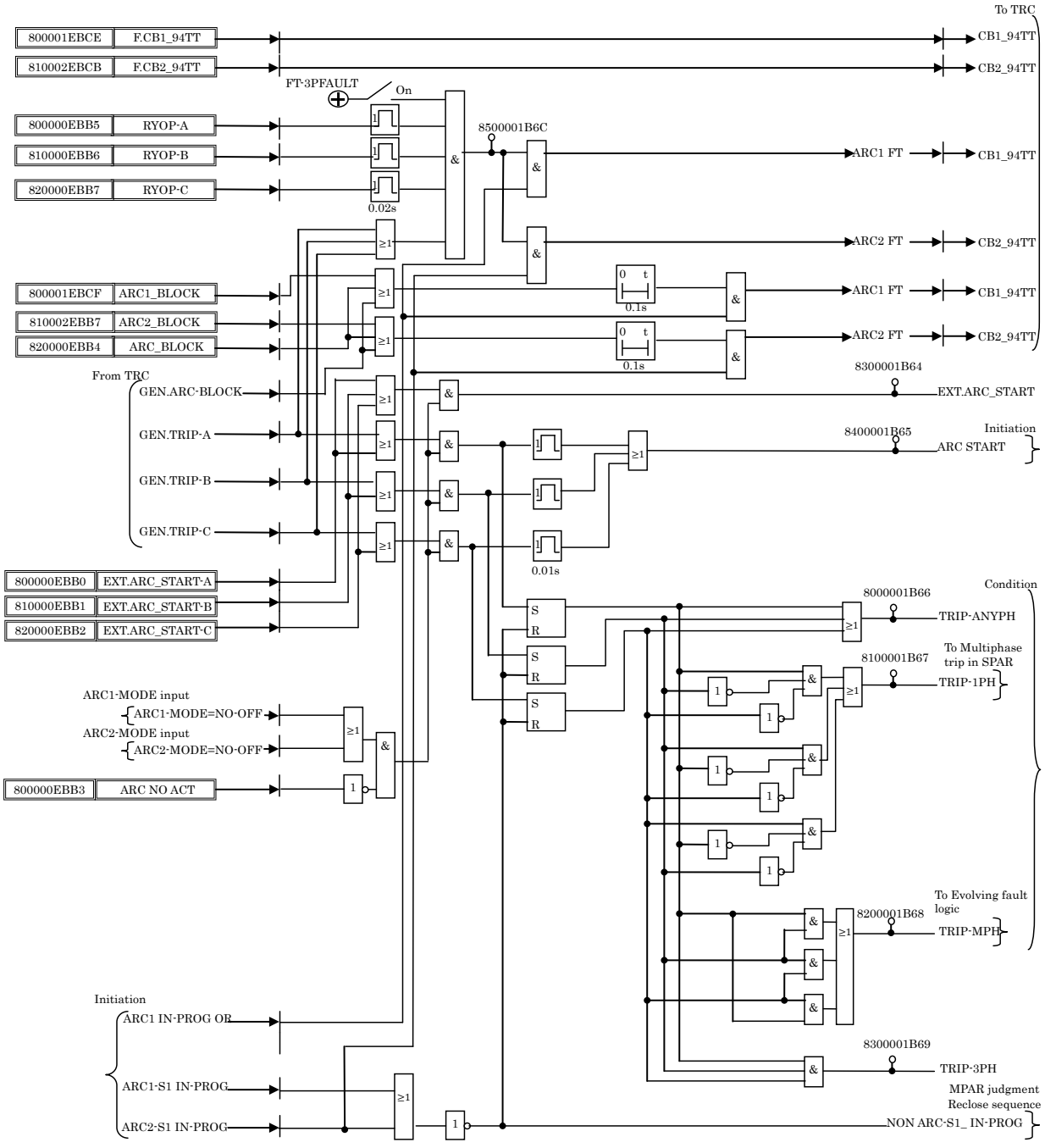


Figure 2.27-14 Start logic

If the scheme switch [**FT-3P FAULT**] is set to **On**, 'CB1_94TT' and 'CB2_94TT' signals are generated and introduce the three-phase tripping (final trip) for the TRC function during the

ARC1 and ARC2 functions being generating 'ARC1 IN-PROG OR' or 'ARC2-S1 IN-PROG' signals. The switch [**FT-3P FAULT**] requires signals of the external relay; PLC connection points 'RYOP-A, RYOP-B, and RYOP-C' are used to get the signals.

Note that the 'CB1_94TT' and 'CB2_94TT' signals are generated when 'ARC BLOCK' signals are injected, provided 'ARC1 IN-PROG OR' or 'ARC2-S1 IN-PROG' signals is being generated.

If, with regard to the tripped poles of CBs, there is not consistency between the CB#1 and the CB#2, the ARC function can generate the 'CB1_94TT' and 'CB2_94TT' signals when an external device is able to detect the consistency; use PLC connection points 'F.CB1_94TT' and 'F.CB2_94TT' for the operation of the inconsistency.

The Start logic can receive a stop signal not to operate the ARC function; use PLC connection point 'ARC NO ACT'.

(v) Initiation logic – setting (TREADY1, TRESET)

Figure 2.27-15 illustrates the initiation logic for CB#1, which has 'ARC1 READY' signal issued by the reception of signals 'ARC1-MODE=ON' and 'CB1_ALLPH_CLOSE'. Note that the user should connect a ready signal of the CB with PLC connection point 'CB1-ARC READY' using the BI circuit. Reclaim timer [**TREADY1**] is provided; the flip-flop is set to issue 'ARC1 IN-PROG' signal when signals 'ARC_READY', 'SHOT_1ST' and 'ARC1 START' are provided. 'ARC1-S1 IN-PROG' signal succeeds followed by the 'ARC1 IN-PROG' signal.

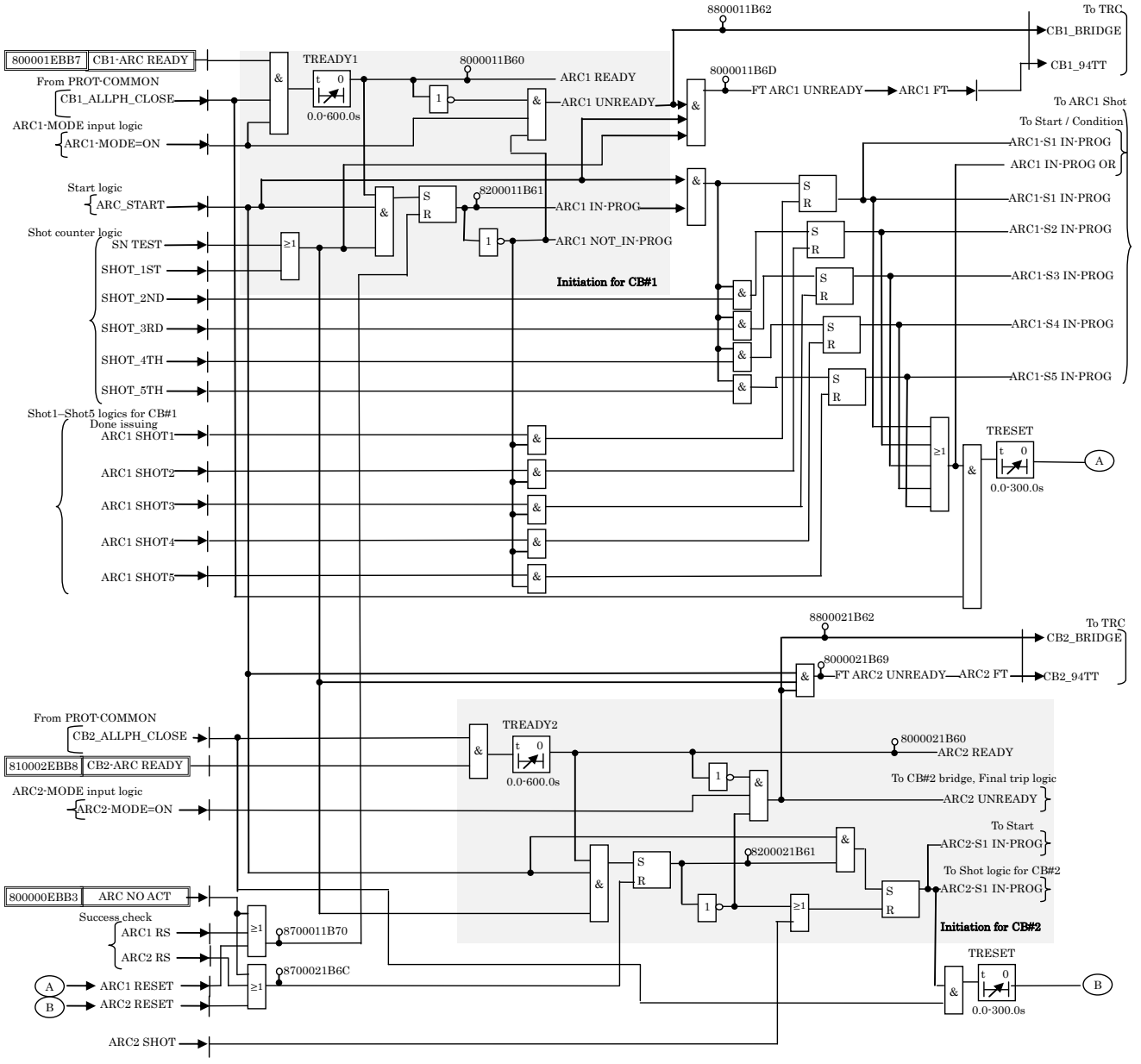


Figure 2.27-15 Initiation and its outside logics

If the 'ARC1 UNREADY' signal is present, Initiation logic abandons to reclose the CB#1; then, the status of the ARC function reaches the Final Trip stage (FT); three-phase trip signal (CB1_94TT) is generated transferred for the TRC function.

The 'CB1-BRIDGE' signal is used to combine any 'per-phase trip signal' into the three-phase trip signal in the TRC function. Thus, the CB will be tripped in three-phases forcibly even if a GEN.TRIP-A (TRIP COMMAND-A) signal is only generated in the TRC function during the 'ARC1 UNREADY' being decided (as well as GEN.TRIP-B or GEN.TRIP-C).

(vi) Shot counter- setting (SHOTNUM-TEST)

Figure 2.27-16 illustrates the shot counter logic. Scheme switch [**SHOTNUM-TEST**] is provided for the shot number test. For example, if two shots are required for the test, set **S2** for the [**SHOTNUM-TEST**]. Table 2.27-11 shows the counting up in the shot counter logic. Note that the ARC function reaches the final trip stage if the counter is over.

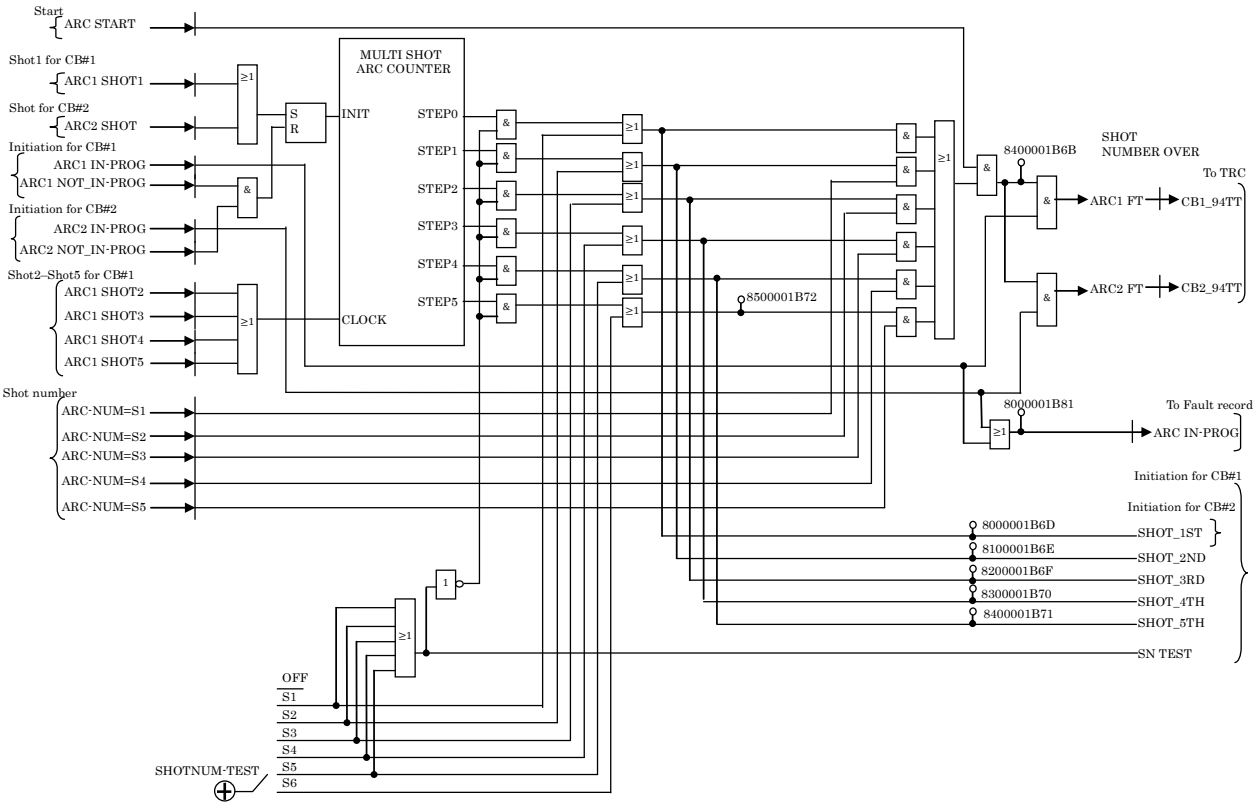


Figure 2.27-16 Shot counter

Table 2.27-11 Counting up in Shot counter logic

Input signals for Shot counter logic		Output signals for SHOT1–5 logics					
		SHOT_1ST	SHOT_2ND	SHOT_3RD	SHOT_4TH	SHOT_5TH	SHOT NUMBER OVER
INIT	CLOCK	STEP0	STEP1	STEP2	STEP3	STEP4	STEP5
0	(Undefined)	X					
1	Not turning		X				
	First cycle			X			
	Second cycle				X		
	Third cycle					X	
	Fourth cycle						X

(vii) Condition logic – setting (TEVLV)

The Condition logic determines the reclosing mode of either SPAR or TPAR by detecting the tipped-phases if **SPAR**, **TPAR**, or **SPAR&TPAR** mode is selected.

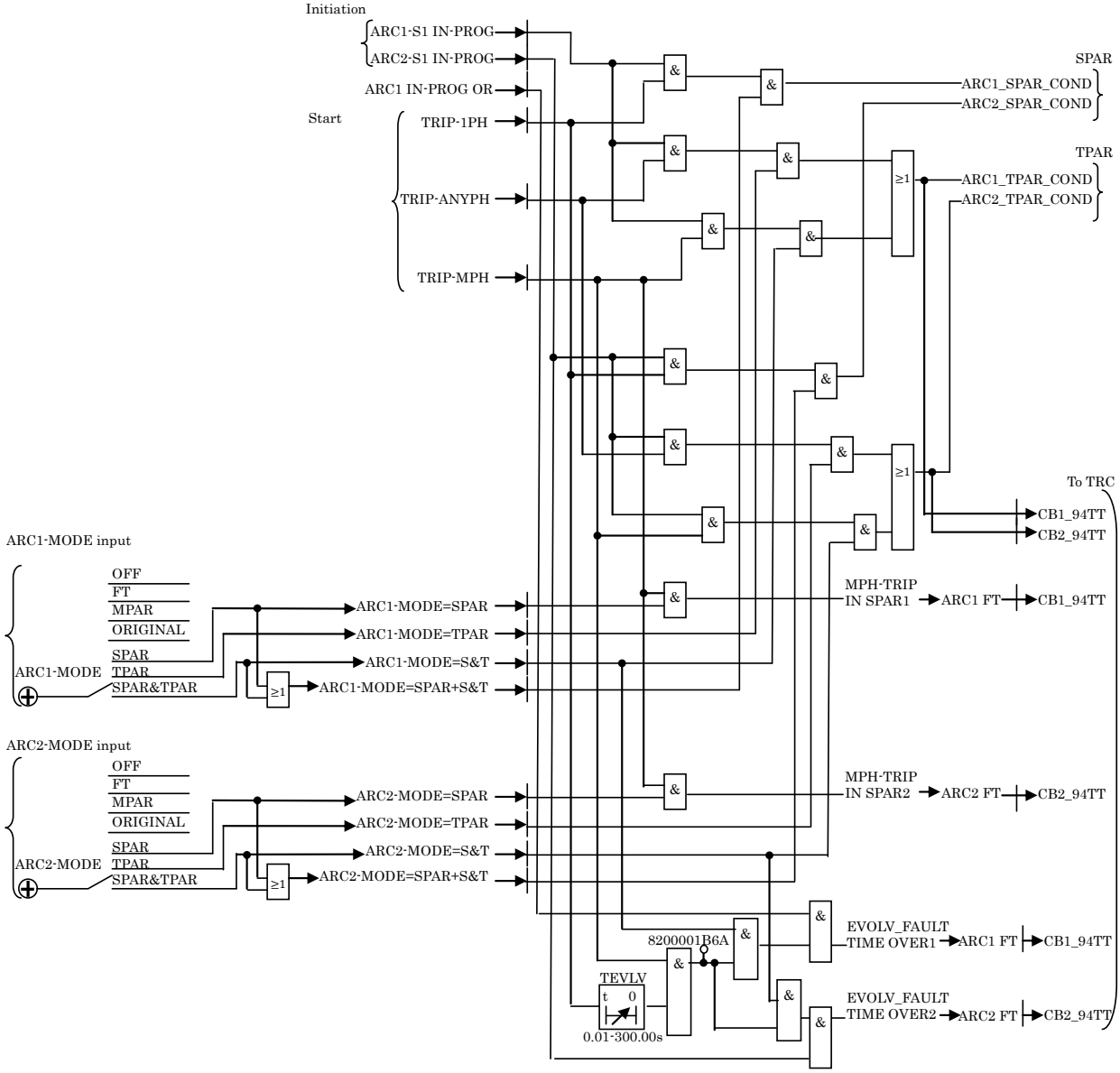


Figure 2.27-17 Condition logic

When a multiphase fault (TRIP-MPH) occurs in the settings [**ARC1-MODE**]=**SPAR**, then CB1_94TT signal is generated so that the function will reach the final trip stage. When a single phase fault (TRIP-1PH) evolves to a multiphase fault (TRIP-MPH), then the final trip stage is also induced; a timer [**TEVLV**] is provided for this purpose. Note that the timer [**TEVLV**] should be lower than the dead timers [**TSPAR1**].

Note that the 'CB1_94TT' and 'CB2_94TT' signals are unconditionally generated when a single phase tripping occurs in **TPAR**.

(viii) SPAR logic – settings (TSPAR1, TRR1)

The SPAR logic for CB#1 and CB#2 is illustrated in Figure 2.27-18. The 'ARC1_SPAR' signal is generated when the SPAR condition is appeared in the Condition logic; the SPAR logic has the dead timer [**TSPAR1**] provided to delay issuing a reclose command, which turns into 'ARC1 SHOT1' signal later. The user should set the [**TRR1**] to have the coordination with the [**TSPAR1**]; the final trip will occur when 'ARC1-S1 TRR' signal is present. The SPAR logic for CB#2 is similar to the one for CB#1.

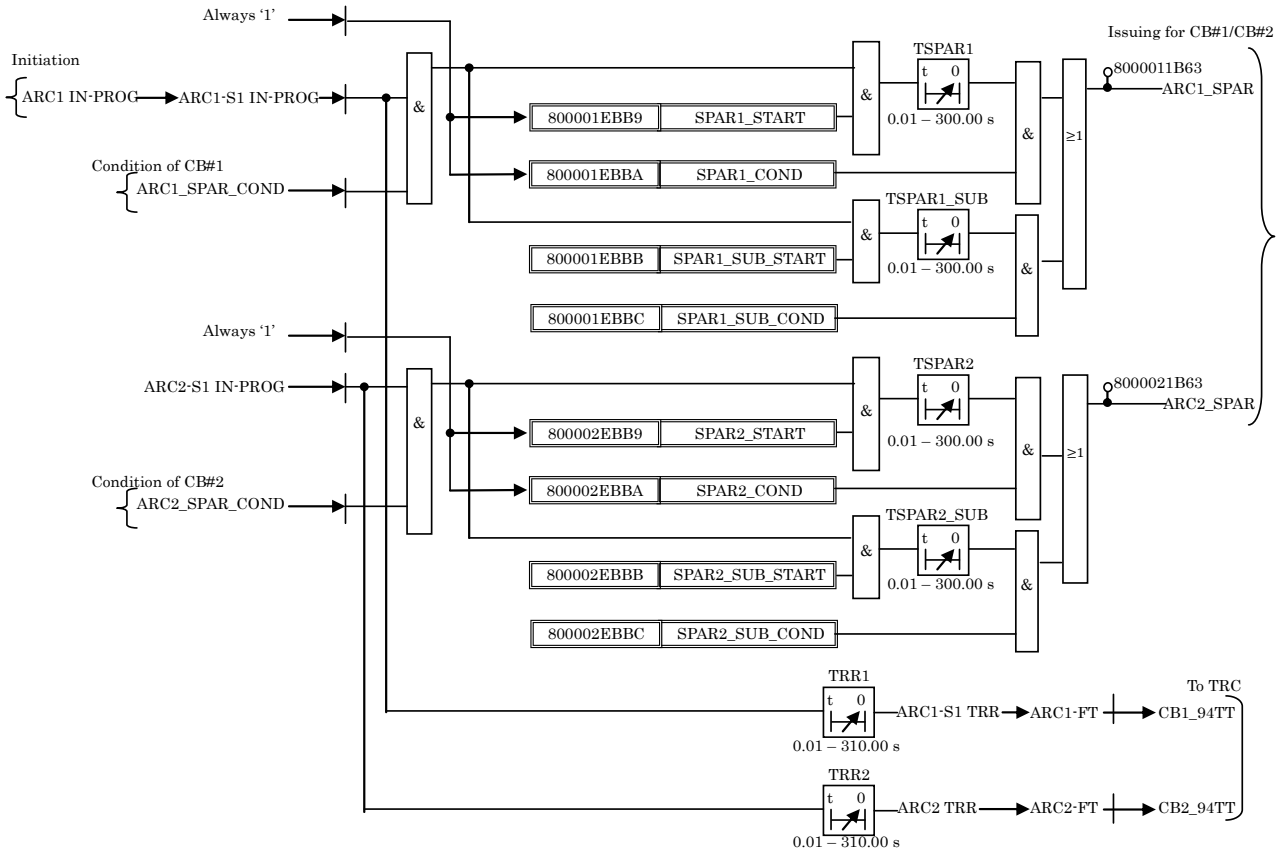


Figure 2.27-18 ARC1 SPAR and ARC2 SPAR

Note: Settings [**TSPAR1_SUB**] and [**TSPAR2_SUB**] are not required as in the default.

(ix) TPAR logic – settings (TTPAR1, TRR1)

The TPAR logic for CB#1 and CB#2 are illustrated in Figure 2.27-19. To operate in the TPAR mode in the CB#1, the VCHK function provides a permission signal for the TPAR logic. The dead timer [**TTPAR1**] is required to set in the logic. The user should set the [**TRR1**] to have the coordination with the [**TTPAR1**].

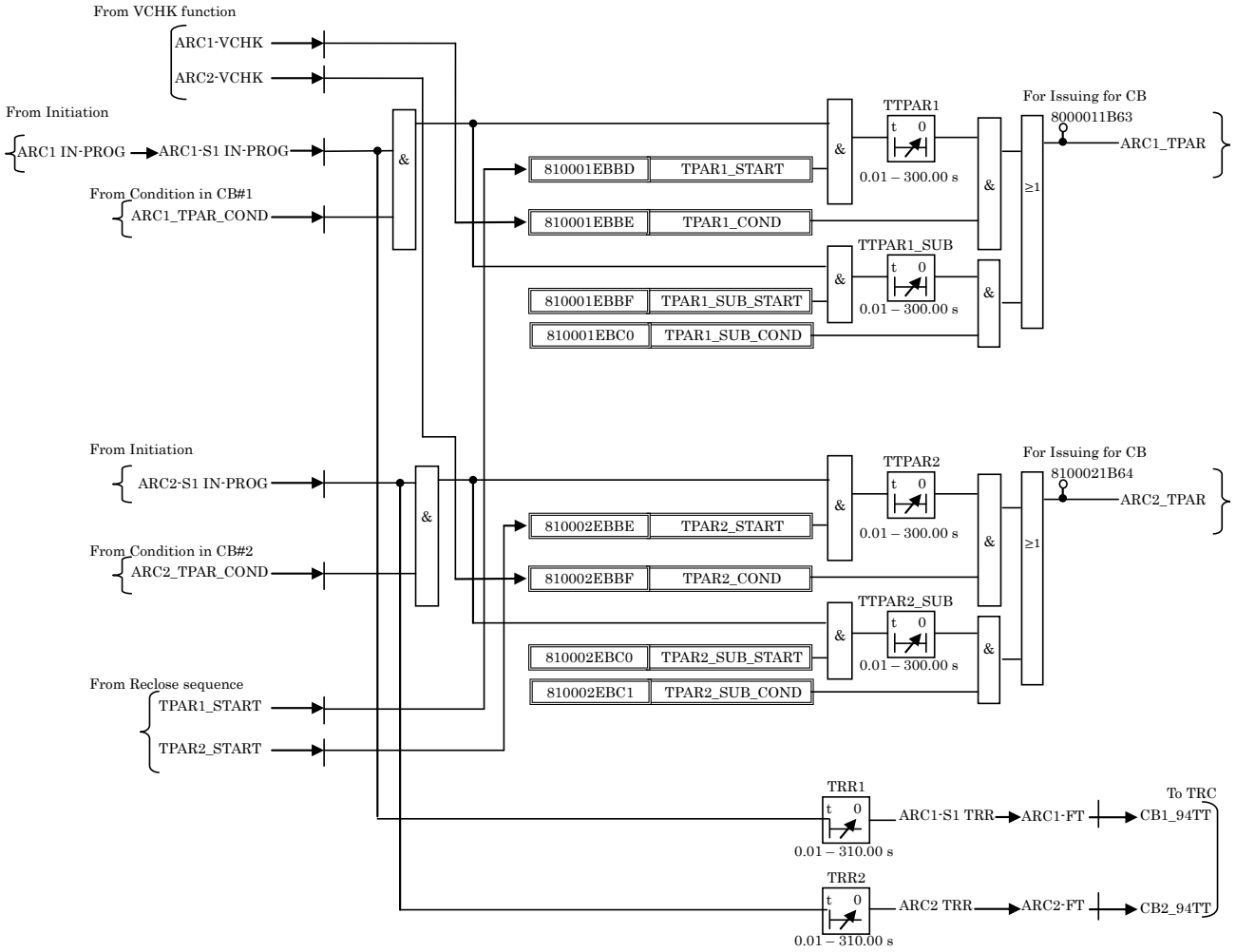


Figure 2.27-19 ARC1 TPAR and ARC2 TPAR

Note: Settings [**TTPAR1_SUB**], [**TTPAR2_SUB**] are not required as in the default.

(x) SPAR+TPAR logic – settings (TSPAR1,TTPAR1,and TRR1)

The SPAR&TPAR logic for CB#1 and CB#2 is illustrated in Figure 2.27-18. As for the CB#1, the dead timers [**TSPAR1**] and [**TTPAR1**] should be set in the coordination with the [**TRR1**].

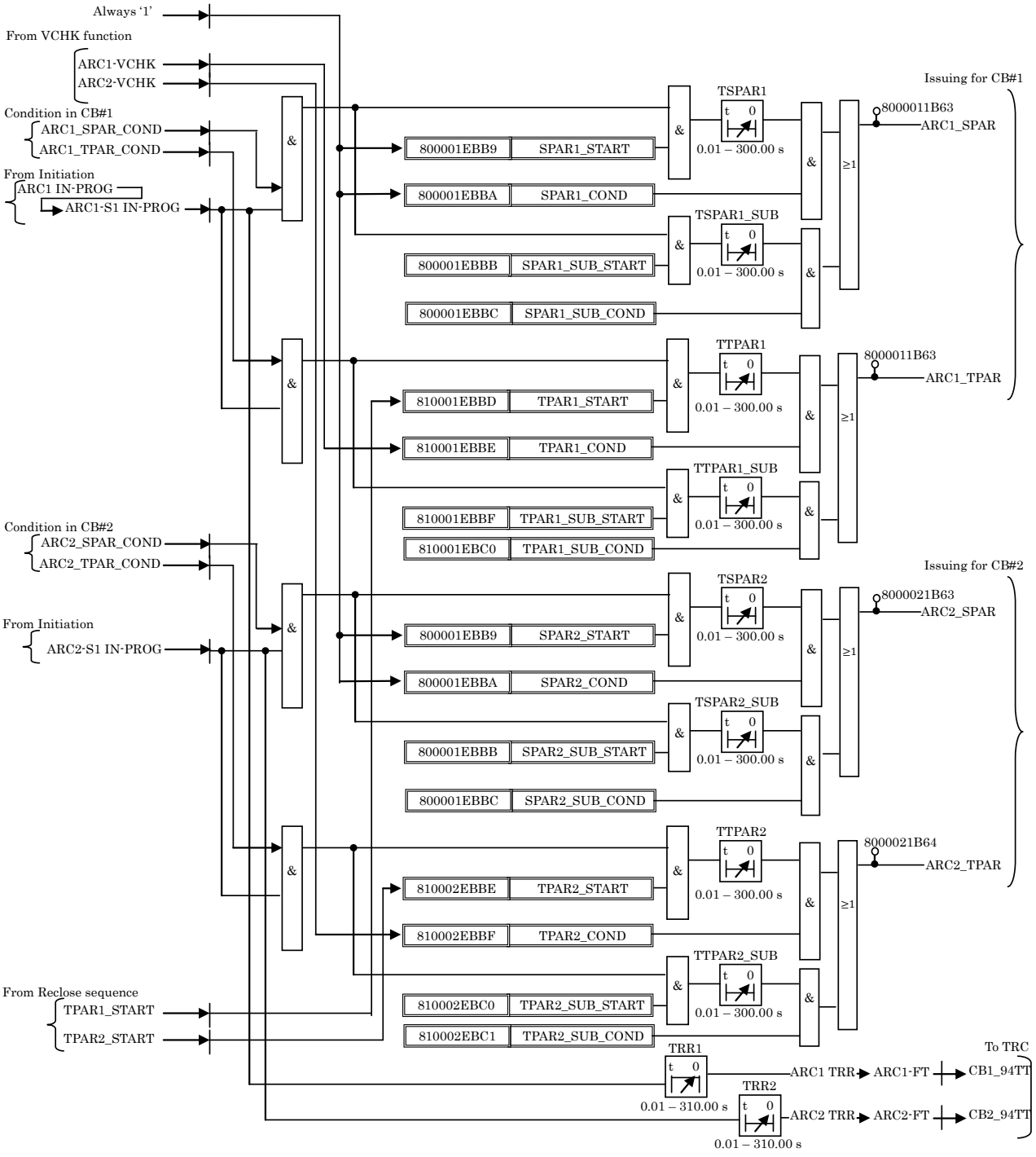


Figure 2.27-20 ARC1 SPAR&TPAR and ARC2 SPAR

Note: Settings [**TSPAR1_SUB**], [**TSPAR2_SUB**], [**TTPAR1_SUB**], [**TTPAR2_SUB**] are not required as in the default.

(xi) Shot2 to Shot5 for CB#1 –settings (TD_MS2, TRR2 and others)

The ARC1 logic for shot 2-shot5 is illustrated in Figure 2.27-21. Shots 2-5 are applicable for a CB#1 only. For example, two shots (Shot2 and Shot3, i.e., [**ARC_NUM**]=**S3**) are required following the Shot1, the user should set the [**TS_MS2**]/[**TS_MS3**] and [**TRR2**]/[**TRR3**]. The user should program to inject a permission signal for the Shot2 and Shot3 at PLC connection points 'ARC1-S2 COND' and 'ARC1-S3 COND', as shown in Figure 2.27-21. Note that the CB will be tripped in three-phases forcibly even if a GEN.TRIP-A (TRIP COMMAND-A) signal is only generated, because the 'CB1_BRIDGE' signal is generated during the Shot 2-Shot5.

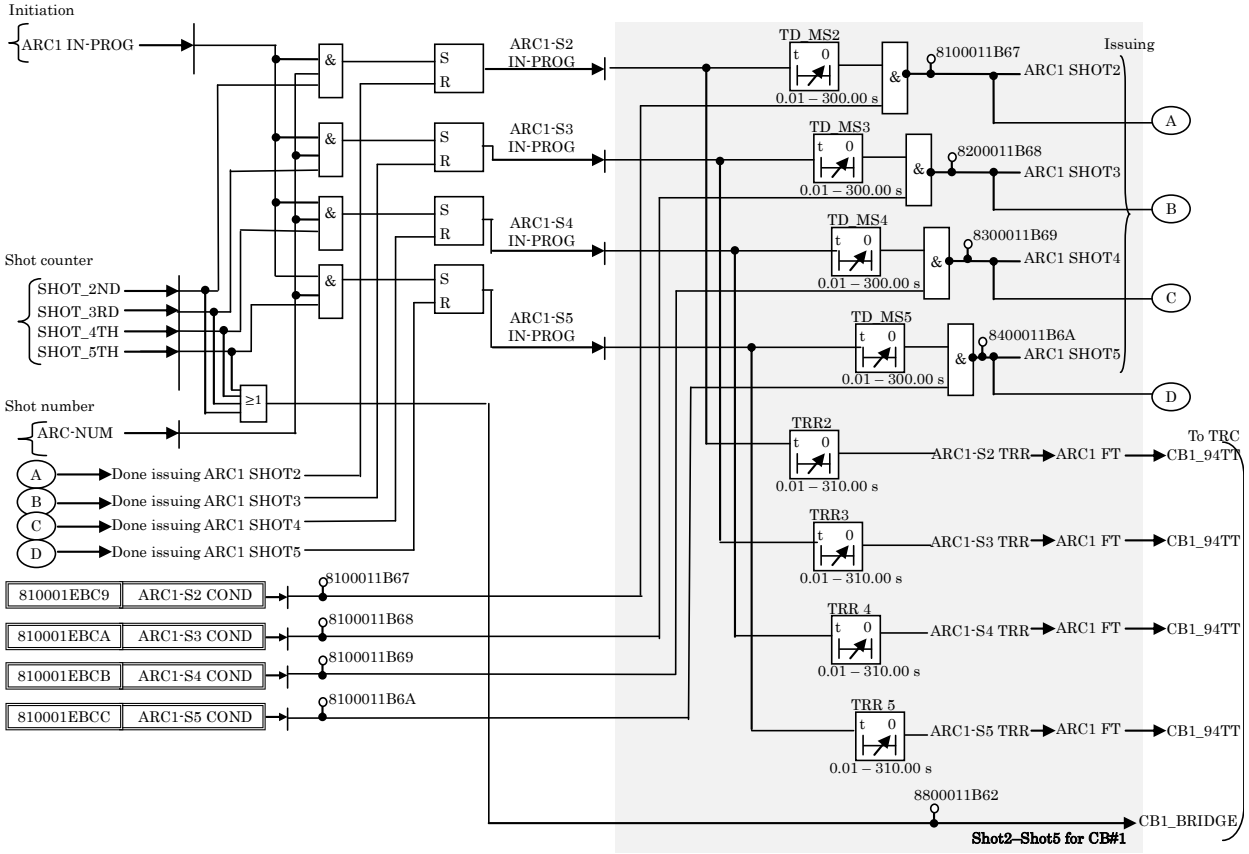


Figure 2.27-21 ARC1 logic for Shot2 to Shot5

(xii) Issuing close command – setting (TCCW1)

The logic for issuing close command for ARC1 and ARC2 is illustrated in Figure 2.27-22.

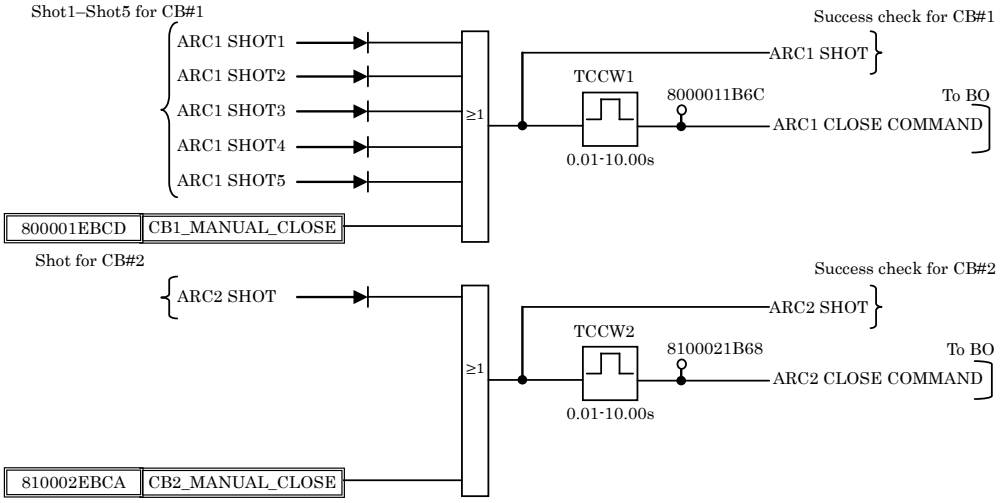


Figure 2.27-22 Issuing for CB#1 and CB#2

(xiii) Success check logic – settings (TARCSUC, ARC-SucChk)

Figure 2.27-23 illustrates the success check logic for CB1 and CB2.

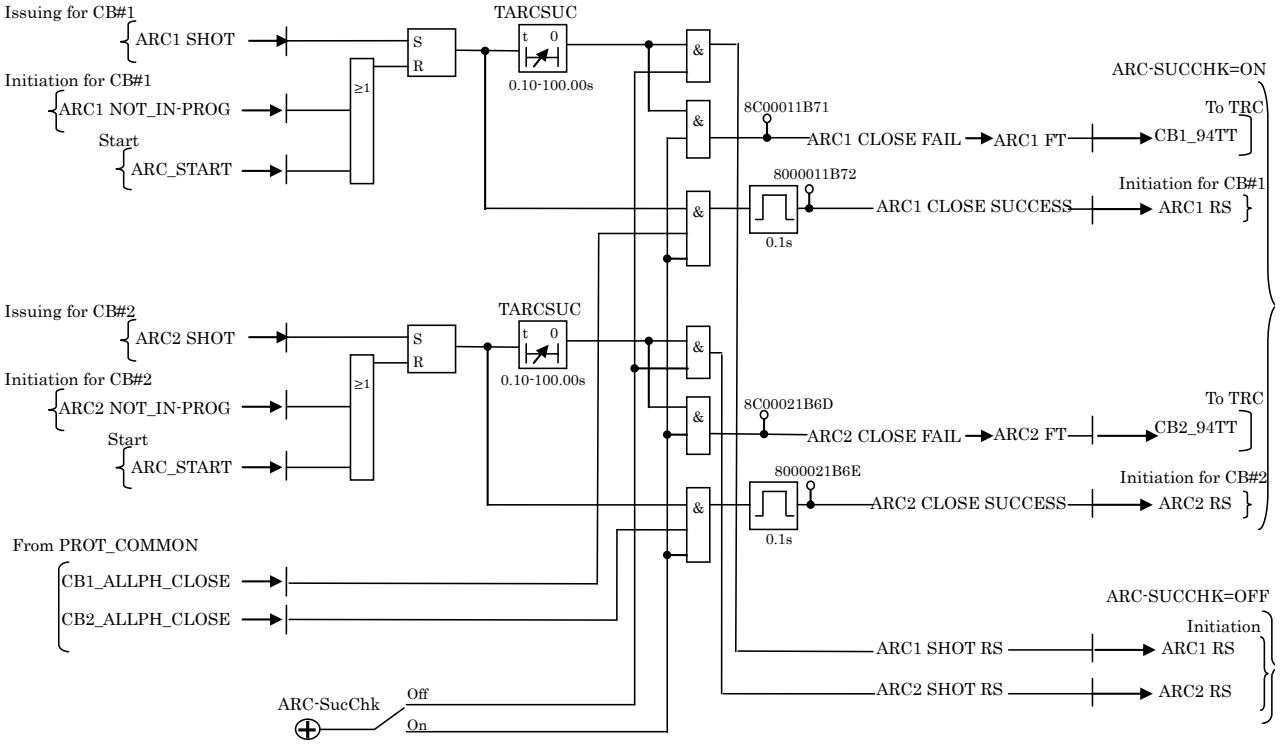


Figure 2.27-23 Success check logic

(xiv) Reclosing sequence for two CBs system– setting (ARC-ORDER)

Figure 2.27-24 shows that the logic determines the reclosing priority between CB#1 and CB#2; the scheme switch [**ARC-ORDER**] is provided to set the process priority. For example, the user should set **CB1** for the [**ARC-ORDER**] if the CB#1 is being closed firstly.

Table 2.27-12 Starting condition for two CBs system

Mode setting	Setting [ARC-ORDER]	Start condition
[**ARC1 mode**]= **TPAR** or **SPAR&TPAR**	**CB1**	CB#1 recloses first.
	CB2	CB#2 recloses first.
[**ARC2 mode**]= **TPAR** or **SPAR&TPAR**	**SIMUL**	Both CB#1 and CB#2 reclose simultaneously.

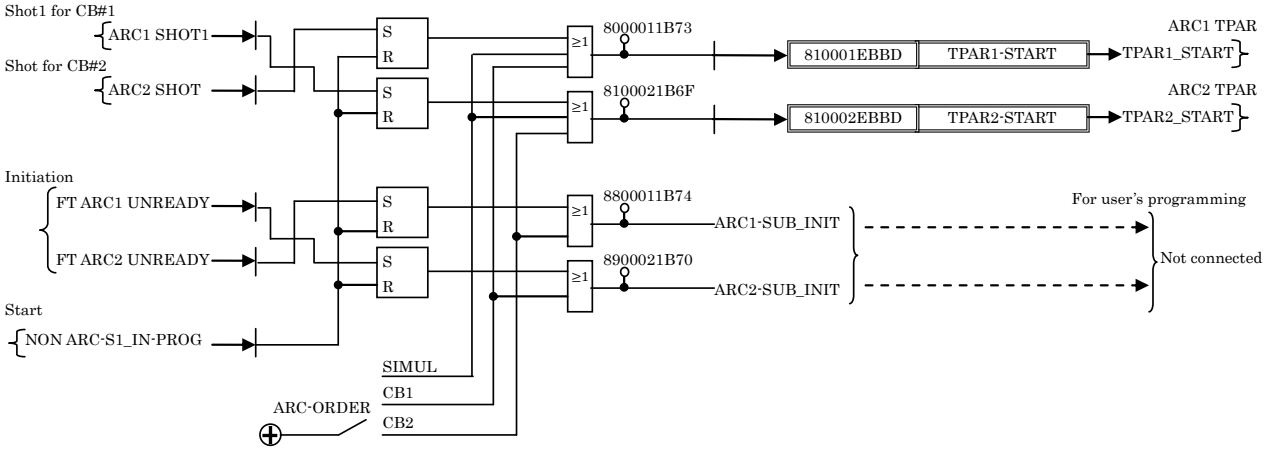


Figure 2.27-24 Reclose sequence logic

(xv) MPAR logic – settings (TMPAR, ARC-MANOLK, MPAR-MODE)

The MPAR logic is consisted of SPAR scheme, TPAR scheme, and MPAR scheme (Figure 2.27-27); the Link judgment logic (Figure 2.27-28) select a scheme when reclosing the CB is required.

In parallel lines, when power is able to flow in three-phases (i.e., [**MPAR-MODE**]=**M3**; 'MPAR-LINK' is judged), the MPAR scheme is selected in the MPAR logic; then, the CB will be reclosed in the MPAR scheme. If the power does not flow in three-phases (i.e., 'NO-MPAR-LINK'), either the SPAR or the TPAR scheme is selected in the MPAR logic to reclose the CB. The user can set the selection rule of the schemes using setting [**ARC-MANOLK**]=**TPAR** or **SPAR&TPAR**. The behavers of the SPAR scheme and the TPAR scheme are the same as the one of the SPAR logic and the TPAR logic—that have been discussed previously.

Note that the ARC function abandons to reclose the CB when setting [**ARC-MANOLK**]=**FT** if 'MPAR-LINK' is not judged.

The dead times are required to set in the MPAR logic: [**TSPAR1**]/[**TSPAR2**], [**TTPAR1**]/[**TTPAR2**], and [**TMPAR1**]/[**TMPAR2**]. Setting the [**TRR1**] and [**TRR2**] is also required.

Figure 2.27-25 shows the ARC operation in parallel lines (lines RQ and ST). Table 2.27-13 and Table 2.27-14 tabulates every operation result in the MPAR logic when faults occur in the parallel lines. The user should understand that the selection of reclosing schemes in the MPAR logic depends on the settings of [**MPAR-MODE**] and [**ARC-MANOLK**].

For the MPAR operation at Relay$^{(R)}$, Relay$^{(Q)}$, Relay$^{(S)}$, and Relay$^{(T)}$, the user should set **MPAR** for the settings [**ARC1-MODE**] at respective relays. Additionally, the user should connect Relay$^{(R)}$ with Relay$^{(S)}$ using the BO and BI circuits with wires. Similarly, the user should connect Relay$^{(S)}$ with Relay$^{(T)}$. Figure 2.27-26 illustrates the communication flow when the MPAR operation is required at three-terminals.

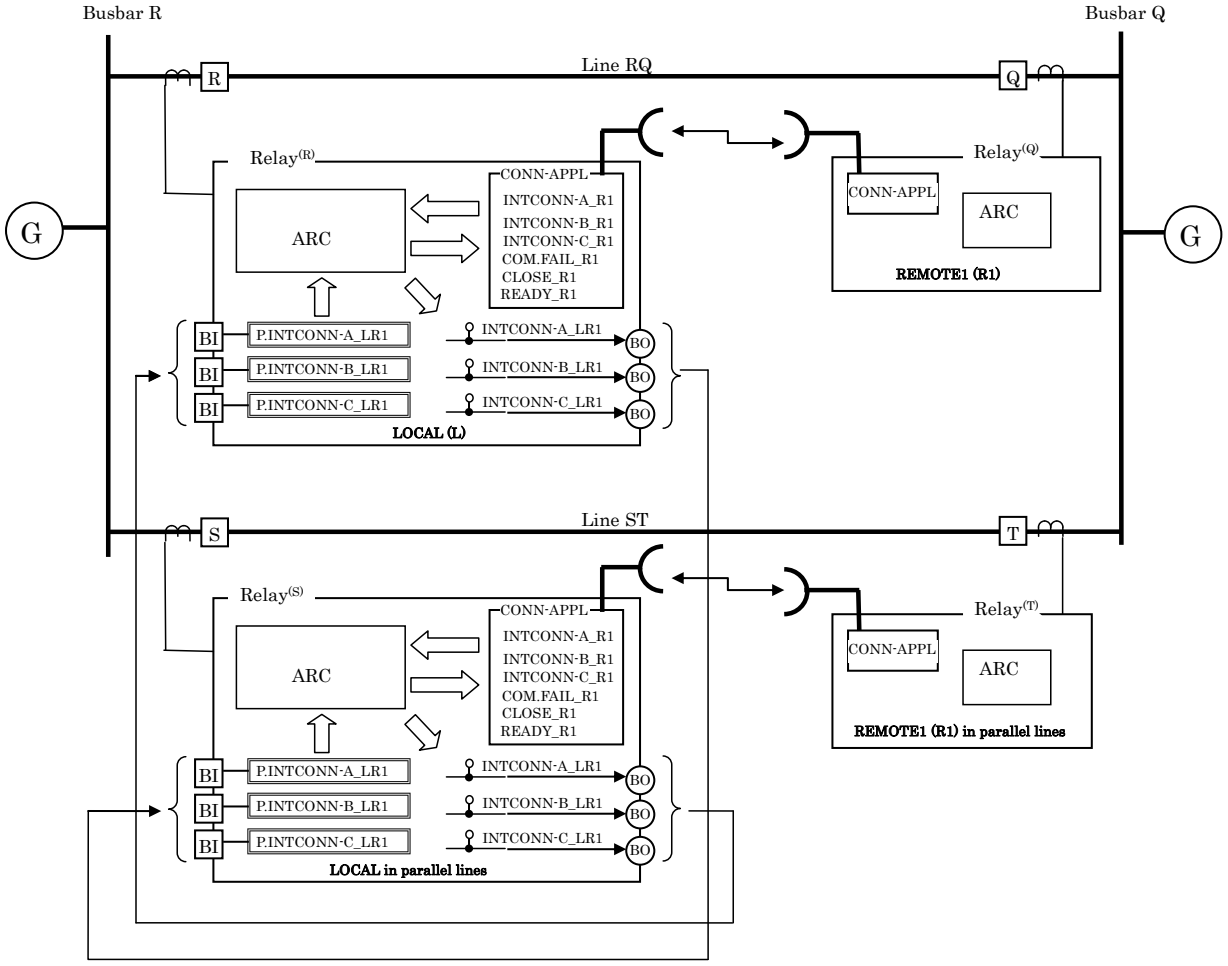


Figure 2.27-25 Parallel lines in MPAR

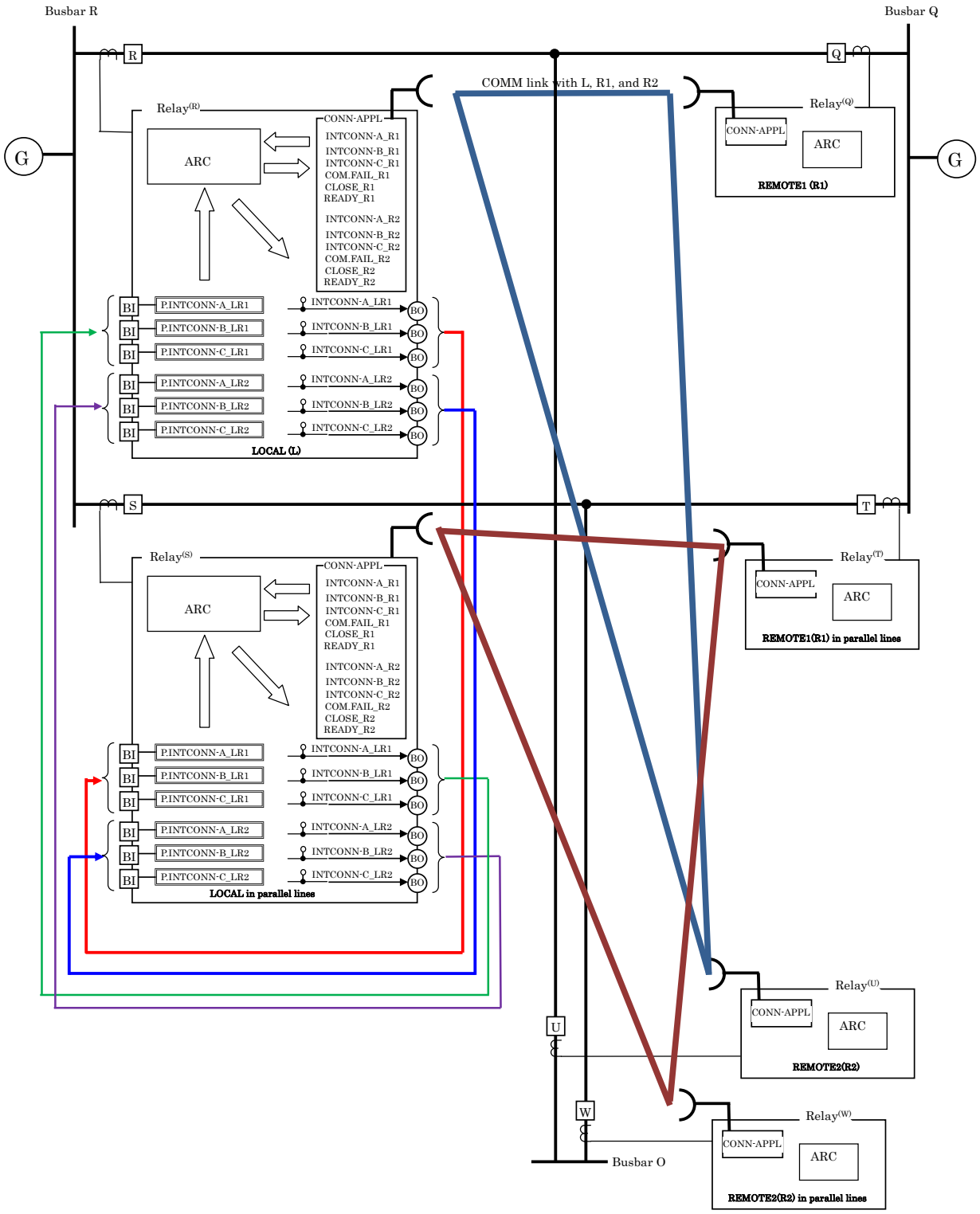


Figure 2.27-26 Three terminals in MPAR

(xv)-1 Settings [**ARC-MANOLK**]=**FT/TPAR/SPAR&TPAR** in [**MPAR-MODE**]=**M2**

Table 2.27-13 shows tripping and reclosing results when the setting [**MPAR-MODE**] is **M2** (i.e., 'M2' means that two or three unfaulted (healthy) phases exist in the parallel lines; respective unfualted phases are different).

For setting [**ARC-MANOLK**]=**TPAR** or **SPAR&TPAR,** the CB can be reclosed in the TPAR scheme when the MPAR-LINK condition is not observed.

For setting [**ARC-MANOLK**]=**FT**, the ARC function abandons to reclose the CB as when the MPAR-LINK condition is not achieved in the paralleled lines.

Table 2.27-13 Tripped phases and mode for CB reclosing in [MPAR-MODE]=M2

No	TRC tripping with [**TP-MODE**]=**PER-PHASE** → ARC reclosing mode with setting [**MPAR-MODE**]=**M2**											
	Faulted phases						Setting [**ARC-MANOLK**]					
	Line RQ			Line ST			**FT**		**TPAR**		**SPAR&TPAR**	
	A	**B**	**C**	**A**	**B**	**C**	**Line RQ**	**Line ST**	**Line RQ**	**Line ST**	**Line RQ**	**Line ST**
1	x			–	–	–	1ΦT→MPAR	–	1ΦT→MPAR	–	1ΦT→MPAR	–
2	x	x		–	–	–	2ΦT→FT	–	2ΦT→TPAR	–	2ΦT→TPAR	–
3	x	x	x	–	–	–	3ΦT→FT	–	3ΦT→TPAR	–	3ΦT→TPAR	–
4	x						1ΦT→MPAR	(N/A)	1ΦT→MPAR	(N/A)	1ΦT→MPAR	(N/A)
5	x			x			1ΦT→MPAR	1ΦT→MPAR	1ΦT→MPAR	1ΦT→MPAR	1ΦT→MPAR	1ΦT→MPAR
6	x	x					2ΦT→MPAR	(N/A)	2ΦT→MPAR	(N/A)	2ΦT→MPAR	(N/A)
7	x				x		1ΦT→MPAR	1ΦT→MPAR	1ΦT→MPAR	1ΦT→MPAR	1ΦT→MPAR	1ΦT→MPAR
8	x	x		x			2ΦT→MPAR	1ΦT→MPAR	2ΦT→MPAR	1ΦT→MPAR	2ΦT→MPAR	1ΦT→MPAR
9	x	x		x	x		2ΦT→FT	2ΦT→FT	2ΦT→TPAR	2ΦT→TPAR	2ΦT→TPAR	2ΦT→TPAR
10	x	x	x				3ΦT→MPAR	(N/A)	3ΦT→MPAR	(N/A)	3ΦT→MPAR	(N/A)
11	x	x				x	2ΦT→MPAR	1ΦT→MPAR	2ΦT→MPAR	1ΦT→MPAR	2ΦT→MPAR	1ΦT→MPAR
12	x	x			x	x	2ΦT→MPAR	2ΦT→MPAR	2ΦT→MPAR	2ΦT→MPAR	2ΦT→MPAR	2ΦT→MPAR
13	x	x	x	x			3ΦT→MPAR	1ΦT→MPAR	3ΦT→MPAR	1ΦT→MPAR	3ΦT→MPAR	1ΦT→TPAR
14	x	x	x	x	x		3ΦT→FT	2ΦT→FT	3ΦT→TPAR	2ΦT→TPAR	3ΦT→TPAR	2ΦT→TPAR
15	x	x	x	x	x	x	3ΦT→FT	3ΦT→FT	3ΦT→TPAR	3ΦT→TPAR	3ΦT→TPAR	3ΦT→TPAR

x: Occurrence of the fault

–: Not energized (out of service)

MPAR: To issue a reclose command by ARC_MPAR_COND

TPAR: The TPAR scheme issuing three-phases tripping by ARC_TPAR_COND; then, to issue a reclose command

FT: To abandon reclosing CB after ARC issuing three-phases tripping by **FT** setting

1ΦT: To issue a single-phase tripping

2ΦT: To issue two-phases tripping

3ΦT: To issue three-phases tripping

(N.A): Tripping and reclosing do not perform

(xv)-2 Settings [**ARC-MANOLK**]=**FT/TPAR/SPAR&TPAR** in [**MPAR-MODE**]=**M3**

Table 2.27-14 shows the operation results when the setting [**MPAR-MODE**] is **M3** (i.e., 'M3' means that three unfaulted (healthy) phases exist in the parallel lines; the respective unfaulted (healthy) phases are different). For setting [**ARC-MANOLK**]=**SPAR&TPAR,** the ARC function operates to recluse the CB in the SPAR scheme when a faulted phase is found in the paralleled lines.

Table 2.27-14 Tripped phases and mode for CB reclosing in [MPAR-MODE]=M3

No	TRC tripping with [**TP-MODE**]=**PER-PHASE** → ARC reclosing mode with setting [**MPAR-MODE**]=**M3**											
	Faulted phases						Setting [**ARC-MANOLK**]					
	Line RQ			Line ST			**FT**		**TPAR**		**SPAR&TPAR**	
	A	**B**	**C**	**A**	**B**	**C**	**Line RQ**	**Line ST**	**Line RQ**	**Line ST**	**Line RQ**	**Line ST**
1	x			–	–	–	1ΦT→FT	–	1ΦT→TPAR	–	1ΦT→SPAR	–
2	x	x		–	–	–	2ΦT→FT	–	2ΦT→TPAR	–	2ΦT→TPAR	–
3	x	x	x	–	–	–	3ΦT→FT	–	3ΦT→TPAR	–	3ΦT→TPAR	–
4	x						1ΦT→MPAR	(N/A)	1ΦT→MPAR	(N/A)	1ΦT→MPAR	(N/A)
5	x			x			1ΦT→FT	1ΦT→FT	1ΦT→TPAR	1ΦT→TPAR	1ΦT→SPAR	1ΦT→SPAR
6	x	x					2ΦT→MPAR	(N/A)	2ΦT→MPAR	(N/A)	2ΦT→MPAR	(N/A)
7	x				x		1ΦT→MPAR	1ΦT→MPAR	1ΦT→MPAR	1ΦT→MPAR	1ΦT→MPAR	1ΦT→MPAR
8	x	x		x			2ΦT→FT	1ΦT→FT	2ΦT→TPAR	1ΦT→TPAR	2ΦT→TPAR	1ΦT→SPAR
9	x	x		x	x		2ΦT→FT	2ΦT→FT	2ΦT→TPAR	2ΦT→TPAR	2ΦT→TPAR	2ΦT→TPAR
10	x	x	x				3ΦT→MPAR	(N/A)	3ΦT→MPAR	(N/A)	3ΦT→MPAR	(N/A)
11	x	x				x	2ΦT→MPAR	1ΦT→MPAR	2ΦT→MPAR	1ΦT→MPAR	2ΦT→MPAR	1ΦT→MPAR
12	x	x			x	x	2ΦT→FT	2ΦT→FT	2ΦT→TPAR	2ΦT→TPAR	2ΦT→TPAR	2ΦT→TPAR
13	x	x	x	x			3ΦT→FT	1ΦT→FT	3ΦT→TPAR	1ΦT→TPAR	3ΦT→TPAR	1ΦT→SPAR
14	x	x	x	x	x		3ΦT→FT	2ΦT→FT	3ΦT→TPAR	2ΦT→TPAR	3ΦT→TPAR	2ΦT→TPAR
15	x	x	x	x	x	x	3ΦT→FT	3ΦT→FT	3ΦT→TPAR	3ΦT→TPAR	3ΦT→TPAR	3ΦT→TPAR

x: Occurrence of the fault

–: Not energized (out of service)

MPAR: To issue a reclose command by ARC_MPAR_COND

TPAR: The TPAR scheme issuing three-phases tripping by ARC_TPAR_COND; then, to issue a reclose command

SPAR: To issue a reclose command by ARC_SPAR_COND

FT: To abandon reclosing CB after ARC issuing three-phases tripping by **FT** setting

1ΦT: To issue a single-phase tripping

2ΦT: To issue two-phases tripping

3ΦT: To issue three-phases tripping

(N.A): Tripping and reclosing do not perform

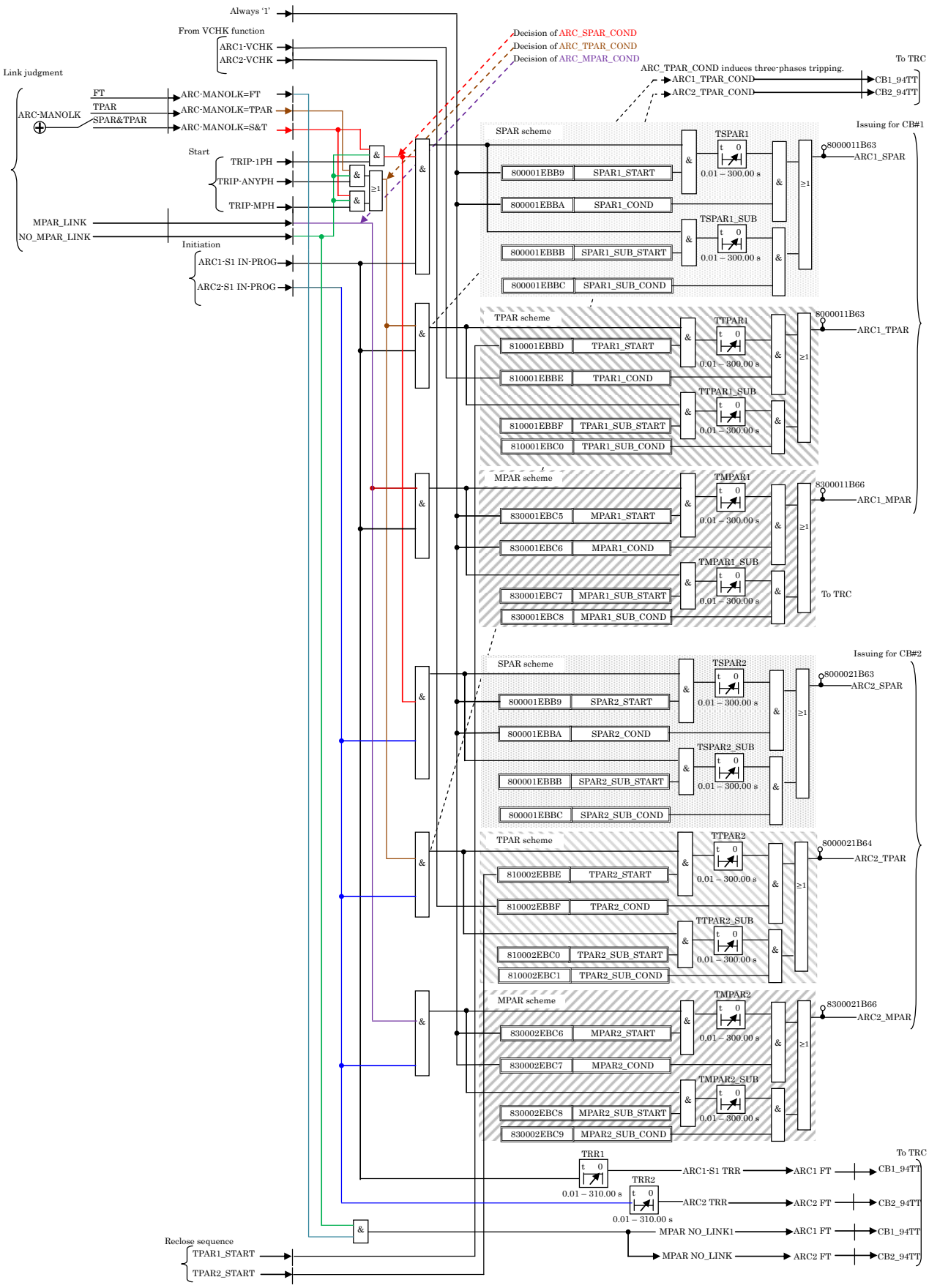


Figure 2.27-27 MPAR logic

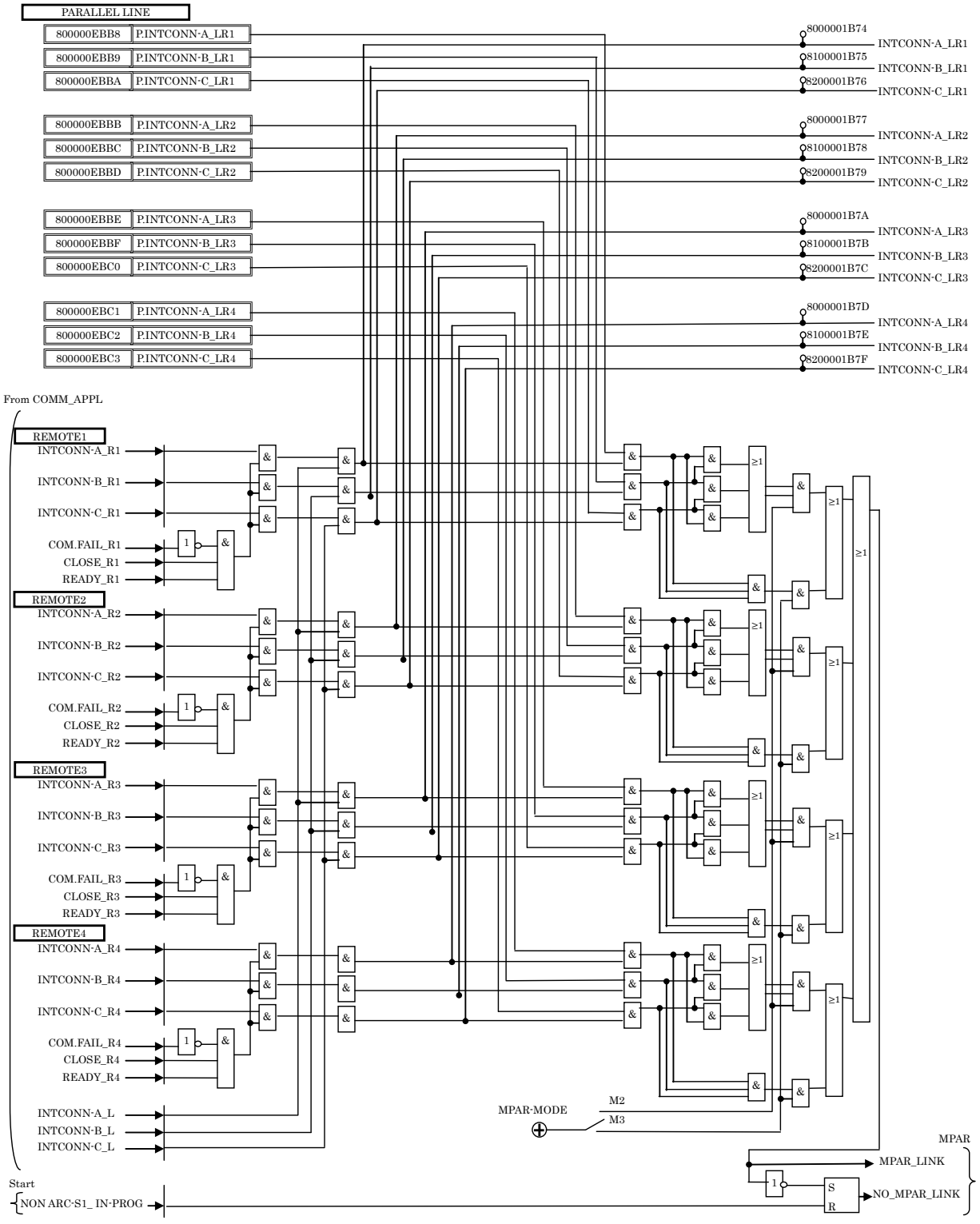


Figure 2.27-28 Link judgment logic

2.27.6 Setting

ARC Setting (Function ID: 4A6001)

Setting item		Range	Units	Contents	Default setting value	Notes
Auto reclose	ARC1-MODE	Off / FT / SPAR / TPAR / SPAR&TPAR / MPAR† / Original	-	ARC mode in 1CB-system	Off	
	ARC2-MODE	Off / FT / SPAR / TPAR / SPAR&TPAR / MPAR / Original	-	ARC mode of Center-CB in 2CB-system	Off	
	MPAR-MODE	M2 / M3	-	Multi-phase ARC mode	M2	
	ARC-MANOLK	FT / TPAR / SPAR&TPAR	-	Operation in MPAR MODE	FT	
	ARC-ORDER	SIMUL / CB1 / CB2	-	Order of the 3-phase auto-reclosing start	SIMUL	
	ARC-NUM	S1 / S2 / S3 / S4 / S5	-	ARC maximum shot number	S1	
ARC1	TREADY1	0.0 - 600.0	s	ARC1 ready check time	60.0	
	TSPAR1	0.01 - 300.00	s	ARC1 SPAR dead time	0.80	
	TSPAR1_SUB	0.01 - 300.00	s	ARC1 sub-SPAR dead time	300.00	
	TTPAR1	0.01 - 300.00	s	ARC1 TPAR dead time	0.60	
	TTPAR1_SUB	0.01 - 300.00	s	ARC1 sub-TPAR dead time	300.00	
	TMPAR1	0.01 - 300.00	s	ARC1 MPAR dead time	1.00	
	TMPAR1_SUB	0.01 - 300.00	s	ARC1 sub-MPAR dead time	300.00	
	TORGAR1	0.01 - 300.00	s	ARC1 user original ARC dead time	300.00	
	TORGAR1_SUB	0.01 - 300.00	s	ARC1 sub user original ARC dead time	300.00	
	TRR1	0.01 - 310.00	s	ARC1 reset time	2.00	
	TCCW1	0.01 - 10.00	s	ARC1 ARC command pulse width	0.20	
Multi-shot	TD_MS2	0.01 - 300.00	s	2nd shot ARC dead time	20.00	
	TRR_MS2	0.01 - 310.00	s	2nd shot ARC reset time	30.00	
	TD_MS3	0.01 - 300.00	s	3rd shot ARC dead time	20.00	
	TRR_MS3	0.01 - 310.00	s	3rd shot ARC reset time	30.00	
	TD_MS4	0.01 - 300.00	s	4th shot ARC dead time	20.00	
	TRR_MS4	0.01 - 310.00	s	4th shot ARC reset time	30.00	
	TD_MS5	0.01 - 300.00	s	5th shot ARC dead time	20.00	
	TRR_MS5	0.01 - 310.00	s	5th shot ARC reset time	30.00	
ARC2	TREADY2	0.0 - 600.0	s	ARC2 ready check time	60.0	
	TSPAR2	0.01 - 300.00	s	ARC2 SPAR dead time	0.80	
	TSPAR2_SUB	0.01 - 300.00	s	ARC2 sub-SPAR dead time	300.00	
	TTPAR2	0.01 - 300.00	s	ARC2 TPAR dead time	0.60	
	TTPAR2_SUB	0.01 - 300.00	s	ARC2 sub-TPAR dead time	300.00	
	TMPAR2	0.01 - 300.00	s	ARC2 MPAR dead time	1.00	
	TMPAR2_SUB	0.01 - 300.00	s	ARC2 sub-MPAR dead time	300.00	
	TORGAR2	0.01 - 300.00	s	ARC2 user original ARC dead time	300.00	
	TORGAR2_SUB	0.01 - 300.00	s	ARC2 sub user original ARC dead time	300.00	
	TRR2	0.01 - 310.00	s	ARC2 reset time	2.00	
	TCCW2	0.01 - 10.00	s	ARC2 ARC command pulse width	0.20	
	ARC-SucChk	Off / On	-	ARC success checking enable	On	
	TARCSUC	0.10 - 100.00	s	ARC success checking time	0.30	
	FT-3pFault	Off / On	-	Execute final trip in 3-phase fault mode	Off	
	TRESET	0.01 - 300.00	s	ARC reset time under CB closed	0.30	
	TEVLV	0.01 - 300.00	s	Evolving fault waiting time	0.30	
	SHOTNUM-TEST	Off / S1 / S2 / S3 / S4 / S5 / S6	-	ARC test shot number	Off	

2.27.7 Data ID

◆ Signal monitoring point

ARC(Function ID: 4A6001)

Element ID	Name	Description
8500001B6C	3PHASE FAULT	3 phase fault
8000001B81	ARC IN-PROG	
8000001BB3	ARC NO ACT	No action for ARC
8000011B6C	ARC1 CLOSE COMMAND	CB close command for ARC1
8C00011B71	ARC1 CLOSE FAIL	ARC1 fail
8000011B72	ARC1 CLOSE SUCCESS	ARC1 success
8400011B6E	ARC1 FT	Final trip for ARC1
8200011B61	ARC1 IN-PROG	ARC1 in progress
8000011B60	ARC1 READY	ARC1 ready
8700011B70	ARC1 RESET	ARC1 reset when ARC no action or success
8000011B6B	ARC1 SHOT1	ARC1 shot1
8100011B67	ARC1 SHOT2	ARC1 shot2
8200011B68	ARC1 SHOT3	ARC1 shot3
8300011B69	ARC1 SHOT4	ARC1 shot4
8400011B6A	ARC1 SHOT5	ARC1 shot5
8800011B74	ARC1-SUB_INIT	ARC1 sub initiation
3000001B82	ARC1_AUTORECST	AutoRecSt signal in RREC of IEC61580 LN
8000011B73	ARC1_INIT	ARC1 initiation
8300011B66	ARC1_MPAR	For multi-phase ARC1 operation
8200011B65	ARC1_ORGAR	For original ARC1 operation
8000011B63	ARC1_SPAR	For single-phase ARC1 operation
8100011B64	ARC1_TPAR	For three-phase ARC1 operation
8100021B68	ARC2 CLOSE COMMAND	CB close command for ARC2
8C00021B6D	ARC2 CLOSE FAIL	ARC2 fail
8000021B6E	ARC2 CLOSE SUCCESS	ARC2 success
8400021B6A	ARC2 FT	Final trip for ARC2
8200021B61	ARC2 IN-PROG	ARC2 in progress
8000021B60	ARC2 READY	ARC2 ready
8700021B6C	ARC2 RESET	ARC2 reset when ARC no action or success
8100021B67	ARC2 SHOT	ARC2 shot
8900021B70	ARC2-SUB_INIT	ARC2 sub initiation
3000001B83	ARC2_AUTORECST	AutoRecSt signal in RREC of IEC61580 LN
8100021B6F	ARC2_INIT	ARC2 initiation
8300021B66	ARC2_MPAR	For multi-phase ARC2 operation
8200021B65	ARC2_ORGAR	For original ARC2 operation
8000021B63	ARC2_SPAR	For single-phase ARC2 operation
8100021B64	ARC2_TPAR	For three-phase ARC2 operation
8200001BB4	ARC_BLOCK	ARC1 & ARC2 block signal
8400001B65	ARC_START	ARC start by general trip
8500011B6F	CB1_94TT	Discrepancy trip signal in CB1
8800011B62	CB1_BRIDGE	CB1 bridge
8500021B6B	CB2_94TT	Discrepancy trip signal in CB2
8800021B62	CB2_BRIDGE	CB2 bridge

◆ Signal monitoring point

ARC(Function ID: 4A6001)

Element ID	Name	Description
8200001B6A	EVOLV-FAULT TIME OVER	Time over of evolved fault under S&T mode
8300001B64	EXT.ARC_START	External ARC operation
8000001BB0	EXT.ARC_START-A	External ARC start signal (phase-A)
8100001BB1	EXT.ARC_START-B	External ARC start signal (phase-B)
8200001BB2	EXT.ARC_START-C	External ARC start signal (phase-C)
8000011B6D	FT ARC1 UNREADY	Final trip under ARC1 unready condition
8000021B69	FT ARC2 UNREADY	Final trip under ARC2 unready condition
8000001B74	INTCONN-A_LR1	
8000001B77	INTCONN-A_LR2	
8000001B7A	INTCONN-A_LR3	
8000001B7D	INTCONN-A_LR4	
8100001B75	INTCONN-B_LR1	
8100001B78	INTCONN-B_LR2	
8100001B7B	INTCONN-B_LR3	
8100001B7E	INTCONN-B_LR4	
8200001B76	INTCONN-C_LR1	
8200001B79	INTCONN-C_LR2	
8200001B7C	INTCONN-C_LR3	
8200001B7F	INTCONN-C_LR4	
8000001B80	MPAR_LINK	
8400001B6B	SHOT NUMBER OVER	Shot number over
8000001B6D	SHOT_1ST	1st shot from Multi shot ARC counter
8100001B6E	SHOT_2ND	2ND shot from Multi shot ARC counter
8200001B6F	SHOT_3RD	3RD shot from Multi shot ARC counter
8300001B70	SHOT_4TH	4TH shot from Multi shot ARC counter
8400001B71	SHOT_5TH	5TH shot from Multi shot ARC counter
8500001B72	SHOT_6TH	6TH shot from Multi shot ARC counter
8000001B84	SHOT_MULTI	Signal of the second and the following ARC shots
8100001B67	TRIP-1PH	1 phase trip signal
8300001B69	TRIP-3PH	3 phase trip signal
8000001B66	TRIP-ANYPH	Any phase trip signal
8200001B68	TRIP-MPH	Multi-phase trip signal

◆ Connection point on PLC logic

ARC(Function ID: 4A60001)

Element ID	Name	Description
800000EBB3	ARC NO ACT	No action for ARC
810001EBC9	ARC1-S2 COND	ARC1 shot2 condition
820001EBCA	ARC1-S3 COND	ARC1 shot3 condition
830001EBCB	ARC1-S4 COND	ARC1 shot4 condition
840001EBCC	ARC1-S5 COND	ARC1 shot5 condition
800001EBCF	ARC1_BLOCK	ARC1 block signal
810001EBB1	ARC1_MODE-FT	Final trip mode for autoreclose 1
850001EBB5	ARC1_MODE-MPAR	Multi-phase mode for autoreclose 1

◆ Connection point on PLC logic

ARC(Function ID: 4A60001)

Element ID	Name	Description
800001EBB0	ARC1_MODE-OFF	Off mode for autoreclose 1
860001EBB6	ARC1_MODE-ORG	Original mode for autoreclose 1
840001EBB4	ARC1_MODE-S&T	Single and three-phase mode for autoreclose 1
820001EBB2	ARC1_MODE-SPAR	Single-phase mode for autoreclose 1
830001EBB3	ARC1_MODE-TPAR	Three-phase mode for autoreclose 1
810002EBB7	ARC2_BLOCK	ARC2 block signal
810002EBB1	ARC2_MODE-FT	Final trip mode for autoreclose 2
850002EBB5	ARC2_MODE-MPAR	Multi-phase mode for autoreclose 2
800002EBB0	ARC2_MODE-OFF	Off mode for autoreclose 2
860002EBB6	ARC2_MODE-ORG	Original mode for autoreclose 2
840002EBB4	ARC2_MODE-S&T	Single and three-phase mode for autoreclose 2
820002EBB2	ARC2_MODE-SPAR	Single-phase mode for autoreclose 2
830002EBB3	ARC2_MODE-TPAR	Three-phase mode for autoreclose 2
820000EBB4	ARC_BLOCK	ARC1 & ARC2 block signal
800001EBB8	CB1 F.BRIDGE	Forcible bridge signal for CB1
800001EBB7	CB1-ARC READY	CB1 ready signal for ARC1
800001EBCD	CB1_MANUAL_CLOSE	CB1 manual close siganl
810002EBB9	CB2 F.BRIDGE	Forcible bridge signal for CB2
810002EBB8	CB2-ARC READY	CB2 ready signal for ARC2
810002EBCA	CB2_MANUAL_CLOSE	CB2 manual close siganl
800000EBB0	EXT.ARC_START-A	External ARC start signal (phase-A)
810000EBB1	EXT.ARC_START-B	External ARC start signal (phase-B)
820000EBB2	EXT.ARC_START-C	External ARC start signal (phase-C)
800001EBCE	F.CB1_94TT	Forcible discrepancy trip signal in CB1
810002EBCB	F.CB2_94TT	Forcible discrepancy trip signal in CB2
830001EBC6	MPAR1_COND	For multi-phase ARC1 condition
830001EBC5	MPAR1_START	For multi-phase ARC1 start
830001EBC8	MPAR1_SUB_COND	For multi-phase ARC1 condition (sub)
830001EBC7	MPAR1_SUB_START	For multi-phase ARC1 start (sub)
830002EBC7	MPAR2_COND	For multi-phase ARC2 condition
830002EBC6	MPAR2_START	For multi-phase ARC2 start
830002EBC9	MPAR2_SUB_COND	For multi-phase ARC2 condition (sub)
830002EBC8	MPAR2_SUB_START	For multi-phase ARC2 start (sub)
820001EBC2	ORGAR1_COND	For original ARC1 condition
820001EBC1	ORGAR1_START	For original ARC1 start
820001EBC4	ORGAR1_SUB_COND	For original ARC1 condition (sub)
820001EBC3	ORGAR1_SUB_START	For original ARC1 start (sub)
820002EBC3	ORGAR2_COND	For original ARC2 condition
820002EBC2	ORGAR2_START	For original ARC2 start
820002EBC5	ORGAR2_SUB_COND	For original ARC2 condition (sub)
820002EBC4	ORGAR2_SUB_START	For original ARC2 start (sub)
800000EBB8	P.INTCONN-A_LR1	
800000EBBB	P.INTCONN-A_LR2	
800000EBBE	P.INTCONN-A_LR3	

◆ Connection point on PLC logic

ARC(Function ID: 4A60001)

Element ID	Name	Description
800000EBC1	P.INTCONN-A_LR4	
810000EBB9	P.INTCONN-B_LR1	
810000EBBC	P.INTCONN-B_LR2	
810000EBBF	P.INTCONN-B_LR3	
810000EBC2	P.INTCONN-B_LR4	
820000EBBA	P.INTCONN-C_LR1	
820000EBBD	P.INTCONN-C_LR2	
820000EBC0	P.INTCONN-C_LR3	
820000EBC3	P.INTCONN-C_LR4	
800000EBB5	RYOP-A	Relay operation (phase-A)
810000EBB6	RYOP-B	Relay operation (phase-B)
820000EBB7	RYOP-C	Relay operation (phase-C)
800001EBBA	SPAR1_COND	For single-phase ARC1 condition
800001EBB9	SPAR1_START	For single-phase ARC1 start
800001EBBC	SPAR1_SUB_COND	For single-phase ARC1 condition (sub)
800001EBBB	SPAR1_SUB_START	For single-phase ARC1 start (sub)
800002EBBB	SPAR2_COND	For single-phase ARC2 condition
800002EBBA	SPAR2_START	For single-phase ARC2 start
800002EBBD	SPAR2_SUB_COND	For single-phase ARC2 condition (sub)
800002EBBC	SPAR2_SUB_START	For single-phase ARC2 start (sub)
810001EBBE	TPAR1_COND	For three-phase ARC1 condition
810001EBBD	TPAR1_START	For three-phase ARC1 start
810001EBC0	TPAR1_SUB_COND	For three-phase ARC1 condition (sub)
810001EBBF	TPAR1_SUB_START	For three-phase ARC1 start (sub)
810002EBBF	TPAR2_COND	For three-phase ARC2 condition
810002EBBE	TPAR2_START	For three-phase ARC2 start
810002EBC1	TPAR2_SUB_COND	For three-phase ARC2 condition (sub)
810002EBC0	TPAR2_SUB_START	For three-phase ARC2 start (sub)

2.28 Voltage check for autoreclose (VCHK)

The voltage-check-for-autoreclose (VCHK) function is used along with the function of autoreclose (ARC), as Bus-bar between Lines requires the restoration of service after the clearance of fault.

The ARC covers two breaker systems: single breaker system (1CB) and single-and-a-half breaker system (1.5CB), and the ARC has two scheme logics: one scheme logic (ARC1) is for 1CB and for Bus-bar CB of 1.5CB, and another scheme logic (ARC2) is for Center CB of 1.5CB. Thus, the VCHK consist of two scheme logics (VCHK1 and VCHK2), and VCHK1 is applied to ARC1; on the other hand, VCHK2 is used for ARC2.

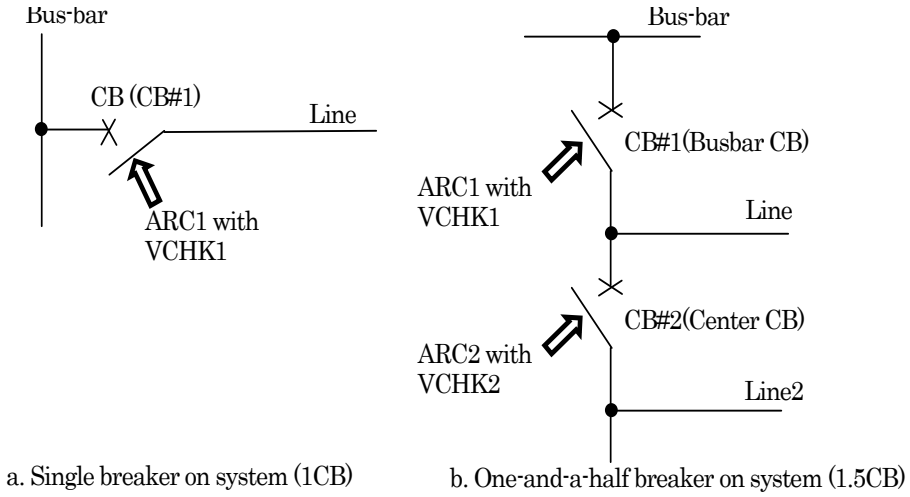


Figure 2.28-1 Single breaker and double breakers on the system

---

Note: To determine whether the features are implemented in the IED or not, locate the IED ordering number; and check the order number at "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 2.28-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
VCHK	Voltage check for Auto-reclosing	NA	✓	✓	(✓)	✓

✓: Applicable NA: Not applicable

(✓): Partial applicable. For the operation of the distance protection (ZS/ZG), the user shall stop two or more unnecessary applications; select them among DISCAR, DEFCAR, OC, EF, OCN, THM, BCD, CBF, SOTF-OC, OV, OVS, UV, UVS, FRQ/DFRQ, FS, VTF, CTF, ARC.

2.28.1 VCHK1 for 1CB system

(i) Characteristic and elements

VCHK1 does voltage and synchronous check in 1CB system. Four relay elements (OVB, OVB, UVL, and UVL) are used for voltage check. Tow relay elements (OVB and OVL) are used for verification of existing voltage; the remaining ones (UVB and UVL) are used for verification of non-existing voltage.

(ii) Voltage condition and check zone

Figure 2.28-2 shows four zones (A1 to D1) for voltage verification. For example, if both UVB and OVL elements are active, VHCK1 determines that the Bus-bar is in Dead condition (no-voltage) and Line is in Live condition (existing voltage). This condition holds true for A1 zone. If voltage condition matches with B1 zone, synchronous check is carried out on VCHK1. Thus, this means that Synchronous check is not carried out in A1, C1 or D1 zones.

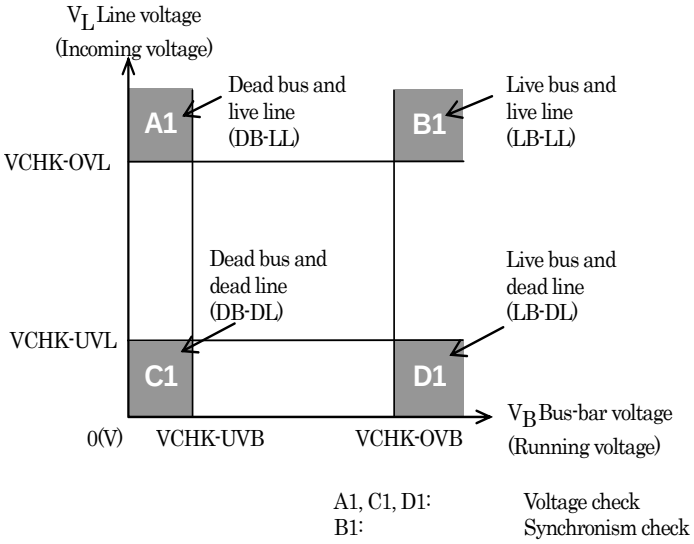


Figure 2.28-2 Check zones by VCHK1

Table 2.28-2 Voltage condition by VCHK1

Voltage condition	DB_LL	LB_LL	DB_DL	LB_DL
Check zone	A1	B1	C1	D1
Bus-bar voltage (V_B)	Dead	Live	Dead	Live
Line voltage (V_L)	Live	Live	Dead	Dead

2.28.2 VCHK1 and VCHK2 for 1.5CB system

(i) Characteristic and elements

VCHK1 and VCHK2 are used for verification of existence or non-existence of voltage on 1.5CB system. As shown in Figure 2.28-3(b), VCHK2 is used in the center CB (CB#2). Four elements (OVL2, UVL2, OVL, and UVL) are configured for VCHK2; they are used for determination of existence or non-existence of voltage.

(ii) Voltage condition and check zone

Figure 2.28-3(a) shows that VCHK1 checks the presence of voltage between the Bus-bar and Line; Figure 2.28-3(b) shows that the VCHK2 checks the presence of voltage between Line2 and Line. The result of the VCHK1 and VCHK2 are shown in Table 2.28-3 and Table 2.28-4, respectively. Sync check is carried out if the result by VCHK1 is B1 zone and if the result by VCHK2 is B2 zone.

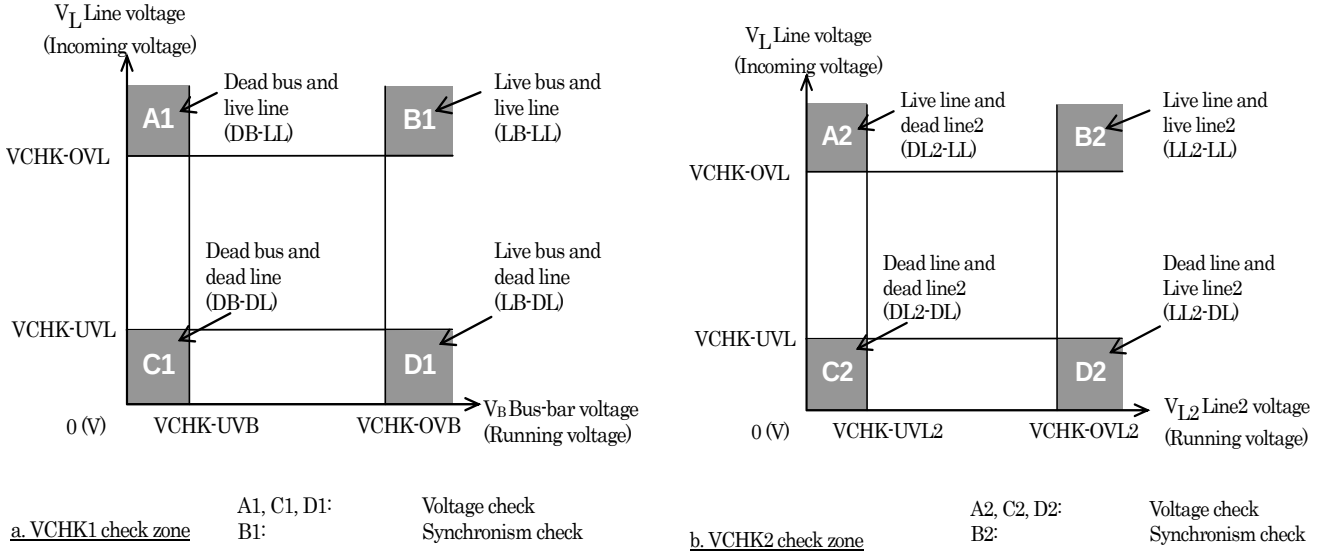


Figure 2.28-3 Check zones by VCHK1 and VCHK2

Table 2.28-3 Voltage condition by VCHK1

Voltage condition	DB_LL	LB_LL	DB_DL	LB_DL
Check zone	A1	B1	C1	D1
Bus-bar voltage (V_B)	Dead	Live	Dead	Live
Line voltage (V_L)	Live	Live	Dead	Dead

Table 2.28-4 Voltage condition by VCHK2

Voltage condition	DL2_LL	LL2_LL	DL2_DL	DL2_LL
Check zone	A2	B2	C2	D2
Line2 voltage (V_{L2})	Dead	Live	Dead	Dead
Line voltage (V_L)	Live	Live	Dead	Live

2.28.3 Scheme for synchronism

VCHK has a measuring function, which checks the difference between a running voltage and an incoming voltage. The measuring function checks phase angles, voltages, and frequencies. The VCHK1 determines the synchronism based on the presence of voltage on both Bus-bar and Line, as shown in Figure 2.28-4(a). The VCHK2 also determines the synchronism based on the presence of voltage on both Line2 and Line, as shown in Figure 2.28-4(b).

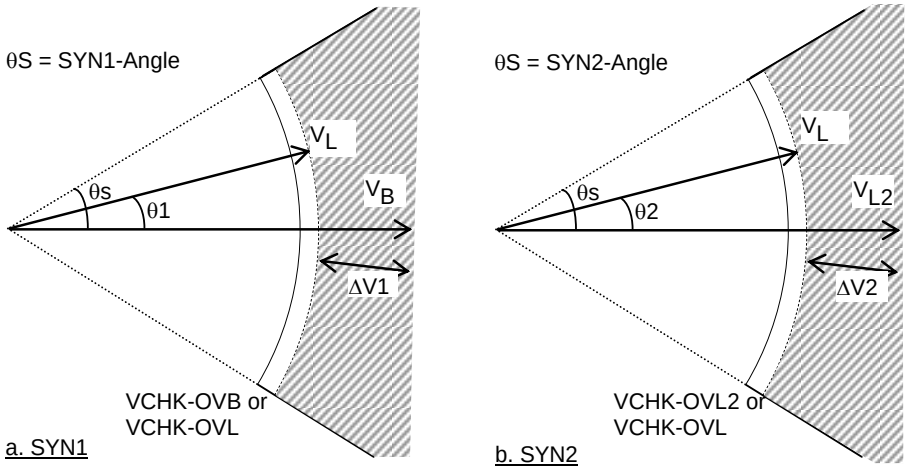


Figure 2.28-4 SYN1 and SYN2 characteristics

This function performs three checks: (1) checking voltage difference, (2) checking frequency difference, and (3) checking phase difference. The following variables represent algebraic expression used in these checking:

V_B = Bus-bar voltage
V_{L1} = Line voltage
V_{L2} = Line2 voltage
ΔV1 = Voltage difference between Bus-bar and Line
ΔV2 = Voltage difference between Line2 and Line
fV_B = frequency of V_B
fV_L = frequency of V_L
fV_{L2} = frequency of V_{L2}
f = slip cycle
Δf1 = frequency difference between Bus-bar and Line
Δf2 = frequency difference between Line2 and Line1
θ1= phase difference between V_B and V_L
θ2 = phase difference between V_{L2} and V_L
SYN1-dV = Voltage difference setting [**SYN1-dV**]
SYN2-dV = another voltage difference setting [**SYN2-dV**]
VCHK-OVB = voltage setting for Bus-bar [**VCHK-OVB**]
VCHK-OVL = voltage setting for Line [**VCHK-OVL**]
VCHK-OVL2 =voltage setting for Line2 [**VCHK-OVL2**]

SYN1-Angle = phase difference between V_B and V_L, set by [**SYN1-Angle**]
SYN2-Angle = phase difference between V_{L2} and V_L, set by [**SYN2-Angle**]
SYN1-df = value of frequency difference between Bus-bar and Line, set by [**SYN1-df**]
SYN2-df = value of frequency difference between Line2 and Line, set by [**SYN2-df**]
T_SYN1 = setting of synch check timer (second) [**T_SYN1**]
T_SYN2 = setting of synch check timer (second) [**T_SYN2**]

Table 2.28-5 VCHK synchronism setting

Scheme switch	Set	Comment
SYN1-dV	0 - 150	Difference voltage for the checking SYN1
SYN1-df	0.01 - 2.00	Difference frequency for the checking SYN1
SYN1-Angle	0 - 75	Difference angle for the checking SYN1
SYN1-dfEN	Off/ On	Enabling for df checking in SYN1
SYN2-df	0.01 - 2.00	Difference frequency for the checking SYN2
SYN2-Angle	0 - 75	Difference angle for the checking SYN2
SYN2-dfEN	Off/ On	Enabling for df checking in SYN2
VCHK-OVL	10 - 150	Voltage for the checking Live-Line
VCHK-UVL	10 - 150	Voltage for the checking Dead-Line
VCHK-OVL2	10 - 150	Voltage for the checking Live-Line2
T_SYN1	0.01 - 100.00	Voltage check time "SYN1(Live-Bus & Live-Line & Synchro.)"
T_SYN2	0.01 - 100.00	Voltage check time "SYN2(Live-Line2 & Live-Line & Synchro.)"

The VCHK can have the decision of synchronism between the running voltage and the incoming voltage when the following items (i) to (iv) are satisfied:

(i) Voltage magnitudes

The magnitude of the running voltage and the incoming voltage are greater than the SYN1 and SYN2 settings:

For SYN1 setting: $V_B \geq$ [**VCHK-OVB**] and $V_L \geq$ [**VCHK-OVL**]
For SYN2 setting: $V_{L2} \geq$ [**VCHK-OVL2**] and $V_L \geq$ [**VCHK-OVL**]

(ii) Voltage difference

The differences of the magnitude between the running voltage and the incoming voltage ($\Delta V1$ and $\Delta V2$) are smaller than the SYN1 and SYN2 settings:

For SYN1 setting: $\Delta V1 \geq | V_B - K \times V_L | \leq$ [**SYN1-dV**]
For SYN2 setting: $\Delta V2 \geq | V_{L2} - K \times V_L | \leq$ [**SYN2-dV**]

Note: The VCHK calculation should be achieved correctly even if respective rating voltages in V_B, V_L, and V_{L2} are not identical. Thus, the VCHK function has a matching factor (K) designed to adjust the respective rating voltages when they are not identical. The matching factor (K) is calculated automatically using the setting values of VCT ratios; the K is generated

based on the busbar voltage as shown below:

$$K = \frac{\text{VT ratio at Line}}{\text{VT ratio at busbar}}$$

whereas, 'VT ratio at Line' is obtained from the actual value in VCT ratio setting corresponding with scheme switch [**SYN-VLine**], and 'VT ratio at busbar' is obtained from the actual one corresponding with the scheme switch [**SYN-VBus**]. We shall see the scheme switches in the succeeding section.

(iii) Frequency difference

The frequency differences between the running voltage and the incoming voltage (Δf1 and Δf2) are smaller than the SYN1 and SYN2 settings:

For SYN1 setting: $\Delta f1 \geq | fV_B - fV_L | \leq$ [**SYN1-df**]

For SYN2 setting: $\Delta f2 \geq | f_{L2} - fV_L | \leq$ [**SYN2-df**]

Note: When **Off** is set for the scheme switch [**SYN1-dfEN**], the VCHK abandons the frequency difference condition from synchronism requirements. Similarly, the frequency difference condition is not valid when [**SYN2-dfEN**] = **Off**.

(iv) Phase angle difference

The phase differences between the running voltage and the incoming voltage (θ1 and θ2) are smaller than the SYN1 and SYN2 settings:

For SYN1 setting: $V_B \times V_L \cos\theta1 \geq 0$

$V_B \times V_L \sin$ ([**SYN1-Angle**]) $\geq V_B \times V_L \sin \theta1$

For SYN2 setting: $V_{L2} \times V_L \cos\theta2 \geq 0$

$V_{L2} \times V_L \sin$ ([**SYN2-Angle**]) $\geq V_{L2} \times V_L \sin \theta2$

(v) Notice and tips

If the frequency difference between the V_L and the V_B is shown very large, the VCHK may fail to make the decision for the synchronism, although **Off** is set for the [**SYN1-dfEN**] to abandon checking the frequency difference. This is because; the vector passes the [**SYN1-Angle**] zone very quickly. As a result, the VCHK may fail to issue the permission command. To avoid the failure, the user has to set values for settings [**SYN1-Angle**] and [**T_SYN1**] depending on the assumed frequency difference (Δf):

$$\Delta f > \frac{\text{Setting [SYN1-Angle]}}{180° \times \text{Setting [T_SYN1]}} \qquad (2.28\text{-}1)$$

where,

Δf= Frequency-difference (or cycle-slip in Hertz)

Tips: **Cycles for the synchronism closure can be calculated:**

$$\text{Cycle for synchronism} = {}^{1}/_{\Delta f[\text{Hz}]} \tag{2.28-2}$$

Time length for getting a synchronism:

$$\text{Time} = \frac{2 \times \text{Setting [SYN1-Angle]}}{360°} \times \frac{1}{\Delta f[\text{Hz}]} \tag{2.28-3}$$

Check time for the synchronism:

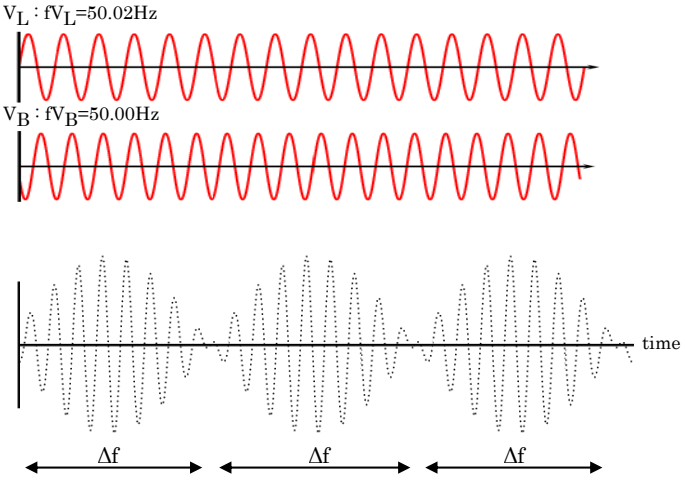
$$\text{Setting [T_SYN1]} < \frac{2 \times \text{Setting [SYN1-Angle]}}{360°} \times \frac{1}{\Delta f[\text{Hz}]} \tag{2.28-4}$$

Equations rearrangements:

$$\text{Setting [T_SYN1]} < \frac{\text{Setting [SYN1-Angle]}}{180°} \times \frac{1}{\Delta f[\text{Hz}]} \tag{2.28-5}$$

$$\frac{1}{\Delta f[Hz]} > \frac{Setting \text{ [T_SYN1]}}{\text{Setting [SYN1-Angle]}} \div \frac{1}{180°} \tag{2.28-6}$$

$$Setting \text{ [T_SYN1]} < \frac{Setting \text{ [SYN1-Angle]}}{180°} \times \frac{1}{\Delta f[Hz]} \tag{2.28-7}$$



Example: $|fV_B - fV_L| = |50.00Hz - 50.02Hz| = 0.02Hz = 10s$

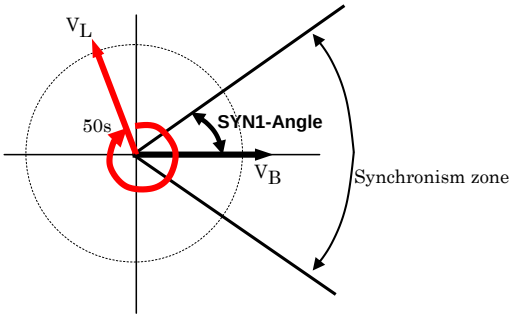


Figure 2.28-5 Synchronism between V_B and V_L when system frequency = 50Hz

Note: Settings [**SYN2-Angle**] and [**T_SYN2**] are also applicable for these calculations.

2.28.4 VCHK1 setting for 1CB system

When the VCHK1 is applied to 1CB system, OVB and UVB check the voltage of a Bus-bar, whereas OVL and UVL check the voltage of Line, as described earlier. The Bus-bar and Line voltages are obtained in the VCT[1]. Thus, user should set the scheme switches [**SYN-VBus**] and [**SYN-VLine**] in accordance with the phase(s) of input-voltage(s). The following are the setting examples when VCHK is used in 1CB system.

[1]Note: For more information on VCT, see *Chapter Technical description: Transfer module*. For external connection, see *Appendix: Typical external connection*.

Table 2.28-6 VCHK line selection setting

Scheme switch	Set	Comment
SYN-VBus	V-L1 / V-L2 / V-L3 V-L12 / V-L23 / V-L31 V2-L1 / V2-L2 / V2-L3 V2-L12 / V2-L23 / V2-L31 V3 / V4	Selection of Bus voltage(Running Voltage) for SYN1
SYN-VLine	V-L1 / V-L2 / V-L3 V-L12 / V-L23 / V-L31 V2-L1 / V2-L2 / V2-L3 V2-L12 / V2-L23 / V2-L31 V3 / V4	Selection of Line voltage (Incoming Voltage) for SYN1

(i) Setting example 1 (Bus-bar VT=three phases, Line VT=phase-A)

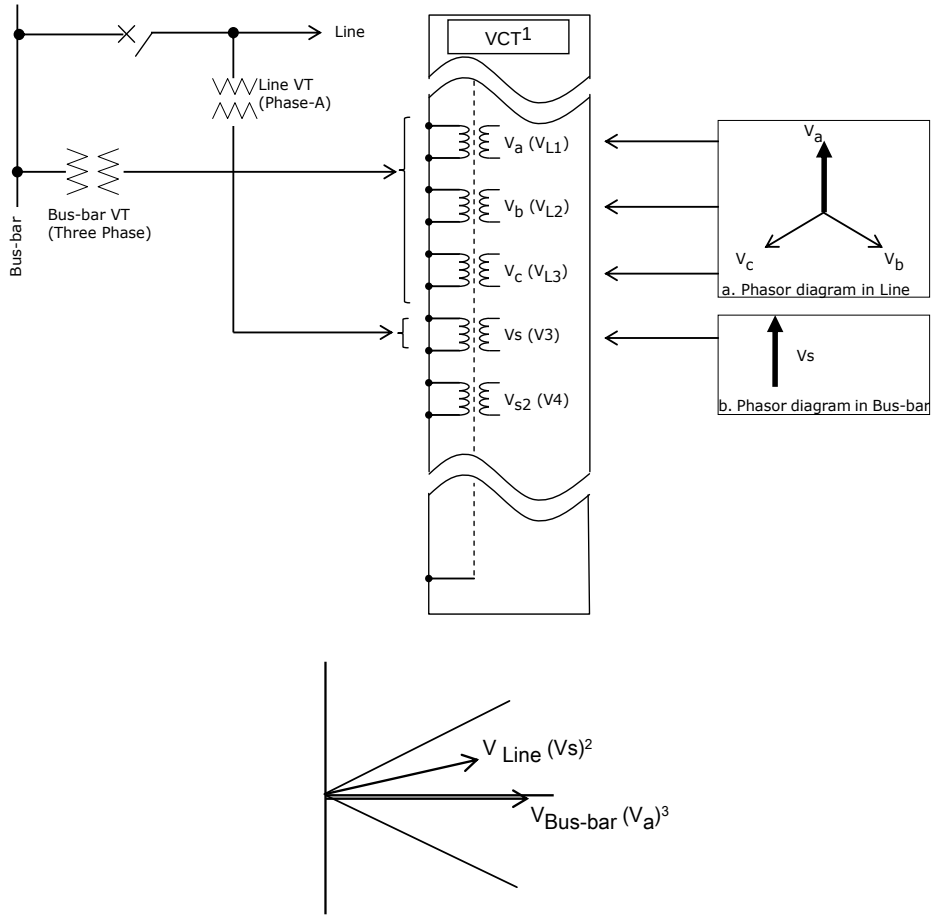


Figure 2.28-6 Example 1: Input voltages and respective phasor diagram for SYN1

[1]Note: The structure of VCT is dependent on the VCT type. (See chapter *Technical description: Transformer module*)

[2]Note: $V_{Bus\text{-}bar}$ is Running voltage.

[3]Note: V_{Line} is Incoming voltage.

Figure 2.28-6 shows the VCT input voltages and phases from Bus-bar and Line, and shows the phase relationship between the running voltage and the incoming voltage. In this case, configure the settings in accordance with Figure 2.28-6 and Table 2.28-7.

Table 2.28-7 Setting for example 1

Output voltage at VT	Bus-bar VT= Three phase Line VT= Phase-A
Input voltage at VCHK	Running voltage (V_a)= Phase-A (Bus-bar VT) Incoming voltage (Vs)= Phase-A (Line VT)
VCHK Setting[4]	[**SYN-VBus**] = **V-L1** [**SYN-VLine**]= **V3**

[4]Note: Set **V3** for the scheme switch [**SYN-VLine**]. This is because V3 and V-L1 are in the same phase.

(ii) Setting example 2 (Bus-bar VT=three phases, Line VT=phase-BC)

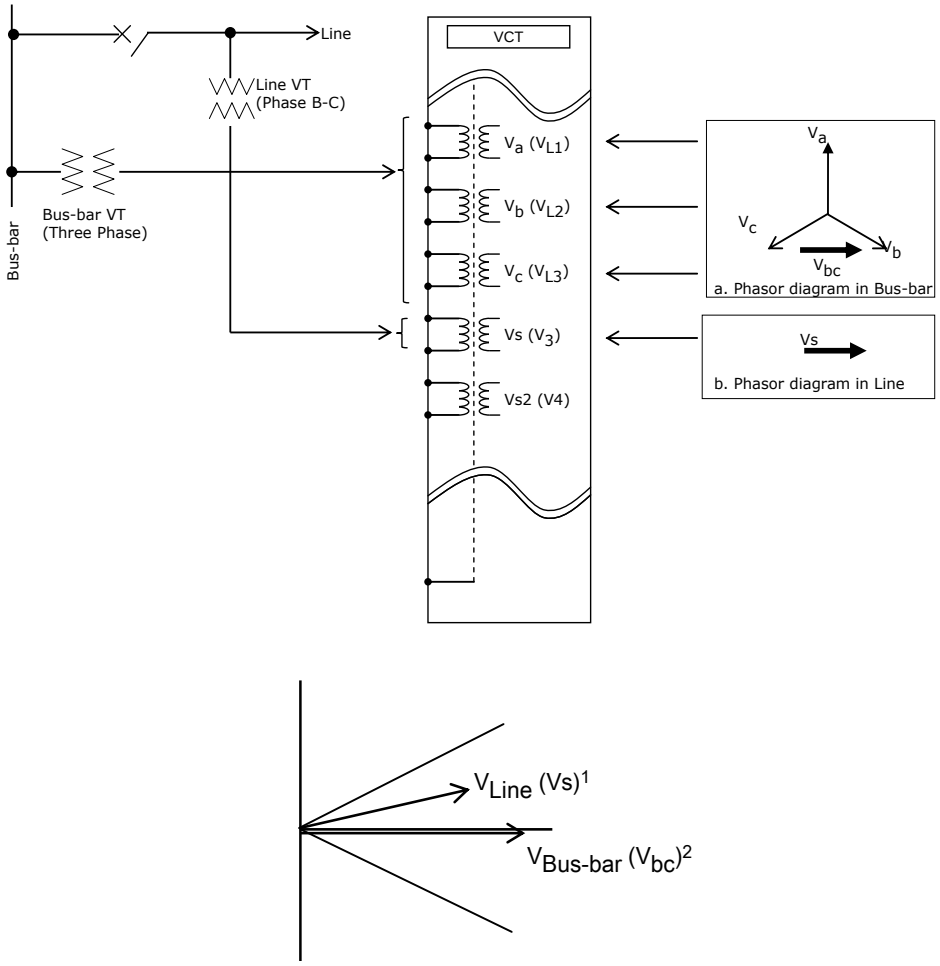


Figure 2.28-7 Example 2: Input voltages and respective phasor diagram for SYN1

[1]Note: $V_{Bus\text{-}bar}$ is Running voltage.

[2]Note: V_{Line} is Incoming voltage.

Similarly, Figure 2.28-7 shows the VCT input voltages and phases from Bus-bar and Line. In this case, configure the settings in accordance with Figure 2.28-7 and Table 2.28-8.

Table 2.28-8 Setting for example 2

Output voltage at VT	Bus-bar VT= Three phase Line VT= Phase-BC	
Input voltage at VCHK	Running voltage($V_{b \text{ and } c}$)=	Phase-B and C (Bus-bar VT)
	Incoming voltage (Vs)=	Phase-BC (Line VT)
VCHK Setting[3]	[**SYN-VBus**] = **V-L23** [**SYN-VLine**]= **V3**	

[3]Note: **V3** is set for the scheme switch [**SYN-VLine**]. This is because the resultant phase of V-L2, V-L3 and V3 is same.

(iii) Setting example 3 (Bus-bar VT=Phase-C, Line VT= Three-phase)

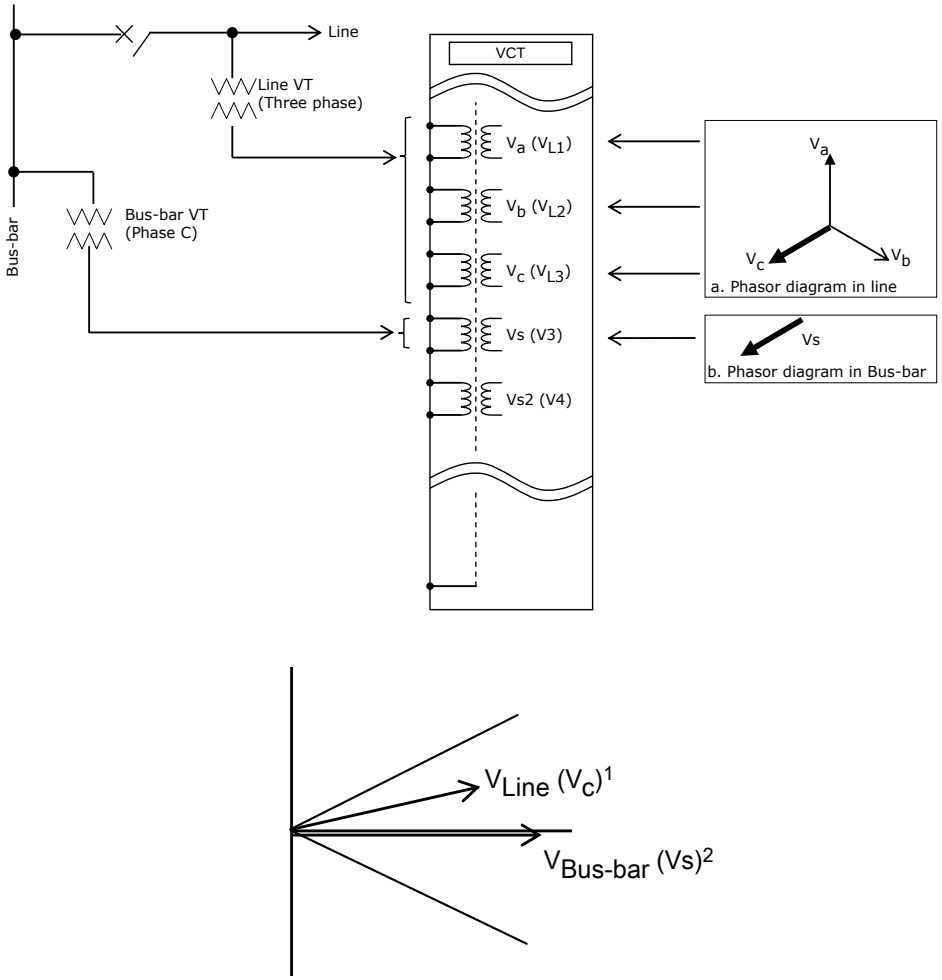


Figure 2.28-8 Example 3: Input voltages and respective phasor diagram for SYN1

[1]Note: $V_{Bus\text{-}bar}$ is Running voltage.

[2]Note: V_{Line} is Incoming voltage.

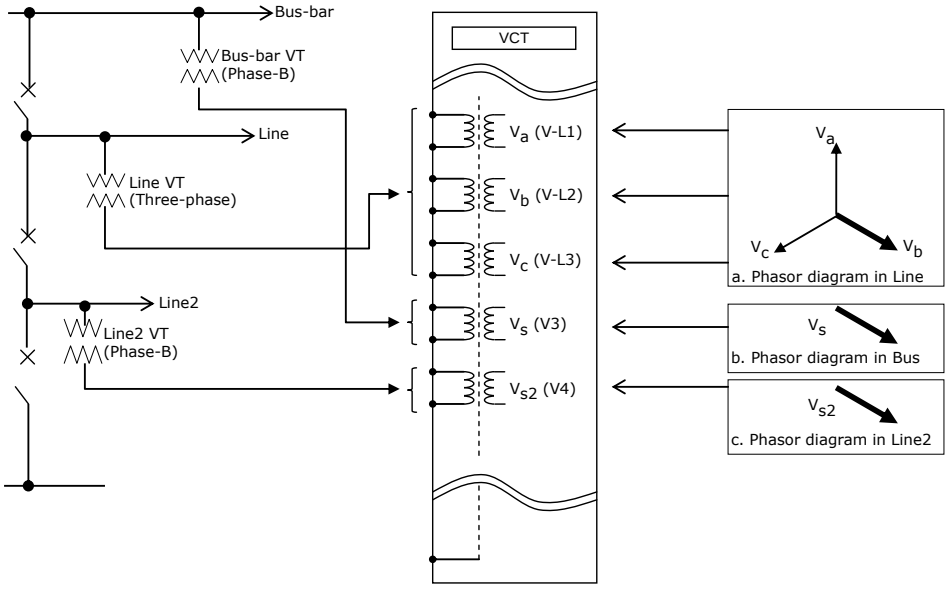
The configuration of inputs voltages and phases is done as shown in Figure 2.28-8. In this case, configure the settings in accordance with Figure 2.28-8 and Table 2.28-9.

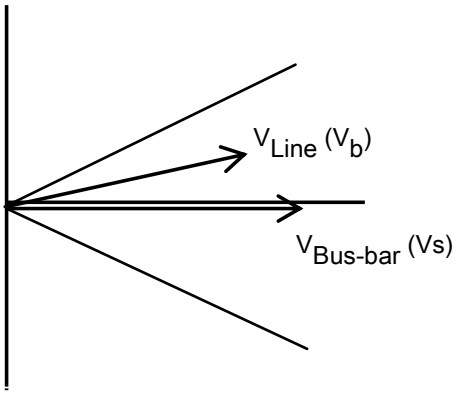
Table 2.28-9 Setting for example 3

Output voltage at VT	Bus-bar VT= Phase-C Line VT= Three phase
Input voltage at VCT	Running voltage (Vs)= Phase-C (Bus-bar VT) Incoming voltage (V_c)= Phase-C (Line VT)
VCHK Setting	[**SYN-VBus**] = **V3** [**SYN-VLine**]= **V-L3**[1]

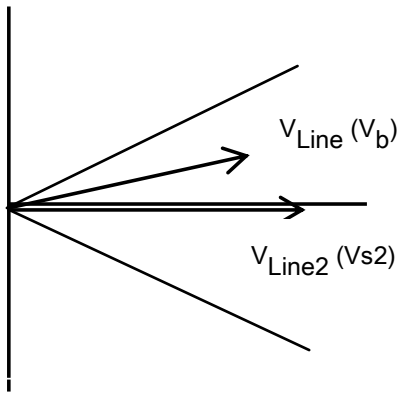
[1]Note: Set **V-L3** for the scheme switch [**SYN-VLine**]. This is because V3 and V-L3 are in the same phase.

2.28.5 VCHK1 and VCHK2 settings for 1.5CB system





d. Phasor diagram in SYN1[1]



e. Phasor diagram in SYN2[2]

Figure 2.28-9 Input voltages and respective phasor diagram for SYN1 and SYN2

[1]Note: $V_{Bus\text{-}bar}$ is Running voltage. V_{Line} is Incoming voltage.

[2]Note: V_{Line2} is Running voltage. V_{Line} is Incoming voltage.

When VCHK1 and VCHK2 are used in 1.5CB system, set the scheme switches [**SYN-VBus**], [**SYN-VLine**], and [**SYN-VLine2**]. For example, the settings in Figure 2.28-9 are applied when VCHK 1 and VCHK2 are applied in the 1.5CB system.

Table 2.28-10 Setting example for 1.5CB system

Output voltage at VT	Bus-bar VT= Phase-B Line VT= Three phase Line2 VT= Phase-B
Input voltage at VCT	Running voltage of SYN1(V_S)=Phase-B (Bus-bar VT) Incoming voltage of SYN1 and SYN2 (V_b)=Phase-B (Line VT) Running voltage of SYN2 (V_{S2})= Phase-B (Line2 VT)
VCHK Setting[3]	[**SYN-VBus**] = **V3** [**SYN-VLine**]= **V-L2** [**SYN-VLine2**] = **V4**

[3]Note: Set **V-L2** for the scheme switch [**SYN-VLine**]. This is because V3 and V_{L2} are in the same phase. Set **V4** for the scheme switch [**SYN-VLine2**]. This is because V3 and V4 are in the same phase.

Table 2.28-11 VCHK line1 and line2 selection setting

Scheme switch	Set	Comment
SYN-VBus	V-L1 / V-L2 / V-L3 / V-L12 / V-L23 / V-L31 / V2-L1 / V2-L2 / V2-L3 / V2-L12 / V2-L23 / V2-L31 / V3 / V4	Selection of Bus voltage(Running Voltage) for SYN1
SYN-VLine	V-L1 / V-L2 / V-L3 / V-L12 / V-L23 / V-L31 / V2-L1 / V2-L2 / V2-L3 / V2-L12 / V2-L23 / V2-L31 / V3 / V4	Selection of Line voltage (Incoming Voltage) for SYN1 and SYN2
SYN-VLine2	V-L1 / V-L2 / V-L3 / V-L12 / V-L23 / V-L31 / V2-L1 / V2-L2 / V2-L3 / V2-L12 / V2-L23 / V2-L31 / V3 / V4	Selection of Line2 voltage (Running voltage) for SYN2

2.28.6 Scheme and activation

VCHK1 and VCHK2 provide output signals to the ARC with results of voltage check and synchronism check as described earlier. The energizing control scheme of VCHK1 is drawn in Figure 2.28-10, the output signal ARC1-VCHK is fed to ARC1 when one or more of the following conditions are established: (1) the VCHK1 runs, (2) the OVB and the UVL run, or (3) the UVB and the OVL run. The activation of VCHK1 is controlled by using the scheme switches: [**ARC1-LB_DL**], [**ARC1-DB_LL**], [**ARC1-DB_DL**], and [**ARC1-SYN1**]. For example, DB_LL in Table 2.28-2 is only the criteria for ARC1 operation, **On** is set for the scheme switch [**ARC1-DB_LL**] while **Off** is set for other scheme switches. As a result, the system is energized in the direction from line to bus with ARC1. As shown in Figure 2.28-11, the operation of the VCHK2 is also applicable in accordance with Figure 2.28-3 similar to VCHK1. Note that the SYN1-df and SYN2-df operations are nullified when **Off** are set for the [**SYN1-dfEN**] and [**SYN2-dfEN**].

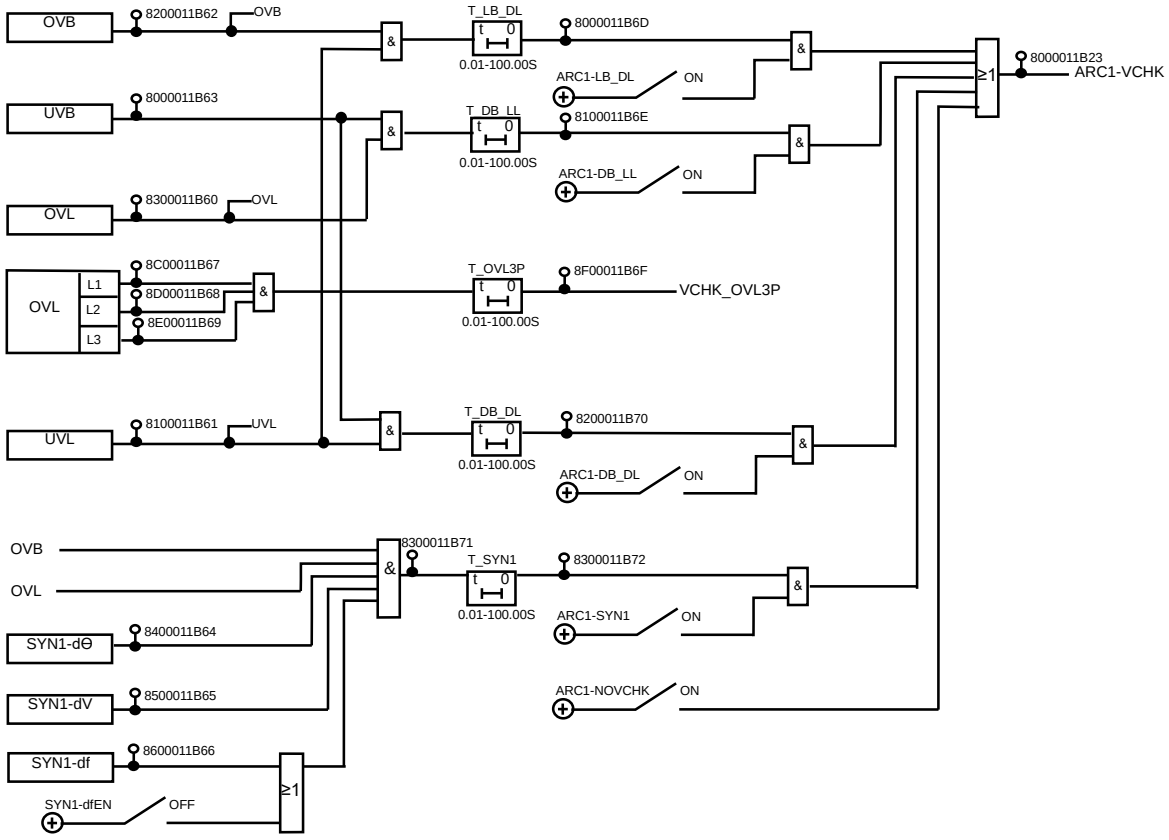


Figure 2.28-10 Logic of VCHK1

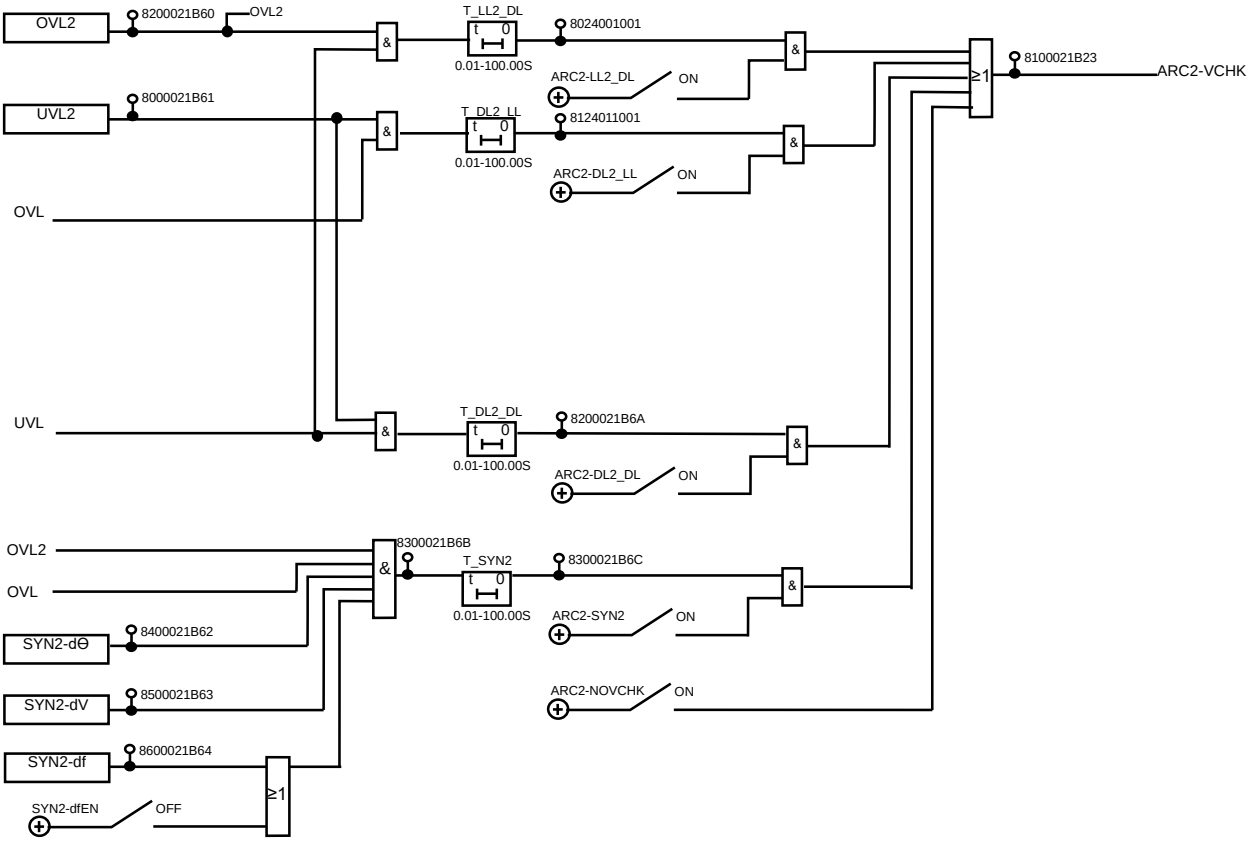


Figure 2.28-11 Logic of VCHK2

2.28.7 Setting

Setting of VCHK (Function ID: 4A8001)

Setting items		Range		Units	Contents	Default setting value			Notes
		1A rating	5A rating			1CB system V-Bus : Input from three-phase voltage V-Line : Input from representative phase voltage	1CB system V-Bus : Input from representative phase voltage V-Line : Input from three-phase voltage	2CB system V-Line : Input from three-phase voltage V-Bus & V-Line2 : Input from representative phase voltage (Fixed)	
ARC1 Voltage check	SYN-VBus	V-L1 / V-L2 / V-L3 / V-L12 / V-L23 / V-L31 / V2-L1 / V2-L2 / V2-L3 / V2-L12 / V2-L23 / V2-L31 / V3 / V4		-	Selection of Bus voltage(Running Voltage) for SYN	Select a set from V-L1, V-L2, V-L3, V-L12, V-L23, V-L31	V3 (Fixed setting)	V3 (Fixed setting)	
	SYN-VLine	V-L1 / V-L2 / V-L3 / V-L12 / V-L23 / V-L31 / V2-L1 / V2-L2 / V2-L3 / V2-L12 / V2-L23 / V2-L31 / V3 / V4		-	Selection of Line voltage (Incoming Voltage) for SYN	V3 (Fixed setting)	Select a set from V-L1, V-L2, V-L3, V-L12, V-L23, V-L31	Select a set from V-L1, V-L2, V-L3, V-L12, V-L23, V-L31	
	VCHK-OVB	10 - 150		V	Voltage for the checking Live-Bus	51			
	VCHK-UVB	10 - 150		V	Voltage for the checking Dead-Bus	13			
	VCHK-OVL	10 - 150		V	Voltage for the checking Live-Line	51			
	VCHK-UVL	10 - 150		V	Voltage for the checking Dead-Line	13			
	SYN1-Angle	0 - 75		deg	Difference angle for the checking SYN1	30			
	SYN1-dV	0 - 150		V	Difference voltage for the checking SYN1	150			
	SYN1-df	0.01 - 2.00		Hz	Difference frequency for the checking SYN1	1.00			
	SYN1-dfEN	Off / On		-	Enabling switch in SYN1	Off			
	ARC1-LB_DL	Off / On		-	Voltage check "Live-Bus & Dead-Line" is applied to ARC1	Off			
	ARC1-DB_LL	Off / On		-	Voltage check "Dead-Bus & Live-Line" is applied to ARC1	Off			
	ARC1-DB_DL	Off / On		-	Voltage check "Dead-Bus & Dead-Line" is applied to ARC1	Off			
	ARC1-SYN1	Off / On		-	Voltage check "SYN(Live-Bus & Live-Line & Synchro.)" is applied to ARC1	Off			
	ARC1-NOVCHK	Off / On		-	Voltage check is not applied to ARC1	On			
	T_LB_DL	0.01 - 100.00		s	Voltage check time "Live-Bus and Dead-Line"	0.05			
	T_DB_LL	0.01 - 100.00		s	Voltage check time "Dead-Bus and Live-Line"	0.05			
	T_DB_DL	0.01 - 100.00		s	Voltage check time "Dead-Bus and Dead-Line"	0.05			
	T_SYN1	0.01 - 100.00		s	Voltage check time "SYN1(Live-Bus & Live-Line & Synchro.)"	1.00			

Setting of VCHK (Function ID: 4A8001)

Setting items		Range		Units	Contents	Default setting value			Notes
		1A rating	5A rating			1CB system V-Bus : Input from three-phase voltage V-Line : Input from representative phase voltage	1CB system V-Bus : Input from representative phase voltage V-Line : Input from three-phase voltage	2CB system V-Line : Input from three-phase voltage V-Bus & V-Line2 : Input from representative phase voltage (Fixed)	
	T_OVL3P	0.01 - 100.00		s	Voltage check time "Live-line"	0.05			
ARC2 Voltage check	SYN-VLine2	V-L1 / V-L2 / V-L3 / V-L12 / V-L23 / V-L31 / V2-L1 / V2-L2 / V2-L3 / V2-L12 / V2-L23 / V2-L31 / V3 / V4		-	Selection of Line2 voltage (Running voltage) for SYN2	Not applicable		V4 (Fixed setting)	
	VCHK-OVL2	10 - 150		V	Voltage for the checking Live-Line2	--		51	
	VCHK-UVL2	10 - 150		V	Voltage for the checking Dead-Line2	--		13	
	SYN2-Angle	0 - 75		deg	Difference angle for the checking SYN2	--		30	
	SYN2-dV	0 - 150		V	Difference voltage for the checking SYN2	--		150	
	SYN2-df	0.01 - 2.00		Hz	Difference frequency for the checking SYN2	--		1.00	
	SYN2-dfEN	Off / On		-	Enabling switch in SYN2	--		Off	
	ARC2-LL2_DL	Off /On		-	Voltage check "Live-Line2 & Dead-Line" is applied to ARC2	--		Off	
	ARC2-DL2_LL	Off /On		-	Voltage check "Dead-Line2 & Live-Line" is applied to ARC2	--		Off	
	ARC2-DL2_DL	Off /On		-	Voltage check "Dead-Line2 & Dead-Line" is applied to ARC2	--		Off	
	ARC2-SYN2	Off /On		-	Voltage check "SYN2(Live-Line2 & Live-Line & Synchro.)" is applied to ARC2	--		Off	
	ARC2-NOVCHK	Off /On		-	Voltage check is not applied to ARC2	--		On	
	T_LL2_DL	0.01 - 100.00		s	Voltage check time "Live-Line2 and Dead-Line"	--		0.05	
	T_DL2_LL	0.01 - 100.00		s	Voltage check time "Dead-Line2 and Live-Line"	--		0.05	
	T_DL2_DL	0.01 - 100.00		s	Voltage check time "Dead-Line2 and Dead-Line"	--		0.05	
	T_SYN2	0.01 - 100.00		s	Voltage check time "SYN2(Live-Line2 & Live-Line & Synchro.)"	--		1.00	

2.28.8 Data ID

◆ Signal monitoring point

VCHK(Function ID: 4A8001)

Element ID	Name	Description
8300011B60	OVL	OVL relay element operated
8100011B61	UVL	UVL relay element operated
8200011B62	OVB	OVB relay element operated
8000011B63	UVB	UVB relay element operated
8400011B64	SYN1-Angle	SYN1-Angle relay element operated
8500011B65	SYN1-dV	SYN1-dV relay element operated
8600011B66	SYN1-df	SYN1-df relay element operated
8C00011B67	OVL-L1	OVL relay element operated (phase-L1)
8D00011B68	OVL-L2	OVL relay element operated (phase-L2)
8E00011B69	OVL-L3	OVL relay element operated (phase-L3)
8700011B6A	SYN1-Angle zero	SYN1 Angle check(zero)
8800011B6B	SYN1-Angle loss	SYN1 Angle check(loss)
8B00011B6C	SYN1-V5per	SYN1 Voltage check(V5per)
8000011B6D	VCHK_LB-DL	Voltage check(Live Bus & Dead Line)
8100011B6E	VCHK_DB_LL	Voltage check(Dead Bus & Live Line)
8F00011B6F	VCHK_OVL3P	Voltage check(Live 3phase Line)
8200011B70	VCHK_DB-DL	Voltage check(Dead Bus & Dead Line)
8300011B72	VCHK_SYN1	Synchronous voltage 1(after timer)
8000011B23	ARC1-VCHK	Voltage check for autoreclose 1
8200021B60	OVL2	OVL2 relay element operated
8000021B61	UVL2	UVL2 relay element operated
8400021B62	SYN2-Angle	SYN2-Angle relay element operated
8500021B63	SYN2-dV	SYN2-dV relay element operated
8600021B64	SYN2-df	SYN2-df relay element operated
8700021B65	SYN2-Angle zero	SYN2 Angle check(zero)
8800021B66	SYN2-Angle loss	SYN2 Angle check(loss)
8B00021B67	SYN2-V5per	SYN2 Voltage check(V5per)
8300021B6C	VCHK_SYN2	Synchronous voltage 2(after timer)

2.29 Transmission control function (DIF_COMM with three terminals)

In order that several protection functions can handle their computation diversely, the transmission control (DIF_COMM) function is provided along with protection signalling modules†. The DIF_COMM function operates with the telecommunication system; the telecommunication medium is provided such as dark fiber (dedicated fiber-optic cable), multiplexed fiber-optics, digital microwave, and others. Accordingly, the protection functions linked with the remote-terminals can exchange their data mutually.

For the DIF_COMM operation, the user should arrange communication interface†, synchronization method, and topology consideration: the communication interface provides the link means physically; the synchronization method provides accuracy in their computation; the topology provides the network configuration philosophy

†Note:For more information about the protection signaling modules, see Chapter *Technical description: Signal processing module: Communication modules*. .

Note: The DIF_COMM function is feasible in entire models, which can be enumerated in the IED ordering number. For more information, see *Appendix: Ordering*.

Table 2.29-1 Comparative table in respective ordering numbers

	Features	Ordering No. at "G&T"				
		10	11	13	19	22
Main features	Communication for protection	✓	✓	✓	✓	✓
Number of terminals	Number of available maximum terminals	3	3	3	3	3

✓: Applicable NA: Not applicable

2.29.1 Data communication interface

Communication interface is relevant to the property and capacity of channels; hence, IEEE C37.94 (either N=1 or N=3) is provided in the DIF_COMM function. Securing clock recovery, jitter tolerance, physical connection, and spuriousness are specified by the international standard.

(i) IEEE C37.94 (N=1)

The C37.94 (N=1) link provides transmission format. Thereby, the DIF_COMM function uses the transmission format for sending. The data which is sent for the remote-terminal is current values, command signals and others:

- Current data in phase–a, –b, and –c at sampling time
- Residual current data at sampling time
- Output signals in phase-a, -b, and –c from the differential protection function
- Statuses of breaker and disconnector in phase–a, –b, and –c
- Statuses of scheme switches such as test and others
- Blocking commands for reclosing
- Sampling synchronization control signals
- Synchronized test trigger signals
- User configurable data

The current data are represented in instantaneous values; the values are sampled every 30-electrical degree. For instance, provided the power system frequency is 60 Hz, the 30-electrical degree means that the sampling interval is 1.38 milliseconds (=1/720Hz). Twelve bits (11 data bits plus a sign bit) are used to present a current data. The IED determines the current data in the every 30-electrical degree; hence the DIF_COMM function can send the data in the every 30-electrical degree. The DIF_COMM function also sends commands and other data; the data are made of several signals: a signal of the differential current function, a signal of the direct transfer trip function, a test signal, and a sync signal. Note that the DIF_COMM function sends a signal per the 30-electrical degree with regard to the differential current function the direct the transfer trip function. On the other hand, the DIF_COMM function sends the other signals per 360-electrcal degree (=a cycle of the power system frequency)

The transmission format includes cyclic redundancy check (CRC) bits and check bit solid. In case of communication failure, the DIF_COMM function set zero data for the format so as not to operate the differential and other protection functions. Consequently, the protection function corresponding to the DIF_COMM function can halt.

When the user wishes to use a communication module for the protection in the IEEE C37.94 (N=1) at the channel#1, set **Normal** for the scheme switch [**CH1_COM_WIDTH**], for

example.

(ii) IEEE C37.94 (N=3)

The IEEE C37.94 (N=3) is provided when the transmission capacity is wider than the IEEE (N=1); the DIF_COMM function can also transmit current data at pre-sampling time; consequently the computation range is extended dynamically. Thus, the computation performance and accuracy are improved in the differential and other protection functions.

The transmission capacity in the IEEE C37.94 (N=3) is wider than the one in the IEEE C37.94 (N=1). Followings are added newly when the IEEE C37.94 (N=3) is applied for the communication:

- Current data at pre-sampling time in phase–a, –b, and –c
- Residual current data at pre-sampling time

In order to apply for the IEEE C37.94 (N=3) at the channel#1, the user should set **Wide** for the scheme switch [**CH1_COM_WIDTH**].

2.29.2 Synchronization control

All the IEDs are required to examine the data sampled at the same time and to keep handing this data at the same address. Thus, the DIF_COMM function has synchronization control functions that are referred as timing, addressing, delaying, master-and-slave, and re-synchronization functions. That is, it is not until the entire IEDs start sampling their data simultaneously. The synchronization control function does not require an external reference clock or a synchronized internal clock because the channel delay in the telecommunication is equalized automatically in the IEDs. This equalization method is performed by the master-and-slave setup and delay compensation technique. These also bring the IED to recover when the master-and-slave setup function is broken abruptly for the operation. Consequently, the entire IEDs can stay in their synchronization state as possible.

(i) IEDs arrangement and setup

(i)-1 **2Term** mode

Figure 2.29-1 shows two IEDs arrangement when the two IEDs connect with a channel. In the arrangement, the user can select IED_G as the master and should set **1** for the scheme switch [**TERM_ID**], whereas the user should select another IED_H as the slave and set **2** for the scheme switch [**TERM_ID**]. The user should also set **2Term** for the scheme switch [**TERM_TOPOLOGY**] in both IEDs.

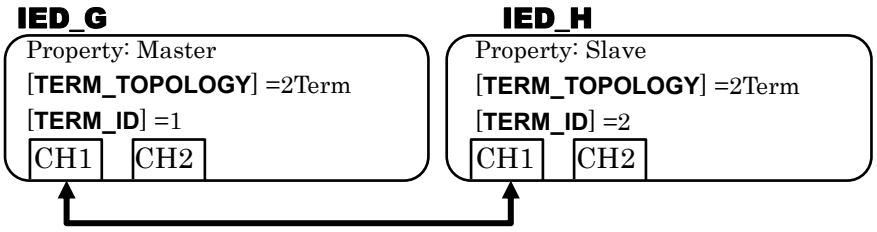


Figure 2.29-1 Two IEDs and setup for a single channel

(i)-2 **2Term-Dual** mode

When two IEDs are linked with dual channels, the user set **2Term-Dual** for the scheme switch [**TERM_TOPOLOGY**] respectively, as shown in Figure 2.29-2. Note that IEDs will have incorrect relay computations and improper communication, if the IEDs do not have the same data communication interface. Thus, the user shall set either **Normal** or **Wide** for the scheme switches [**CH1_COM_WIDTH**] and [**CH2_COM_WIDTH**] at both IEDs.

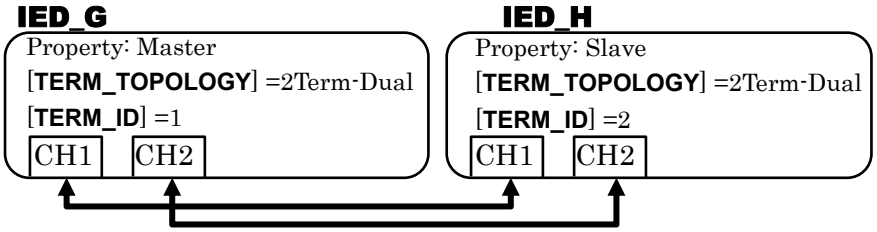


Figure 2.29-2 Two IEDs and setup for dual channels

(i)-3 **3Term** mode

Figure 2.29-3 shows three IEDs arrangement; the IEDs are linked with three channels. Based on the IED's property, IED_G can run as the master while IED_H and IED_R can run as the slave. Thus, the user should set **1** for the scheme switch [**TERM_ID**] at the IED_G. On the other hand, set **2** and **3** for the IED_H's [**TERM_ID**] of and the IED_R's [**TERM_ID**], respectively; then, the user can set **3Term** for the scheme switch [**TERM_TOPOLOGY**] at three IEDs. Either **Normal** or **Wide** shall be set for the [**CH*_COM_WIDTH**] at all IEDs unconditionally in order that the communication interface between IEDs are united.

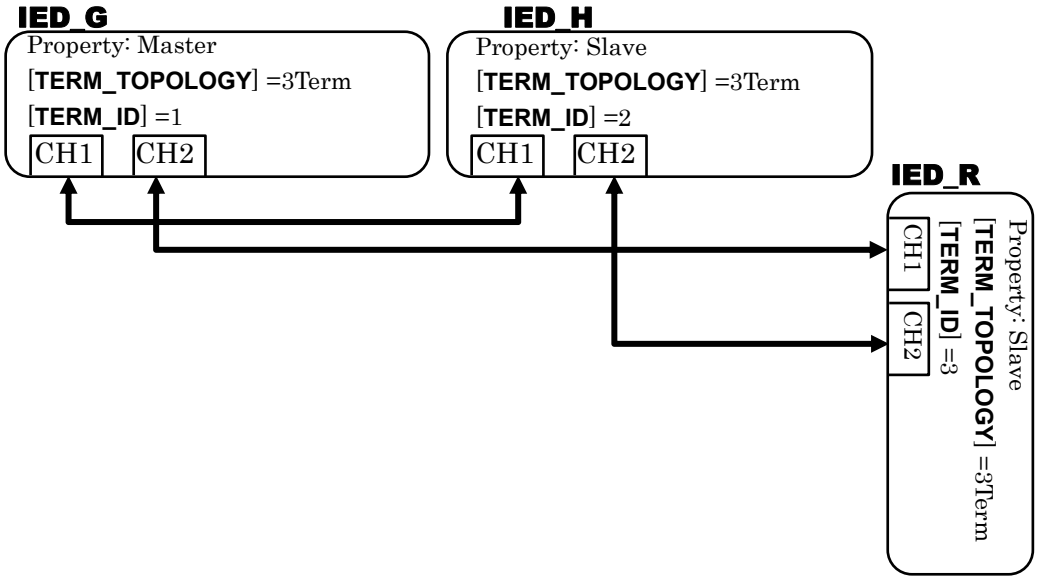


Figure 2.29-3 Three IEDs and setup

(ii) Time synchronization

When the user selects an IED as the master; the IED becomes the time reference. After the selection, the sampling time difference between (ΔT) is determined between the master and the slave, as shown in Figure 2.29-4.

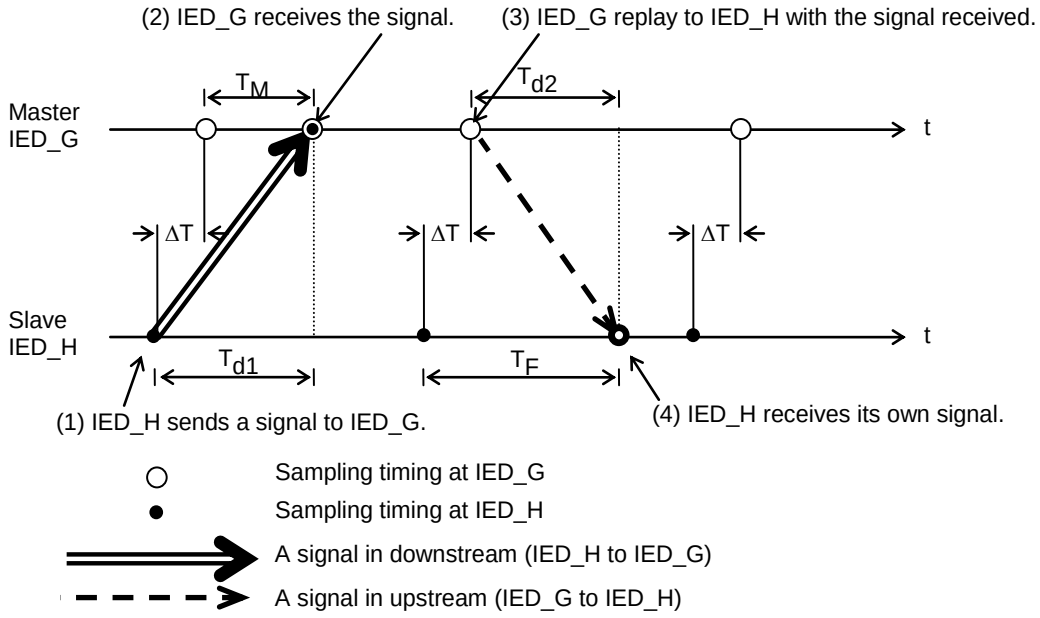


Figure 2.29-4 Sampling timing before synchronization

Figure 2.29-4 shows pre-synchronization circumstance between the master IED_G and the slave IDE_H. The user can find that the sampling timings between are different. In order that the IED_H synchronizes with the IED_G, accounting for the synchronization is provided

with process (1) to (4) of Figure 2.29-4.

1. The IED_H send a signal to the IED_G at sampling time of IED_H.
2. The IED_G receives this signal.
3. The IED_G replies to the IED_H at sampling time of IED_G.
4. This signal reverts to the IED_H.

As seen from Figure 2.29-4(2), the IED_G can determine the time T_M with the clock in the IED_G and the arrival time of this signal. On the other hand, in Figure 2.29-4(4), the IED_H can determine the time T_F with the clock in the IED_H. The IED_H also can determine the arrival time of that signal.

Figure 2.29-5 shows a communication for the protection; the channel is provided at both the master IED_G and the slave IED_H.

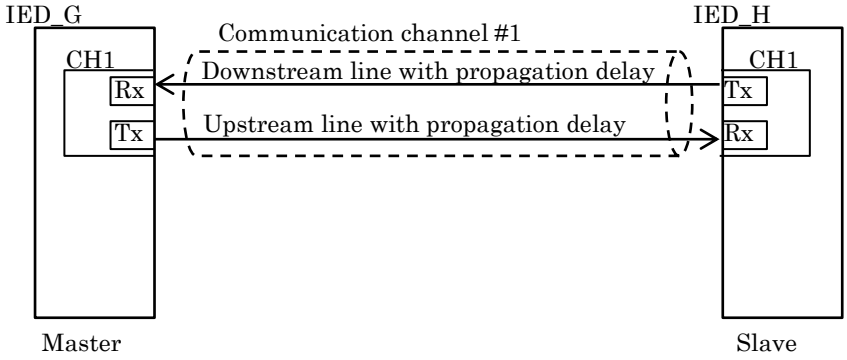


Figure 2.29-5 Communication channel between IEDs

When provided delay time of channel #1 provided by the telecommunication carrier, the ΔT can be obtained from the following equations:

$$\Delta T = \frac{(T_F - T_M) + (T_{d1} - T_{d2})}{2} \qquad (2.29\text{-}1)$$

where,

T_M: Sampling displacement between IEDs on the master IED ($T_M = T_{d1} - \Delta T$)

T_F: Sampling displacement between IEDs on the slave IED ($T_F = T_{d2} + \Delta T$)

T_{d1}: Propagation time of the downstream line

T_{d2}: Propagation time of the upstream line

Sampling pulses are generated by the clock in the slave IED_H; hence, the slave IED_H can carry out its sampling in advance on its discretion because the slave IED_H can vary its sampling interval with its own clock. As a result, the slave IED_H move its sampling time in advance based on the ΔT calculated with equation (2.29-1); and the ΔT of the master IED_G

can be close to zero. The slave IED_H can of course reduce its sampling time with equation (2.29-1).

$$\Delta T = \frac{(T_F - T_M) + (T_{d1} - T_{d2})}{2} \qquad (2.29\text{-}2)$$

$$T_{dd} = T_{d1} - T_{d2} \qquad (2.29\text{-}3)$$

The delay difference (T_{dd}) between sending and receiving is determined with Equation (2.29-2); you should set the difference (T_{dd}) as zero in all the IEDs when the upstream and the downstream are carried out with the same route. On the other hand, suppose the route between the upstream and the downstream is divided and their propagation times are different, you are required that the values of T_{dd} in all the IEDs are identical. Note that the T_{dd} should be less than 6ms. For setting T_{dd} at the channel#1, the user can use setting [**CH1_TCDT**]. Likewise, the settings at other channels are treated as same to the channel#1 setting.

When three IEDs are operated, their communication channels are linked as shown in Figure 2.29-6. When IED_G is set as the master seen from Figure 2.29-3, the synchronization control is performed between the master IED_G and the slave IED_H; likewise, the synchronization control is performed between the master IED_G and the slave IED_R. Both the slave IED_H and the slave IED_R carry out the follow-up control at their channel#2.

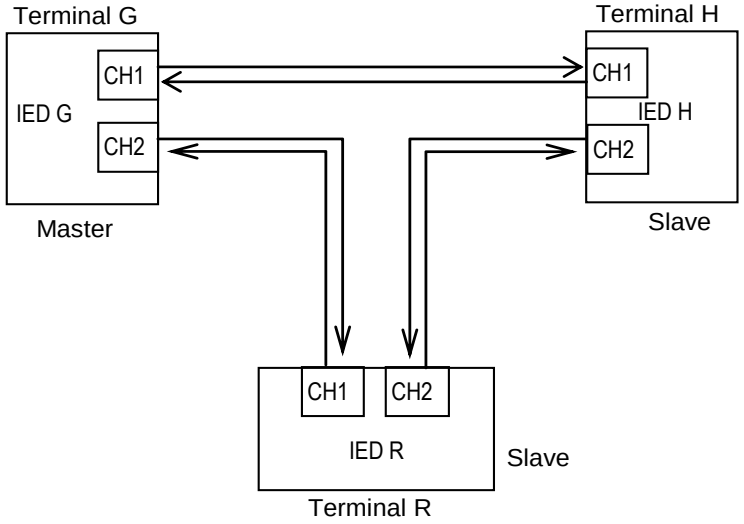


Figure 2.29-6 Communication link in three terminal lines

(iii) Sampling address synchronization

Once the synchronization between IEDs is established, all the IEDs start sampling address synchronization function. This principle is shown in Figure 1.1-8; and this function is to make symmetrical sampling addresses in the eniter IEDs. Keep in mind here that the sampling is synchronized in the entire IEDs.

In Figure 2.29-7, the slave IED_H sends a timing reference signal at point (1). The master IED_G receives this signal at point (2). You can find that the master IED_G replies this signal at point (3). Finally, at point (4), this signal reverts to the slave IED_H again. When the δ is placed in Figure 2.29-7, the following equation is obtained with the T_{d1}, the T_{d2}, and the T_M:

$$T_o - \delta = T_{d1} + T_{d2} \qquad (2.29\text{-}4)$$

The δ is delivered with the T and the T_M as follows:

$$\delta = T - T_M \qquad (2.29\text{-}5)$$

Substituting Equation (2.29-5) and Equation (2.29-3) for Equation (2.29-4) yields

$$T_{d1} = \frac{T_o - (T - T_m)}{2} + \frac{T_{dd}}{2} \qquad (2.29\text{-}6)$$

The T_{d1} calculated is distributed into the T and the T_M, as can be seen from Figure 2.29-7. The mantissa is truncated and the quotient is expressed as an integer. If the integer is set to “P”, the reception at the slave IED_H of the signal sent from the master IED_G occurs at P sampling intervals from the transmission. Accordingly, by performing control so that the sampling address of the slave IED_H equals integer P when the sampling address is 0 signal is received from the master IED_G, the sampling address of the slave IED_H can be made the same as the master IED_G.

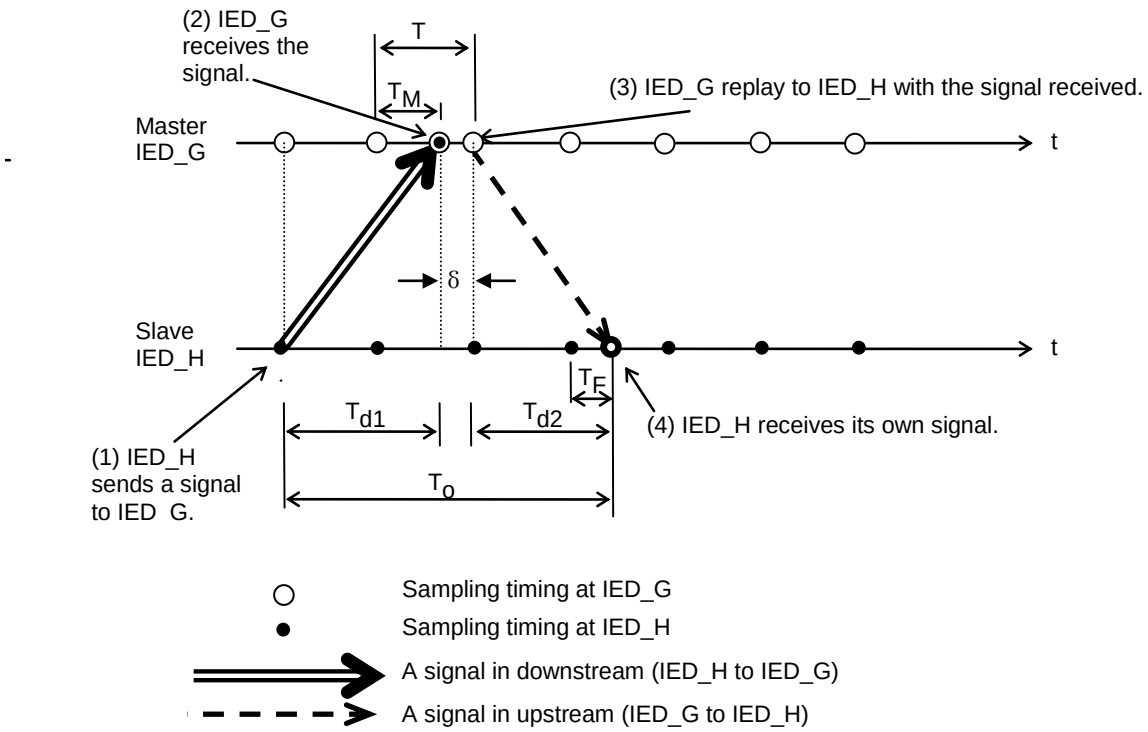


Figure 2.29-7 Sampling address after synchronization

(iv) Delay compensation

Synchronized sampling allows compensating the differential protection calculation even if a transmission delay exists. The compensation is shown in Figure 2.29-8.

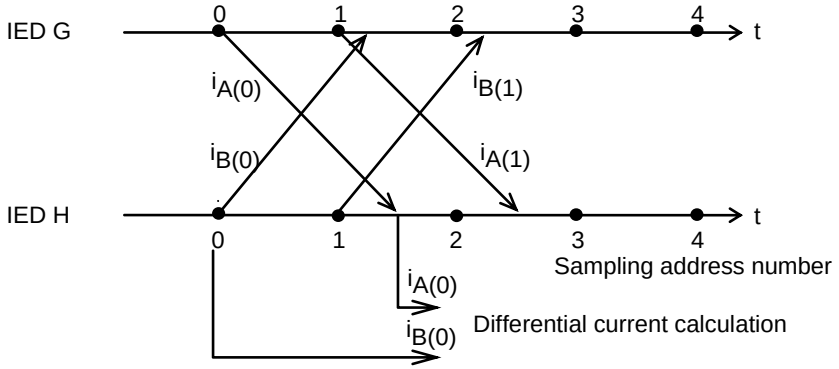


Figure 2.29-8 Calculation of differential current with transmission delay time

Suppose sampling synchronization is made between the IED_G and the IED_H, their sampling timing and their sampling address is match between; and their instantaneous current data and their sampling address are sent each other. Consequently, the IEDs between can use instant data sampled at the same time and they can compute the differential current irrelevant to large transmission delay.

(v) Resynchronization

Even when any of the IEDs is taken out-of-service, the other IEDs except the out-of-service IEDs can operate the differential protection function, in which case the logic of out-of-service detection is provided.

As for the operation of two IEDs on a line, suppose an IED is taken out-of-service, another IED can continue to operate the differential protection function with the local current data. It is required that another IED is neither the master nor the slave.

On the other hand, when an IED on a three-terminal line is taken out-of-service, synchronized sampling is established between the remaining two IEDs; hence, the two IEDs keeps operating the differential protection function.

Note: If the master IED is taken out-of-service, one of the slave IEDs takes over the master IED synchronized sampling function and enables the differential protection function operates between the remaining IEDs. If the slave IED is taken out-of-service, the master and another slave IED can maintain operating the differential protection function.

2.29.3 Topology of telecommunication

The DIF_COMM function has two topologies for telecommunication network: a peer-to-peer connection and a star connection. The peer-to-peer connection is used in a two-terminal line (dual mode), whereas the star connection is used where there being less than five terminals (star mode).

(i) Dual mode

When an application is applied for a two-terminal line, the application may operate in the dual mode between the IEDs. As illustrated in Figure 2.29-9, each IED is connected with two bidirectional channels. The second channel provides a redundancy as a backup line with automatic switchover, if the first channel is lost. As a result, it's possible to continue sampling and calculating simultaneously at each other. For the dual mode, the user should set the scheme switch [**TERM_TOPOLOGY**] =**2Term-Dual**.

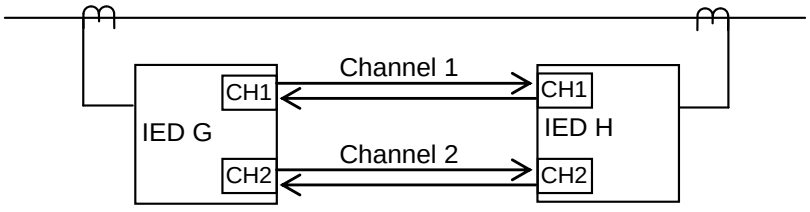


Figure 2.29-9 Dual communication mode

(ii) Star mode

When a multi terminal line application is applied, the star mode is selected. As seen from Figure 2.29-10, the IED is connected with the others with a bidirectional channel, provided two or more IEDs exist.

When switching of channel route is occurred, and the fluctuation of channel delay is appeared, the IED corrects the channel delay automatically. As a result, the switching does not influence the synchronized sampling, and the IED can take sending and receiving data as usual. When a difference exists on the communication route, the difference of channel delay should be set and calibrated.

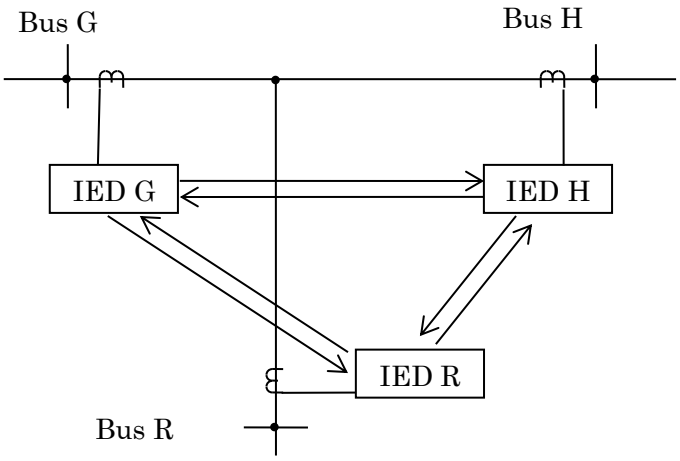


Figure 2.29-10 Star communication mode (example of Three-terminal line)

2.29.4 Communication setup

(i) Setting of Channel exchange

In the case of the two-terminal line arrangement, the communication is interlinked using the channel#1 and the channel#2, as shown in Figure 2.29-1. In the case of three-terminal line agreement, the IED at terminal G is linked with the channel#1 and the channel#2, as shown in Figure 2.29-3. Suppose the IEDs have the normal linkages, the user should set **Off** for scheme switch [**CHCON**]. However, the user should set **On** for the scheme switch [**CHCON**] when the change of the channel between is required.

(ii) Setting in multiplexer

Scheme switches are provided so that the IED is able to connect with the multiplexer (MUX) properly.

- Scheme switches [**CH*_T.SFT**] are used to synchronize the IED with MUX by shifting the send signal by a half-bit provided the IED is placed far from the MUX. Suppose electrical interface ITU-T G.703-1.2.3 is applied and the distance (cable length from relay to multiplexer) is 300m or more, you should place a set of **On**

for the scheme swathes [**CH*_T.SFT**]

- Note that **On** should be set for the scheme switches [**CH*_B.SYN**] when the IED connects to the MUX. On the other hand, the user should set **OFF** for the scheme switches when the IED is linked with the MUX absent. The setting is available for the ITU-T G703-1.2.1, 1.2.3 and optical interface (short distance: 2km class). In the case of optical interface 30km and 80km class, this setting is neglected.

(iii) Setting of integral communication

The integral communication function is provided for the differential protection function. Thus, the user should set **On** for the scheme switch [**INTCOM**] when the differential protection function is applied. On the other hand, when the distance protection function and others are applied, but the differential protection function is not used, the user should set **Off** for the scheme switch [**INTCOM**] because of the prevention of the unnecessary communication failure output.

(iv) Setting of open terminal detection

The open terminal detection (OTD) function is provided and a set of **Off** is placed for scheme switch [**OTD**] as a default.

(v) Setting of open terminal detection

The open terminal detection (OTD) function can operate when **On** is set for scheme switch [**OTD**]. Note that **Off** is set as a default.

(vi) Setting for the check of master-slave relationship

The master-slave check (MSCHK) function can supervise its relationship when **On** is set for scheme switch [**MSCHK-EN**]. The master-slave coordination is performed in synchronization control between the IEDs (See Chapter *Relay application: Transmission control function*).

2.29.5 Setting

Setting of DIF_COMM (Function ID: 250001)

Setting item		Range	Units	Contents	Default setting value	Notes
	TERM_ID	1 / 2 / 3	–	Terminal ID	1	
PCM	TERM_TOPOLOGY	2Term / 2Term-Dual / 3Term	–	Communication style of line differential protection	2Term	
	CHCON	Off / On	–	Exchange ch1 to ch2	Off	
	SPCHKLVL	100 - 1000	μs	SP error detection level	200	
	CH1_COM_WIDTH	Normal / Wide	–	Normal: 64kbps / Wide: 192kbps"	Normal	
	CH1_T.SFT	Off / On	–	T.SFT: 1/2 bit shift control	Off	
	CH1_B.SYN	Off / On	–	B.SYN: MUX connection or 2km type	Off	
	CH1_TCDT	-6000 - 6000	μs	TCDT: Tdd (delay difference) setting	0 μs	
	CH2_COM_WIDTH	Normal / Wide	–	Normal: 64kbps / Wide: 192kbps"	Normal	
	CH2_T.SFT	Off / On	–	T.SFT: 1/2 bit shift control	Off	
	CH2_B.SYN	Off / On	–	B.SYN: MUX connection or 2km type	Off	
	CH2_TCDT	-6000 - 6000	μs	TCDT: Tdd (delay difference) setting	0 μs	
APL	OTD	Off / On	–	Open-terminal-detection function enable	Off	
	INTCOM	Off / On	–	Integral communication enable	On	
Test	Local-Test	Off / On	–	Local test condition	Off	
	Open-R1	Off / On	–	To think of the Remote-CH1 as Out-out-service	Off	
	Open-R2	Off / On	–	To think of the Remote-CH2 as Out-out-service	Off	

2.30 Communication application (COMM_APPL)

Communication channels† can be switched when new configuration is introduced into the communication network; there is a possibility that the data carried with the new configuration is not transferred to the correct destination. Communication application (COMM_APPL) function can assign a unique relay-address to each IED; consequently, respective IEDs can check the received data either true or false using the relay-address.

Using the COMM_APPL function the user can send and receive an arbitrary data in a bit. Auxiliary areas of the transmission frame are used for sending the arbitrary bit-data; they are named "sub-communication channels". Several relay applications requires the user to send some data for the remote terminals; thus, the user may be required to set up the sub-communication channels using the COMM_APPL function. The transmission frames and others are discussed separately (see Chapter *Relay application: Transmission control function*).

†Note: If communication channels are not connected with the IED, and when the IED operates without communication, the user should set **Off** for setting [**INTCOM**].

Note: The TC function is feasible in entire models, which can be enumerated in the IED ordering number. For more information, see *Appendix: Ordering*.

Table 2.30-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
RYID	Relay address	✓	✓	✓	✓	✓
Sub-channel	Sub-communication channel	✓	✓	✓	✓	✓

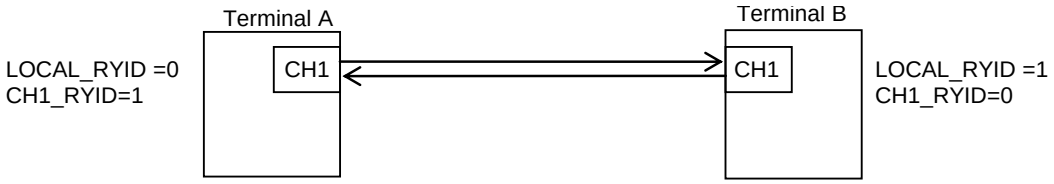
✓: Applicable NA: Not applicable

2.30.1 Relay-address configuration

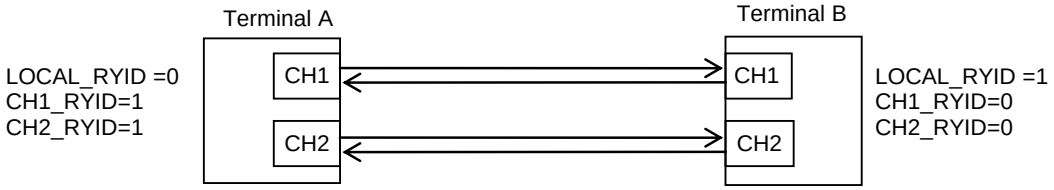
To apply the relay-address for the IED, the user should set **ON** for scheme switch [**RYID-EN**].

(i) Address configuration

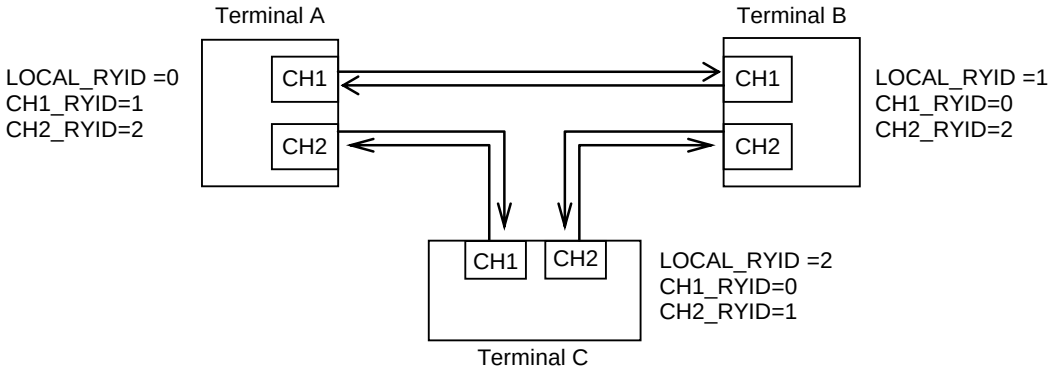
The user should set relay-addresses for the respective IEDs. Figure 2.30-1 (a) shows the relay-address number for terminals A and B; Figure 2.30-1 (c) shows for three-terminals A, B, and C on star network. With regard to the relay-address number, 64 unique addresses (0 to 63) are provided for the network.



(a) 2 term communication (Terminal A and B)



(b) Pair network / 2 term-dual communication (Terminal A and B)



(c) Star network communication (Terminal A, B and C)

Figure 2.30-1 Example for relay addresses

(i)-1 ID numbering for two-terminals

For two-terminal mode (Figure 2.30-1 a), an IED at terminal A is required to set **0** for setting [**LOCAL_RYID**]; the user should set **1** for both settings [**CH1_RYID**] and [**CH2_RYID**]. Another IED at terminal B should be set **1** for setting [**LOCAL_RYID**]; then **0** for both settings [**CH1_RYID**] and [**CH2_RYID**]. Do not touch the [**CH*_RYID**] if one of the settings need not operate (zero (0) is set as default).

(i)-2 Three-terminal application

As for setting for the relay-addresses in the star network in Figure 2.30-1 (c), the user should pick respective relay-address numbers at remote terminals; then set them for the settings [**CH1_RYID**] and [**CH2_RYID**].

2.30.2 Sub-communication channel for 1CB arrangement

(i) Narrow (N=1) communication

Figure 2.30-2 shows the Narrow (N=1)† frame in the IEEE C37.94 standard. When Narrow is applied, sub-communication channels are provided at bits: COM1(2bits). The use of the sub-communication channels are not restricted, hence the user can use them for sending user-wishing data.

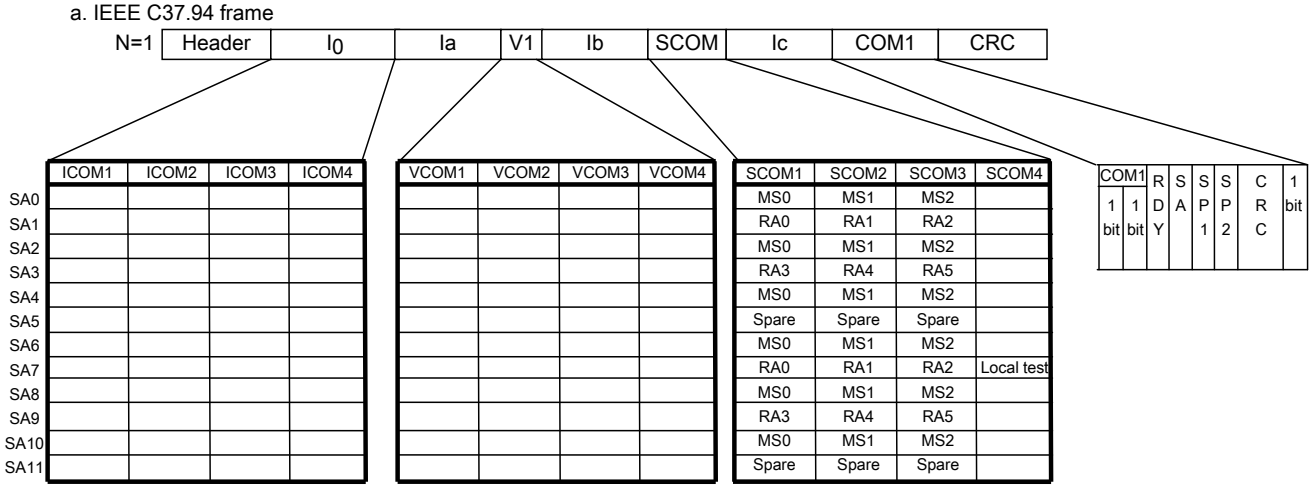


Figure 2.30-2 Sub communication channels at N=1 in C37.94 for 1CB

†Note: For the operation of the sub-communication channels, the user is required to set **Narrow** for scheme switch [**CH*_COM_WIDTH**]. For more information, see Chapter *Relay application: Transmission control*.

(ii) Wide (N=3) communication

Figure 2.30-3 shows the Wide (N=3)† frames in the IEEE C37.94 standard. When Wide is applied, sub-communication channels are provided at bits: COM1(2bits), COM2(2bits), COM3(2bits), COM4(2bits), and COM6(6bits). The use of the sub-communication channels are not restricted, hence the user can use them for sending user-wishing data.

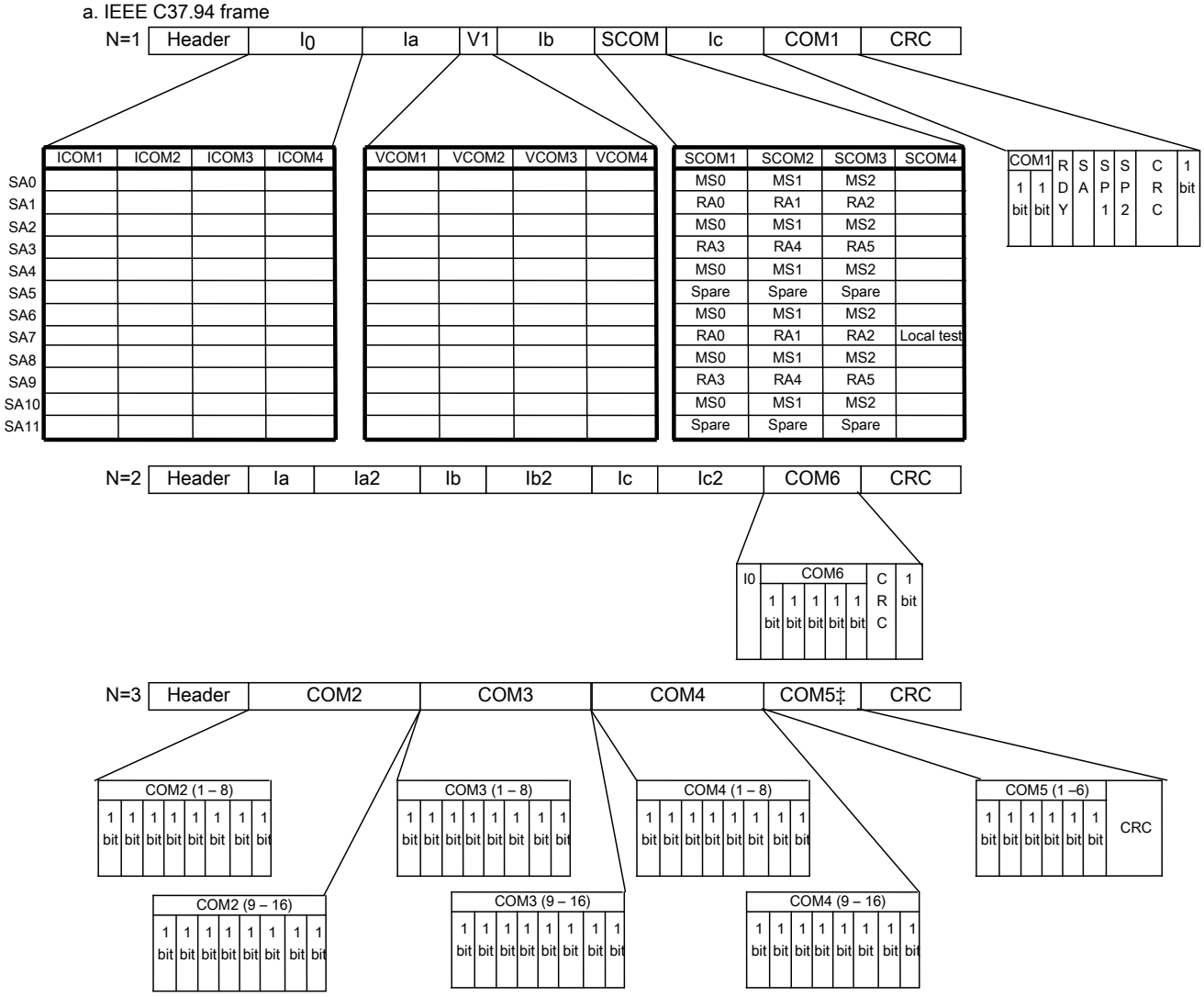


Figure 2.30-3 Sub communication channels at N=1,2, and 3† in C37.94 for 1CB

†Note:Set **Wide** for scheme switch [**CH*_COM_WIDTH**]. For more information, see Chapter *Relay application: Transmission control*.

‡Note:Three bits in the COM2 (1–3) are pre-assigned for sending signals "CBDS-A, -B,-C".

2.30.3 Sub-communication channel for 1.5CB arrangement

(i) Narrow (N=1) communication

Figure 2.30-4 shows the Narrow (N=1)† frame in the IEEE C37.94 standard. When Narrow is applied, sub-communication channels are provided at bits: COM1(2bits).

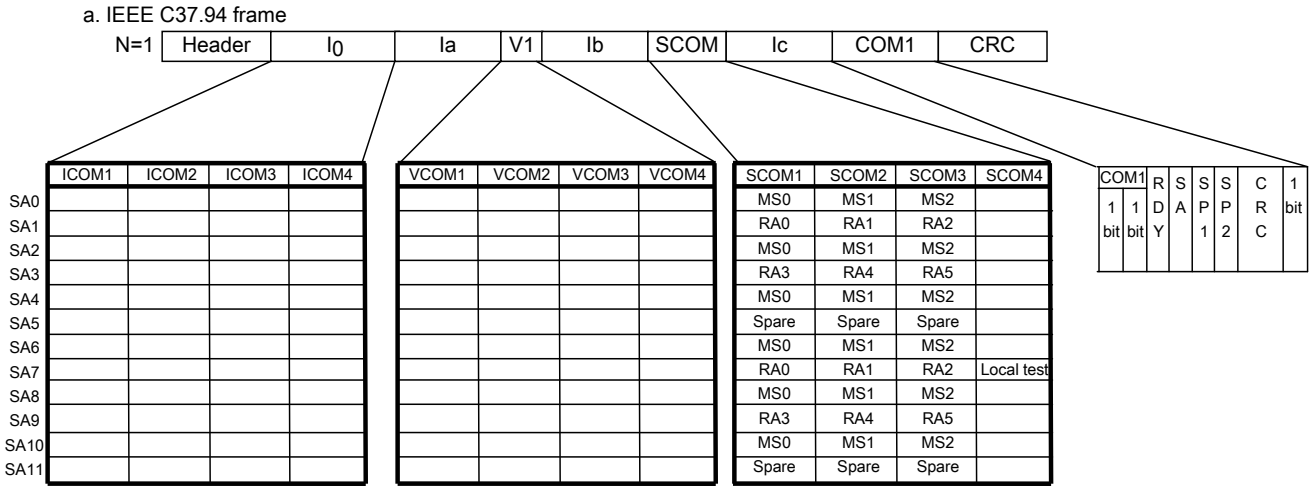


Figure 2.30-4 Sub communication channels at N=1 in C37.94† for 1.5CB

†Note:Set **Narrow** for scheme switch [**CH*_COM_WIDTH**].

(ii) Wide (N=3) communication

Figure 2.30-5 shows the Wide (N=3)† frames in the IEEE C37.94 standard. When Wide is applied, sub-communication channels are provided at bits: COM1(2bits), COM2(2bits), COM3(2bits), COM4(2bits), and COM6(6bits).

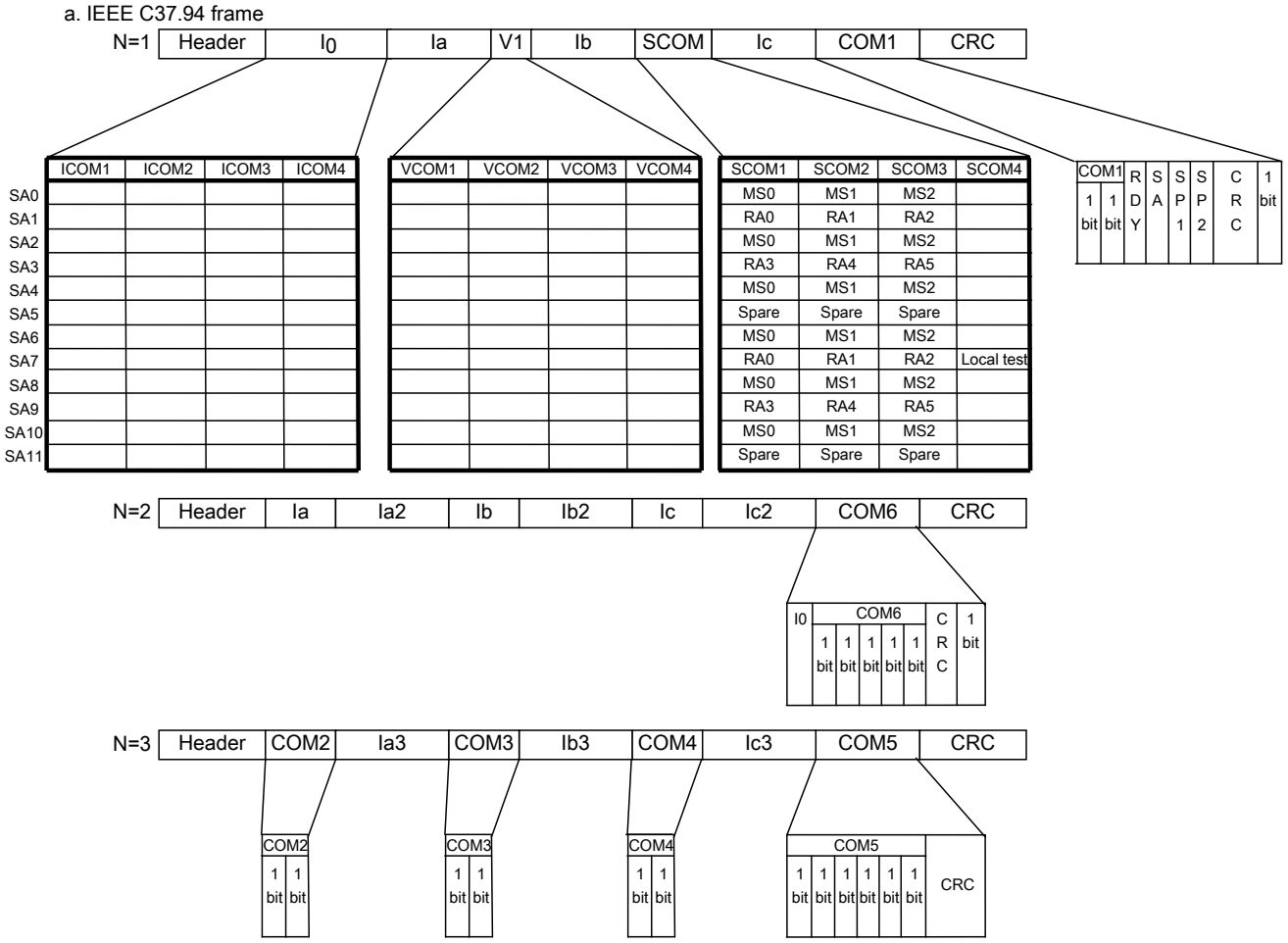


Figure 2.30-5 Sub communication channels at N=1,2, and 3 in C37.94 for 1.5CB

†Note:Set **Wide** for scheme switch [**CH*_COM_WIDTH**]. For more information, see Chapter *Relay application: Transmission control*.

‡Note:Three bits in the COM5 (1–3) are pre-assigned for sending signals "CBDS-A,-B,-C". Other three bits in the COM5 (4–6) are pre-assigned for sending signals "DIF-A, -B,-C".

2.30.4 Integral communication bits

When **On** is set for setting [**DIFGL-EN**]†, zero-sequence current data 'I_0'will be sent to the remote end using the integral channel spaces (ICOM1—4) in the communion frame. If **Off** is set, the ICOM1—4 space will not be used during the communication. Therefore, the user can use those spaces for user's PLC data.

†Note:see *Chapter Relay application: Zero-sequence current differential protection (DIFGL)* for more detail.

2.30.5 Communication bits for OSTV

When the function 'Out of step tripping by voltage (OSTV)' operates, the area of the 'V_0' is used for the communication for the OSTV function in place of sending the zero-sequence voltage. For more information about the OSTV function, see Chapter *Relay application: Out of step tripping by voltage*.

2.30.6 Usage of sub-communication channel

Figure 2.30-6 shows the connection and monitoring points in the COM3_1bit to COM3_8bit of Wide (N=3) communication. For example, when the user wishes to send a bit-signal using the COM3_1 sub-channel, the user should connect the signal with PLC connection point "COM3-1_S". On the other hand, when the user wishes to retrieve a bit-signal from the COM3_1 sub-channel of the remote terminal-1, the user should use PLC monitoring point "COM3-1_R1". With regard to the reception from the remote terminal-2, other PLC monitoring points are provided. Entire PLC connection points and monitoring points for the sub-communication channels are shown later.

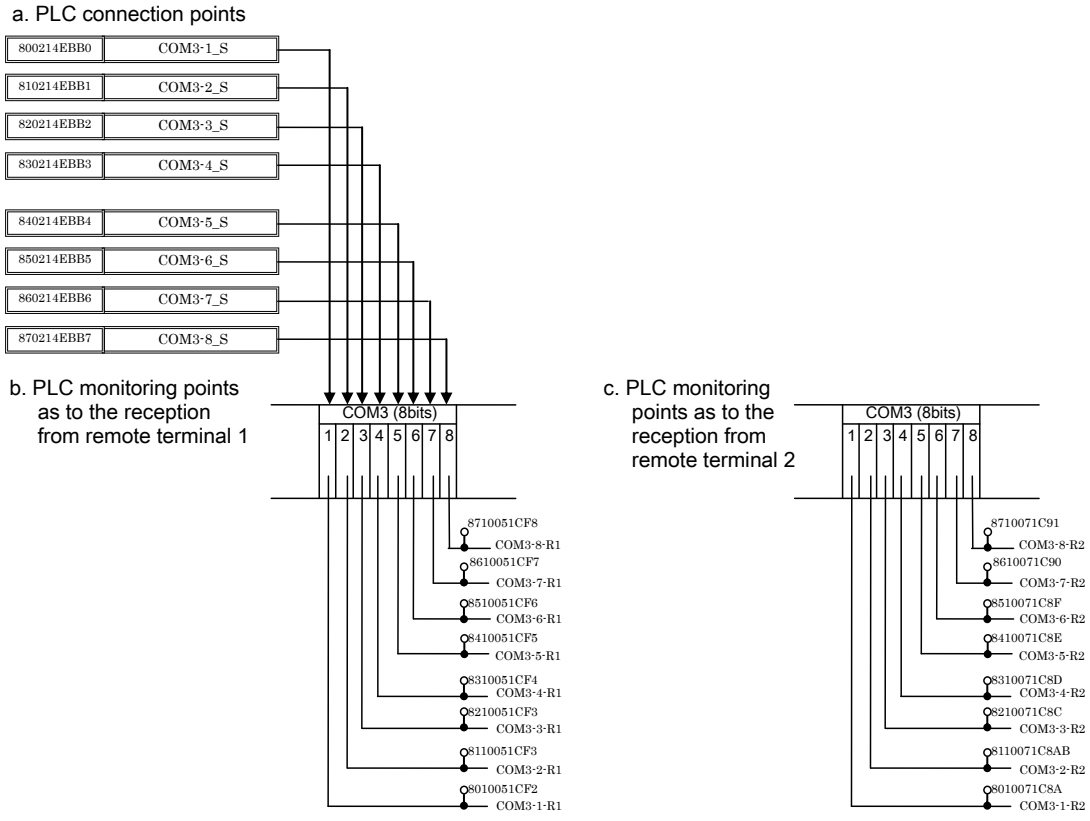


Figure 2.30-6 Connection and monitoring points for COM3 (1 to 8 bits)

2.30.7 Setting of open terminal detection

The open terminal detection (OTD) function is provided and a set of **Off** is placed for scheme switch [**OTD**] as a default.

2.30.8 Communication test

(i) Local test (Local-test)

When setting [**Local-test**]=**On**, '1' is set for Local test bit of SCOM4 frame so that zero-ampere control is executed at the remote end. The zero-ampere control is the one of test functions that a local IED can treat the remote current data as zero.

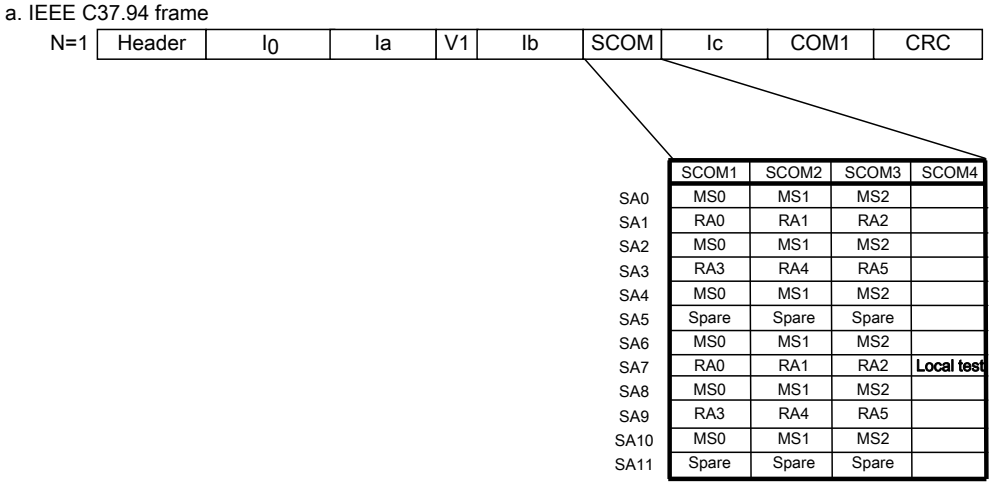


Figure 2.30-7 Location of local test bit

For example, during the test, suppose that setting [**Local-test**]=**Off** (as a default condition); and CB and DSs are open at the local end. Remote CB can be tripped by the remote IED, if currents are injected at the local IED while the communication is established between IEDs. That is, the user needs to set [**Local-test**]=**On** for the test. Note that Test LED is lit while the setting is **On**.

(ii) Local loop test (Loop-test)

Suppose that GRL200s at local and remote ends are connected with TX and RX fiber optical cables. If setting [**Loop-test**]=**On,** the user can have loop-back test at the local IED by disabling sampling synchronization supervision function. Note other supervision functions are not disabled, but there are following limitations during the test.

- Sensitivity of DIF and DIFG elements becomes double. (If the injection of test current at one terminal is 1A, the differential current Id becomes 2A.)
- "Test LED" is On ("In service LED" is Off.)

(iii) Open test (OPEN 1/OPEN 2)

If communication channels between IEDs should not be connected for testing, the user can cut the channel when **On** is set setting [**OPEN ***]. For example, when setting [**OPEN 1**]=**On**, the communication channel#1 will be cut at the local end. The default setting is **Off**.

2.30.9 Setting

Setting of COMM_APPL (Function ID: 4A9001)

Setting item			Range	Units	Contents	Default setting value	Notes
	Test	Local-Test	Off / On	–	Local Test Switch	Off	
		Loop-Test	Off / On	–	External Loop Test Switch	Off	
		Open 1	Off / On	–	CH1 Open Test Switch	Off	
		Open 2	Off / On	–	CH2 Open Test Switch	Off	
		Open 3	Off / On	–	CH3 Open Test Switch	Off	
		Open 4	Off / On	–	CH4 Open Test Switch	Off	
		SYSTEM_F	Off / On	–	50/60Hz toggle signal	Off	
		2CT SEND	Off / On	–	send 2nd CT's current data Switch	Off	
		MSCHK-EN	Off / On	–	master and slave check Switch	Off	
		Local-Test	Off / On	–	Local Test Switch	Off	
	RYID	RYID-EN	Off / On	–	relay ID check Switch	Off	
		LOCAL_RYID	0–63	–	Local RYID setting for RYID SV	0	
		CH1_RYID	0–63	–	ch1 RYID setting for RYID SV	0	
		CH2_RYID	0–63	–	ch2 RYID setting for RYID SV	0	

2.30.10 Data ID

◆ Signal monitoring point

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
CANCEL CODE_R1	8B30041B67	
CANCEL CODE_R2	8B30051B67	
CANCEL CODE_R3	8B30061B67	
CANCEL CODE_R4	8B30071B67	
CB1 CLOSE COMMAND	8020001BB0	
CB2 CLOSE COMMAND	8120001BB1	
COM1-1_R1	8010051CF0	Transmission On/Off signal to receive from remote-1
COM1-1_R2	8010071C78	Transmission On/Off signal to receive from remote-2
COM1-2_R1	8110051CF1	Transmission On/Off signal to receive from remote-1
COM1-2_R2	8110071C79	Transmission On/Off signal to receive from remote-2
COM2-10_R1	8910051CFB	Transmission On/Off signal to receive from remote-1
COM2-10_R2	8910071C83	Transmission On/Off signal to receive from remote-2
COM2-11_R1	8A10051CFC	Transmission On/Off signal to receive from remote-1
COM2-11_R2	8A10071C84	Transmission On/Off signal to receive from remote-2
COM2-12_R1	8B10051CFD	Transmission On/Off signal to receive from remote-1
COM2-12_R2	8B10071C85	Transmission On/Off signal to receive from remote-2
COM2-13_R1	8C10051CFE	Transmission On/Off signal to receive from remote-1
COM2-13_R2	8C10071C86	Transmission On/Off signal to receive from remote-2
COM2-14_R1	8D10051CFF	Transmission On/Off signal to receive from remote-1
COM2-14_R2	8D10071C87	Transmission On/Off signal to receive from remote-2
COM2-15_R1	8E10061C60	Transmission On/Off signal to receive from remote-1
COM2-15_R2	8E10071C88	Transmission On/Off signal to receive from remote-2
COM2-16_R1	8F10061C61	Transmission On/Off signal to receive from remote-1
COM2-16_R2	8F10071C89	Transmission On/Off signal to receive from remote-2
COM2-1_R1	8010051CF2	Transmission On/Off signal to receive from remote-1
COM2-1_R2	8010071C7A	Transmission On/Off signal to receive from remote-2
COM2-2_R1	8110051CF3	Transmission On/Off signal to receive from remote-1
COM2-2_R2	8110071C7B	Transmission On/Off signal to receive from remote-2
COM2-3_R1	8210051CF4	Transmission On/Off signal to receive from remote-1
COM2-3_R2	8210071C7C	Transmission On/Off signal to receive from remote-2
COM2-4_R1	8310051CF5	Transmission On/Off signal to receive from remote-1
COM2-4_R2	8310071C7D	Transmission On/Off signal to receive from remote-2
COM2-5_R1	8410051CF6	Transmission On/Off signal to receive from remote-1
COM2-5_R2	8410071C7E	Transmission On/Off signal to receive from remote-2
COM2-6_R1	8510051CF7	Transmission On/Off signal to receive from remote-1
COM2-6_R2	8510071C7F	Transmission On/Off signal to receive from remote-2
COM2-7_R1	8610051CF8	Transmission On/Off signal to receive from remote-1
COM2-7_R2	8610071C80	Transmission On/Off signal to receive from remote-2
COM2-8_R1	8710051CF9	Transmission On/Off signal to receive from remote-1
COM2-8_R2	8710071C81	Transmission On/Off signal to receive from remote-2
COM2-9_R1	8810051CFA	Transmission On/Off signal to receive from remote-1
COM2-9_R2	8810071C82	Transmission On/Off signal to receive from remote-2
COM3-10_R1	8910061C6B	Transmission On/Off signal to receive from remote-1

◆ Signal monitoring point

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
COM3-10_R2	8910071C93	Transmission On/Off signal to receive from remote-2
COM3-11_R1	8A10061C6C	Transmission On/Off signal to receive from remote-1
COM3-11_R2	8A10071C94	Transmission On/Off signal to receive from remote-2
COM3-12_R1	8B10061C6D	Transmission On/Off signal to receive from remote-1
COM3-12_R2	8B10071C95	Transmission On/Off signal to receive from remote-2
COM3-13_R1	8C10061C6E	Transmission On/Off signal to receive from remote-1
COM3-13_R2	8C10071C96	Transmission On/Off signal to receive from remote-2
COM3-14_R1	8D10061C6F	Transmission On/Off signal to receive from remote-1
COM3-14_R2	8D10071C97	Transmission On/Off signal to receive from remote-2
COM3-15_R1	8E10061C70	Transmission On/Off signal to receive from remote-1
COM3-15_R2	8E10071C98	Transmission On/Off signal to receive from remote-2
COM3-16_R1	8F10061C71	Transmission On/Off signal to receive from remote-1
COM3-16_R2	8F10071C99	Transmission On/Off signal to receive from remote-2
COM3-1_R1	8010061C62	Transmission On/Off signal to receive from remote-1
COM3-1_R2	8010071C8A	Transmission On/Off signal to receive from remote-2
COM3-2_R1	8110061C63	Transmission On/Off signal to receive from remote-1
COM3-2_R2	8110071C8B	Transmission On/Off signal to receive from remote-2
COM3-3_R1	8210061C64	Transmission On/Off signal to receive from remote-1
COM3-3_R2	8210071C8C	Transmission On/Off signal to receive from remote-2
COM3-4_R1	8310061C65	Transmission On/Off signal to receive from remote-1
COM3-4_R2	8310071C8D	Transmission On/Off signal to receive from remote-2
COM3-5_R1	8410061C66	Transmission On/Off signal to receive from remote-1
COM3-5_R2	8410071C8E	Transmission On/Off signal to receive from remote-2
COM3-6_R1	8510061C67	Transmission On/Off signal to receive from remote-1
COM3-6_R2	8510071C8F	Transmission On/Off signal to receive from remote-2
COM3-7_R1	8610061C68	Transmission On/Off signal to receive from remote-1
COM3-7_R2	8610071C90	Transmission On/Off signal to receive from remote-2
COM3-8_R1	8710061C69	Transmission On/Off signal to receive from remote-1
COM3-8_R2	8710071C91	Transmission On/Off signal to receive from remote-2
COM3-9_R1	8810061C6A	Transmission On/Off signal to receive from remote-1
COM3-9_R2	8810071C92	Transmission On/Off signal to receive from remote-2
COM4-10_R1	8910061C7B	Transmission On/Off signal to receive from remote-1
COM4-10_R2	8910071CA3	Transmission On/Off signal to receive from remote-2
COM4-11_R1	8A10061C7C	Transmission On/Off signal to receive from remote-1
COM4-11_R2	8A10071CA4	Transmission On/Off signal to receive from remote-2
COM4-12_R1	8B10061C7D	Transmission On/Off signal to receive from remote-1
COM4-12_R2	8B10071CA5	Transmission On/Off signal to receive from remote-2
COM4-13_R1	8C10061C7E	Transmission On/Off signal to receive from remote-1
COM4-13_R2	8C10071CA6	Transmission On/Off signal to receive from remote-2
COM4-14_R1	8D10061C7F	Transmission On/Off signal to receive from remote-1
COM4-14_R2	8D10071CA7	Transmission On/Off signal to receive from remote-2
COM4-15_R1	8E10061C80	Transmission On/Off signal to receive from remote-1
COM4-15_R2	8E10071CA8	Transmission On/Off signal to receive from remote-2
COM4-16_R1	8F10061C81	Transmission On/Off signal to receive from remote-1

◆ Signal monitoring point

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
COM4-16_R2	8F10071CA9	Transmission On/Off signal to receive from remote-2
COM4-1_R1	8010061C72	Transmission On/Off signal to receive from remote-1
COM4-1_R2	8010071C9A	Transmission On/Off signal to receive from remote-2
COM4-2_R1	8110061C73	Transmission On/Off signal to receive from remote-1
COM4-2_R2	8110071C9B	Transmission On/Off signal to receive from remote-2
COM4-3_R1	8210061C74	Transmission On/Off signal to receive from remote-1
COM4-3_R2	8210071C9C	Transmission On/Off signal to receive from remote-2
COM4-4_R1	8310061C75	Transmission On/Off signal to receive from remote-1
COM4-4_R2	8310071C9D	Transmission On/Off signal to receive from remote-2
COM4-5_R1	8410061C76	Transmission On/Off signal to receive from remote-1
COM4-5_R2	8410071C9E	Transmission On/Off signal to receive from remote-2
COM4-6_R1	8510061C77	Transmission On/Off signal to receive from remote-1
COM4-6_R2	8510071C9F	Transmission On/Off signal to receive from remote-2
COM4-7_R1	8610061C78	Transmission On/Off signal to receive from remote-1
COM4-7_R2	8610071CA0	Transmission On/Off signal to receive from remote-2
COM4-8_R1	8710061C79	Transmission On/Off signal to receive from remote-1
COM4-8_R2	8710071CA1	Transmission On/Off signal to receive from remote-2
COM4-9_R1	8810061C7A	Transmission On/Off signal to receive from remote-1
COM4-9_R2	8810071CA2	Transmission On/Off signal to receive from remote-2
COM5-1_R1	8010061C82	Transmission On/Off signal to receive from remote-1
COM5-1_R2	8010071CAA	Transmission On/Off signal to receive from remote-2
COM5-2_R1	8110061C83	Transmission On/Off signal to receive from remote-1
COM5-2_R2	8110071CAB	Transmission On/Off signal to receive from remote-2
COM5-3_R1	8210061C84	Transmission On/Off signal to receive from remote-1
COM5-3_R2	8210071CAC	Transmission On/Off signal to receive from remote-2
COM5-4_R1	8310061C85	Transmission On/Off signal to receive from remote-1
COM5-4_R2	8310071CAD	Transmission On/Off signal to receive from remote-2
COM5-5_R1	8410061C86	Transmission On/Off signal to receive from remote-1
COM5-5_R2	8410071CAE	Transmission On/Off signal to receive from remote-2
COM5-6_R1	8510061C87	Transmission On/Off signal to receive from remote-1
COM5-6_R2	8510071CAF	Transmission On/Off signal to receive from remote-2
COMM.DATA FAIL	3140001B60	
COMM.DATA FAIL_R1	80300A1B60	
COMM.DATA FAIL_R2	81300A1B61	
COMM.DATA FAIL_R3	82300A1B62	
COMM.DATA FAIL_R4	83300A1B63	
COMM.FAIL_R1	8030081B60	
COMM.FAIL_R2	8130081B61	
COMM.FAIL_R3	8230081B62	
COMM.FAIL_R4	8330081B63	
CRC FAIL_R1	8030041B60	
CRC FAIL_R2	8030051B60	
CRC FAIL_R3	8030061B60	
CRC FAIL_R4	8030071B60	

◆ Signal monitoring point

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
EXECUTE-CH	3140011B60	
FG_OUT	8000181C60	FG Output for BO
FIXED BIT FAIL_R1	8130041B61	
FIXED BIT FAIL_R2	8130051B61	
FIXED BIT FAIL_R3	8130061B61	
FIXED BIT FAIL_R4	8130071B61	
FRAME SYNCHRO.FAIL_R1	8230041B62	
FRAME SYNCHRO.FAIL_R2	8230051B62	
FRAME SYNCHRO.FAIL_R3	8230061B62	
FRAME SYNCHRO.FAIL_R4	8230071B62	
ICOM1-SA0_R1	8010051C60	Transmission On/Off signal to receive from remote-1
ICOM1-SA0_R2	8010061C88	Transmission On/Off signal to receive from remote-2
ICOM1-SA10_R1	8A10051C6A	Transmission On/Off signal to receive from remote-1
ICOM1-SA10_R2	8A10061C92	Transmission On/Off signal to receive from remote-2
ICOM1-SA11_R1	8B10051C6B	Transmission On/Off signal to receive from remote-1
ICOM1-SA11_R2	8B10061C93	Transmission On/Off signal to receive from remote-2
ICOM1-SA1_R1	8110051C61	Transmission On/Off signal to receive from remote-1
ICOM1-SA1_R2	8110061C89	Transmission On/Off signal to receive from remote-2
ICOM1-SA2_R1	8210051C62	Transmission On/Off signal to receive from remote-1
ICOM1-SA2_R2	8210061C8A	Transmission On/Off signal to receive from remote-2
ICOM1-SA3_R1	8310051C63	Transmission On/Off signal to receive from remote-1
ICOM1-SA3_R2	8310061C8B	Transmission On/Off signal to receive from remote-2
ICOM1-SA4_R1	8410051C64	Transmission On/Off signal to receive from remote-1
ICOM1-SA4_R2	8410061C8C	Transmission On/Off signal to receive from remote-2
ICOM1-SA5_R1	8510051C65	Transmission On/Off signal to receive from remote-1
ICOM1-SA5_R2	8510061C8D	Transmission On/Off signal to receive from remote-2
ICOM1-SA6_R1	8610051C66	Transmission On/Off signal to receive from remote-1
ICOM1-SA6_R2	8610061C8E	Transmission On/Off signal to receive from remote-2
ICOM1-SA7_R1	8710051C67	Transmission On/Off signal to receive from remote-1
ICOM1-SA7_R2	8710061C8F	Transmission On/Off signal to receive from remote-2
ICOM1-SA8_R1	8810051C68	Transmission On/Off signal to receive from remote-1
ICOM1-SA8_R2	8810061C90	Transmission On/Off signal to receive from remote-2
ICOM1-SA9_R1	8910051C69	Transmission On/Off signal to receive from remote-1
ICOM1-SA9_R2	8910061C91	Transmission On/Off signal to receive from remote-2
ICOM2-SA0_R1	8010051C6C	Transmission On/Off signal to receive from remote-1
ICOM2-SA0_R2	8010061C94	Transmission On/Off signal to receive from remote-2
ICOM2-SA10_R1	8A10051C76	Transmission On/Off signal to receive from remote-1
ICOM2-SA10_R2	8A10061C9E	Transmission On/Off signal to receive from remote-2
ICOM2-SA11_R1	8B10051C77	Transmission On/Off signal to receive from remote-1
ICOM2-SA11_R2	8B10061C9F	Transmission On/Off signal to receive from remote-2
ICOM2-SA1_R1	8110051C6D	Transmission On/Off signal to receive from remote-1
ICOM2-SA1_R2	8110061C95	Transmission On/Off signal to receive from remote-2
ICOM2-SA2_R1	8210051C6E	Transmission On/Off signal to receive from remote-1
ICOM2-SA2_R2	8210061C96	Transmission On/Off signal to receive from remote-2

◆ Signal monitoring point

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
ICOM2-SA3_R1	8310051C6F	Transmission On/Off signal to receive from remote-1
ICOM2-SA3_R2	8310061C97	Transmission On/Off signal to receive from remote-2
ICOM2-SA4_R1	8410051C70	Transmission On/Off signal to receive from remote-1
ICOM2-SA4_R2	8410061C98	Transmission On/Off signal to receive from remote-2
ICOM2-SA5_R1	8510051C71	Transmission On/Off signal to receive from remote-1
ICOM2-SA5_R2	8510061C99	Transmission On/Off signal to receive from remote-2
ICOM2-SA6_R1	8610051C72	Transmission On/Off signal to receive from remote-1
ICOM2-SA6_R2	8610061C9A	Transmission On/Off signal to receive from remote-2
ICOM2-SA7_R1	8710051C73	Transmission On/Off signal to receive from remote-1
ICOM2-SA7_R2	8710061C9B	Transmission On/Off signal to receive from remote-2
ICOM2-SA8_R1	8810051C74	Transmission On/Off signal to receive from remote-1
ICOM2-SA8_R2	8810061C9C	Transmission On/Off signal to receive from remote-2
ICOM2-SA9_R1	8910051C75	Transmission On/Off signal to receive from remote-1
ICOM2-SA9_R2	8910061C9D	Transmission On/Off signal to receive from remote-2
ICOM3-SA0_R1	8010051C78	Transmission On/Off signal to receive from remote-1
ICOM3-SA0_R2	8010061CA0	Transmission On/Off signal to receive from remote-2
ICOM3-SA10_R1	8A10051C82	Transmission On/Off signal to receive from remote-1
ICOM3-SA10_R2	8A10061CAA	Transmission On/Off signal to receive from remote-2
ICOM3-SA11_R1	8B10051C83	Transmission On/Off signal to receive from remote-1
ICOM3-SA11_R2	8B10061CAB	Transmission On/Off signal to receive from remote-2
ICOM3-SA1_R1	8110051C79	Transmission On/Off signal to receive from remote-1
ICOM3-SA1_R2	8110061CA1	Transmission On/Off signal to receive from remote-2
ICOM3-SA2_R1	8210051C7A	Transmission On/Off signal to receive from remote-1
ICOM3-SA2_R2	8210061CA2	Transmission On/Off signal to receive from remote-2
ICOM3-SA3_R1	8310051C7B	Transmission On/Off signal to receive from remote-1
ICOM3-SA3_R2	8310061CA3	Transmission On/Off signal to receive from remote-2
ICOM3-SA4_R1	8410051C7C	Transmission On/Off signal to receive from remote-1
ICOM3-SA4_R2	8410061CA4	Transmission On/Off signal to receive from remote-2
ICOM3-SA5_R1	8510051C7D	Transmission On/Off signal to receive from remote-1
ICOM3-SA5_R2	8510061CA5	Transmission On/Off signal to receive from remote-2
ICOM3-SA6_R1	8610051C7E	Transmission On/Off signal to receive from remote-1
ICOM3-SA6_R2	8610061CA6	Transmission On/Off signal to receive from remote-2
ICOM3-SA7_R1	8710051C7F	Transmission On/Off signal to receive from remote-1
ICOM3-SA7_R2	8710061CA7	Transmission On/Off signal to receive from remote-2
ICOM3-SA8_R1	8810051C80	Transmission On/Off signal to receive from remote-1
ICOM3-SA8_R2	8810061CA8	Transmission On/Off signal to receive from remote-2
ICOM3-SA9_R1	8910051C81	Transmission On/Off signal to receive from remote-1
ICOM3-SA9_R2	8910061CA9	Transmission On/Off signal to receive from remote-2
ICOM4-SA0_R1	8010051C84	Transmission On/Off signal to receive from remote-1
ICOM4-SA0_R2	8010061CAC	Transmission On/Off signal to receive from remote-2
ICOM4-SA10_R1	8A10051C8E	Transmission On/Off signal to receive from remote-1
ICOM4-SA10_R2	8A10061CB6	Transmission On/Off signal to receive from remote-2
ICOM4-SA11_R1	8B10051C8F	Transmission On/Off signal to receive from remote-1
ICOM4-SA11_R2	8B10061CB7	Transmission On/Off signal to receive from remote-2

◆ Signal monitoring point

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
ICOM4-SA1_R1	8110051C85	Transmission On/Off signal to receive from remote-1
ICOM4-SA1_R2	8110061CAD	Transmission On/Off signal to receive from remote-2
ICOM4-SA2_R1	8210051C86	Transmission On/Off signal to receive from remote-1
ICOM4-SA2_R2	8210061CAE	Transmission On/Off signal to receive from remote-2
ICOM4-SA3_R1	8310051C87	Transmission On/Off signal to receive from remote-1
ICOM4-SA3_R2	8310061CAF	Transmission On/Off signal to receive from remote-2
ICOM4-SA4_R1	8410051C88	Transmission On/Off signal to receive from remote-1
ICOM4-SA4_R2	8410061CB0	Transmission On/Off signal to receive from remote-2
ICOM4-SA5_R1	8510051C89	Transmission On/Off signal to receive from remote-1
ICOM4-SA5_R2	8510061CB1	Transmission On/Off signal to receive from remote-2
ICOM4-SA6_R1	8610051C8A	Transmission On/Off signal to receive from remote-1
ICOM4-SA6_R2	8610061CB2	Transmission On/Off signal to receive from remote-2
ICOM4-SA7_R1	8710051C8B	Transmission On/Off signal to receive from remote-1
ICOM4-SA7_R2	8710061CB3	Transmission On/Off signal to receive from remote-2
ICOM4-SA8_R1	8810051C8C	Transmission On/Off signal to receive from remote-1
ICOM4-SA8_R2	8810061CB4	Transmission On/Off signal to receive from remote-2
ICOM4-SA9_R1	8910051C8D	Transmission On/Off signal to receive from remote-1
ICOM4-SA9_R2	8910061CB5	Transmission On/Off signal to receive from remote-2
INTCONN-A1_L	8030001B60	
INTCONN-A2_L	8030011B60	
INTCONN-A_L	8030021B60	
INTCONN-A_R1	8020021BB0	
INTCONN-A_R2	8020031BB0	
INTCONN-A_R3	8020041BB0	
INTCONN-A_R4	8020051BB0	
INTCONN-B1_L	8130001B61	
INTCONN-B2_L	8130011B61	
INTCONN-B_L	8130021B61	
INTCONN-B_R1	8120021BB1	
INTCONN-B_R2	8120031BB1	
INTCONN-B_R3	8120041BB1	
INTCONN-B_R4	8120051BB1	
INTCONN-C1_L	8230001B62	
INTCONN-C2_L	8230011B62	
INTCONN-C_L	8230021B62	
INTCONN-C_R1	8220021BB2	
INTCONN-C_R2	8220031BB2	
INTCONN-C_R3	8220041BB2	
INTCONN-C_R4	8220051BB2	
INTCONN_R1	3140031B60	
INTCONN_R2	3140041B60	
INTCONN_R3	3140051B60	
INTCONN_R4	3140061B60	
LOCAL_TEST=ON	8130031B60	

◆ Signal monitoring point

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
LOCAL_TEST_R1	8020061BB0	
LOCAL_TEST_R2	8120061BB1	
LOCAL_TEST_R3	8220061BB2	
LOCAL_TEST_R4	8320061BB3	
OPEN_R	3140021B60	
READY_R1	8C30041B68	
READY_R2	8C30051B68	
READY_R3	8C30061B68	
READY_R4	8C30071B68	
RECEIVED INTERRUPT_R1	8330041B63	
RECEIVED INTERRUPT_R2	8330051B63	
RECEIVED INTERRUPT_R3	8330061B63	
RECEIVED INTERRUPT_R4	8330071B63	
RECEIVED LEVEL_R1	8E30041B6A	
RECEIVED LEVEL_R2	8E30051B6A	
RECEIVED LEVEL_R3	8E30061B6A	
RECEIVED LEVEL_R4	8E30071B6A	
RELAY BLOCK 31	3100091C2D	Relay block 31: Relay block(for each CH)
REMOTE_DATA_ZERO	8020011BB0	
RSA SYNCHRO.FAIL_R1	8730041B64	
RSA SYNCHRO.FAIL_R2	8730051B64	
RSA SYNCHRO.FAIL_R3	8730061B64	
RSA SYNCHRO.FAIL_R4	8730071B64	
RYBLK-AND	8E00111C34	Relay block AND
RYBLK-CH1	8000111C30	Relay block CH1
RYBLK-CH2	8100111C31	Relay block CH2
RYBLK-OR	8F00111C35	Relay block OR
SA SYNCHRO.FAIL_R1	8930041B66	
SA SYNCHRO.FAIL_R2	8930051B66	
SA SYNCHRO.FAIL_R3	8930061B66	
SA SYNCHRO.FAIL_R4	8930071B66	
SCOM1-SA0_R1	8010051CC0	Transmission On/Off signal to receive from remote-1
SCOM1-SA0_R2	8010061CE8	Transmission On/Off signal to receive from remote-2
SCOM1-SA10_R1	8A10051CCA	Transmission On/Off signal to receive from remote-1
SCOM1-SA10_R2	8A10061CF2	Transmission On/Off signal to receive from remote-2
SCOM1-SA11_R1	8B10051CCB	Transmission On/Off signal to receive from remote-1
SCOM1-SA11_R2	8B10061CF3	Transmission On/Off signal to receive from remote-2
SCOM1-SA1_R1	8110051CC1	Transmission On/Off signal to receive from remote-1
SCOM1-SA1_R2	8110061CE9	Transmission On/Off signal to receive from remote-2
SCOM1-SA2_R1	8210051CC2	Transmission On/Off signal to receive from remote-1
SCOM1-SA2_R2	8210061CEA	Transmission On/Off signal to receive from remote-2
SCOM1-SA3_R1	8310051CC3	Transmission On/Off signal to receive from remote-1
SCOM1-SA3_R2	8310061CEB	Transmission On/Off signal to receive from remote-2
SCOM1-SA4_R1	8410051CC4	Transmission On/Off signal to receive from remote-1

◆ Signal monitoring point

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
SCOM1-SA4_R2	8410061CEC	Transmission On/Off signal to receive from remote-2
SCOM1-SA5_R1	8510051CC5	Transmission On/Off signal to receive from remote-1
SCOM1-SA5_R2	8510061CED	Transmission On/Off signal to receive from remote-2
SCOM1-SA6_R1	8610051CC6	Transmission On/Off signal to receive from remote-1
SCOM1-SA6_R2	8610061CEE	Transmission On/Off signal to receive from remote-2
SCOM1-SA7_R1	8710051CC7	Transmission On/Off signal to receive from remote-1
SCOM1-SA7_R2	8710061CEF	Transmission On/Off signal to receive from remote-2
SCOM1-SA8_R1	8810051CC8	Transmission On/Off signal to receive from remote-1
SCOM1-SA8_R2	8810061CF0	Transmission On/Off signal to receive from remote-2
SCOM1-SA9_R1	8910051CC9	Transmission On/Off signal to receive from remote-1
SCOM1-SA9_R2	8910061CF1	Transmission On/Off signal to receive from remote-2
SCOM2-SA0_R1	8010051CCC	Transmission On/Off signal to receive from remote-1
SCOM2-SA0_R2	8010061CF4	Transmission On/Off signal to receive from remote-2
SCOM2-SA10_R1	8A10051CD6	Transmission On/Off signal to receive from remote-1
SCOM2-SA10_R2	8A10061CFE	Transmission On/Off signal to receive from remote-2
SCOM2-SA11_R1	8B10051CD7	Transmission On/Off signal to receive from remote-1
SCOM2-SA11_R2	8B10061CFF	Transmission On/Off signal to receive from remote-2
SCOM2-SA1_R1	8110051CCD	Transmission On/Off signal to receive from remote-1
SCOM2-SA1_R2	8110061CF5	Transmission On/Off signal to receive from remote-2
SCOM2-SA2_R1	8210051CCE	Transmission On/Off signal to receive from remote-1
SCOM2-SA2_R2	8210061CF6	Transmission On/Off signal to receive from remote-2
SCOM2-SA3_R1	8310051CCF	Transmission On/Off signal to receive from remote-1
SCOM2-SA3_R2	8310061CF7	Transmission On/Off signal to receive from remote-2
SCOM2-SA4_R1	8410051CD0	Transmission On/Off signal to receive from remote-1
SCOM2-SA4_R2	8410061CF8	Transmission On/Off signal to receive from remote-2
SCOM2-SA5_R1	8510051CD1	Transmission On/Off signal to receive from remote-1
SCOM2-SA5_R2	8510061CF9	Transmission On/Off signal to receive from remote-2
SCOM2-SA6_R1	8610051CD2	Transmission On/Off signal to receive from remote-1
SCOM2-SA6_R2	8610061CFA	Transmission On/Off signal to receive from remote-2
SCOM2-SA7_R1	8710051CD3	Transmission On/Off signal to receive from remote-1
SCOM2-SA7_R2	8710061CFB	Transmission On/Off signal to receive from remote-2
SCOM2-SA8_R1	8810051CD4	Transmission On/Off signal to receive from remote-1
SCOM2-SA8_R2	8810061CFC	Transmission On/Off signal to receive from remote-2
SCOM2-SA9_R1	8910051CD5	Transmission On/Off signal to receive from remote-1
SCOM2-SA9_R2	8910061CFD	Transmission On/Off signal to receive from remote-2
SCOM3-SA0_R1	8010051CD8	Transmission On/Off signal to receive from remote-1
SCOM3-SA0_R2	8010071C60	Transmission On/Off signal to receive from remote-2
SCOM3-SA10_R1	8A10051CE2	Transmission On/Off signal to receive from remote-1
SCOM3-SA10_R2	8A10071C6A	Transmission On/Off signal to receive from remote-2
SCOM3-SA11_R1	8B10051CE3	Transmission On/Off signal to receive from remote-1
SCOM3-SA11_R2	8B10071C6B	Transmission On/Off signal to receive from remote-2
SCOM3-SA1_R1	8110051CD9	Transmission On/Off signal to receive from remote-1
SCOM3-SA1_R2	8110071C61	Transmission On/Off signal to receive from remote-2
SCOM3-SA2_R1	8210051CDA	Transmission On/Off signal to receive from remote-1

◆ Signal monitoring point

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
SCOM3-SA2_R2	8210071C62	Transmission On/Off signal to receive from remote-2
SCOM3-SA3_R1	8310051CDB	Transmission On/Off signal to receive from remote-1
SCOM3-SA3_R2	8310071C63	Transmission On/Off signal to receive from remote-2
SCOM3-SA4_R1	8410051CDC	Transmission On/Off signal to receive from remote-1
SCOM3-SA4_R2	8410071C64	Transmission On/Off signal to receive from remote-2
SCOM3-SA5_R1	8510051CDD	Transmission On/Off signal to receive from remote-1
SCOM3-SA5_R2	8510071C65	Transmission On/Off signal to receive from remote-2
SCOM3-SA6_R1	8610051CDE	Transmission On/Off signal to receive from remote-1
SCOM3-SA6_R2	8610071C66	Transmission On/Off signal to receive from remote-2
SCOM3-SA7_R1	8710051CDF	Transmission On/Off signal to receive from remote-1
SCOM3-SA7_R2	8710071C67	Transmission On/Off signal to receive from remote-2
SCOM3-SA8_R1	8810051CE0	Transmission On/Off signal to receive from remote-1
SCOM3-SA8_R2	8810071C68	Transmission On/Off signal to receive from remote-2
SCOM3-SA9_R1	8910051CE1	Transmission On/Off signal to receive from remote-1
SCOM3-SA9_R2	8910071C69	Transmission On/Off signal to receive from remote-2
SCOM4-SA0_R1	8010051CE4	Transmission On/Off signal to receive from remote-1
SCOM4-SA0_R2	8010071C6C	Transmission On/Off signal to receive from remote-2
SCOM4-SA10_R1	8A10051CEE	Transmission On/Off signal to receive from remote-1
SCOM4-SA10_R2	8A10071C76	Transmission On/Off signal to receive from remote-2
SCOM4-SA11_R1	8B10051CEF	Transmission On/Off signal to receive from remote-1
SCOM4-SA11_R2	8B10071C77	Transmission On/Off signal to receive from remote-2
SCOM4-SA1_R1	8110051CE5	Transmission On/Off signal to receive from remote-1
SCOM4-SA1_R2	8110071C6D	Transmission On/Off signal to receive from remote-2
SCOM4-SA2_R1	8210051CE6	Transmission On/Off signal to receive from remote-1
SCOM4-SA2_R2	8210071C6E	Transmission On/Off signal to receive from remote-2
SCOM4-SA3_R1	8310051CE7	Transmission On/Off signal to receive from remote-1
SCOM4-SA3_R2	8310071C6F	Transmission On/Off signal to receive from remote-2
SCOM4-SA4_R1	8410051CE8	Transmission On/Off signal to receive from remote-1
SCOM4-SA4_R2	8410071C70	Transmission On/Off signal to receive from remote-2
SCOM4-SA5_R1	8510051CE9	Transmission On/Off signal to receive from remote-1
SCOM4-SA5_R2	8510071C71	Transmission On/Off signal to receive from remote-2
SCOM4-SA6_R1	8610051CEA	Transmission On/Off signal to receive from remote-1
SCOM4-SA6_R2	8610071C72	Transmission On/Off signal to receive from remote-2
SCOM4-SA7_R1	8710051CEB	Transmission On/Off signal to receive from remote-1
SCOM4-SA7_R2	8710071C73	Transmission On/Off signal to receive from remote-2
SCOM4-SA8_R1	8810051CEC	Transmission On/Off signal to receive from remote-1
SCOM4-SA8_R2	8810071C74	Transmission On/Off signal to receive from remote-2
SCOM4-SA9_R1	8910051CED	Transmission On/Off signal to receive from remote-1
SCOM4-SA9_R2	8910071C75	Transmission On/Off signal to receive from remote-2
SENT LEVEL_R1	8D30041B69	
SENT LEVEL_R2	8D30051B69	
SENT LEVEL_R3	8D30061B69	
SENT LEVEL_R4	8D30071B69	
SP SYNCHRO.FAIL_R1	8830041B65	

◆ Signal monitoring point

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
SP SYNCHRO.FAIL_R2	8830051B65	
SP SYNCHRO.FAIL_R3	8830061B65	
SP SYNCHRO.FAIL_R4	8830071B65	
SYNC.FAIL_R1	8030091B60	
SYNC.FAIL_R2	8130091B61	
SYNC.FAIL_R3	8230091B62	
SYNC.FAIL_R4	8330091B63	
VCOM1-SA0_R1	8010051C90	Transmission On/Off signal to receive from remote-1
VCOM1-SA0_R2	8010061CB8	Transmission On/Off signal to receive from remote-2
VCOM1-SA10_R1	8A10051C9A	Transmission On/Off signal to receive from remote-1
VCOM1-SA10_R2	8A10061CC2	Transmission On/Off signal to receive from remote-2
VCOM1-SA11_R1	8B10051C9B	Transmission On/Off signal to receive from remote-1
VCOM1-SA11_R2	8B10061CC3	Transmission On/Off signal to receive from remote-2
VCOM1-SA1_R1	8110051C91	Transmission On/Off signal to receive from remote-1
VCOM1-SA1_R2	8110061CB9	Transmission On/Off signal to receive from remote-2
VCOM1-SA2_R1	8210051C92	Transmission On/Off signal to receive from remote-1
VCOM1-SA2_R2	8210061CBA	Transmission On/Off signal to receive from remote-2
VCOM1-SA3_R1	8310051C93	Transmission On/Off signal to receive from remote-1
VCOM1-SA3_R2	8310061CBB	Transmission On/Off signal to receive from remote-2
VCOM1-SA4_R1	8410051C94	Transmission On/Off signal to receive from remote-1
VCOM1-SA4_R2	8410061CBC	Transmission On/Off signal to receive from remote-2
VCOM1-SA5_R1	8510051C95	Transmission On/Off signal to receive from remote-1
VCOM1-SA5_R2	8510061CBD	Transmission On/Off signal to receive from remote-2
VCOM1-SA6_R1	8610051C96	Transmission On/Off signal to receive from remote-1
VCOM1-SA6_R2	8610061CBE	Transmission On/Off signal to receive from remote-2
VCOM1-SA7_R1	8710051C97	Transmission On/Off signal to receive from remote-1
VCOM1-SA7_R2	8710061CBF	Transmission On/Off signal to receive from remote-2
VCOM1-SA8_R1	8810051C98	Transmission On/Off signal to receive from remote-1
VCOM1-SA8_R2	8810061CC0	Transmission On/Off signal to receive from remote-2
VCOM1-SA9_R1	8910051C99	Transmission On/Off signal to receive from remote-1
VCOM1-SA9_R2	8910061CC1	Transmission On/Off signal to receive from remote-2
VCOM2-SA0_R1	8010051C9C	Transmission On/Off signal to receive from remote-1
VCOM2-SA0_R2	8010061CC4	Transmission On/Off signal to receive from remote-2
VCOM2-SA10_R1	8A10051CA6	Transmission On/Off signal to receive from remote-1
VCOM2-SA10_R2	8A10061CCE	Transmission On/Off signal to receive from remote-2
VCOM2-SA11_R1	8B10051CA7	Transmission On/Off signal to receive from remote-1
VCOM2-SA11_R2	8B10061CCF	Transmission On/Off signal to receive from remote-2
VCOM2-SA1_R1	8110051C9D	Transmission On/Off signal to receive from remote-1
VCOM2-SA1_R2	8110061CC5	Transmission On/Off signal to receive from remote-2
VCOM2-SA2_R1	8210051C9E	Transmission On/Off signal to receive from remote-1
VCOM2-SA2_R2	8210061CC6	Transmission On/Off signal to receive from remote-2
VCOM2-SA3_R1	8310051C9F	Transmission On/Off signal to receive from remote-1
VCOM2-SA3_R2	8310061CC7	Transmission On/Off signal to receive from remote-2
VCOM2-SA4_R1	8410051CA0	Transmission On/Off signal to receive from remote-1

◆ Signal monitoring point

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
VCOM2-SA4_R2	8410061CC8	Transmission On/Off signal to receive from remote-2
VCOM2-SA5_R1	8510051CA1	Transmission On/Off signal to receive from remote-1
VCOM2-SA5_R2	8510061CC9	Transmission On/Off signal to receive from remote-2
VCOM2-SA6_R1	8610051CA2	Transmission On/Off signal to receive from remote-1
VCOM2-SA6_R2	8610061CCA	Transmission On/Off signal to receive from remote-2
VCOM2-SA7_R1	8710051CA3	Transmission On/Off signal to receive from remote-1
VCOM2-SA7_R2	8710061CCB	Transmission On/Off signal to receive from remote-2
VCOM2-SA8_R1	8810051CA4	Transmission On/Off signal to receive from remote-1
VCOM2-SA8_R2	8810061CCC	Transmission On/Off signal to receive from remote-2
VCOM2-SA9_R1	8910051CA5	Transmission On/Off signal to receive from remote-1
VCOM2-SA9_R2	8910061CCD	Transmission On/Off signal to receive from remote-2
VCOM3-SA0_R1	8010051CA8	Transmission On/Off signal to receive from remote-1
VCOM3-SA0_R2	8010061CD0	Transmission On/Off signal to receive from remote-2
VCOM3-SA10_R1	8A10051CB2	Transmission On/Off signal to receive from remote-1
VCOM3-SA10_R2	8A10061CDA	Transmission On/Off signal to receive from remote-2
VCOM3-SA11_R1	8B10051CB3	Transmission On/Off signal to receive from remote-1
VCOM3-SA11_R2	8B10061CDB	Transmission On/Off signal to receive from remote-2
VCOM3-SA1_R1	8110051CA9	Transmission On/Off signal to receive from remote-1
VCOM3-SA1_R2	8110061CD1	Transmission On/Off signal to receive from remote-2
VCOM3-SA2_R1	8210051CAA	Transmission On/Off signal to receive from remote-1
VCOM3-SA2_R2	8210061CD2	Transmission On/Off signal to receive from remote-2
VCOM3-SA3_R1	8310051CAB	Transmission On/Off signal to receive from remote-1
VCOM3-SA3_R2	8310061CD3	Transmission On/Off signal to receive from remote-2
VCOM3-SA4_R1	8410051CAC	Transmission On/Off signal to receive from remote-1
VCOM3-SA4_R2	8410061CD4	Transmission On/Off signal to receive from remote-2
VCOM3-SA5_R1	8510051CAD	Transmission On/Off signal to receive from remote-1
VCOM3-SA5_R2	8510061CD5	Transmission On/Off signal to receive from remote-2
VCOM3-SA6_R1	8610051CAE	Transmission On/Off signal to receive from remote-1
VCOM3-SA6_R2	8610061CD6	Transmission On/Off signal to receive from remote-2
VCOM3-SA7_R1	8710051CAF	Transmission On/Off signal to receive from remote-1
VCOM3-SA7_R2	8710061CD7	Transmission On/Off signal to receive from remote-2
VCOM3-SA8_R1	8810051CB0	Transmission On/Off signal to receive from remote-1
VCOM3-SA8_R2	8810061CD8	Transmission On/Off signal to receive from remote-2
VCOM3-SA9_R1	8910051CB1	Transmission On/Off signal to receive from remote-1
VCOM3-SA9_R2	8910061CD9	Transmission On/Off signal to receive from remote-2
VCOM4-SA0_R1	8010051CB4	Transmission On/Off signal to receive from remote-1
VCOM4-SA0_R2	8010061CDC	Transmission On/Off signal to receive from remote-2
VCOM4-SA10_R1	8A10051CBE	Transmission On/Off signal to receive from remote-1
VCOM4-SA10_R2	8A10061CE6	Transmission On/Off signal to receive from remote-2
VCOM4-SA11_R1	8B10051CBF	Transmission On/Off signal to receive from remote-1
VCOM4-SA11_R2	8B10061CE7	Transmission On/Off signal to receive from remote-2
VCOM4-SA1_R1	8110051CB5	Transmission On/Off signal to receive from remote-1
VCOM4-SA1_R2	8110061CDD	Transmission On/Off signal to receive from remote-2
VCOM4-SA2_R1	8210051CB6	Transmission On/Off signal to receive from remote-1

◆ Signal monitoring point

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
VCOM4-SA2_R2	8210061CDE	Transmission On/Off signal to receive from remote-2
VCOM4-SA3_R1	8310051CB7	Transmission On/Off signal to receive from remote-1
VCOM4-SA3_R2	8310061CDF	Transmission On/Off signal to receive from remote-2
VCOM4-SA4_R1	8410051CB8	Transmission On/Off signal to receive from remote-1
VCOM4-SA4_R2	8410061CE0	Transmission On/Off signal to receive from remote-2
VCOM4-SA5_R1	8510051CB9	Transmission On/Off signal to receive from remote-1
VCOM4-SA5_R2	8510061CE1	Transmission On/Off signal to receive from remote-2
VCOM4-SA6_R1	8610051CBA	Transmission On/Off signal to receive from remote-1
VCOM4-SA6_R2	8610061CE2	Transmission On/Off signal to receive from remote-2
VCOM4-SA7_R1	8710051CBB	Transmission On/Off signal to receive from remote-1
VCOM4-SA7_R2	8710061CE3	Transmission On/Off signal to receive from remote-2
VCOM4-SA8_R1	8810051CBC	Transmission On/Off signal to receive from remote-1
VCOM4-SA8_R2	8810061CE4	Transmission On/Off signal to receive from remote-2
VCOM4-SA9_R1	8910051CBD	Transmission On/Off signal to receive from remote-1
VCOM4-SA9_R2	8910061CE5	Transmission On/Off signal to receive from remote-2
ZERO CTRL 31	31000A1C2E	Zero ctrl 31: Zero control(for each CH)

◆ Connection point in PLC logic

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
CB1 CLOSE COMMAND	800217EBB0	
CB2 CLOSE COMMAND	810217EBB1	
COM1-1_S	800212EBB0	Transmission On/Off signal to send
COM1-2_S	810212EBB1	Transmission On/Off signal to send
COM2-10_S	890213EBB9	Transmission On/Off signal to send
COM2-11_S	8A0213EBBA	Transmission On/Off signal to send
COM2-12_S	8B0213EBBB	Transmission On/Off signal to send
COM2-13_S	8C0213EBBC	Transmission On/Off signal to send
COM2-14_S	8D0213EBBD	Transmission On/Off signal to send
COM2-15_S	8E0213EBBE	Transmission On/Off signal to send
COM2-16_S	8F0213EBBF	Transmission On/Off signal to send
COM2-1_S	800213EBB0	Transmission On/Off signal to send
COM2-2_S	810213EBB1	Transmission On/Off signal to send
COM2-3_S	820213EBB2	Transmission On/Off signal to send
COM2-4_S	830213EBB3	Transmission On/Off signal to send
COM2-5_S	840213EBB4	Transmission On/Off signal to send
COM2-6_S	850213EBB5	Transmission On/Off signal to send
COM2-7_S	860213EBB6	Transmission On/Off signal to send
COM2-8_S	870213EBB7	Transmission On/Off signal to send
COM2-9_S	880213EBB8	Transmission On/Off signal to send
COM3-10_S	890214EBB9	Transmission On/Off signal to send
COM3-11_S	8A0214EBBA	Transmission On/Off signal to send
COM3-12_S	8B0214EBBB	Transmission On/Off signal to send
COM3-13_S	8C0214EBBC	Transmission On/Off signal to send

◆ Connection point in PLC logic

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
COM3-14_S	8D0214EBBD	Transmission On/Off signal to send
COM3-15_S	8E0214EBBE	Transmission On/Off signal to send
COM3-16_S	8F0214EBBF	Transmission On/Off signal to send
COM3-1_S	800214EBB0	Transmission On/Off signal to send
COM3-2_S	810214EBB1	Transmission On/Off signal to send
COM3-3_S	820214EBB2	Transmission On/Off signal to send
COM3-4_S	830214EBB3	Transmission On/Off signal to send
COM3-5_S	840214EBB4	Transmission On/Off signal to send
COM3-6_S	850214EBB5	Transmission On/Off signal to send
COM3-7_S	860214EBB6	Transmission On/Off signal to send
COM3-8_S	870214EBB7	Transmission On/Off signal to send
COM3-9_S	880214EBB8	Transmission On/Off signal to send
COM4-10_S	890215EBB9	Transmission On/Off signal to send
COM4-11_S	8A0215EBBA	Transmission On/Off signal to send
COM4-12_S	8B0215EBBB	Transmission On/Off signal to send
COM4-13_S	8C0215EBBC	Transmission On/Off signal to send
COM4-14_S	8D0215EBBD	Transmission On/Off signal to send
COM4-15_S	8E0215EBBE	Transmission On/Off signal to send
COM4-16_S	8F0215EBBF	Transmission On/Off signal to send
COM4-1_S	800215EBB0	Transmission On/Off signal to send
COM4-2_S	810215EBB1	Transmission On/Off signal to send
COM4-3_S	820215EBB2	Transmission On/Off signal to send
COM4-4_S	830215EBB3	Transmission On/Off signal to send
COM4-5_S	840215EBB4	Transmission On/Off signal to send
COM4-6_S	850215EBB5	Transmission On/Off signal to send
COM4-7_S	860215EBB6	Transmission On/Off signal to send
COM4-8_S	870215EBB7	Transmission On/Off signal to send
COM4-9_S	880215EBB8	Transmission On/Off signal to send
COM5-1_S	800216EBB0	Transmission On/Off signal to send
COM5-2_S	810216EBB1	Transmission On/Off signal to send
COM5-3_S	820216EBB2	Transmission On/Off signal to send
COM5-4_S	830216EBB3	Transmission On/Off signal to send
COM5-5_S	840216EBB4	Transmission On/Off signal to send
COM5-6_S	850216EBB5	Transmission On/Off signal to send
ICOM1-SA0_S	800200EBB0	Transmission On/Off signal to send
ICOM1-SA10_S	8A0200EBBA	Transmission On/Off signal to send
ICOM1-SA11_S	8B0200EBBB	Transmission On/Off signal to send
ICOM1-SA1_S	810200EBB1	Transmission On/Off signal to send
ICOM1-SA2_S	820200EBB2	Transmission On/Off signal to send
ICOM1-SA3_S	830200EBB3	Transmission On/Off signal to send
ICOM1-SA4_S	840200EBB4	Transmission On/Off signal to send
ICOM1-SA5_S	850200EBB5	Transmission On/Off signal to send
ICOM1-SA6_S	860200EBB6	Transmission On/Off signal to send
ICOM1-SA7_S	870200EBB7	Transmission On/Off signal to send

◆ Connection point in PLC logic

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
ICOM1-SA8_S	880200EBB8	Transmission On/Off signal to send
ICOM1-SA9_S	890200EBB9	Transmission On/Off signal to send
ICOM2-SA0_S	800201EBB0	Transmission On/Off signal to send
ICOM2-SA10_S	8A0201EBBA	Transmission On/Off signal to send
ICOM2-SA11_S	8B0201EBBB	Transmission On/Off signal to send
ICOM2-SA1_S	810201EBB1	Transmission On/Off signal to send
ICOM2-SA2_S	820201EBB2	Transmission On/Off signal to send
ICOM2-SA3_S	830201EBB3	Transmission On/Off signal to send
ICOM2-SA4_S	840201EBB4	Transmission On/Off signal to send
ICOM2-SA5_S	850201EBB5	Transmission On/Off signal to send
ICOM2-SA6_S	860201EBB6	Transmission On/Off signal to send
ICOM2-SA7_S	870201EBB7	Transmission On/Off signal to send
ICOM2-SA8_S	880201EBB8	Transmission On/Off signal to send
ICOM2-SA9_S	890201EBB9	Transmission On/Off signal to send
ICOM3-SA0_S	800202EBB0	Transmission On/Off signal to send
ICOM3-SA10_S	8A0202EBBA	Transmission On/Off signal to send
ICOM3-SA11_S	8B0202EBBB	Transmission On/Off signal to send
ICOM3-SA1_S	810202EBB1	Transmission On/Off signal to send
ICOM3-SA2_S	820202EBB2	Transmission On/Off signal to send
ICOM3-SA3_S	830202EBB3	Transmission On/Off signal to send
ICOM3-SA4_S	840202EBB4	Transmission On/Off signal to send
ICOM3-SA5_S	850202EBB5	Transmission On/Off signal to send
ICOM3-SA6_S	860202EBB6	Transmission On/Off signal to send
ICOM3-SA7_S	870202EBB7	Transmission On/Off signal to send
ICOM3-SA8_S	880202EBB8	Transmission On/Off signal to send
ICOM3-SA9_S	890202EBB9	Transmission On/Off signal to send
ICOM4-SA0_S	800203EBB0	Transmission On/Off signal to send
ICOM4-SA10_S	8A0203EBBA	Transmission On/Off signal to send
ICOM4-SA11_S	8B0203EBBB	Transmission On/Off signal to send
ICOM4-SA1_S	810203EBB1	Transmission On/Off signal to send
ICOM4-SA2_S	820203EBB2	Transmission On/Off signal to send
ICOM4-SA3_S	830203EBB3	Transmission On/Off signal to send
ICOM4-SA4_S	840203EBB4	Transmission On/Off signal to send
ICOM4-SA5_S	850203EBB5	Transmission On/Off signal to send
ICOM4-SA6_S	860203EBB6	Transmission On/Off signal to send
ICOM4-SA7_S	870203EBB7	Transmission On/Off signal to send
ICOM4-SA8_S	880203EBB8	Transmission On/Off signal to send
ICOM4-SA9_S	890203EBB9	Transmission On/Off signal to send
INTCONN-A_R1	800219EBB0	
INTCONN-A_R2	80021AEBB0	
INTCONN-A_R3	80021BEBB0	
INTCONN-A_R4	80021CEBB0	
INTCONN-B_R1	810219EBB1	
INTCONN-B_R2	81021AEBB1	

◆ Connection point in PLC logic

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
INTCONN-B_R3	81021BEBB1	
INTCONN-B_R4	81021CEBB1	
INTCONN-C_R1	820219EBB2	
INTCONN-C_R2	82021AEBB2	
INTCONN-C_R3	82021BEBB2	
INTCONN-C_R4	82021CEBB2	
LOCAL_TEST_R1	80021DEBB0	
LOCAL_TEST_R2	81021DEBB1	
LOCAL_TEST_R3	82021DEBB2	
LOCAL_TEST_R4	83021DEBB3	
REMOTE_DATA_ZERO	800218EBB0	
SCOM1-SA0_S	800208EBB0	Transmission On/Off signal to send
SCOM1-SA10_S	8A0208EBBA	Transmission On/Off signal to send
SCOM1-SA11_S	8B0208EBBB	Transmission On/Off signal to send
SCOM1-SA1_S	810208EBB1	Transmission On/Off signal to send
SCOM1-SA2_S	820208EBB2	Transmission On/Off signal to send
SCOM1-SA3_S	830208EBB3	Transmission On/Off signal to send
SCOM1-SA4_S	840208EBB4	Transmission On/Off signal to send
SCOM1-SA5_S	850208EBB5	Transmission On/Off signal to send
SCOM1-SA6_S	860208EBB6	Transmission On/Off signal to send
SCOM1-SA7_S	870208EBB7	Transmission On/Off signal to send
SCOM1-SA8_S	880208EBB8	Transmission On/Off signal to send
SCOM1-SA9_S	890208EBB9	Transmission On/Off signal to send
SCOM2-SA0_S	800209EBB0	Transmission On/Off signal to send
SCOM2-SA10_S	8A0209EBBA	Transmission On/Off signal to send
SCOM2-SA11_S	8B0209EBBB	Transmission On/Off signal to send
SCOM2-SA1_S	810209EBB1	Transmission On/Off signal to send
SCOM2-SA2_S	820209EBB2	Transmission On/Off signal to send
SCOM2-SA3_S	830209EBB3	Transmission On/Off signal to send
SCOM2-SA4_S	840209EBB4	Transmission On/Off signal to send
SCOM2-SA5_S	850209EBB5	Transmission On/Off signal to send
SCOM2-SA6_S	860209EBB6	Transmission On/Off signal to send
SCOM2-SA7_S	870209EBB7	Transmission On/Off signal to send
SCOM2-SA8_S	880209EBB8	Transmission On/Off signal to send
SCOM2-SA9_S	890209EBB9	Transmission On/Off signal to send
SCOM3-SA0_S	800210EBB0	Transmission On/Off signal to send
SCOM3-SA10_S	8A0210EBBA	Transmission On/Off signal to send
SCOM3-SA11_S	8B0210EBBB	Transmission On/Off signal to send
SCOM3-SA1_S	810210EBB1	Transmission On/Off signal to send
SCOM3-SA2_S	820210EBB2	Transmission On/Off signal to send
SCOM3-SA3_S	830210EBB3	Transmission On/Off signal to send
SCOM3-SA4_S	840210EBB4	Transmission On/Off signal to send
SCOM3-SA5_S	850210EBB5	Transmission On/Off signal to send
SCOM3-SA6_S	860210EBB6	Transmission On/Off signal to send

◆ Connection point in PLC logic

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
SCOM3-SA7_S	870210EBB7	Transmission On/Off signal to send
SCOM3-SA8_S	880210EBB8	Transmission On/Off signal to send
SCOM3-SA9_S	890210EBB9	Transmission On/Off signal to send
SCOM4-SA0_S	800211EBB0	Transmission On/Off signal to send
SCOM4-SA10_S	8A0211EBBA	Transmission On/Off signal to send
SCOM4-SA11_S	8B0211EBBB	Transmission On/Off signal to send
SCOM4-SA1_S	810211EBB1	Transmission On/Off signal to send
SCOM4-SA2_S	820211EBB2	Transmission On/Off signal to send
SCOM4-SA3_S	830211EBB3	Transmission On/Off signal to send
SCOM4-SA4_S	840211EBB4	Transmission On/Off signal to send
SCOM4-SA5_S	850211EBB5	Transmission On/Off signal to send
SCOM4-SA6_S	860211EBB6	Transmission On/Off signal to send
SCOM4-SA7_S	870211EBB7	Transmission On/Off signal to send
SCOM4-SA8_S	880211EBB8	Transmission On/Off signal to send
SCOM4-SA9_S	890211EBB9	Transmission On/Off signal to send
VCOM1-SA0_S	800204EBB0	Transmission On/Off signal to send
VCOM1-SA10_S	8A0204EBBA	Transmission On/Off signal to send
VCOM1-SA11_S	8B0204EBBB	Transmission On/Off signal to send
VCOM1-SA1_S	810204EBB1	Transmission On/Off signal to send
VCOM1-SA2_S	820204EBB2	Transmission On/Off signal to send
VCOM1-SA3_S	830204EBB3	Transmission On/Off signal to send
VCOM1-SA4_S	840204EBB4	Transmission On/Off signal to send
VCOM1-SA5_S	850204EBB5	Transmission On/Off signal to send
VCOM1-SA6_S	860204EBB6	Transmission On/Off signal to send
VCOM1-SA7_S	870204EBB7	Transmission On/Off signal to send
VCOM1-SA8_S	880204EBB8	Transmission On/Off signal to send
VCOM1-SA9_S	890204EBB9	Transmission On/Off signal to send
VCOM2-SA0_S	800205EBB0	Transmission On/Off signal to send
VCOM2-SA10_S	8A0205EBBA	Transmission On/Off signal to send
VCOM2-SA11_S	8B0205EBBB	Transmission On/Off signal to send
VCOM2-SA1_S	810205EBB1	Transmission On/Off signal to send
VCOM2-SA2_S	820205EBB2	Transmission On/Off signal to send
VCOM2-SA3_S	830205EBB3	Transmission On/Off signal to send
VCOM2-SA4_S	840205EBB4	Transmission On/Off signal to send
VCOM2-SA5_S	850205EBB5	Transmission On/Off signal to send
VCOM2-SA6_S	860205EBB6	Transmission On/Off signal to send
VCOM2-SA7_S	870205EBB7	Transmission On/Off signal to send
VCOM2-SA8_S	880205EBB8	Transmission On/Off signal to send
VCOM2-SA9_S	890205EBB9	Transmission On/Off signal to send
VCOM3-SA0_S	800206EBB0	Transmission On/Off signal to send
VCOM3-SA10_S	8A0206EBBA	Transmission On/Off signal to send
VCOM3-SA11_S	8B0206EBBB	Transmission On/Off signal to send
VCOM3-SA1_S	810206EBB1	Transmission On/Off signal to send
VCOM3-SA2_S	820206EBB2	Transmission On/Off signal to send

◆ Connection point in PLC logic

COMM_APPL(Function ID: 4A9001)

Element ID	Name	Description
VCOM3-SA3_S	830206EBB3	Transmission On/Off signal to send
VCOM3-SA4_S	840206EBB4	Transmission On/Off signal to send
VCOM3-SA5_S	850206EBB5	Transmission On/Off signal to send
VCOM3-SA6_S	860206EBB6	Transmission On/Off signal to send
VCOM3-SA7_S	870206EBB7	Transmission On/Off signal to send
VCOM3-SA8_S	880206EBB8	Transmission On/Off signal to send
VCOM3-SA9_S	890206EBB9	Transmission On/Off signal to send
VCOM4-SA0_S	800207EBB0	Transmission On/Off signal to send
VCOM4-SA10_S	8A0207EBBA	Transmission On/Off signal to send
VCOM4-SA11_S	8B0207EBBB	Transmission On/Off signal to send
VCOM4-SA1_S	810207EBB1	Transmission On/Off signal to send
VCOM4-SA2_S	820207EBB2	Transmission On/Off signal to send
VCOM4-SA3_S	830207EBB3	Transmission On/Off signal to send
VCOM4-SA4_S	840207EBB4	Transmission On/Off signal to send
VCOM4-SA5_S	850207EBB5	Transmission On/Off signal to send
VCOM4-SA6_S	860207EBB6	Transmission On/Off signal to send
VCOM4-SA7_S	870207EBB7	Transmission On/Off signal to send
VCOM4-SA8_S	880207EBB8	Transmission On/Off signal to send
VCOM4-SA9_S	890207EBB9	Transmission On/Off signal to send

2.31 Protection common (PROT_COMMON)

The contact states of the circuit breaker (CB) and the disconnector (DS) provided are grouped in the protection common function (PROT_COMMON) and are used in a number of relay applications to decide conditions. The PROT_COMMON function also examines whether a line is dead (de-energizing), as the PROT_COMMON has an under-voltage detection (UV) relay. The PROT_COMMON function is operated as the common function.

Note: The PROT_COMMON function is feasible in entire models, which can be enumerated in the IED ordering number. For more information, see *Appendix: Ordering*.

Table 2.31-1 Comparative table in respective ordering numbers

	feature	Ordering No. at "G&T"				
		10	11	13	19	22
PROT_COMM	Protection common	✓	✓	✓	✓	✓

✓: Applicable NA: Not applicable

2.31.1 Selection of breaker system

A single breaker arrangement (1CB) is applied and the protection function is required to operate in the 1CB, the user should set **1CB** for the scheme switch [**CB-System**]. When a single-and-a-half breaker arrangement system (1.5CB) is applied, the user should set **2CB** for the scheme switch. (2.84.8)

2.31.2 Decision of CB open/close status

Circuit-breaker auxiliary-contact is used to state the CB status; a normal-open contact (N/O) and a normal-close contact (N/C) can be furnished in the CB. Thus, as to the phase-A contact of the CB, signals "CB1-A_NO_CONT" and "CB1-A_NC_CONT" can be used to represent the CB status in phase-A (i.e., tripped or closed in phase-A). The PROT_COMM function can decide the CB status using the both signals; the decision generated will be provided for other protection functions so that the IED can operate in accordance with the CB status.

(i) Signal option

As the CB auxiliary-contacts (N/O and/or N/C) may generate the signals, the user should set the rule for the decision. When the N/O signal is generated but the N/C signal is not generated, set **NO** for the scheme switch [**CB1-Contact**] so that the PROT_COMMON function can decide the CB state using only the N/O. Conversely, the decision should be made with only the N/C, **NC** is set for this scheme switch. When both N/O and the N/C used, set **Both** for the scheme switch [**CB1-Contact**]†.

†Note:When the IED operates for the 1.5CB arrangement (i.e., two CBs are connected with the IED), the user should set the scheme switches [**CB1-Contact**] and [**CB2-Contact**] both.

(ii) Contact supervision

Table 2.31-2 exemplifies the rules between the CB main-contact and the CB auxiliary-contact. Given that the main-contact is open, the N/O is open and the N/C is closed; however if the both are open when the main contact is open, we should decide the information generated in the PROT_COMMON is not true (say, an incorrect signal is generated). The contact supervision can find the inconsistency in the decisions using the rule of Table 2.31-2.

Table 2.31-2 Main and Auxiliary contacts within CB

		Main contact	
		OPEN	CLOSED
Auxiliary contacts	N/O	OPEN	CLOSED
	N/C	CLOSED	OPEN

The user should set **On** for the scheme switch [**CB-SV**] when the operation of the contact

supervision feature is required; set the time for the setting [**TCBSV**] to define the monitoring period, which the user can have an option among 0 to 100 sec.

(iii) CB decision logic

Figure 2.31-1 shows the decision logic of the PROT_COMMON and outputs the decision state of the CB: CB-A_CLOSE, CB-B_CLOSE, and others.

For the operation, the user should inject signals of CB states for the following PLC connection points: 'CB1-A NO CONT', 'CB1-A NC CONT' and others. Note that a common point is ready for the CB designed to three-phase tripping: CB1-NO CONT' and 'CB1-NC CONT'.

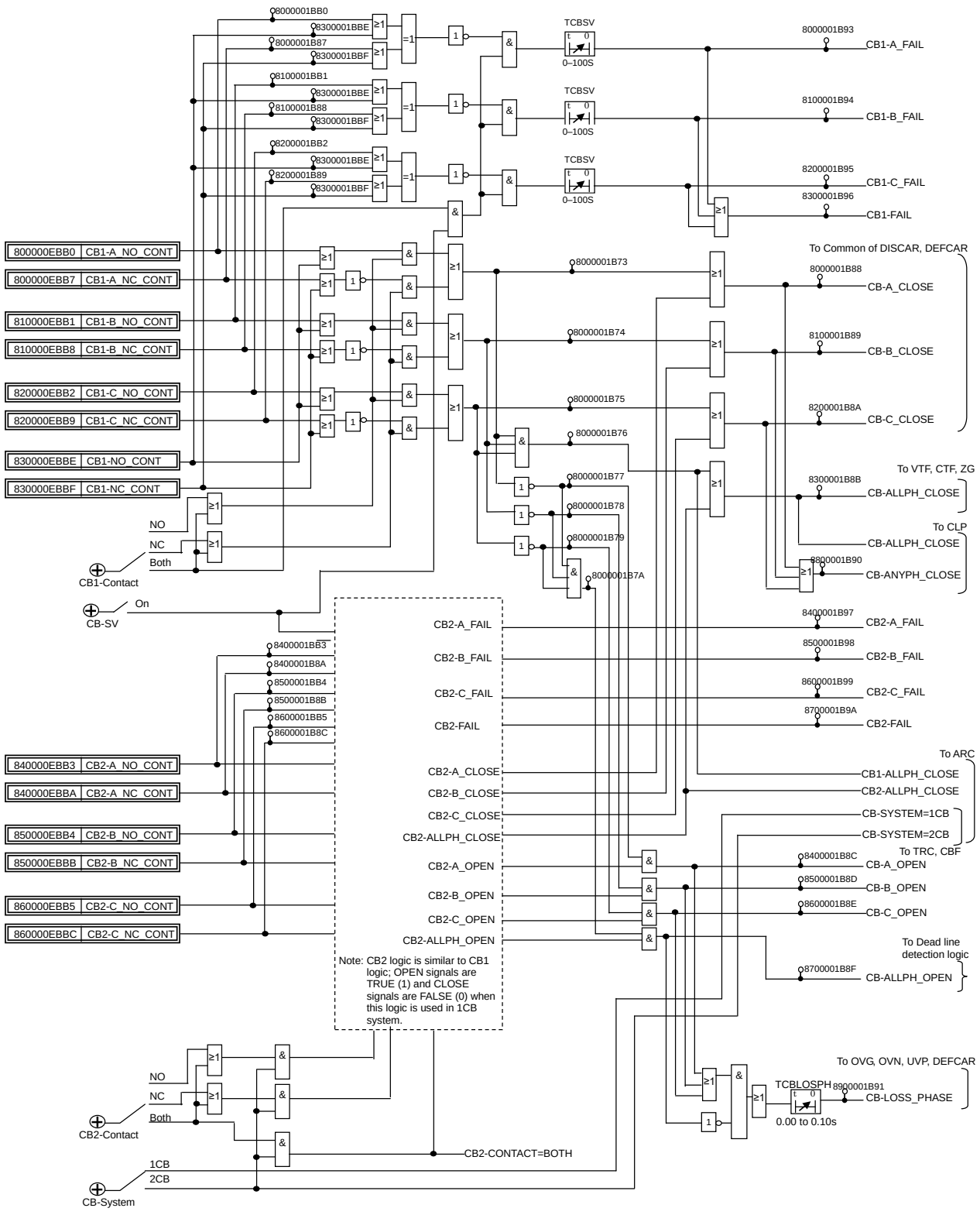


Figure 2.31-1 CB decision logic with supervision feature in 1.5CB system

2.31.3 Decision of DS open/close status

The PROT_COMMON function can determine the behavior and position status of a DS. Signal configuration and settings for the DS position status are similar to that of the CB. Note that settings and logics cited below are just available for the DS.

(i) Signal selection

Set either **NO**, **NC**, or **Both** for scheme switch [**DS-Contact**].

(ii) Contact supervision

When **Both** is set for scheme switch [**DS-Contact**], the auxiliary switch contact state of the DS is supervised. Set **On** for scheme switch [**DS-SV**] when contact supervision is required. The supervision period has to be set between 0 to 100 seconds for the setting [**TDSSV**].

(iii) Logic

Figure 2.31-2 shows the logic used to determine DS status and generates the output signal of the DS state: DS_CLOSE or DS_OPEN. The supervision scheme logic to supervise the status of the DS auxiliary switch contacts. This scheme logic is applied when **BOTH** is set for the scheme switch [**DS-Contact**]. For the operation, the user should inject signals of DS states for the following PLC connection points: 'DS-NO CONT', 'DS NC CONT' and others.

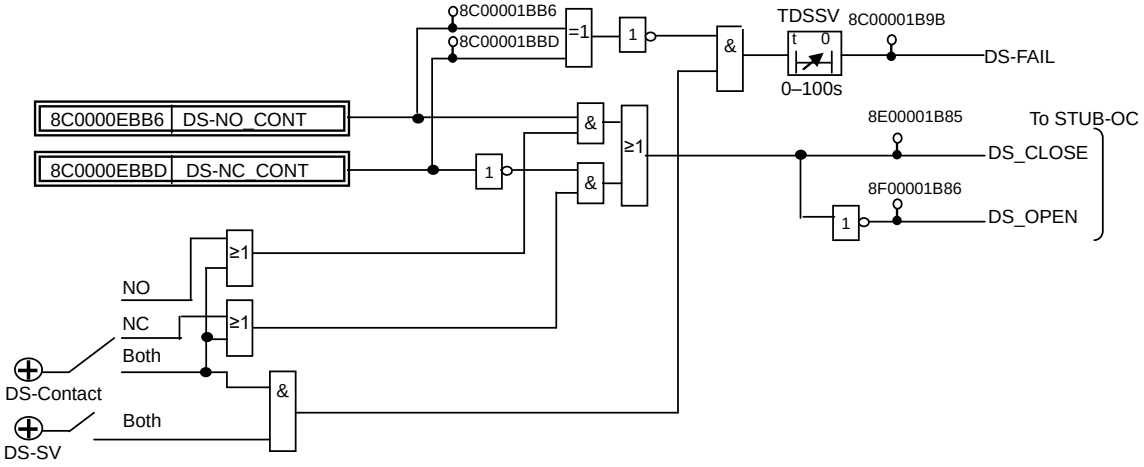


Figure 2.31-2 Scheme logic to determine DS status

2.31.4 Dead line detection

The dead line detection (DLD) determinates whether the line is out-of-service or not. Checking for the voltage existence in three-phase is required when all CBs are closed; hence, the output signal of the DLD is being checked. (2.84.3)

(i) Under-voltage relay

A phase-to-phase (UVLS) element and a phase-to-ground (UVLG) element are provide in the UV relay. Both elements operate when **On** is set for scheme switch [**DLDbyUV**]. (2.84.3.5)

(ii) Decision of CB operation

Deciding the dead line state is carried out by examining the CB position. The user should set **On** for the scheme switch [**DLDbyCB**] for the decision. (2.84.3.2)

(iii) Detection time

The examining period for DLD detection is required to set using the setting [**TDSSV**], the value of the detection time can be set between 0 to 100 seconds. (2.84.3.3)

(iv) Dead line detection logic

Figure 2.31-3 shows the scheme logic for the detection of an under voltage condition. It is also used to determine whether the line is dead or not.

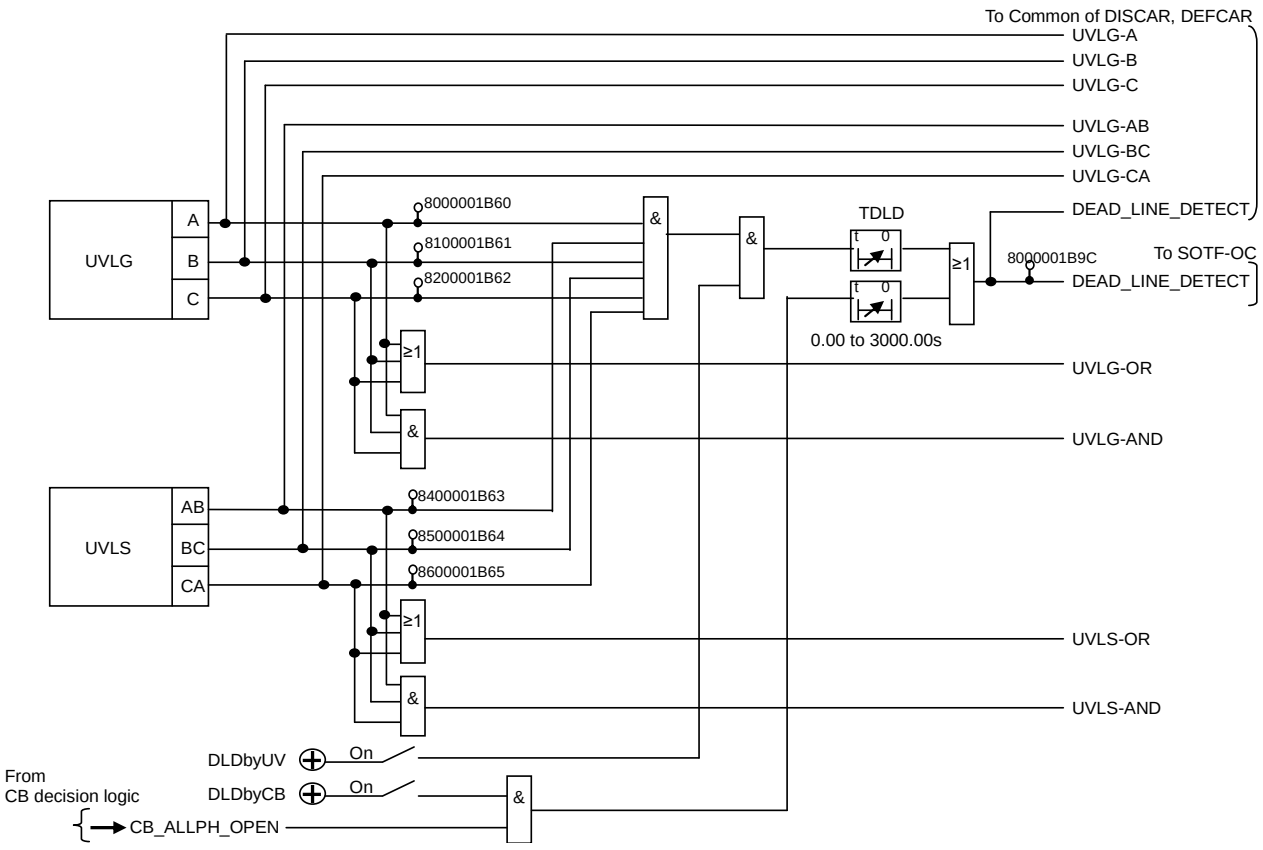


Figure 2.31-3 Dead line detection logic with under voltage relays

2.31.5 Detection of current change (OCD)

(i) Current change detection relay

Suppose that the difference exists between the latest current vector (I_M) and the last current vector (I_N). The OCD function will operate if the difference is larger than the setting. The I_N is measured for the last two-cycles; the difference is decided using Equation (2.31-1):

$$|I_M - I_N| > I_s \qquad (2.31\text{-}1)$$

where a criteria for the decision is given by the pick-up threshold value (I_S).

The pick-up threshold is defined using setting [**OCD**], which is from 0.05 A to 0.20 A at 1 A rating†. At 5 A rating, 0.25 A to 1.00 A is applied.

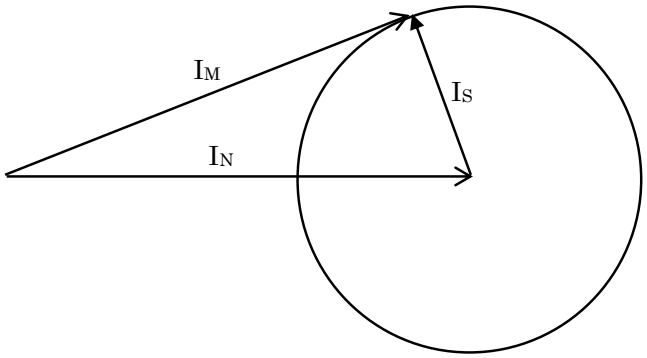


Figure 2.31-4 Current change detection

(ii) OCD logic

Figure 2.31-5 shows the OCD logic and its output signals.

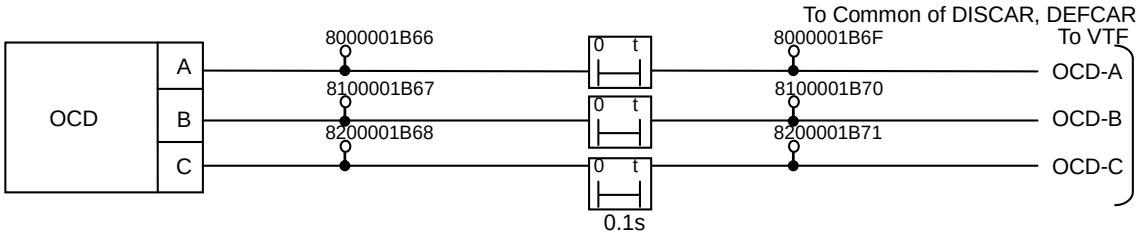


Figure 2.31-5 Scheme logic for current change check

(2.84.4)

2.31.6 Setting

Setting of PROT_COMMON (Function ID: 48A001)

Setting item			Range		Unit s	Contents	Default setting value		Notes
			1A rated	5A rated			1A	5A	
		UVLS	5.0 - 130.0		V	UV phase-phase relay operating value	77.0		
		UVLG	5.0 - 130.0		V	UV phase-ground relay operating value	45.0		
		OCD	0.05 - 0.20	0.25 - 1.00	A	OCD relay operating value	0.10	0.50	
	CB	CB-System	1CB / 2CB		–	Single CB or One-and-a-half CB system	1CB		
		CB1-Contact	NO / NC / Both		–	Kind of injected CB contact Normally open contact, Normally close contact or Both.	NO		
		CB2-Contact	NO / NC / Both		–	Kind of injected CB2 contact Normally open contact, Normally close contact or Both contact.	NO		
		TCBLOSPH	0.00 – 0.10		s	CB loss phase time	0.03		
		CB-SV	Off / On		–	CB contact supervisor enable	Off		
		TCBSV	0 - 100		s	CB contact supervisor time	10		
	DS	DS-Contact	NO / NC / Both		–	Kind of injected DS contact Normally open contact, Normally close contact or Both contact.	NO		
		DS-SV	Off / On		–	DS contact super visor enable	Off		
		TDSSV	0 - 100		s	DS contact super visor time	60		
	Dead-line detection	DLDbyUV	Off / On		–	Dead line detection by under voltage	Off		
		DLDbyCB	Off / On		–	Dead line detection by CB open	Off		
		TDLD	0.00 - 300.00		s	Dead line detection timer	10.00		

2.31.7 Data ID

◆ Signal monitoring point

PROT_COMMON(48A001)

Element ID	Name	Description
8300001B8B	CB_ALLPH_CLOSE	Three-phase contacts closed in CB
8700001B8F	CB_ALLPH_OPEN	Three-phase contacts not closed in CB
8800001B90	CB_ANYPH_CLOSE	Any UVLG element operated in three-phases
8900001B91	CB_LOSS_PHASE	Any one of three-phase contacts opening in CB
8300001B96	CB1_FAIL	States of the CB1 not to be defined in three-phase
8000001B73	CB1-A_CLOSE	Main contact closed in phase-A of CB1
8100001B74	CB1-B_CLOSE	Main contact closed in phase-B of CB1
8200001B75	CB1-C_CLOSE	Main contact closed in phase-C of CB1
8700001B9A	CB2_FAIL	States of the CB2 not to be defined in three-phase
8000001B7C	CB2-A_CLOSE	Main contact closed in phase-A of CB2
8100001B7D	CB2-B_CLOSE	Main contact closed in phase-B of CB2
8200001B7E	CB2-C_CLOSE	Main contact closed in phase-C of CB2
8000001B9C	DEAD_LINE_DETECT	Detected the line not being energized
8E00001B85	DS_CLOSE	Main contacts closed in DS
8C00001B9B	DS_FAIL	States of the DS not to be defined
8F00001B86	DS_OPEN	Main contact opening in DS
8000001B66	OCD-A	OCD element operated in phase-A
8000001B6F	OCD-AT	Off-delay timer after OCD element in phase-A
8100001B67	OCD-B	OCD element operated in phase-C
8100001B70	OCD-BT	Off-delay timer after OCD element in phase-B
8200001B68	OCD-C	OCD element operated in phase-C
8200001B71	OCD-CT	Off-delay timer after OCD element in phase-C
8000001B60	UVLG-A	UVLG element operated in phase-A
8100001B61	UVLG-B	UVLG element operated in phase-B
8200001B62	UVLG-C	UVLG element operated in phase-C
8400001B63	UVLS-AB	UVLS elements operated in phase-AB
8500001B64	UVLS-BC	UVLS elements operated in phase-BC
8600001B65	UVLS-CA	UVLS elements operated in phase-CA
2200001BA9	CB1_OPCNT	IEC61850 OpCnt in three-phase of CB1 in XCBR
3000001BA1	CB1_POS	LN Pos-signal of three-phase of CB1 in XCBR
2200001BA6	CB1-A_OPCNT	IEC61850 OpCnt of CB1-A in XCBR
3000001B9E	CB1-A_POS	IEC61580 Pos-signal of CB1-A in XCBR of LN
2200001BA7	CB1-B_OPCNT	IEC61850 OpCnt of CB1-B in XCBR
3000001B9F	CB1-B_POS	IEC61580 Pos-signal of CB1-B in XCBR of LN
2200001BA8	CB1-C_OPCNT	IEC61850 OpCnt of CB1-C in XCBR
3000001BA0	CB1-C_POS	IEC61580 Pos-signal of CB1-C in XCBR of LN
2200001BAD	CB2_OPCNT	IEC61850 OpCnt in three-phase of CB2 in XCBR
3000001BA5	CB2_POS	LN Pos-signal of three-phase of CB2 in XCBR
2200001BAA	CB2-A_OPCNT	IEC61850 OpCnt of CB2-A in XCBR
3000001BA2	CB2-A_POS	IEC61580 Pos-signal of CB2-A in XCBR of LN
2200001BAB	CB2-B_OPCNT	IEC61850 OpCnt of CB2-B in XCBR
3000001BA3	CB2-B_POS	IEC61580 Pos-signal of CB2-B in XCBR of LN
2200001BAC	CB2-C_OPCNT	IEC61850 OpCnt of CB2-C in XCBR

◆ Signal monitoring point

PROT_COMMON(48A001)

Element ID	Name	Description
3000001BA4	CB2-C_POS	IEC61580 Pos-signal of CB2-C in XCBR of LN

◆ Connection point in PLC logic

PROT_COMMON (48A001)

Element ID	Name	Description
800000EBB0	CB1-A_NO_CONT	CB1-A normally open contact
810000EBB1	CB1-B_NO_CONT	CB1-B normally open contact
820000EBB2	CB1-C_NO_CONT	CB1-C normally open contact
840000EBB3	CB2-A_NO_CONT	CB2-A normally open contact
850000EBB4	CB2-B_NO_CONT	CB2-B normally open contact
860000EBB5	CB2-C_NO_CONT	CB2-C normally open contact
8C0000EBB6	DS_NO_CONT	DS normally open contact
800000EBB7	CB1-A_NC_CONT	CB1-A normally close contact
810000EBB8	CB1-B_NC_CONT	CB1-B normally close contact
820000EBB9	CB1-C_NC_CONT	CB1-C normally close contact
840000EBBA	CB2-A_NC_CONT	CB2-A normally close contact
850000EBBB	CB2-B_NC_CONT	CB2-B normally close contact
860000EBBC	CB2-C_NC_CONT	CB2-C normally close contact
8C0000EBBD	DS_NC_CONT	DS normally close contact
830000EBBE	CB1_NO_CONT	CB1 normally open contact
830000EBBF	CB1_NC_CONT	CB1 normally close contact

3 General control function

3.1 Control scheme

Figure 3.1-1 shows the control overview for the control function; there are two control stages: "Wait for a command" and "Receiving commands". The function will wait for a command from the server in the first stage. During the receiving stage, the function will respond to "Select", "Cancel", and "Operate" commands. Specific logic is provided for each command for each receiving stage. A decision is required from each logic block to move to the next step (i.e., 'Failed' or 'Success'). When a 'success' decision is determined in the operate logic, the respective command is issued to the relevant device; the device commences with its operation (for example, a 43-switch is changed to "ON" from "OFF"). The waiting and receiving stages loop around at the receipt of every command.

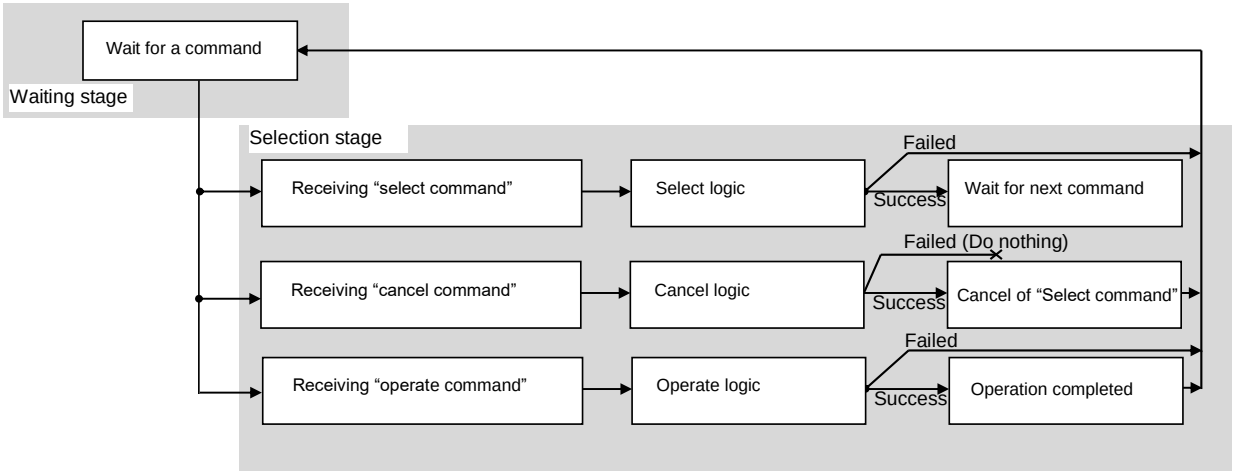


Figure 3.1-1 Stages in control function

The type of control can be categorized in accordance with its origin, (Remote/Local/PLC) and modes (SBO/DIR). That is, the respective control scheme should respond to the respective origin and mode. The user should be aware of the context of the control action, "On (or Closing) control" and "Off (or Open) control" in relationship to its origin and mode†.

†Note:The "On control" and "Off control" can be found in the SPOS, DPSY and other functions. For more information on these functions, see the explanations provided for each respective function.

(i) Command reception in SBO mode

In the SBO receiving stage shown in Figure 3.1-1 we can find three processes: select, cancel, and operate command flows.

(i)-1 Reception of "select command"

Figure 3.1-2 shows a schematic process flow diagram when receiving a "select command" following the "Wait for a command". The receipt "select command" is divided into "select command 'On' (Closing)" and "select command 'Off' (Open)". The select command is carried out based on its origin: "Remote", "Local", and "PLC". If the "select command" is successful, the process will wait for the receipt of the next command.

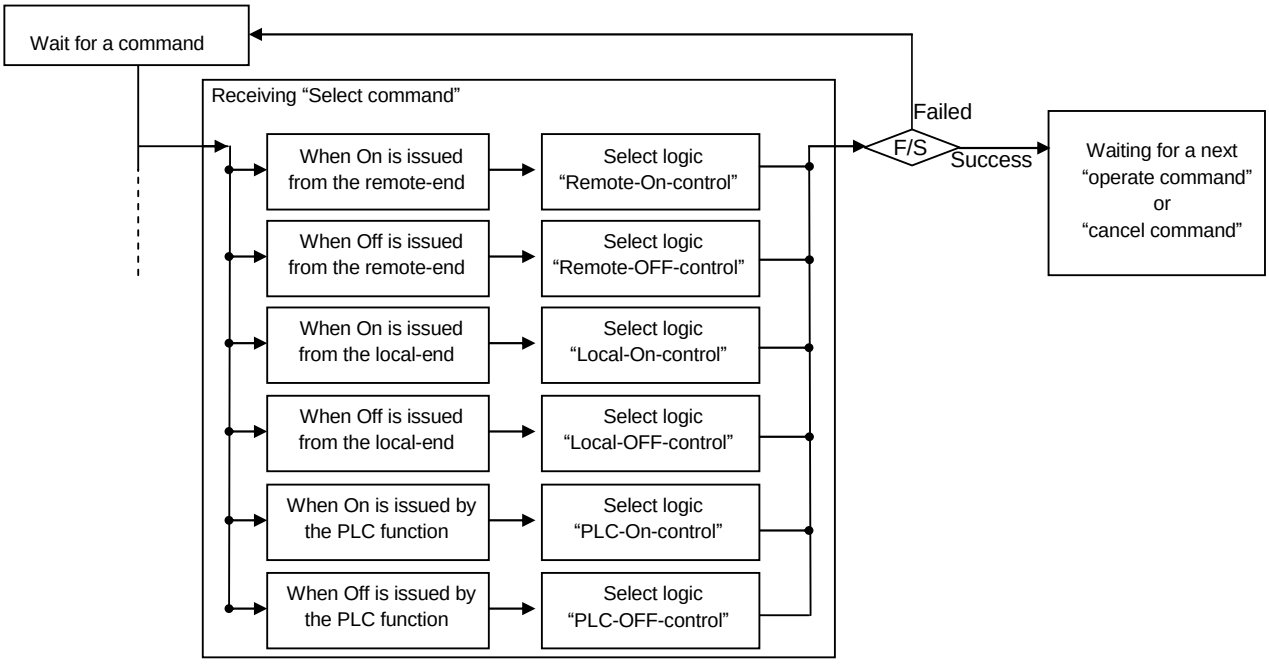


Figure 3.1-2 Schemes for "Select command"

(i)-2 Reception of "cancel command"

If the "select command" proceeds successfully following the receiving stage, the function can subsequently receive a "cancel command". Figure 3.1-3 shows the reception of a "cancel command". If the "cancel command" is successful, the "select command" is discarded and the function returns to the "Wait for a command" stage (i.e., the initial stage). In other words, the function waits for a new "select command" so that the other control functions can receive a command.

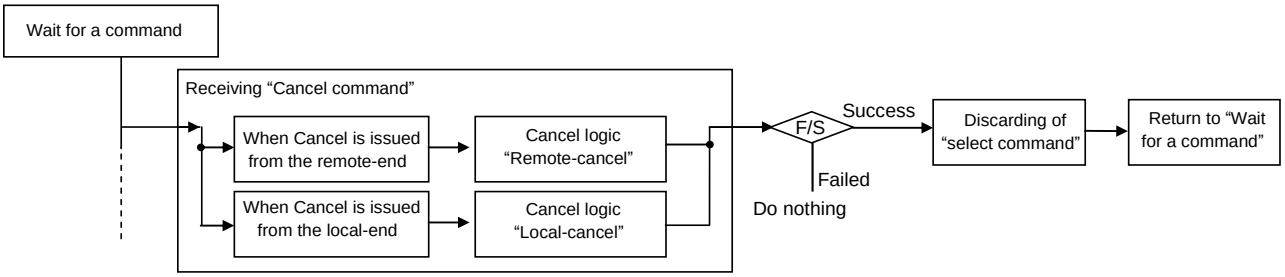


Figure 3.1-3 Scheme “Cancel command”

(i)-3 Reception of “operate command”

Following successful completion of the “select command”, the control function is ready to receive an “operate command” in order to control a device. The receipt of “operate command” is divided into “Operate command ‘On’ (Closing)” and “Control command ‘Off’ (Open)”; each of the two commands is carried out based upon its origin i.e. “Remote”, “Local”, and “PLC”. If the “operate command” is completed, the “select command” can be released; then a new “Wait for a command” stage can commence for receipt of a new “select command”.

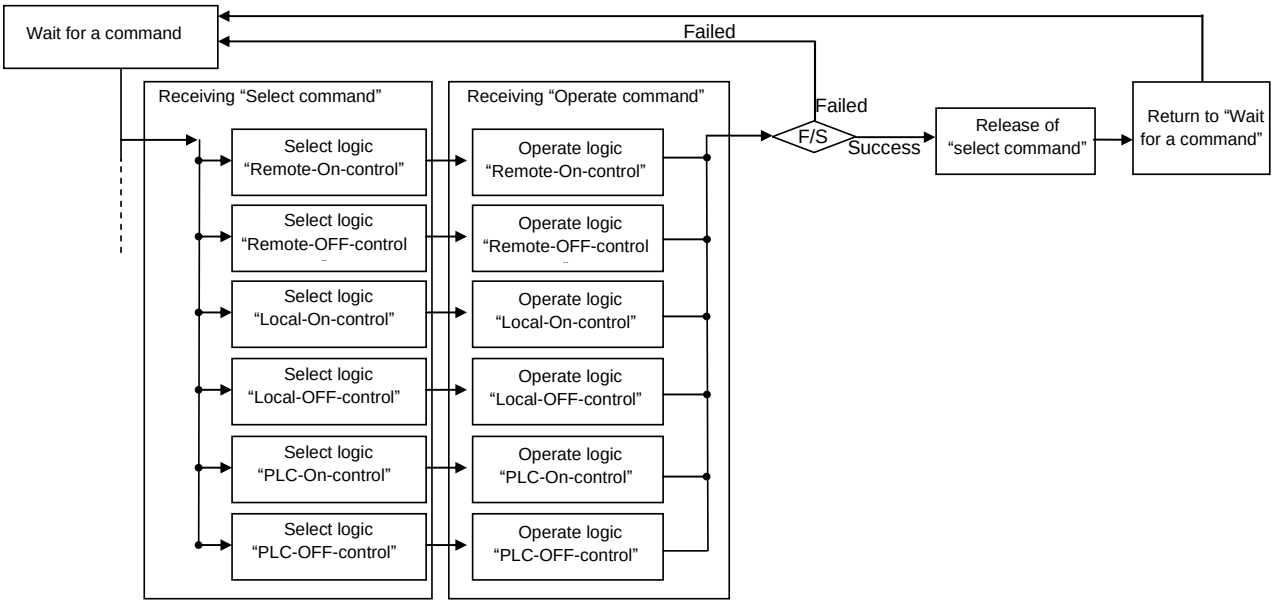


Figure 3.1-4 Scheme “Operate command”

(ii) Command reception in DIR mode

In DIR mode, issuing an “operate command” is possible without the reception of the “select command”. Thus, the reception of an “operation command” only features in the control scheme†. We shall see the DIR mode later.

†Note: We can encompass the operation of the “select command” being performed internally in the control scheme. Thus, the user is not required to take account of the reception of the “select command”.

3.2 Control mode

Either Select-Before-operation (SBO) or Direct-Operate-control (DIR) is provided as a control mode for the device. The user can select the preferred control mode.

3.2.1 Select-before-operation mode (SBO)

The user should be aware that in the SBO mode a signal is returned from the target device in the form of a response signal, (answer). When the target device sends a response to the IED after receiving a command, the server (and the IED) can send another command to the target device if the criterion of the response (answer) is satisfied. A safe SBO operation (**SBOns**) is normally utilized; however, the user can opt to select an enhanced-security SBO operation (**SBOes**), if additional safety is deemed necessary.

(i) SBO with enhanced security (SBOes)

In the SBOes, an operation process (Oper) commences after the completion of a selection process (SBOw). Figure 3.2-1 exemplifies the exchange of commands and responses; the server receives a response (answer#1) from the IED with regard to a SBOw command. Then, provided that the response, (answer#1) received from the IED is satisfied, the server can send an Oper request to the IED to control the device. If the target device completes the operation successfully, the server will receive an operation result. Figure 3.2-1 shows the communication flow between the server (remote-end) and the IED, note that the user will also see the same process flow when using the IED-front-panel key-operations. That is, the IED-front-panel (local-end) takes the place of the server (remote-end).

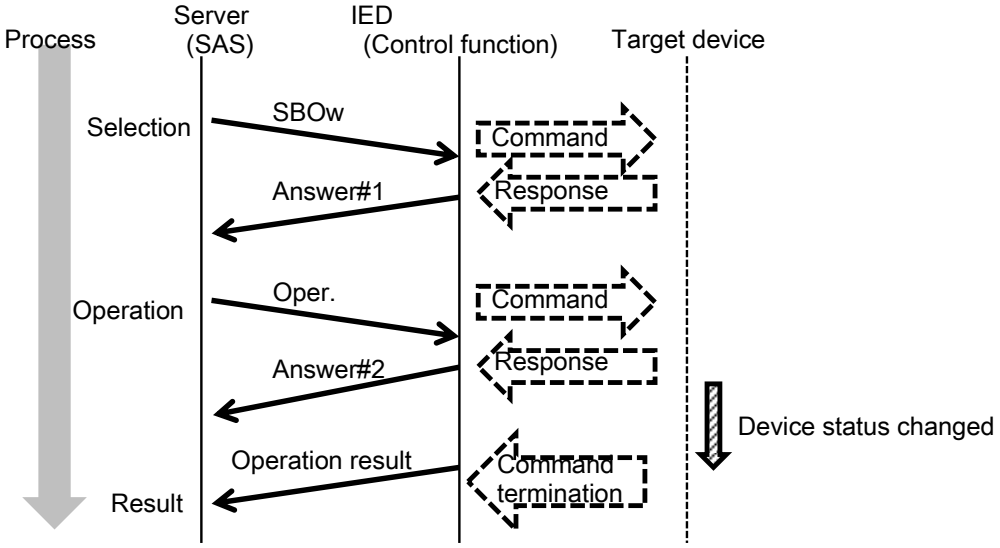


Figure 3.2-1 SBO with enhanced security

(ii) SBO with normal security (SBOns)

Figure 3.2-2 shows normal SBOns control. The difference between the SBOes and the SBOns is that the IED does not send an operation result in response to the request Oper.

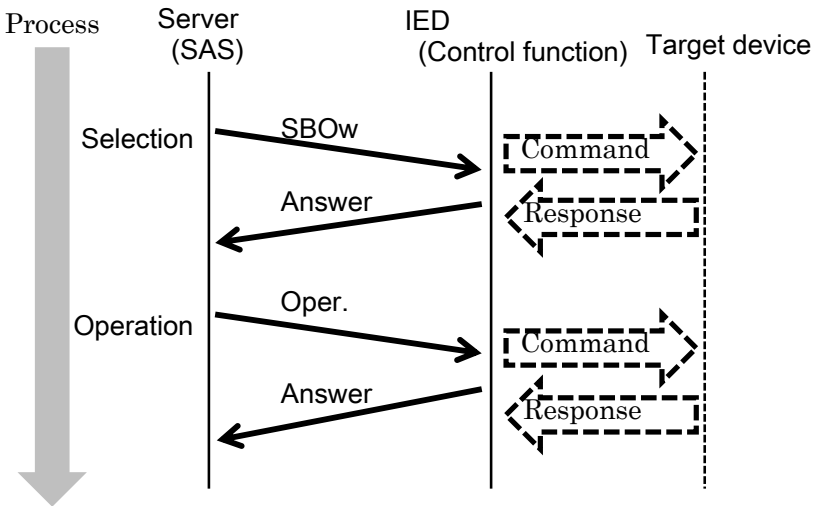


Figure 3.2-2 SBO with normal security

3.2.2 Direct-operation mode (DIR)

In the DIR mode, a target device is controlled without the reception of the select command. An enhanced security mode (**DOes**) is also provided when the user wishes to control a device with additional security rather than the normal level of security experienced with mode (**DOns**) .

(i) DIR with enhanced security (DOes)

Figure 3.2-3 illustrates the server sending the Oper request to the IED; the server receives a response, (answer#1) from the IED. The result is notified when the operation of the target device is complete. The result includes status information; it informs whether the target device has operated normally or not. Note that the control start of the target device is initiated regardless of the state of the target device.

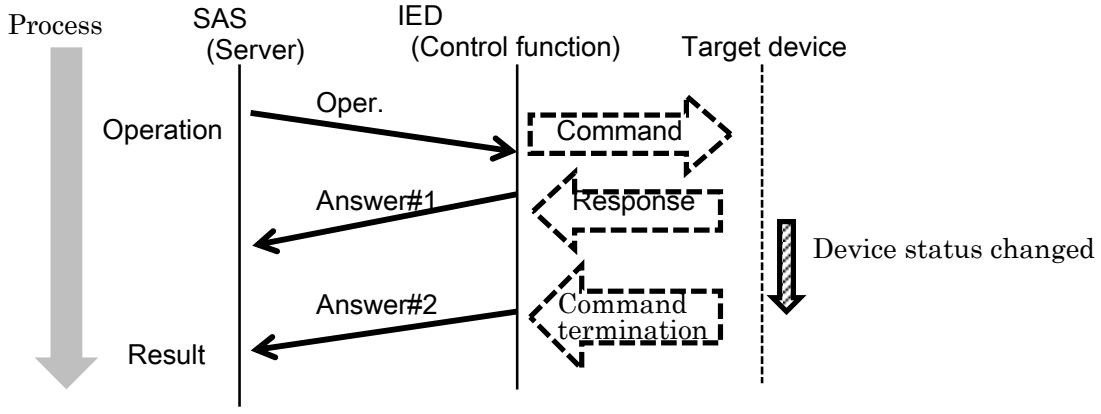


Figure 3.2-3 Direct control with enhanced security

(ii) DIR with normal security (DOns)

A response (answer#2) from the target device is not sent to the SAS in DOns, as shown in Figure 3.2-4.

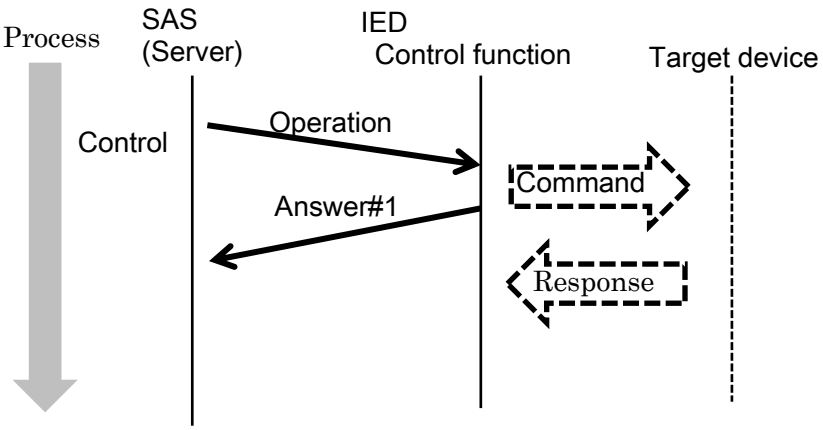


Figure 3.2-4 Direct control with normal security

3.3 Common controls (CMNCTRL)

The CMNCTRL function is designed to act as a mediator to provide a bridge between the control functions.

Note: The implementation of particular features is dependent upon the selection of hardware and the configuration of functions. Several IED models do not support certain features. To determine whether a particular feature has been implemented within an IED, identify the IED ordering number; and check the order number for the "G&T position" whilst referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 3.3-1 Comparative table in respective ordering numbers

Sec.	Feature	Ordering No. at "G&T"				
		10	11	13	19	22
–	Main features	✓	✓	✓	✓	✓

✓: Applicable NA: Not applicable

3.3.1 PLC_BIT/UNIT/BOOL signal

The control and monitoring functions are mutually interconnected within the IED; hence, cascading features are provided to transfer information between them so that the user does not need to check the interconnections. Approximately 1500 signals are included to facilitate the internal connection of the control and monitoring functions; their signals are distributed into BIT, UNIT, BOOLEAN types. Amongst these signals†, approximately 130 are available to the user and can be applied to program an event operation or another function‡. Figure 3.3-1 exemplifies the "PLC_BIT_0201" signal, which can be used for recording events and other purposes.

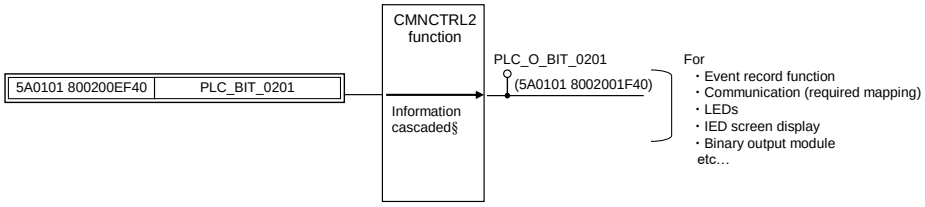


Figure 3.3-1 Cascading information using signal "PLC_BIT_0201"

†Note:The PLC connection points and monitoring points are listed later.

‡Note:Although 130 signals are available for user programming, nonetheless, the PLC function also provides the user with other signals for the same purpose. It is recommended that the user selects the PLC signals provided (i.e., PLC drivers; see chapter *PLC function* for more information).

§Note:The CMNCTRL2 function is used to cascade information between signal processing modules. For more details on the processing module, see chapter *Technical description: Signal processing and communication module.*

Figure 3.3-2 shows the input-points and the output-points. During manufacture, several CMNCTRL2 output-points are connected to the respective control functions. Hence, the user will find that some control functions use the PLC_BIT to import external signals, as shown in Figure 3.3-2.

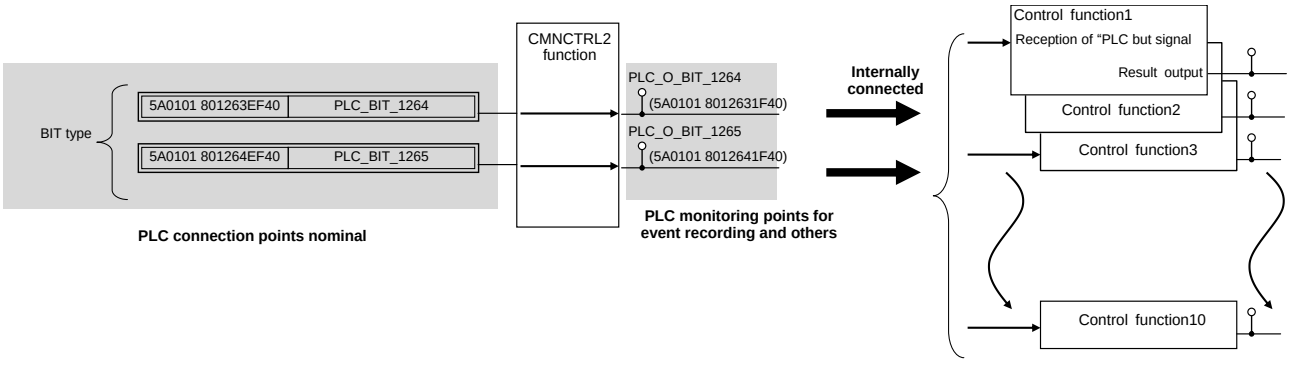


Figure 3.3-2 Mutual connections between CMNCTRL2 and control functions

3.3.2 Provision of selected status

Let us assume that a select-command is sent for an IED to control a target-device by the substation automation system (SAS†), but the target-device is not ready to be controlled. The unready condition might be due to the target-device already being in operation (e.g., CB tripping) or a failure of the device may have occurred; thus, the IED has to drop the select-command. If this occurs, the IED is required to send a message stating the reason to the SAS†. Table 3.3-2 lists the messages generated in the CMNCTRL1 function describing the failure.

Table 3.3-2 Reason messages due to the release of the select-command

Signal Number	Signal Name	Description
5A0001 3008001FB4	SCS_CTLNUM	Reason codes for the SAS†
5A0001 2008001008	SCS_ORCAT	
5A0001 2208001001	SCS_ADDCAUSE	
5A0001 6A08001009	SCS_ORIDENT	
5A0001 3008001FB4	SCS_CTLNUM	

†Note:The user should recognize that the reason messages are only available for operation with the GCS1000 control system manufactured by Toshiba.

3.3.3 Miscellaneous settings

The CMNCTRL1 function has the following five common settings:

1. Control direction: Scheme switch [**SDCEN**] can configure the control directions of the SPOS, DPOS and TPOS functions. If required these functions can be in the same control direction, set **On** for the scheme switch [**SDCEN**].
2. Return value: When the number of the counter reaches its maximum value (in case of the default setting, 999,999), it can return and begin incrementing from either 0 or 1. The return number can be set by [**CNTRV**].
3. Select-cancel timer: If the selection of a target device is made, but the control operation of the selected device is not carried out in a predetermined time limit, the selection is canceled. The time limit can be set using [**TSC**]; the setting range is between 30 and 300 seconds having a 1 second step.
4. Time out: When the selection of the target device and its control execution is made, the selection will be canceled automatically after the setting time [**EXEWAIT**] if the control result is not received at the IED from the target device. The setting time ranges from 30 to 300 seconds in 1 second steps.

5. Counter limit: The maximum value of the counters can be set between 9 and 2,147,483,647 using [**CNTVALMAX**]. The default setting is 999,999.

3.3.4 Setting

CMNCTRL setting list (FunctionID:5A0001)

Setting item		Range	Units	Contents	Default setting value	Notes
CMNCTRL	SDCEN	Off/On	-	Setting of control to the same direction	Off	
	CNTRV	0-1	-	Next value of the counter[**CNTVALMAX**] level	0	
	TSC	30-300	s	Selection cancel time-out timer	30	
	EXEWAIT	30-300	s	Waiting execute operation time-out timer	30	
	CNTVALMAX	9-2147483647	-	Upper limit level of the counter	999999	

3.3.5 Signal

◆ Connection points in bit type

CMNCTRL2 (Function ID: 5A0101)

Element ID	Name	Description
320000EF43	CHK_NMI_M	Main CPU Monitoring Siganal1
320001EF43	CHK_ROMRAM_M	Main CPU Monitoring Siganal2
320002EF43	CHK_SUM_M	Main CPU Monitoring Siganal3
320003EF43	CHK_PROGRAM_M	Main CPU Monitoring Siganal4
320004EF43	CHK_RAM_M	Main CPU Monitoring Siganal5
320005EF43	CHK_ECC_M	Main CPU Monitoring Siganal6
320006EF43	CHK_SAMPLING_M	Main CPU Monitoring Siganal7
320007EF43	CHK_ACC1_M	Main CPU Monitoring Siganal8
320008EF43	CHK_ACC2_M	Main CPU Monitoring Siganal9
320009EF43	CHK_ACC3_M	Main CPU Monitoring Siganal10
320010EF43	CHK_GOOSERCV_M	Main CPU Monitoring Siganal11
320011EF43	CHK_PING1_M	Main CPU Monitoring Siganal12
320012EF43	CHK_PING2_M	Main CPU Monitoring Siganal13
320013EF43	CHK_CMLV_DAT_M	Main CPU Monitoring Siganal14
800000EF40	PLC_BIT_0001	PLC event bit information 1
800001EF40	PLC_BIT_0002	PLC event bit information 2
800002EF40	PLC_BIT_0003	PLC event bit information 3
….	…..	…..
801399EF40	PLC_BIT_1400	PLC event bit information 1400

◆ PLC monitoring points in unit type

CMNCTRL2 (Function ID: 5A0101)

Element ID	Name	Description
310008EF41	PLC_UNIT_9	Free connection point for the user (reserved in 16-bit unsigned integer)
310014EF41	PLC_UNIT_15	Free connection point for the user (reserved in 16-bit unsigned integer)
310015EF41	PLC_UNIT_16	Free connection point for the user (reserved in 16-bit unsigned integer)
310016EF41	PLC_UNIT_17	Free connection point for the user (reserved in 16-bit unsigned integer)
310017EF41	PLC_UNIT_18	Free connection point for the user (reserved in 16-bit unsigned integer)
310018EF41	PLC_UNIT_19	Free connection point for the user (reserved in 16-bit unsigned integer)
310019EF41	PLC_UNIT_20	Free connection point for the user (reserved in 16-bit unsigned integer)

◆ PLC monitoring points in boolean type

CMNCTRL2 (Function ID: 5A0101)

Element ID	Name	Description
000004EF42	PLC_BOOL_5	Free connection point for the user (reserved in boolean)
000006EF42	PLC_BOOL_7	Free connection point for the user (reserved in boolean)
000007EF42	PLC_BOOL_8	Free connection point for the user (reserved in boolean)
000008EF42	PLC_BOOL_9	Free connection point for the user (reserved in boolean)
000009EF42	PLC_BOOL_10	Free connection point for the user (reserved in boolean)
000010EF42	PLC_BOOL_11	Free connection point for the user (reserved in boolean)
000011EF42	PLC_BOOL_12	Free connection point for the user (reserved in boolean)
000012EF42	PLC_BOOL_13	Free connection point for the user (reserved in boolean)

◆ PLC monitoring points in boolean type

CMNCTRL2 (Function ID: 5A0101)

Element ID	Name	Description
000013EF42	PLC_BOOL_14	Free connection point for the user (reserved in boolean)
000014EF42	PLC_BOOL_15	Free connection point for the user (reserved in boolean)

◆ PLC monitoring point in 32 bit unsigned type

CMNCTRL2 (Function ID: 5A0101)

Element ID	Name	Description
320014EF43	PLC_UNIT32_15	Free connection point for the user (reserved in 32bit unsigned)
320015EF43	PLC_UNIT32_16	Free connection point for the user (reserved in 32bit unsigned)
320016EF43	PLC_UNIT32_17	Free connection point for the user (reserved in 32bit unsigned)
320017EF43	PLC_UNIT32_18	Free connection point for the user (reserved in 32bit unsigned)
320018EF43	PLC_UNIT32_19	Free connection point for the user (reserved in 32bit unsigned)
320019EF43	PLC_UNIT32_20	Free connection point for the user (reserved in 32bit unsigned)

◆ Monitoring points in PLC logic in bit type

CMNCTRL2 (Function ID: 5A0101)

Element ID	Name	Description
8000001F40	PLC_O_BIT_001	PLC event bit output 1
8000011F40	PLC_O_BIT_002	PLC event bit output 2
8000021F40	PLC_O_BIT_003	PLC event bit output 3
8000031F40	PLC_O_BIT_004	PLC event bit output 4
8000041F40	PLC_O_BIT_005	PLC event bit output 5
……	……	……..
8013981F40	PLC_O_BIT_1399	PLC event bit output 1399
8013991F40	PLC_O_BIT_1400	PLC event bit output 1400

◆ Monitoring points in PLC logic

CMNCTRL2 (Function ID: 5A0101)

Element ID	Name	Description
0000001F42	PLC_O_BOOL_1	PLC event boolean output 1
0000011F42	PLC_O_BOOL_2	PLC event boolean output 2
0000021F42	PLC_O_BOOL_3	PLC event boolean output 3
0000031F42	PLC_O_BOOL_4	PLC event boolean output 4
0000041F42	PLC_O_BOOL_5	PLC event boolean output 5
0000051F42	PLC_O_BOOL_6	PLC event boolean output 6
0000061F42	PLC_O_BOOL_7	PLC event boolean output 7
0000071F42	PLC_O_BOOL_8	PLC event boolean output 8
0000081F42	PLC_O_BOOL_9	PLC event boolean output 9
0000091F42	PLC_O_BOOL_10	PLC event boolean output 10
……	……	……..
0000141F42	PLC_O_BOOL_15	PLC event boolean output 15

3.4 Local, remote and PLC control

The user can select either local or remote control by pressing the L | R key on the front panel of the IED. Selection is executed within the LOCRMT function. Control logic is provided by default, but the user can customize each application using the PLC function and PLC connection points. Generally, the LOCRMT function is applied within all IEDs. Figure 3.4-1 shows the LOCRMT logic. Note that the LOCRMT function changes for the remote control unconditionally if the operation/function keys on the front panel are not touched within 35 minutes in the local control.

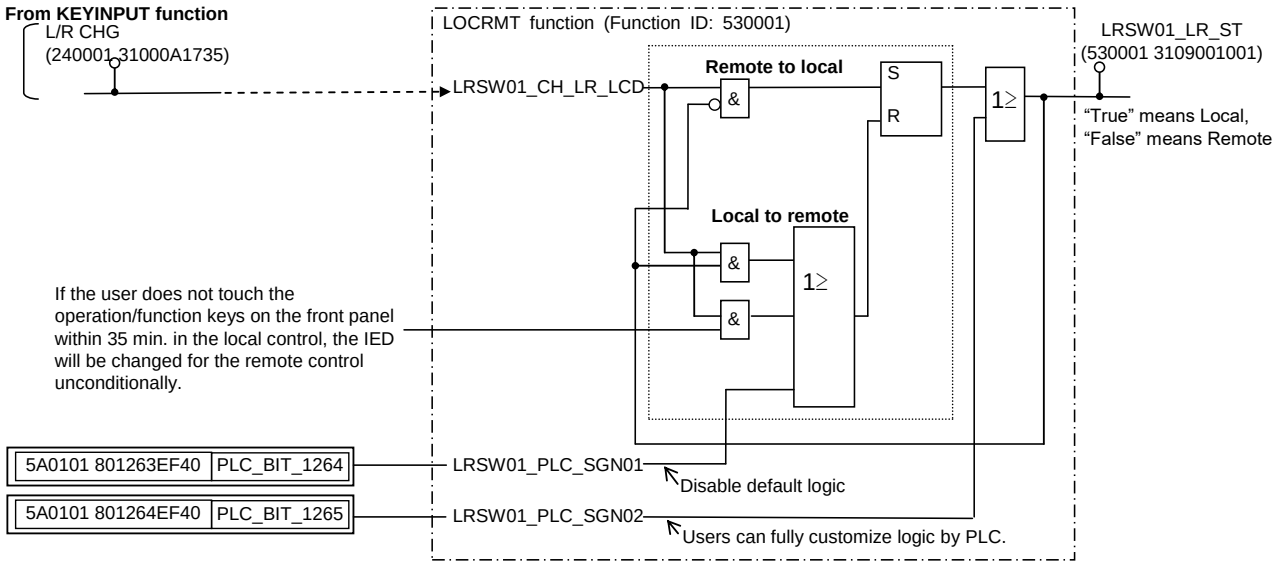


Figure 3.4-1 LOCRMT logic

Note: The implementation of particular features is dependent upon the selection of hardware and the configuration of functions. Several IED models do not support certain features. To determine whether a particular feature has been implemented within an IED, identify the IED ordering number; and check the order number for the "G&T position" whilst referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 3.4-1 Comparative table in respective ordering numbers

Sec.	Feature	Ordering No. at "G&T"				
		10	11	13	19	22
–	Main features	✓	✓	✓	✓	✓

✓: Applicable NA: Not applicable

3.4.1 Local control

Local control refers to control operation from the front panel of the IED. Either the DIR or the SBO modes are available depending on the configuration selected by the user.

3.4.2 Remote control

Remote control refers to control operation from a remote control center or the SAS server. Either the DIR or the SBO modes are available depending on the configuration selected by the user. Note that the parameters used in the control commands are defined in international standards†. The parameter details are provided in the communication profiles. (See Chapter *Communication protocol and Appendices*)

†Note: As a rule, the control commands have parameters. For example, the "Off to On" and "On to Off" control directions that are used in commands are pre-configured as parameters in the communication protocol. Note that the parameters vary depending upon the respective protocol used, such as IEC61850, Modbus and others. For IEC61850, Table 3.4-2 shows the parameters defined: the rule for control direction can be found in "ctlVal", the command publisher is recognized using the parameter "origin". For more information about the parameters, see Appendix *IEC61850 MICS, PICS, PIXIT and TICS*.

Table 3.4-2 Defined command parameters in IEC61850-7-2

Parameter Types	Descriptions
ctlVal	Control direction (On or Off)
origin	Indicates the command publisher
ctlNum	Sequential Number
T	Time that the command is sent
Test	Test information (Test/On)
Check	Interlock synchronizing

3.4.3 Programmable logic control (PLC)

The programmable logic control, (PLC) function can be used to provide user-preferred control schemes. Several control functions have connection points to enable connections to be made to the PLC function; they can be used to create user-preferred control schemes. It is necessary for the user to program the PLC logic that will be used for the particular connection. Users need to apply the automatic sequence control (ASEQ) function in order to initiate the user-preferred control scheme, as shown in Figure 3.4-2. For more details on PLC programming, refer to the Chapter *PLC function*.

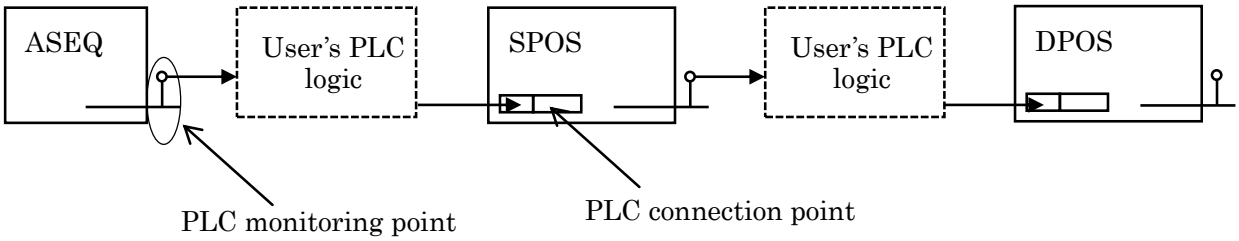


Figure 3.4-2 Example of user-preferred control scheme using PLC user logic

Note: The user-preferred control scheme implemented by users can only be operated in the DIR mode.

3.4.4 Signal for Local/Remote control

Note: The meaning of the following references are used in the column "M/O" in Table 3.4-3 and Table 3.4-4:

"O" means the signal is optional.

"M" means the user should map/set/configure the signal; otherwise, the user may experience an operational failure if the default settings are used.

"N/A" means that the user cannot change the state of the signal.

Table 3.4-3 PLC connection point (Input point for LOCRMT)

Signal Number	Signal Name	Description	M/O
240001 31000A1735	L/R CHG	[L/R] key "push"	N/A
5A0101 801263EF40	PLC_BIT_1264	Disable condition by PLC	O
5A0101 801264EF40	PLC_BIT_1265	User configurable condition by PLC	O

Table 3.4-4 Mapping points for LOCRMT

Signal Number	Signal Name	Description	M/O
530001 3009011008	LRSW01_LR_ORCAT	Mapping data for "originator" in IEC61850	N/A
530001 6A09011009	LRSW01_LR_ORIDENT	Mapping data for "originator" in IEC61850	N/A

Table 3.4-5 PLC monitoring point (LOCRMT)

Signal Number	Signal Name	Description
530001 3109001001	LRSW01_LR_ST	Local(T) / Remote(F) status (single bit expression)
530001 3009011001	LRSW01_LR_ST_RMT	Local(0x40) / Remote(0x80) status (double bit expression)

3.5 LED reset function (LEDR)

A number of LEDs are lined on the IED front panel. For example, "TRIP" LED is lit when a tripping command is issued for the CB. "TRIP" LED is being illuminated until the user can confirm the tripped CB; hence, the user can reliably determine that tripping CB has been initiated by inspection. The following operations are possible to resetting the LED by the LED reset (LEDR) function, which is furnished in the IED:

1 Pushing "CLEAR" key[1]

2 Operation by GR-TIEMS[2]

3 Operation by the SAS

[1]Note: For the operation, see Chapter *User interface: Outline*. Note that pressing the "CLEAR" key causes the Reset of the LEDs.

[2]Note: For more information, see Chapter *Engineering tool.*

Note: The implementation of particular features is dependent upon the selection of hardware and the configuration of functions. Several IED models do not support certain features. To determine whether a particular feature has been implemented within an IED, identify the IED ordering number; and check the order number for the "G&T position" whilst referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 3.5-1 Comparative table in respective ordering numbers

Sec.	Feature	Ordering No. at "G&T"				
		10	11	13	19	22
–	Main features	✓	✓	✓	✓	✓

✓: Applicable NA: Not applicable

3.5.1 Select logic for resetting LEDs

The user should set scheme switch [**LEDDR1**] to **On** prior to the LEDR operation. Figure 3.5-1 shows selection logic in the LEDR function.

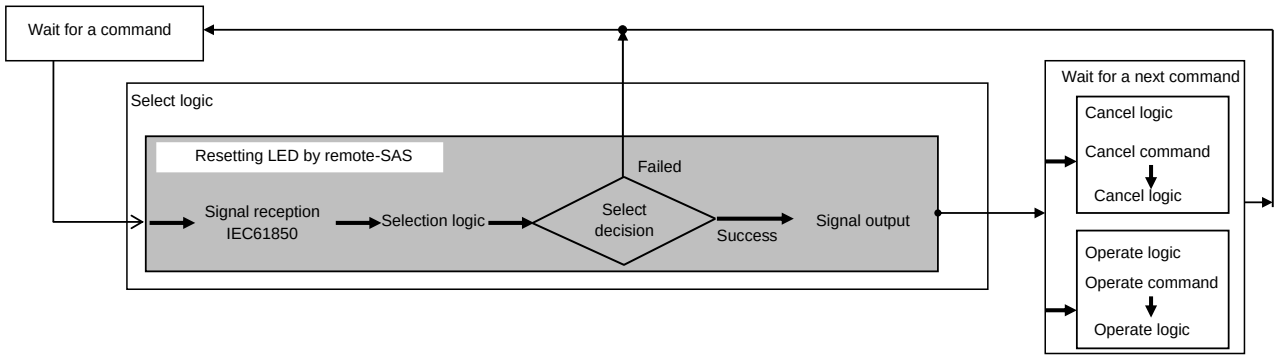


Figure 3.5-1 Outline of selection command for resetting LEDs

(i) Input signal required mapping

Figure 3.5-2 shows the select logic when a "Select command (reset)" signal is applied to the LEDR function. The logic has an input-point "LEDR01_CONTROL_REQ" for the reception; the input-point must be mapped for IEC61850 communication. The function will fail to operate if mapping is not performed correctly. We will discuss how to map the input points for the IEC61850 communication in section 3.5.5.

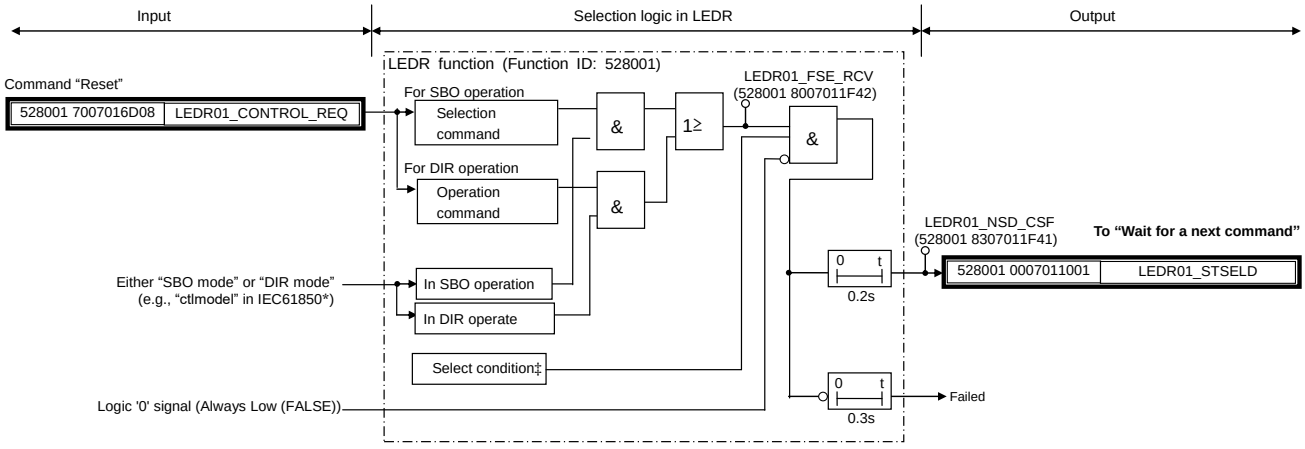


Figure 3.5-2 Selection logic for resetting LEDs

‡Note: A "select condition" signal is provided from the select condition scheme. For more information, see Figure 3.5-8.

*Note: The LEDR function can run on either "the SBO mode" or "the DIR mode" using a "ctlmodel" signal when the communication is carried out in the IEC61850; thus, mapping is required for the IEC61850 communication.

(ii) Output signal required mapping

The LEDR function can issue a "Select success" signal at the output point "LEDR01_NSD_CSF", when the LEDR function determines that the input signal "Select

command (reset)" is true. If the LEDR function determines that the "LEDR01_NSD_CSF" is not true, the LEDR function returns to the "Wait for a next command" stage.

(iii) Select condition

Figure 3.5-3 shows the select condition logic in the LEDR function.

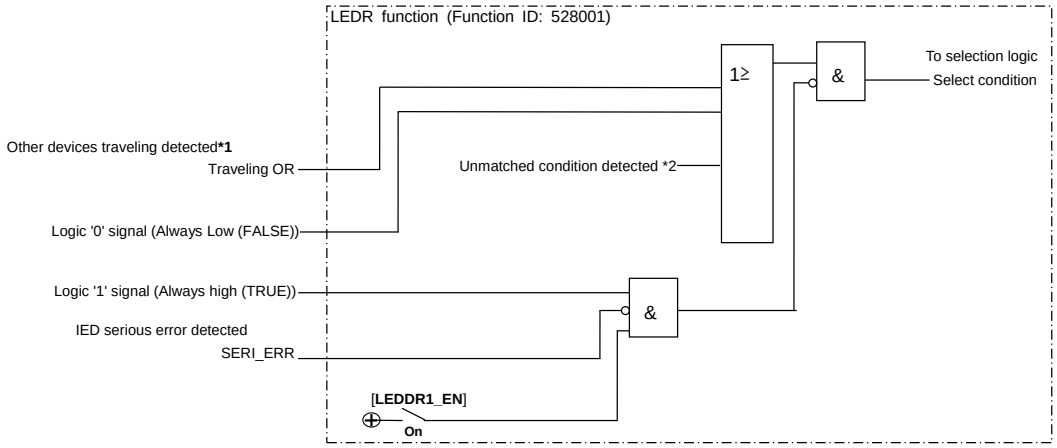


Figure 3.5-3 Select condition logic in LEDR*4

*1Note: If the event "device-travelling" is detected in the CMNCTRL function, it indicates that another operator is changing the status of a device. Thus, the IED should inhibit the operation of any device for the duration that the event is detected. The detecting signal is denoted as "Traveling OR" in Table 3.5-2.

*2Note: Criteria "unmatched conditions" are decided when the "Test-bit status" in a command is not identical to the "IED test status".

*3Note: To identify the input point of the LEDR function, see Table 3.5-2.

Table 3.5-2 Input signals for condition logic

Signal Number	Signal Name	Description	M/O
5A0001 0008001F40	Traveling OR	Travelling events are detected.	N/A
5A0101 3100001F43	SERI_ERR	Serious Error detected	N/A

Table 3.5-3 Setting of LEDR

Setting Name	Description	Default	Setting item or value
LEDDR1_EN	Activate LED reset control	On	Off / On

3.5.2 Cancel logic in SBO mode

In the SBO mode the reception of a cancel command is possible when the cancel conditions are satisfied. Accordingly, the function can discard the select command; finally, the operation returns to the initial stage (i.e., "Wait for a command".)

(i) Receiving "Cancel" from the remote-end

Figure 3.5-4 depicts the cancel command procedure for a cancel command initiated from the remote-end.

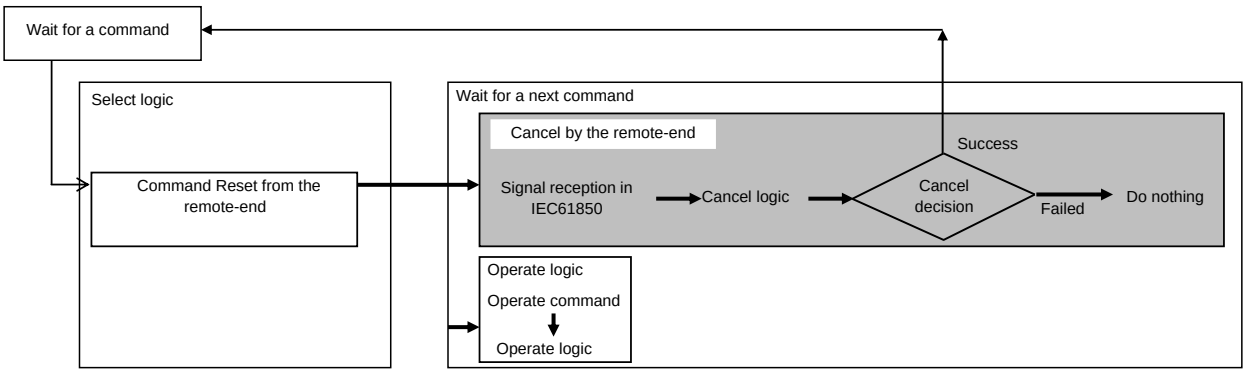


Figure 3.5-4 Outline of 'cancel' command from the remote-end

(ii) Input signal required mapping

Figure 3.5-6 depicts the cancel logic when a "Cancel command (Remote-Cancel)" signal is applied to the LEDR function. The input-point "LEDR01_CONTROL_REQ" is the same the same as that for the signal as shown in Figure 3.5-2.

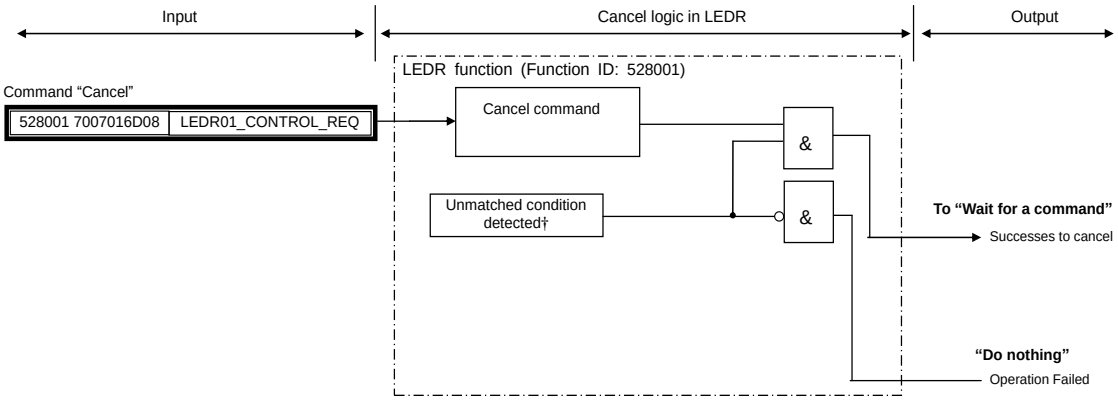


Figure 3.5-5 'Cancel' from the remote-end

†Note:The criteria "unmatched conditions" are determined when the "Test-bit status" in a command is not identical to the "IED test status".

3.5.3 Operate logic for SBO/DIR mode

Once the operation of the select logic is completed, the operate logic is applied to reset LEDs. Resetting LEDs is executed when the operate conditions are satisfied.

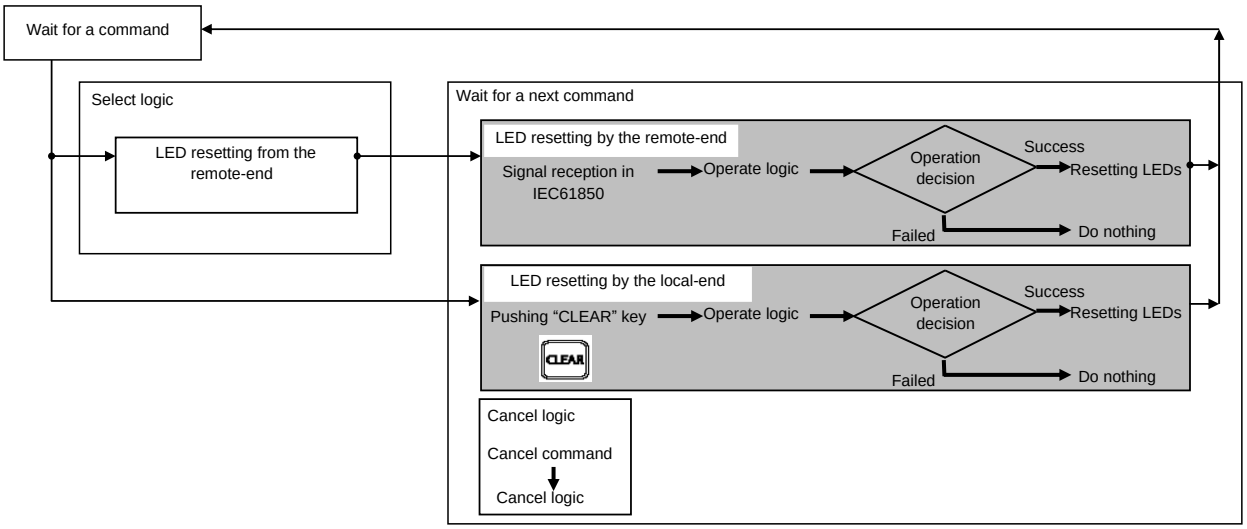


Figure 3.5-6 Outline of operation command for resetting LEDs

†Note: For more information, see Chapter *User interface: Outline*.

(i) Mapping required Input signal

Figure 3.5-7 illustrates the operate logic when an "Operation command (reset)" signal is applied to the LEDR function. The input-point "LEDR_CONTROL_REQ" is used for the reception of the "Operation command (reset)" signal. Pressing "CLEAR" key or the operation on GR-TIEMS will reset LEDs.

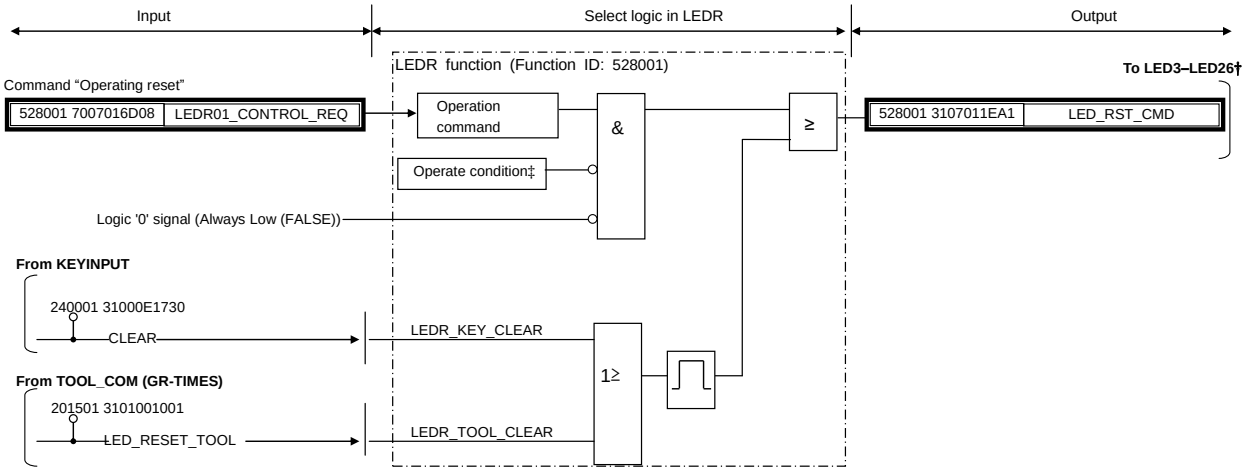


Figure 3.5-7 Operation logic for resetting LEDs

(ii) Output signal required mapping

The operation logic issues a "LED_RST_COM" signal to clear the LEDs†. The signal "LED_RST_COM" is also transferred to the remote-end, when signal mapping is executed in IEC61850 communication. (See section 3.5.5)

†Note: Although the "LED_RST_COM" signal is connected previously with several LEDs, by the manufacturer, user can also connect the signal with the LEDs. See section 3.5.4 for how to connect.

(iii) Operate condition

Figure 3.5-8 shows the operate condition logic of the LEDR function, which is used to determine a reset-condition for the operation.

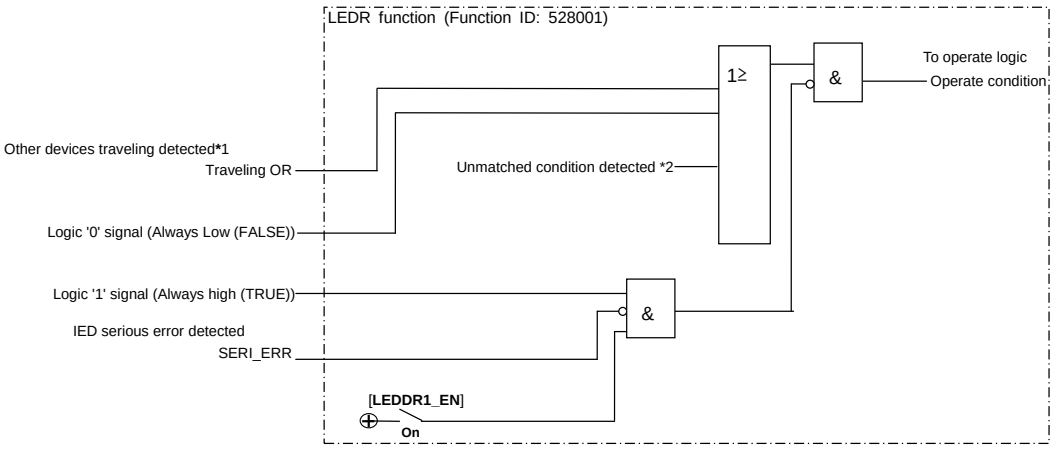


Figure 3.5-8 Operate condition logic in LEDR

*1Note: If the event "device-travelling" is detected in the CMNCTRL function, it indicates that another operator is changing the status of a device. Thus, the IED should inhibit the operation of any device for the duration that the event is detected. The detecting signal is denoted as "Traveling OR" in Table 3.5-2.

*2Note: Criteria "unmatched conditions" are decided when the "Test-bit status" in a command is not identical to the "IED test status".

3.5.4 Settings in LED logics

The user can program the status and the signal of the LED, so that the LEDs are possible to switch off upon occurrence of the reset. As shown in the logic relating to the LED†, each logic has a timer and a setting; accordingly, setting **Latch** should be set for the operation of the LEDR function. Additionally, the user should connect the signal LED_RST_CMD with the LED logic.

†Note: For more information on LED logics, see Chapter *Technical description: Human machine interface: LED indicators*.

(i) Settings using GR-TIEMS

Figure 3.5-9 shows how to connect the reset signal LED_RST_CMD for the LED-03 logic. The user can assign a reset signal for the respective LED logics by the drag and drop operation. The user should also select **Latch** for the behavior from the pull-down menu.

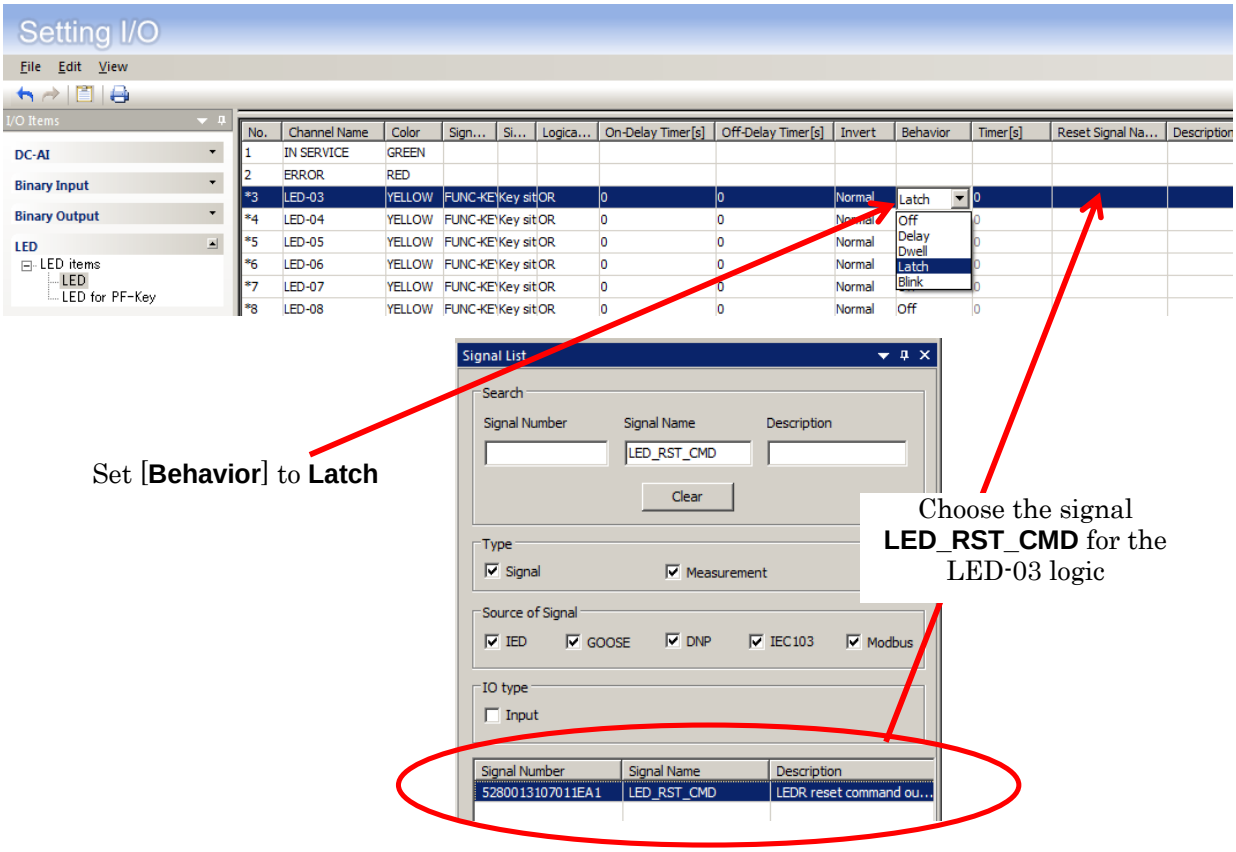


Figure 3.5-9 Settings for LED-03 circuit provided by "Setting I/O menu" of GR-TIEMS

(ii) Settings using IED screen

The operation from the IED screen can also be set. See Chapter *User interface: I/O setting sub-menu*.

3.5.5 Mapping for IEC61850 communication

The user can operate the LEDR function over IEC 61850 communication following mapping using GR-TIEMS. Note that the LEDR function is designed for "LEDRs" in the IEC 61850 standard for communication. The user should follow these steps, each of which is discussed below:

Step1: Editing Logical Node

Step2: Mapping output data

Step3: Mapping input data

(i) Editing Logical Node

The user will need to create a logical node (LN) for the LEDR function. Figure 3.5-10 exemplifies the editing of a LN; the LN "logical node zero (LLN0)" is chosen for the LERD function. Either the SBO mode or the DIR mode should be chosen in the editing for the LN.

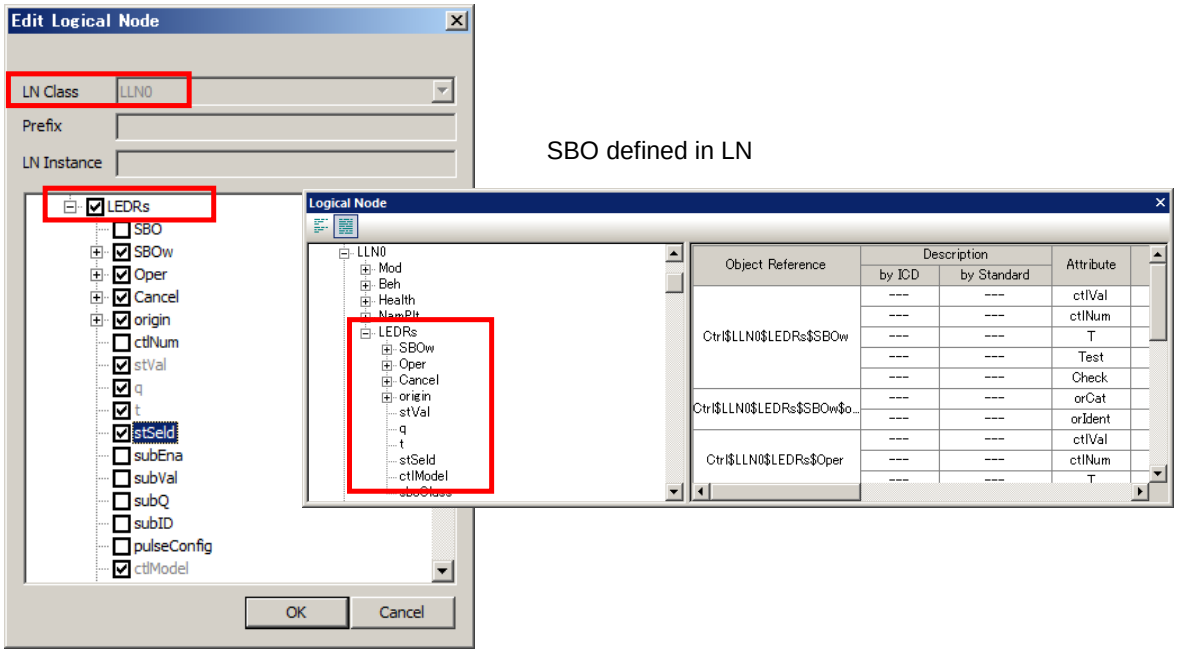
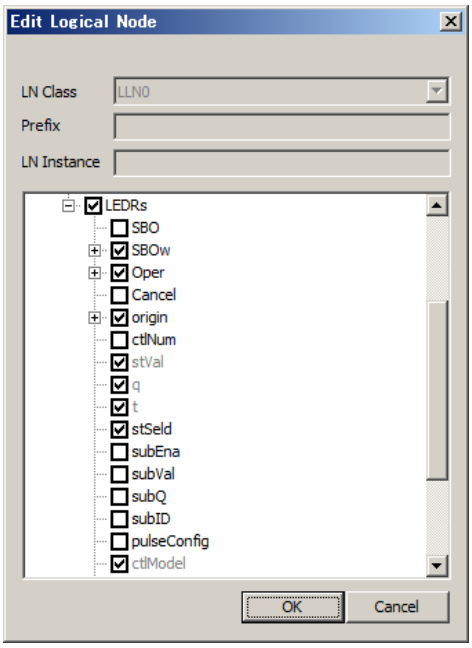


Figure 3.5-10 Defining "LEDRs" object in LLN0 logic node

(i)-1 Defining SBO mode

Figure 3.5-11 exemplifies the LEDR logic node saved as "LLN0". In the SBO mode, the user should select the following items in the "LLN0$LEDRs" using GR-TIEMS:



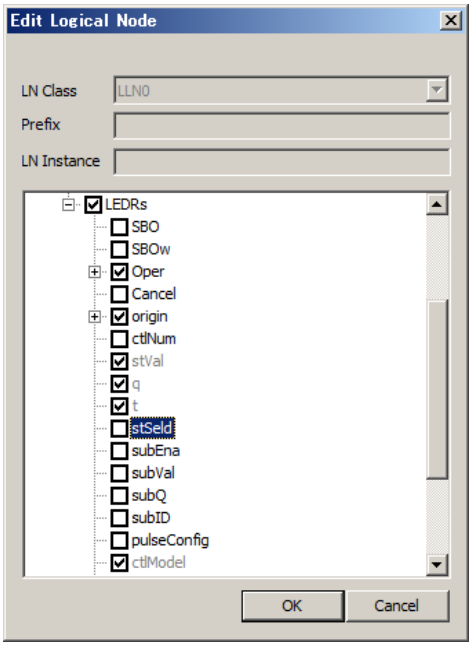
- ✓ SBOw
- ✓ Oper
- ✓ Cancel
- ✓ Origin
- ✓ stSeld
- ✓ sboClass† (choice ”operate-once”)
- ✓ ctlmodel (choice ”SBOes or SBOns”)

†”sboClass” can be found by scrolling down.

Figure 3.5-11 LN editing for SBO mode (for example)

(i)-2 Defining DIR mode

Figure 3.5-12 exemplifies the LEDR logic node saved as LLN0. In the DIR mode, the following three items should be selected using GR-TIEMS:



- ✓ Oper
- ✓ origin
- ✓ ctlmodel (choice ”DOes or DOns”)

Figure 3.5-12 LN editing for DIR mode (for example)

(ii) Mapping output data

The user should group the LEDR signals with regard to GOOSE and Report; the user should map them for IEC61850 communication using GR-TIEMS. Figure 3.5-13 illustrates how to map a signal for IEC61850 communication; it indicates that the signals for the LEDR function

are required to be mapped for IEC 61850 communication

Table 3.5-4 Mapping signals for SPC object

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/LLN0$LEDRs$origin	orCat	orCategory	ST	5280013107011008	LEDR01_ORCAT
Ctrl/LLN0$LEDRs$origin	orIdent	Octet64	ST	5280016A07011009	LEDR01_ORIDENT
Ctrl/LLN0$LEDRs	stVal	BOOLEAN	ST	5280013107011EA1	LED_RST_CMD
Ctrl/LLN0$LEDRs	q	Quality	ST	3010013110041005	Qual_Val
Ctrl/LLN0$LEDRs	t	Timestamp	ST	2003019010001006	SYS_TIME
Ctrl/LLN0$LEDRs	stSeld	BOOLEAN	ST	5280010007011001	LEDR01_STSELD

Note: "Status (ST)" is defined in the function constraint (FC) of the IEC 61850.

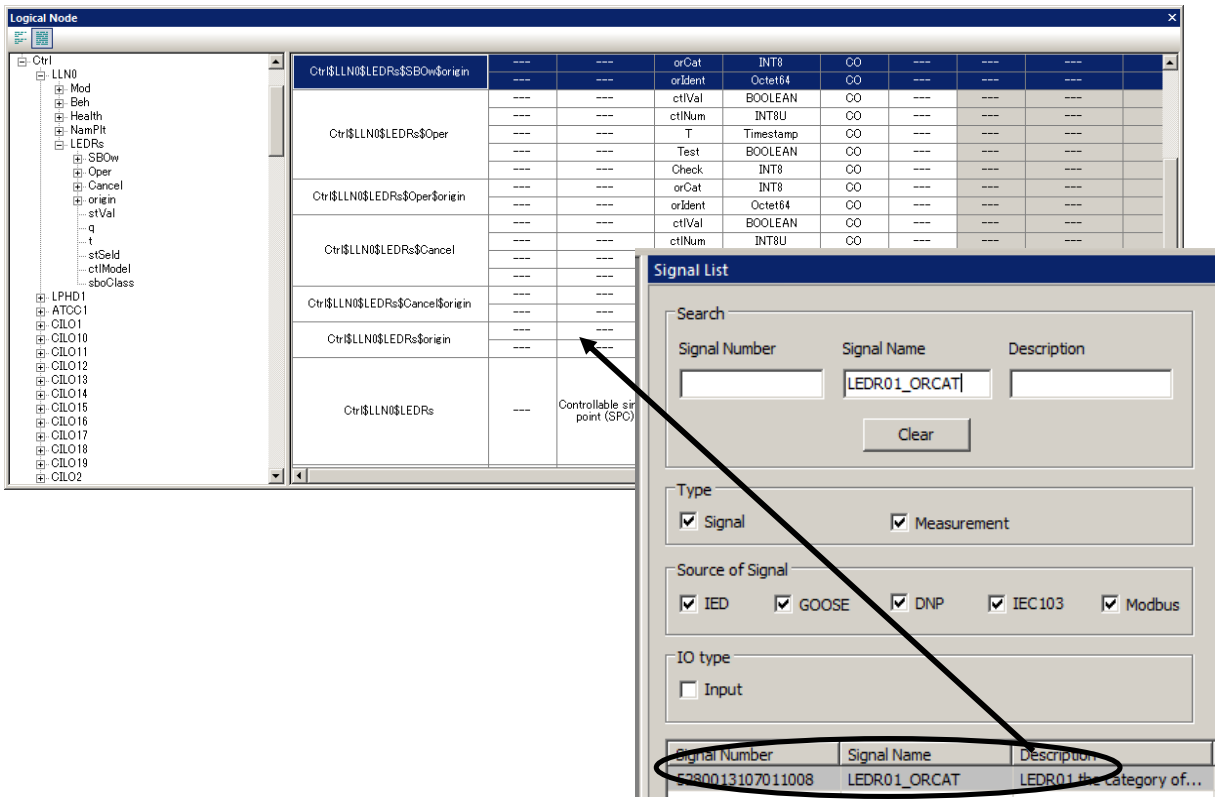


Figure 3.5-13 orCat attribute mapped for LEDRs object of LLN0

(iii) Mapping input data

The LEDR function can receive three commands "select, operate, and cancel". Thus, the user should map the input-point "LED01_CONTROL_REQ" to the IEC61850 communication. Table 3.5-5 shows the input-point "LED01_CONTROL_REQ" and the Object reference "Ctrl/LLN0$LEDRs"; the user should map the input-point to the Object references having attributes CO and CF†. Figure 3.5-14 shows how to map a signal.

†Note: The attribute is defined in the IEC 61850; "CO" stands for "Control" and "CF" stands for "Configuration" in the functional constraint (FC).

Table 3.5-5 Mapping signals required for LEDRs object for LLN0

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/LLN0$LEDRs$Oper	ctlVal	BOOLEAN	CO	5280017007016D08	LEDR01_CONTROL_REQ
Ctrl/LLN0$LEDRs$Oper	ctlNum	INT8U	CO		
Ctrl/LLN0$LEDRs$Oper	T	Timestamp	CO		
Ctrl/LLN0$LEDRs$Oper	Test	BOOLEAN	CO		
Ctrl/LLN0$LEDRs$Oper	Check	Check	CO		
Ctrl/LLN0$LEDRs$Oper$origin	orCat	orCategory	CO		
Ctrl/LLN0$LEDRs$Oper$origin	orIdent	Octet64	CO		
Ctrl/LLN0$LEDRs	ctlModel	ctlModel	CF		
Ctrl/LLN0$LEDRs	sboClass	sboClass	CF		

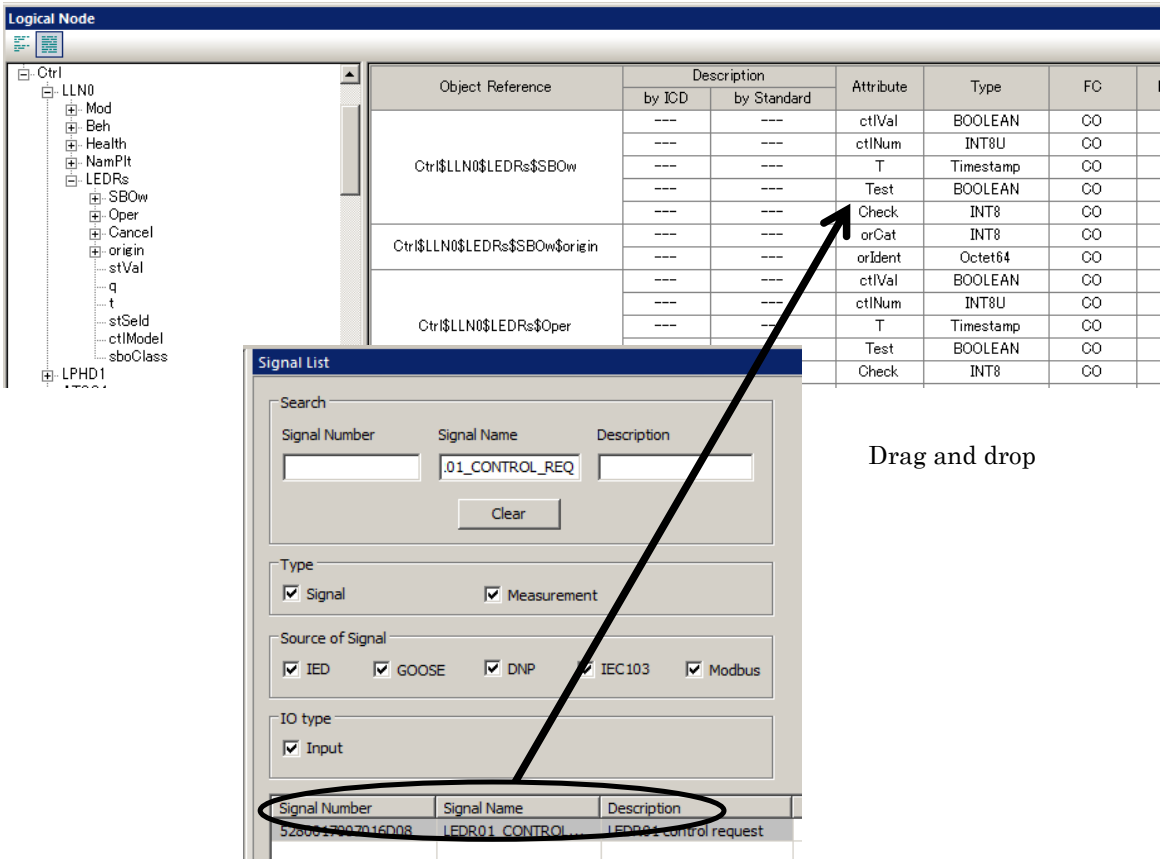


Figure 3.5-14 Input-point mapped for LLN0

3.5.6 Setting

Setting of LEDR (Function ID: 528001)

Setting item	Range	Units	Contents	Default setting value	Notes
LEDDR1-EN	Off / On	-	LEDR01 Reset Control Enable	Off	

3.5.7 Signal

◆ Signal monitoring points

LRST(Function ID: 528001)

Element ID	Name	Description
5280018007011D53	LEDR01_SC	LEDR01 select command
5280018007011D57	LEDR01_EC	LEDR01 execute command
5280018007011D51	LEDR01_SC_OWS	LEDR01 select command by OWS(HMI)
5280018007011D52	LEDR01_SC_RCC	LEDR01 select command by RCC
5280018007011D55	LEDR01_EC_OWS	LEDR01 execute command by OWS(HMI)
5280018007011D56	LEDR01_EC_RCC	LEDR01 execute command by RCC
5280018207011F40	LEDR01_TMP1	LEDR01 signal before KC_LEDR_SA001
5280018307011F41	LEDR01_NSD_CSF	LEDR01 signal after KC_LEDR_SA001
5280018007011F42	LEDR01_FSE_RCV	LEDR01 signal before LC_LEDR_SA002
5280018607011F43	LEDR01_TMP2	LEDR01 signal after KC_LEDR_SA002
5280018B07011F44	LEDR01_CTR_SGU	LEDR01 signal before KC_LEDR_SC001
5280018607011F45	LEDR01_TMP3	LEDR01 signal after KC_LEDR_SC001
5280018607011F46	LEDR01_SLF_FCT_FLG1	LEDR01 signal before MCTLEDR_SC001
5280018E07011F47	LEDR01_SLD_TM0	LEDR01 signal after MCTLEDR_SC001
5280018707011F48	LEDR01_SLF_FCT_FLG2	LEDR01 signal before MCTLEDR_SC002
5280018F07011F49	LEDR01_EX_CMP_TM0	LEDR01 signal after MCTLEDR_SC002

◆ Connection point in PLC logic

LRST(Function ID: 528001)

Element ID	Name	Description
820701ED50	LEDR01_CTRL_RIGHT	LEDR01 control right from PLC

3.6 Counter function for the general (GCNT)

When a signal is generated and it is received by the generic counter function (GCNT), the GCNT function can count the transition of signals. For example, as shown in Figure 3.6-1, a signal is issued repeatedly and if it is required that the number of signals is reported, the GCNT function is able to count the number of signal transitions and report them. When an object is in a device state, a binary input-circuit (BI) is provided to receive the signal.

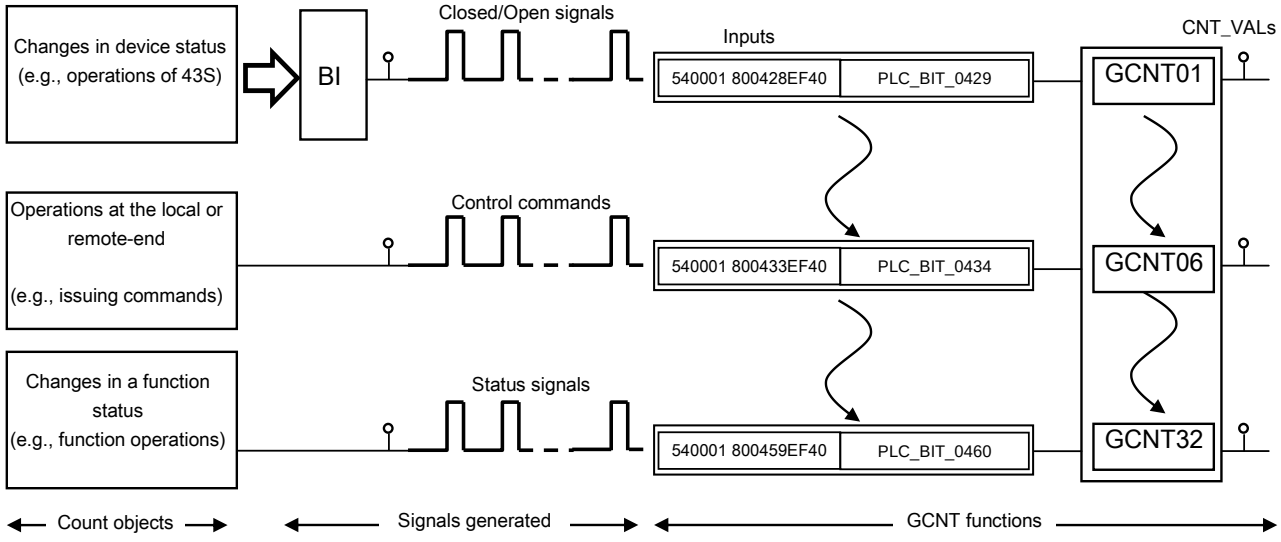


Figure 3.6-1 Reception of signals at the GCNT functions

Note: The implementation of particular features is dependent upon the selection of hardware and the configuration of functions. Several IED models do not support certain features. To determine whether a particular feature has been implemented within an IED, identify the IED ordering number; and check the order number for the "G&T position" whilst referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 3.6-1 Comparative table in respective ordering numbers

Sec.	Feature	Ordering No. at "G&T"				
		10	11	13	19	22
–	Main features	✓	✓	✓	✓	✓

✓: Applicable NA: Not applicable

Signal acquisition timing must be adjusted in accordance with the application, in that the acquisition should be regulated for the nature of the signal; hence, several settings are provided in the GCNT functions. Thirty-two independent GCNT counters† are available. That is, counters GCNT01 to GCNT32† can operate simultaneously. The values counted are stored in the non-volatile memory so that they are not erased if the power supply to the IED is interrupted.

†Note: The number of counters provided in GCNT functions depends on the model. Several models are limited to having a couple of counters.

For simplicity, only the GCNT01 function is discussed; the features in the remaining GCNT02–GCNT32 functions are identical to the GCNT01 function.

3.6.1 Counter setting for a signal

(i) Setting for count timing

In the GCNT01 function count timing is grouped into three, as shown in Figure 3.6-2 (a, b, and c). When the user wishes to count the On(Closed), set **On** for the scheme switch [**GCNT01-CNTS**]; conversely, set **Off** for the scheme switch when the Off(Open) is to be counted. Additionally, **OnOff** is provided for counting the number of pulses. If the GCNT01 function is not required, set **NA** for the scheme switch.

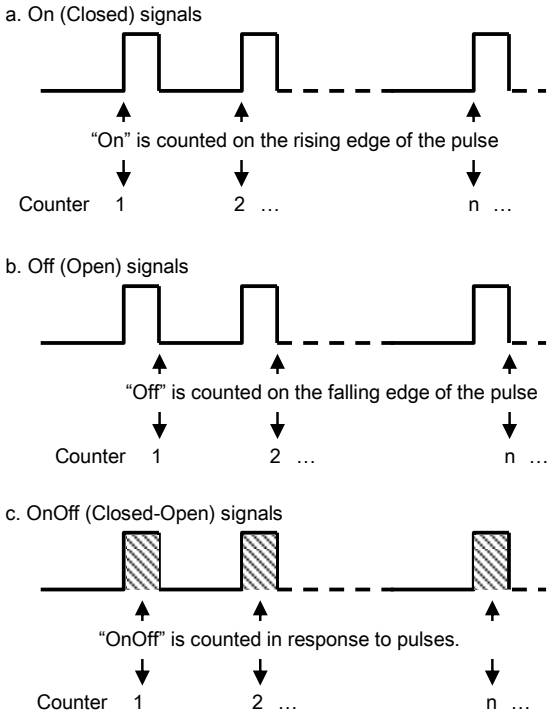


Figure 3.6-2 Count types

(ii) Setting the maximum value

The GCNT01 function is able to count to 2147483647 (=$2^{31}-1$). When the count-value reaches the value "2147483647", the count-value returns to an initial-value. If the user wishes to set a different maximum number in place of "2147483647", the user can use the setting [**GCNT01-CNTMAX**] and set a user-preferred value. Note that the user can set the maximum number from 9 to 2147483647.

(iii) Setting the initial-value

The counter returns to an initial-value when the counter reaches the maximum value; generally, the initial-value is set to either zero or one (0 or 1); hence, the number is re-counted from either "0 (or 1)" following the maximum value. If the user wishes to set an alternative initial number, setting [**GCNT01-CNTRV**] can be used. Note that the user can select the initial-value from zero (0) to 999999.

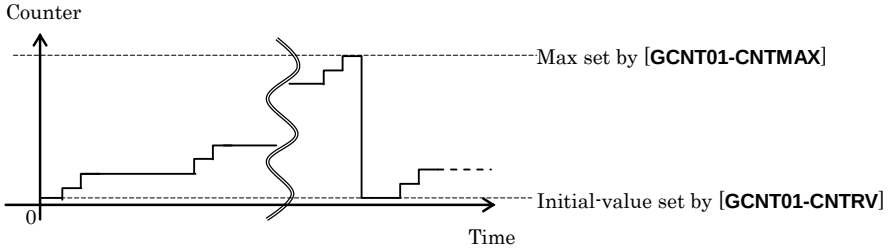


Figure 3.6-3 Maximum-value and initial-value

(iv) Setting for the report (Dead band)

The counter-value can be reported to the remote-end; the user can set the report-timing using the setting [**GCNT01-SDB**]. For example, if the counter-value is to be reported for every change, the user should set **0** for the setting [**GCNT01-SDB**]. When five(5) is set for the [**GCNT01-SDB**], reporting is performed when the counter has incremented by six(6) following the previously reported counter-value.

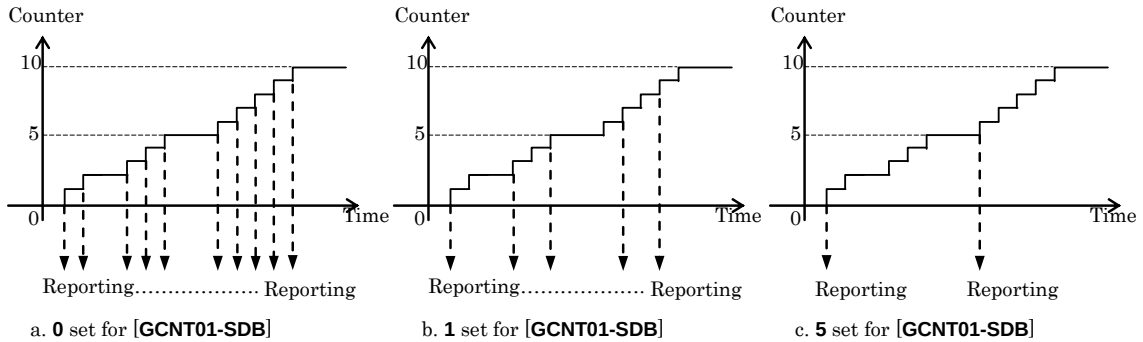


Figure 3.6-4 Counter value and report timing

3.6.1 Select logics for SBO/DIR modes

The user should set scheme switch [**GCNT01-EN**] to **On** prior to counting.

(i) Receiving "Select command Reset" from the remote-end

Figure 3.6-5 outlines the reception of the Select command 'Reset' from the remote-end.

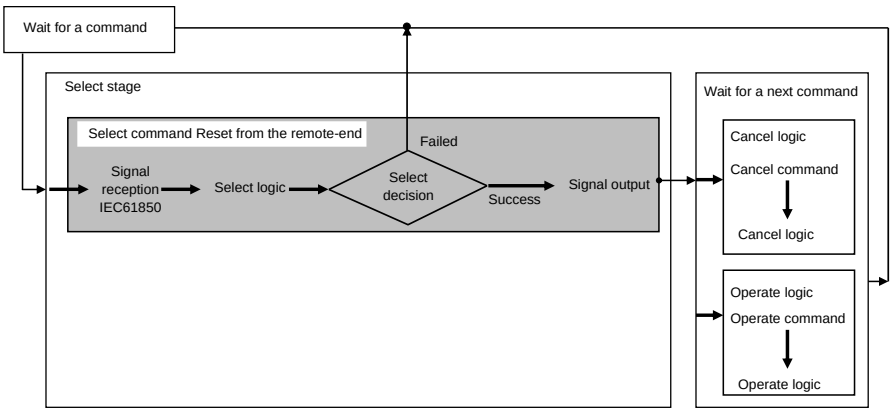


Figure 3.6-5 Outline of Select command 'Reset'

(i)-1 Input point required mapping

Figure 3.6-6 shows the select logic when a "Select command Reset (Remote-Reset-Control)" signal is applied to the GCNT01 function. The logic has an input-point "GCNT01_CMM_REQ" for the reception of the select command. That is, the input-point must be mapped for IEC61850 communication. The function will fail to operate if mapping is not performed correctly. We will discuss how to map the input-points for IEC61850 communication in section 3.6.4.

(i)-2 Output signal to BO

The GCNT01 function can issue a "Complete" signal at the output point "GCNT01_SLD_CSCN", when the GCNT01 function determines that the input signal "Remote-Reset-Control" is true. If the GCNT01 function determines that the "Remote-Reset-Control" is not true, the GCNTS01 function returns to the "Wait for a command" stage.

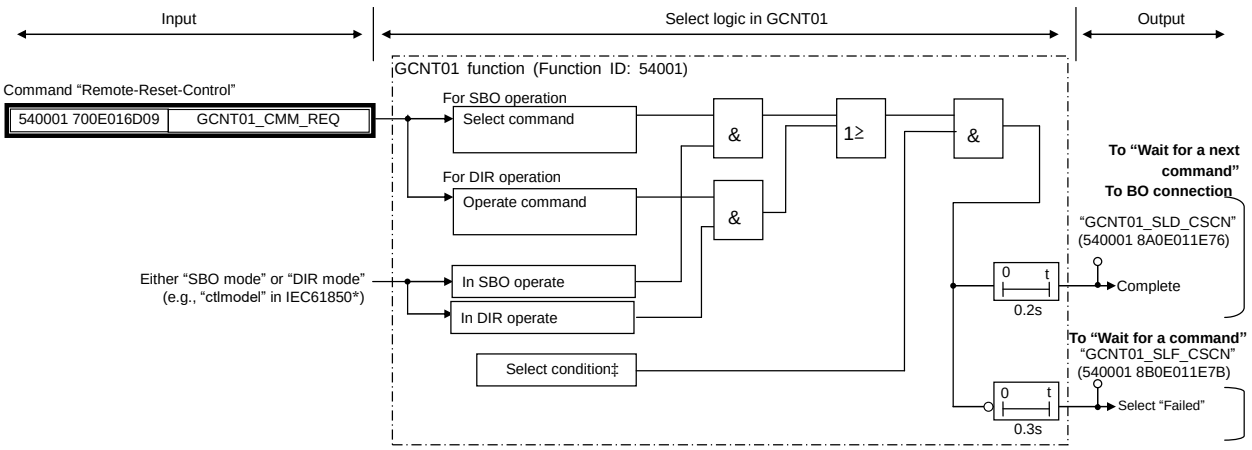


Figure 3.6-6 Select 'Reset' in GCNT01††

‡Note: A "select condition" signal is provided from the select condition logic. For more information, see Figure 3.6-7.

*Note: The GNCT01 function can run in either the "SBO mode" or the "DIR mode" using a signal called "ctlmodel" when communication is implemented using IEC61850. To use this signal, the user should map it for IEC61850 communication.

††Note: To identify the input and output points of the other GCNT02–GCNT32 logics, see Table 3.6-2 for the inputs and Table 3.6-4 for the outputs.

(ii) Select condition

Figure 3.6-8 shows the select condition logic in the GCNT01 function. When resetting the counter is performed from the "Statics sub-menu" in the HMI operation†, the user should set **On** for scheme switch [**GCNT01-HMI**].

†Note: The HMI operation is discussed in *Chapter User interface: Monitoring sub-menu*.

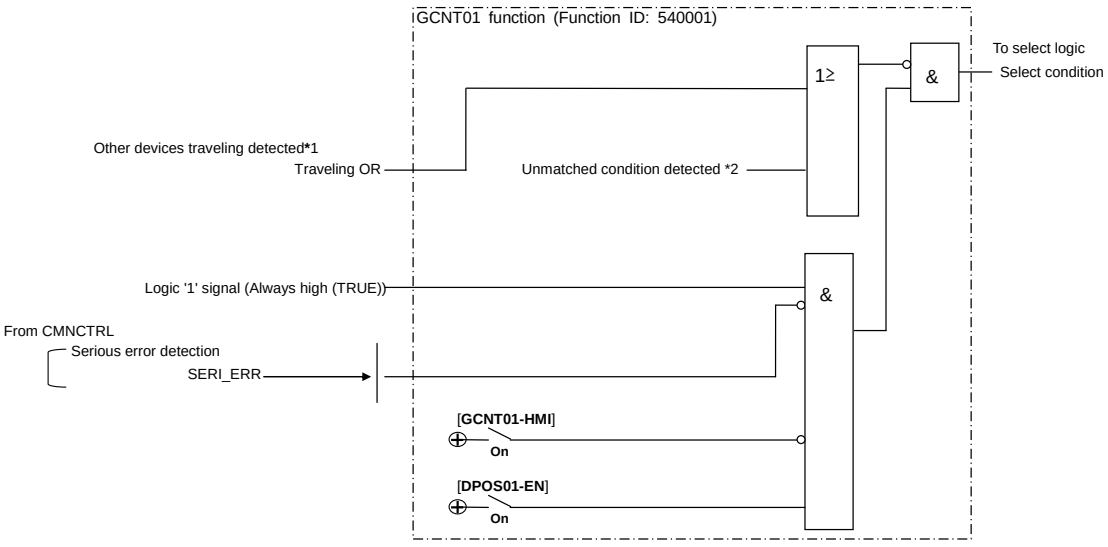


Figure 3.6-7 Select condition logic for Reset in GCNT01

[1]Note: If the event "device-travelling" is detected, it indicates that another operator is

changing the status of a device. Thus, the IED should inhibit the operation of any device for the duration that the event is detected. The detected signal is denoted as "Traveling OR" in Table 3.6-3.

[2]Note: Criteria "unmatched conditions" are decided when the "Test-bit status" in a command is not identical to the "IED test status".

(iii) Signal name and number

Note: The user should note the following descriptions shown in the column "M/O" for each table:

"O" indicates that the signal is provided for optional use.

"M" indicates that the user should map/set/configure the signal; otherwise, the user may experience an operational failure if the default settings are used.

"N/A" indicates that the user cannot change the state of the signal.

Table 3.6-2 Mapping points for the reception of control command

Signal Number	Signal Name	Description	M/O
540001 700E016D09	GCNT01_CMM_REQ	GCNT01 control request(Mapping data)	M
540001 700E026D09	GCNT02_CMM_REQ	GCNT02 control request(Mapping data)	M
540001 700E036D09	GCNT03_CMM_REQ	GCNT03 control request(Mapping data)	M
540001 700E046D09	GCNT04_CMM_REQ	GCNT04 control request(Mapping data)	M
540001 700E056D09	GCNT05_CMM_REQ	GCNT05 control request(Mapping data)	M
540001 700E066D09	GCNT06_CMM_REQ	GCNT06 control request(Mapping data)	M
540001 700E076D09	GCNT07_CMM_REQ	GCNT07 control request(Mapping data)	M
540001 700E086D09	GCNT08_CMM_REQ	GCNT08 control request(Mapping data)	M
540001 700E096D09	GCNT09_CMM_REQ	GCNT09 control request(Mapping data)	M
540001 700E0A6D09	GCNT10_CMM_REQ	GCNT10 control request(Mapping data)	M
540001 700E0B6D09	GCNT11_CMM_REQ	GCNT11 control request(Mapping data)	M
540001 700E0C6D09	GCNT12_CMM_REQ	GCNT12 control request(Mapping data)	M
540001 700E0D6D09	GCNT13_CMM_REQ	GCNT13 control request(Mapping data)	M
540001 700E0E6D09	GCNT14_CMM_REQ	GCNT14 control request(Mapping data)	M
540001 700E0F6D09	GCNT15_CMM_REQ	GCNT15 control request(Mapping data)	M
540001 700E106D09	GCNT16_CMM_REQ	GCNT16 control request(Mapping data)	M
540001 700E116D09	GCNT17_CMM_REQ	GCNT17 control request(Mapping data)	M
540001 700E126D09	GCNT18_CMM_REQ	GCNT18 control request(Mapping data)	M
540001 700E136D09	GCNT19_CMM_REQ	GCNT19 control request(Mapping data)	M
540001 700E146D09	GCNT20_CMM_REQ	GCNT20 control request(Mapping data)	M
540001 700E156D09	GCNT21_CMM_REQ	GCNT21 control request(Mapping data)	M
540001 700E166D09	GCNT22_CMM_REQ	GCNT22 control request(Mapping data)	M
540001 700E176D09	GCNT23_CMM_REQ	GCNT23 control request(Mapping data)	M
540001 700E186D09	GCNT24_CMM_REQ	GCNT24 control request(Mapping data)	M
540001 700E196D09	GCNT25_CMM_REQ	GCNT25 control request(Mapping data)	M
540001 700E1A6D09	GCNT26_CMM_REQ	GCNT26 control request(Mapping data)	M
540001 700E1B6D09	GCNT27_CMM_REQ	GCNT27 control request(Mapping data)	M
540001 700E1C6D09	GCNT28_CMM_REQ	GCNT28 control request(Mapping data)	M
540001 700E1D6D09	GCNT29_CMM_REQ	GCNT29 control request(Mapping data)	M
540001 700E1E6D09	GCNT30_CMM_REQ	GCNT30 control request(Mapping data)	M
540001 700E1F6D09	GCNT31_CMM_REQ	GCNT31 control request(Mapping data)	M
540001 700E206D09	GCNT32_CMM_REQ	GCNT32 control request(Mapping data)	M

Table 3.6-3 Input signals to condition logic

Signal Number	Signal Name	Description	M/O
5A0001 0008001F40	Traveling OR	Travelling events are detected.	N/A
5A0101 3100001F43	SERI_ERR	Serious Error detected	N/A

Table 3.6-4 PLC Monitoring points (Signal "select complete/ failed" for BIO)

Signal Number	Signal Name	Description
540001 8A0E011E76	GCNT01_SLD_CSCN	GCNT01 Selection completed (Mapping)
540001 8A0E021E76	GCNT02_SLD_CSCN	GCNT02 Selection completed (Mapping)
540001 8A0E031E76	GCNT03_SLD_CSCN	GCNT03 Selection completed (Mapping)
540001 8A0E041E76	GCNT04_SLD_CSCN	GCNT04 Selection completed (Mapping)
540001 8A0E051E76	GCNT05_SLD_CSCN	GCNT05 Selection completed (Mapping)
540001 8A0E061E76	GCNT06_SLD_CSCN	GCNT06 Selection completed (Mapping)
540001 8A0E071E76	GCNT07_SLD_CSCN	GCNT07 Selection completed (Mapping)
540001 8A0E081E76	GCNT08_SLD_CSCN	GCNT08 Selection completed (Mapping)
540001 8A0E091E76	GCNT09_SLD_CSCN	GCNT09 Selection completed (Mapping)
540001 8A0E0A1E76	GCNT10_SLD_CSCN	GCNT10 Selection completed (Mapping)
540001 8A0E0B1E76	GCNT11_SLD_CSCN	GCNT11 Selection completed (Mapping)
540001 8A0E0C1E76	GCNT12_SLD_CSCN	GCNT12 Selection completed (Mapping)
540001 8A0E0d1E76	GCNT13_SLD_CSCN	GCNT13 Selection completed (Mapping)
540001 8A0E0E1E76	GCNT14_SLD_CSCN	GCNT14 Selection completed (Mapping)
540001 8A0E0F1E76	GCNT15_SLD_CSCN	GCNT15 Selection completed (Mapping)
540001 8A0E101E76	GCNT16_SLD_CSCN	GCNT16 Selection completed (Mapping)
540001 8A0E111E76	GCNT17_SLD_CSCN	GCNT17 Selection completed (Mapping)
540001 8A0E121E76	GCNT18_SLD_CSCN	GCNT18 Selection completed (Mapping)
540001 8A0E131E76	GCNT19_SLD_CSCN	GCNT19 Selection completed (Mapping)
540001 8A0E141E76	GCNT20_SLD_CSCN	GCNT20 Selection completed (Mapping)
540001 8A0E151E76	GCNT21_SLD_CSCN	GCNT21 Selection completed (Mapping)
540001 8A0E161E76	GCNT22_SLD_CSCN	GCNT22 Selection completed (Mapping)
540001 8A0E171E76	GCNT23_SLD_CSCN	GCNT23 Selection completed (Mapping)
540001 8A0E181E76	GCNT24_SLD_CSCN	GCNT24 Selection completed (Mapping)
540001 8A0E191E76	GCNT25_SLD_CSCN	GCNT25 Selection completed (Mapping)
540001 8A0E1A1E76	GCNT26_SLD_CSCN	GCNT26 Selection completed (Mapping)
540001 8A0E1B1E76	GCNT27_SLD_CSCN	GCNT27 Selection completed (Mapping)
540001 8A0E1C1E76	GCNT28_SLD_CSCN	GCNT28 Selection completed (Mapping)
540001 8A0E1d1E76	GCNT29_SLD_CSCN	GCNT29 Selection completed (Mapping)
540001 8A0E1E1E76	GCNT30_SLD_CSCN	GCNT30 Selection completed (Mapping)
540001 8A0E1F1E76	GCNT31_SLD_CSCN	GCNT31 Selection completed (Mapping)
540001 8A0E201E76	GCNT32_SLD_CSCN	GCNT32 Selection completed (Mapping)
5400018B0E011E7B	GCNT01_SLF_CSCN	GCNT01 select failed
5400018B0E021E7B	GCNT02_SLF_CSCN	GCNT02 select failed
5400018B0E031E7B	GCNT03_SLF_CSCN	GCNT03 select failed
5400018B0E041E7B	GCNT04_SLF_CSCN	GCNT04 select failed
5400018B0E051E7B	GCNT05_SLF_CSCN	GCNT05 select failed
5400018B0E061E7B	GCNT06_SLF_CSCN	GCNT06 select failed
5400018B0E071E7B	GCNT07_SLF_CSCN	GCNT07 select failed
5400018B0E081E7B	GCNT08_SLF_CSCN	GCNT08 select failed
5400018B0E091E7B	GCNT09_SLF_CSCN	GCNT09 select failed
5400018B0E0A1E7B	GCNT10_SLF_CSCN	GCNT10 select failed
5400018B0E0B1E7B	GCNT11_SLF_CSCN	GCNT11 select failed
5400018B0E0C1E7B	GCNT12_SLF_CSCN	GCNT12 select failed
5400018B0E0D1E7B	GCNT13_SLF_CSCN	GCNT13 select failed
5400018B0E0E1E7B	GCNT14_SLF_CSCN	GCNT14 select failed
5400018B0E0F1E7B	GCNT15_SLF_CSCN	GCNT15 select failed

Signal Number	Signal Name	Description
5400018B0E101E7B	GCNT16_SLF_CSCN	GCNT16 select failed
5400018B0E111E7B	GCNT17_SLF_CSCN	GCNT17 select failed
5400018B0E121E7B	GCNT18_SLF_CSCN	GCNT18 select failed
5400018B0E131E7B	GCNT19_SLF_CSCN	GCNT19 select failed
5400018B0E141E7B	GCNT20_SLF_CSCN	GCNT20 select failed
5400018B0E151E7B	GCNT21_SLF_CSCN	GCNT21 select failed
5400018B0E161E7B	GCNT22_SLF_CSCN	GCNT22 select failed
5400018B0E171E7B	GCNT23_SLF_CSCN	GCNT23 select failed
5400018B0E181E7B	GCNT24_SLF_CSCN	GCNT24 select failed
5400018B0E191E7B	GCNT25_SLF_CSCN	GCNT25 select failed
5400018B0E1A1E7B	GCNT26_SLF_CSCN	GCNT26 select failed
5400018B0E1B1E7B	GCNT27_SLF_CSCN	GCNT27 select failed
5400018B0E1C1E7B	GCNT28_SLF_CSCN	GCNT28 select failed
5400018B0E1D1E7B	GCNT29_SLF_CSCN	GCNT29 select failed
5400018B0E1E1E7B	GCNT30_SLF_CSCN	GCNT30 select failed
5400018B0E1F1E7B	GCNT31_SLF_CSCN	GCNT31 select failed
5400018B0E201E7B	GCNT32_SLF_CSCN	GCNT32 select failed

Table 3.6-5 PLC Monitoring points (Signal "stSeld" for BIO)

Signal Number	Signal Name	Description
540001 000E011D91	GCNT01_TMP_01	GCNT01 count change selected signal(stSeld) for SAS
540001 000E021D91	GCNT02_TMP_01	GCNT02 count change selected signal(stSeld) for SAS
540001 000E031D91	GCNT03_TMP_01	GCNT03 count change selected signal(stSeld) for SAS
540001 000E041D91	GCNT04_TMP_01	GCNT04 count change selected signal(stSeld) for SAS
540001 000E051D91	GCNT05_TMP_01	GCNT05 count change selected signal(stSeld) for SAS
540001 000E061D91	GCNT06_TMP_01	GCNT06 count change selected signal(stSeld) for SAS
540001 000E071D91	GCNT07_TMP_01	GCNT07 count change selected signal(stSeld) for SAS
540001 000E081D91	GCNT08_TMP_01	GCNT08 count change selected signal(stSeld) for SAS
540001 000E091D91	GCNT09_TMP_01	GCNT09 count change selected signal(stSeld) for SAS
540001 000E0A1D91	GCNT10_TMP_01	GCNT10 count change selected signal(stSeld) for SAS
540001 000E0B1D91	GCNT11_TMP_01	GCNT11 count change selected signal(stSeld) for SAS
540001 000E0C1D91	GCNT12_TMP_01	GCNT12 count change selected signal(stSeld) for SAS
540001 000E0D1D91	GCNT13_TMP_01	GCNT13 count change selected signal(stSeld) for SAS
540001 000E0E1D91	GCNT14_TMP_01	GCNT14 count change selected signal(stSeld) for SAS
540001 000E0F1D91	GCNT15_TMP_01	GCNT15 count change selected signal(stSeld) for SAS
540001 000E101D91	GCNT16_TMP_01	GCNT16 count change selected signal(stSeld) for SAS
540001 000E111D91	GCNT17_TMP_01	GCNT17 count change selected signal(stSeld) for SAS
540001 000E121D91	GCNT18_TMP_01	GCNT18 count change selected signal(stSeld) for SAS
540001 000E131D91	GCNT19_TMP_01	GCNT19 count change selected signal(stSeld) for SAS
540001 000E141D91	GCNT20_TMP_01	GCNT20 count change selected signal(stSeld) for SAS
540001 000E151D91	GCNT21_TMP_01	GCNT21 count change selected signal(stSeld) for SAS
540001 000E161D91	GCNT22_TMP_01	GCNT22 count change selected signal(stSeld) for SAS
540001 000E171D91	GCNT23_TMP_01	GCNT23 count change selected signal(stSeld) for SAS
540001 000E181D91	GCNT24_TMP_01	GCNT24 count change selected signal(stSeld) for SAS
540001 000E191D91	GCNT25_TMP_01	GCNT25 count change selected signal(stSeld) for SAS
540001 000E1A1D91	GCNT26_TMP_01	GCNT26 count change selected signal(stSeld) for SAS
540001 000E1B1D91	GCNT27_TMP_01	GCNT27 count change selected signal(stSeld) for SAS
540001 000E1C1D91	GCNT28_TMP_01	GCNT28 count change selected signal(stSeld) for SAS
540001 000E1D1D91	GCNT29_TMP_01	GCNT29 count change selected signal(stSeld) for SAS
540001 000E1E1D91	GCNT30_TMP_01	GCNT30 count change selected signal(stSeld) for SAS
540001 000E1F1D91	GCNT31_TMP_01	GCNT31 count change selected signal(stSeld) for SAS
540001 000E201D91	GCNT32_TMP_01	GCNT32 count change selected signal(stSeld) for SAS

(iv) Setting names

Table 3.6-6 Settings of select logics for GCNT01 to GCNT32

Setting Name	Description	Default	Setting item or value
GCNTxx-EN	Activation of the GCNTxx function	On	Off / On
GCNTxx-HMI	Counter is used for the HMI operation in the GCNTxx function	Off	Off / On

3.6.2 Cancel logic for SBO mode

In the SBO control mode the reception of a cancel command is possible when the cancel conditions are satisfied; accordingly, the function can discard the select command; finally, the operation returns to the initial stage (i.e., "Wait for a command".)

(i) Receiving "Cancel" from the remote-end

Figure 3.6-8 depicts the cancel command procedure for a cancel command initiated from the remote-end.

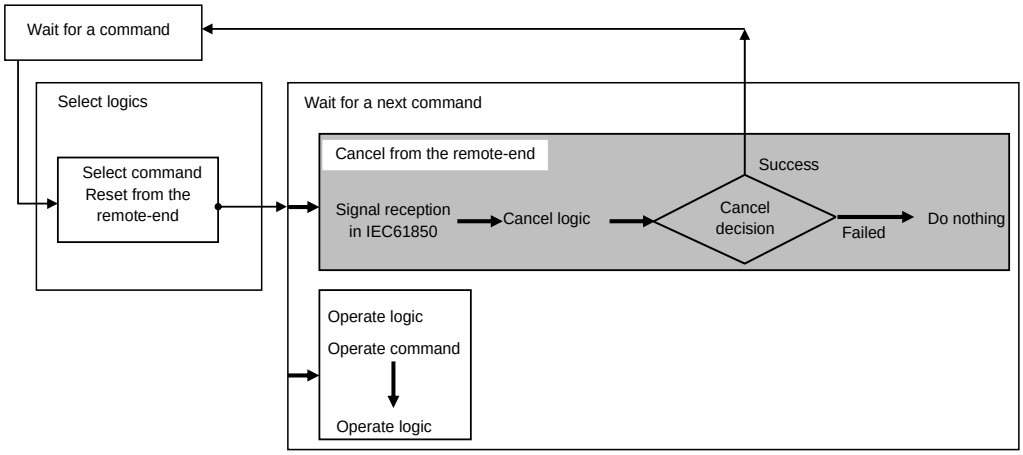


Figure 3.6-8 Outline of 'cancel' command from the remote-end

(i)-1 Input point required mapping

Figure 3.6-9 depicts the cancel logic when a "Cancel command (Remote-Cancel)" signal is applied to the GCNT01 function. The input-point "GCNT01_CMM_REQ" is the same as that for the signal "Select command Reset (Remote-Reset-Control)".

(i)-2 Output signal to BO

The GCNT01 function can issue a "Success to cancel" signal at the monitoring point "GCNT01_CC_SSCN", when the GCNT01 function has determined that the signal "Remote-cancel" is true. Another signal "Operation failed" is issued if the function is able to determine that the signal "Remote-cancel" is not true.

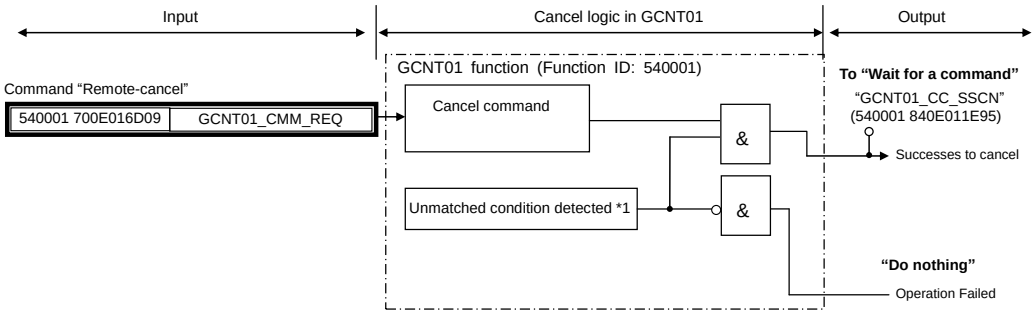


Figure 3.6-9 'Cancel' from the remote-end in GCNT01

[1]Note: The criteria "unmatched conditions" are determined when the "Test-bit status" in

a command is not identical to the “IED test status”.

(ii) Signal name and number

Table 3.6-7 PLC monitoring points (Output signal for ‘cancel’ logic)

Signal Number	Signal Name	Description
540001 840E011E95	GCNT01_CC_SSCN	GCNT01 cancel success signal
540001 840E021E95	GCNT02_CC_SSCN	GCNT02 cancel success signal
540001 840E031E95	GCNT03_CC_SSCN	GCNT03 cancel success signal
540001 840E041E95	GCNT04_CC_SSCN	GCNT04 cancel success signal
540001 840E051E95	GCNT05_CC_SSCN	GCNT05 cancel success signal
540001 840E061E95	GCNT06_CC_SSCN	GCNT06 cancel success signal
540001 840E071E95	GCNT07_CC_SSCN	GCNT07 cancel success signal
540001 840E081E95	GCNT08_CC_SSCN	GCNT08 cancel success signal
540001 840E091E95	GCNT09_CC_SSCN	GCNT09 cancel success signal
540001 840E0A1E95	GCNT10_CC_SSCN	GCNT10 cancel success signal
540001 840E0B1E95	GCNT11_CC_SSCN	GCNT11 cancel success signal
540001 840E0C1E95	GCNT12_CC_SSCN	GCNT12 cancel success signal
540001 840E0D1E95	GCNT13_CC_SSCN	GCNT13 cancel success signal
540001 840E0E1E95	GCNT14_CC_SSCN	GCNT14 cancel success signal
540001 840E0F1E95	GCNT15_CC_SSCN	GCNT15 cancel success signal
540001 840E101E95	GCNT16_CC_SSCN	GCNT16 cancel success signal
540001 840E111E95	GCNT17_CC_SSCN	GCNT17 cancel success signal
540001 840E121E95	GCNT18_CC_SSCN	GCNT18 cancel success signal
540001 840E131E95	GCNT19_CC_SSCN	GCNT19 cancel success signal
540001 840E141E95	GCNT20_CC_SSCN	GCNT20 cancel success signal
540001 840E151E95	GCNT21_CC_SSCN	GCNT21 cancel success signal
540001 840E161E95	GCNT22_CC_SSCN	GCNT22 cancel success signal
540001 840E171E95	GCNT23_CC_SSCN	GCNT23 cancel success signal
540001 840E181E95	GCNT24_CC_SSCN	GCNT24 cancel success signal
540001 840E191E95	GCNT25_CC_SSCN	GCNT25 cancel success signal
540001 840E1A1E95	GCNT26_CC_SSCN	GCNT26 cancel success signal
540001 840E1B1E95	GCNT27_CC_SSCN	GCNT27 cancel success signal
540001 840E1C1E95	GCNT28_CC_SSCN	GCNT28 cancel success signal
540001 840E1D1E95	GCNT29_CC_SSCN	GCNT29 cancel success signal
540001 840E1E1E95	GCNT30_CC_SSCN	GCNT30 cancel success signal
540001 840E1F1E95	GCNT31_CC_SSCN	GCNT31 cancel success signal
540001 840E201E95	GCNT32_CC_SSCN	GCNT32 cancel success signal

3.6.3 Operate logic for SBO/DIR modes

After the operation of the select logic, the operate logic starts to clear the counters.

(i) Receiving "Operate command Reset" from the remote-end

Figure 3.6-10 depicts the reception of the operate command 'Reset' from the remote-end.

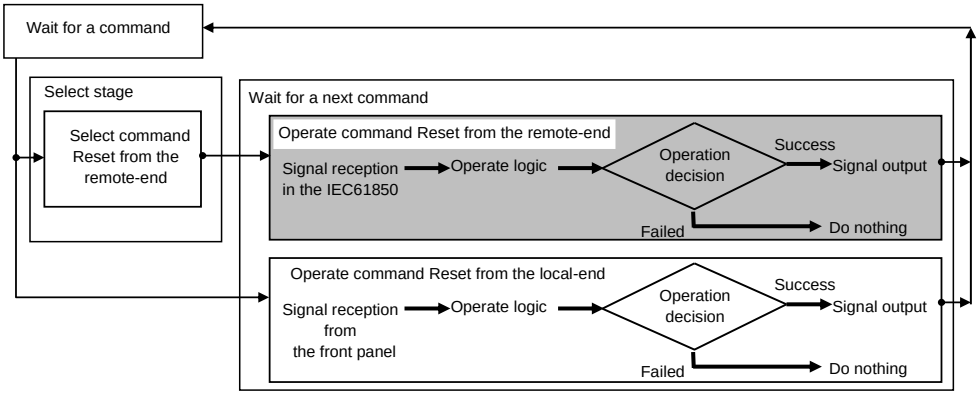


Figure 3.6-10 Outline of Operate command 'Reset'

(i)-1 Mapping required for Input point

Figure 3.6-11 illustrates the operation logic when an "Operate command Reset (Remote-Reset-Control)" signal is applied to the GCNT01 function. The input-point "GCNT01_CMM_REQ" is used for the reception of the "Operate command Reset (Remote-Reset-Control)".

(i)-2 Output signal to BO

The GCNT01 function, in Figure 3.6-11, can provide a signal at the point "GCNT01_OK_CSC", when the GCNT01 function determines that the signal "Remote-Reset-Control" is true.

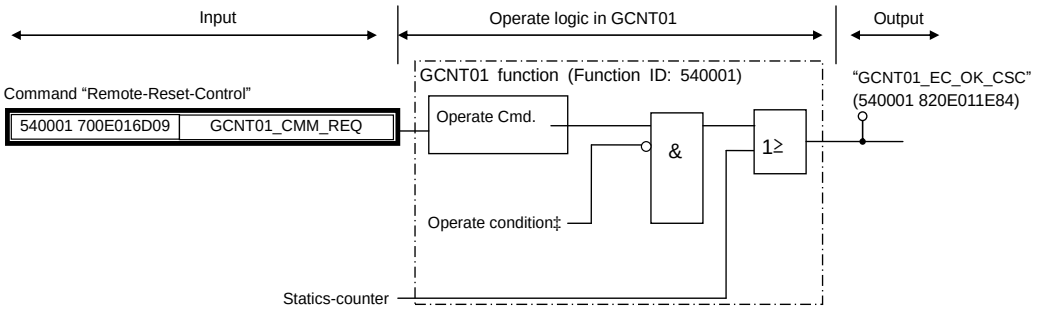


Figure 3.6-11 Operate 'On' from the remote-end ††

††Note: To identify the input and output signal-points of the GCNT02–32 logics, see Table 3.6-2 for the mapping points, Table 3.6-8 for the outputs.

(ii) Receiving "Operate command Reset" from the local-end

Figure 3.6-12 depicts the reception of the operate command 'Reset' from the local-end.

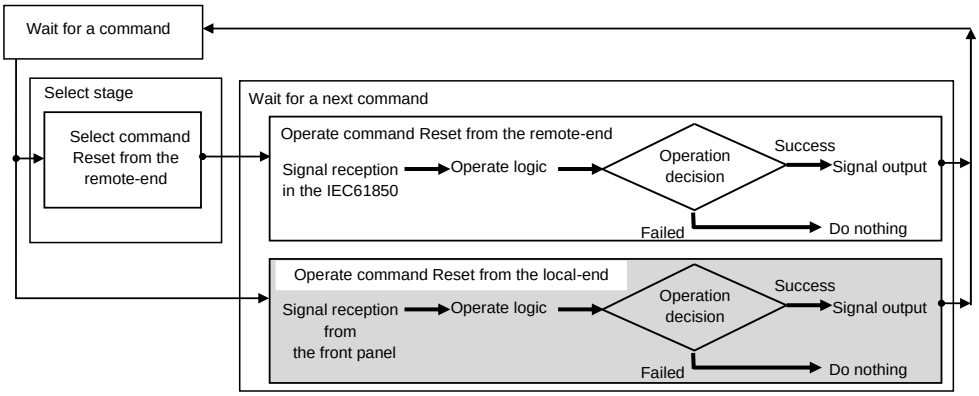


Figure 3.6-12 Outline of Operate command 'Reset'

(ii)-1 New counter value

Figure 3.6-13 shows that the user can set a new value for the counter using the statics sub-menu†. The new value is applied into "Statics counter" point in Figure 3.6-11.

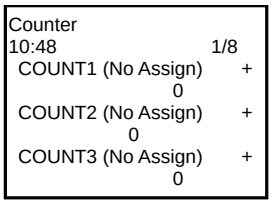


Figure 3.6-13 Counter menu in the statics sub-menu

†Note: For the operation, see *Chapter User interface: Monitoring sub-menu*.

(ii)-2 Output signal to BO

The GCNT01 function can provide a signal at the point "GCNT01_OK_CSC", when the new value applied from the sub-menu is appropriate.

(iii) Select condition

Similar to the select condition (see sec.3.6.1(ii)), the GCNT01 function has an operate-condition logic. Figure 3.6-14 shows the operate-condition logic.

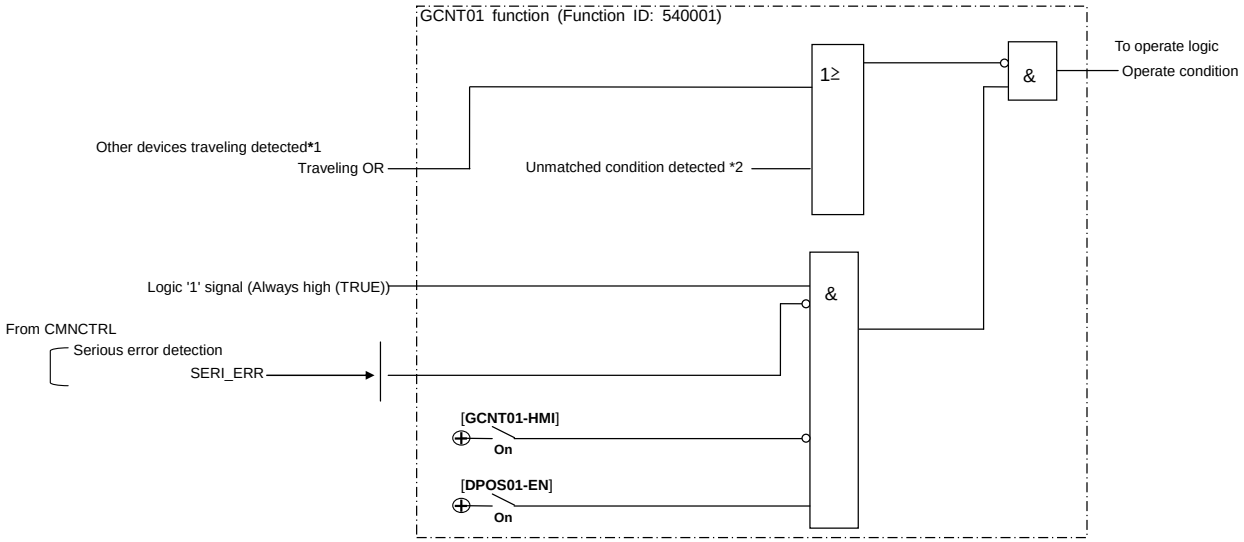


Figure 3.6-14 Operate condition logic for GCNT01

[1–2]Note: The signals and settings in Figure 3.6-14 are same as the signals shown in Figure 3.6-7.

(iv) Signal names and number

Table 3.6-8 PLC monitoring points (Output signal for BIO)

Signal Number	Signal Name	Description
540001 820E011E84	GCNT01_EC_OK_CSCN	GCNT01 execute command OK condition signal
540001 820E021E84	GCNT02_EC_OK_CSCN	GCNT02 execute command OK condition signal
540001 820E031E84	GCNT03_EC_OK_CSCN	GCNT03 execute command OK condition signal
540001 820E041E84	GCNT04_EC_OK_CSCN	GCNT04 execute command OK condition signal
540001 820E051E84	GCNT05_EC_OK_CSCN	GCNT05 execute command OK condition signal
540001 820E061E84	GCNT06_EC_OK_CSCN	GCNT06 execute command OK condition signal
540001 820E071E84	GCNT07_EC_OK_CSCN	GCNT07 execute command OK condition signal
540001 820E081E84	GCNT08_EC_OK_CSCN	GCNT08 execute command OK condition signal
540001 820E091E84	GCNT09_EC_OK_CSCN	GCNT09 execute command OK condition signal
540001 820E0A1E84	GCNT10_EC_OK_CSCN	GCNT10 execute command OK condition signal
540001 820E0B1E84	GCNT11_EC_OK_CSCN	GCNT11 execute command OK condition signal
540001 820E0C1E84	GCNT12_EC_OK_CSCN	GCNT12 execute command OK condition signal
540001 820E0D1E84	GCNT13_EC_OK_CSCN	GCNT13 execute command OK condition signal
540001 820E0E1E84	GCNT14_EC_OK_CSCN	GCNT14 execute command OK condition signal
540001 820E0F1E84	GCNT15_EC_OK_CSCN	GCNT15 execute command OK condition signal
540001 820E101E84	GCNT16_EC_OK_CSCN	GCNT16 execute command OK condition signal
540001 820E111E84	GCNT17_EC_OK_CSCN	GCNT17 execute command OK condition signal
540001 820E121E84	GCNT18_EC_OK_CSCN	GCNT18 execute command OK condition signal
540001 820E131E84	GCNT19_EC_OK_CSCN	GCNT19 execute command OK condition signal
540001 820E141E84	GCNT20_EC_OK_CSCN	GCNT20 execute command OK condition signal
540001 820E151E84	GCNT21_EC_OK_CSCN	GCNT21 execute command OK condition signal
540001 820E161E84	GCNT22_EC_OK_CSCN	GCNT22 execute command OK condition signal
540001 820E171E84	GCNT23_EC_OK_CSCN	GCNT23 execute command OK condition signal
540001 820E181E84	GCNT24_EC_OK_CSCN	GCNT24 execute command OK condition signal
540001 820E191E84	GCNT25_EC_OK_CSCN	GCNT25 execute command OK condition signal
540001 820E1A1E84	GCNT26_EC_OK_CSCN	GCNT26 execute command OK condition signal
540001 820E1B1E84	GCNT27_EC_OK_CSCN	GCNT27 execute command OK condition signal
540001 820E1C1E84	GCNT28_EC_OK_CSCN	GCNT28 execute command OK condition signal
540001 820E1D1E84	GCNT29_EC_OK_CSCN	GCNT29 execute command OK condition signal
540001 820E1E1E84	GCNT30_EC_OK_CSCN	GCNT30 execute command OK condition signal
540001 820E1F1E84	GCNT31_EC_OK_CSCN	GCNT31 execute command OK condition signal
540001 820E201E84	GCNT32_EC_OK_CSCN	GCNT32 execute command OK condition signal

3.6.4 Mapping for IEC61850 communication

The user can operate the GCNT function over IEC 61850 communication following mapping using GR-TIEMS. Note that the GCNT function is designed for the class of "Integer Status Controller (ISC)" in the IEC 61850 standard for communication. The user should follow these steps, each of which is discussed below:

Step1: Editing Logical Node

Step2: Mapping output data

Step3: Mapping input data

(i) Editing Logical Node

The user will need to create a logical node (LN) for the GCNT01 function. Figure 3.6-15 exemplifies the editing of a LN; the LN "Integer Status controller (ISCSO)" is chosen for the GCNT01 function. After the user has defined an object "ISCSO", the GCNT01 logical node can be saved with the name "GIGO" plus "LN Instance". Create a definition of the object "ISCSO" in the GGIO logical node. Either the SBO mode or the DIR mode can be chosen in the editing for the LN.

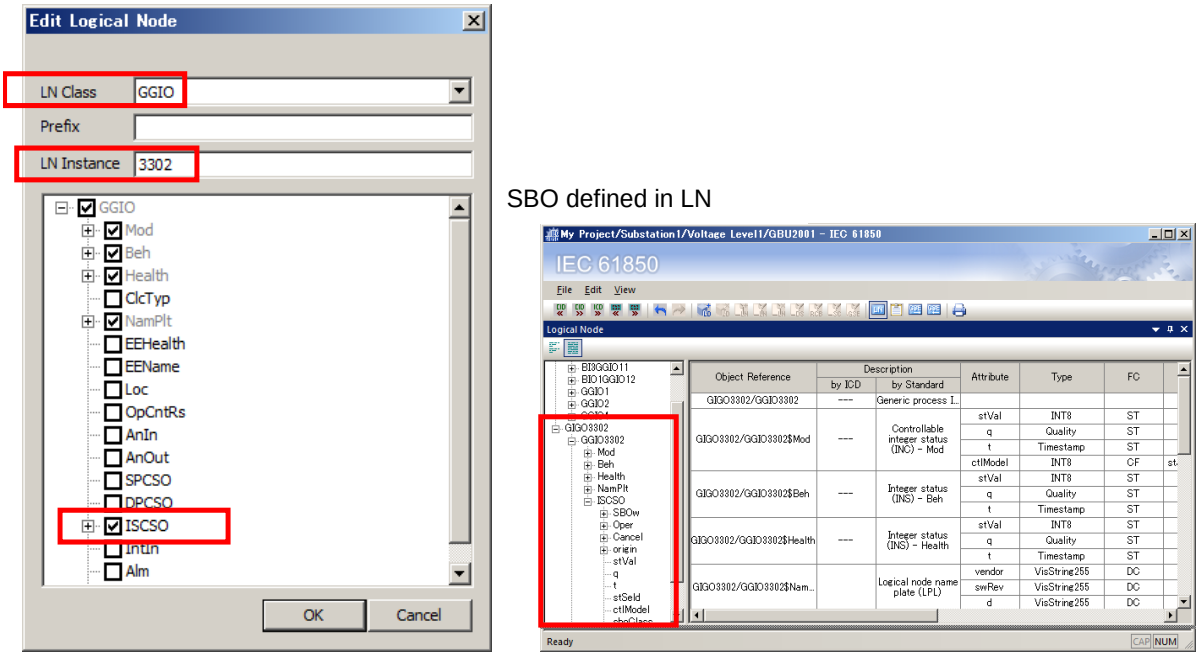
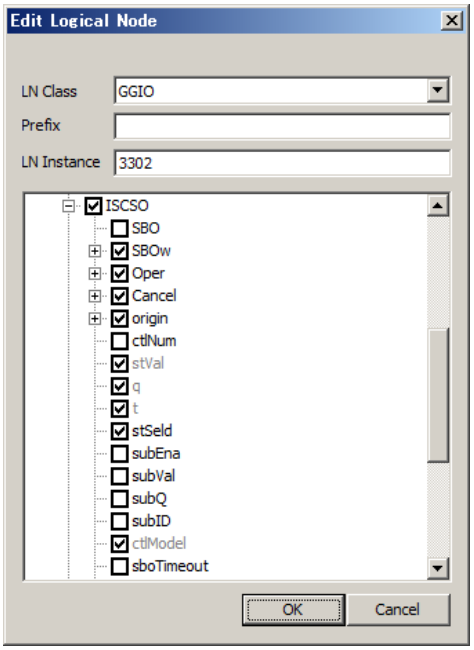


Figure 3.6-15 Defining "ISCSO" object in GIGO3302 logic node

(i)-1 Defining SBO mode

Figure 3.6-16 exemplifies the GCNT01 logic node saved as “GIGO3302”; in the SBO mode, the user should select the following items for the “GIGO3302$ISCSO” using GR-TIEMS:



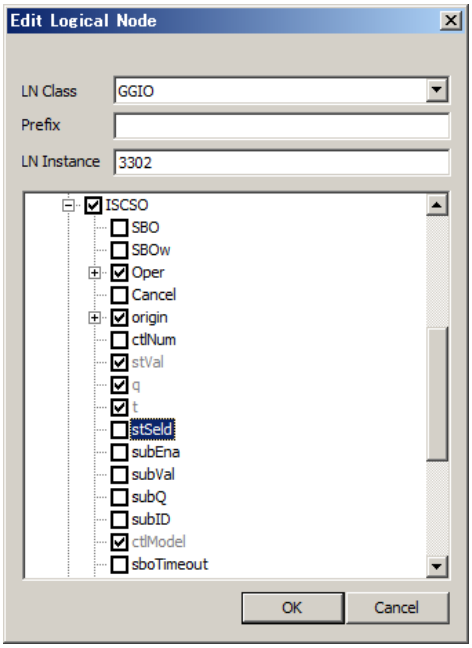
- ✓ SBOw
- ✓ Oper
- ✓ Cancel
- ✓ Origin
- ✓ stSeld
- ✓ sboClass† (choice ”operate-once”)
- ✓ ctlmodel (choice ”SBOes or SBOns”)

†”sboClass” can be found by scrolling down.

Figure 3.6-16 LN editing screen for SBO mode (for example)

(i)-2 Defining DIR mode

Figure 3.6-17 exemplifies the GCNT01 logic node saved as save as “GIGO3302”; in the DIR mode, the following three items should be selected using GR-TIEMS.



- ✓ Oper
- ✓ Origin
- ✓ ctlmodel (choice ”SBOes or SBOns”)

Figure 3.6-17 LN editing screen for DIR mode (for example)

(ii) Mapping output data

The user should group the GCNT01 signals with regard to GOOSE and REPORT; the user should map them for IEC61850 communication using GR-TIEMS (Figure 3.6-18 illustrates how to map a signal); it indicates that the signals for the GCNT01 function are required to map the IEC 61850 communications.

Table 3.6-9 Mapping signals required for GIGO3302 object in GCNT01 function

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/GGIO3302$ISCSO$origin	orCat	orCategory	ST	540001300e011D23	GCNT01_CNT_ORCAT
Ctrl/GGIO3302$ISCSO$origin	orIdent	Octet64	ST	5400016A0e011FA7	GCNT01_CNT_ORIDENT
Ctrl/GGIO3302$ISCSO	stVal	INT32	ST	540001320e011D20	GCNT01_CNT_VAL
Ctrl/GGIO3302$ISCSO	q	Quality	ST	3010013110041005	Qual_Val
Ctrl/GGIO3302$ISCSO	t	Timestamp	ST	2003019010001006	SYS_TIME
Ctrl/GGIO3302$ISCSO	stSeld	BOOLEAN	ST	540001000E011D91	GCNT01_TMP_01

Note: "Status (ST)" is defined in the function constraint (FC) of the IEC 61850.

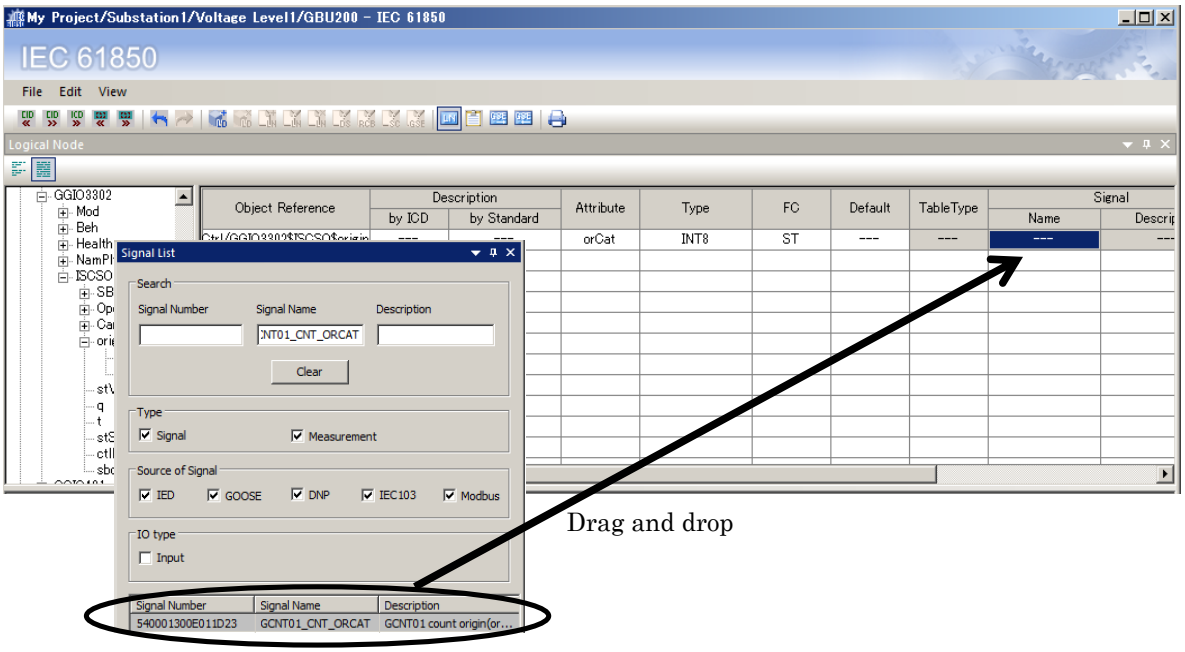


Figure 3.6-18 orCat attribute mapped into ISCSO object of GIGO3302

(iii) Mapping input data

The GCNT01 function can receive three commands "select, operate, and cancel". Thus, the user should map the input-point "GCNT01_CMM_REQ". Table 3.6-10 shows the input-point "GCNT01_CMM_REQ" and the Object reference "Ctrl/GIGO3302$ISCSO1"; the user should map the input-point to the Object reference having attributes CO and CF in FC†. Figure 3.6-19 shows how to map a signal.

†Note: The attribute is defined in the IEC 61850; "CO" stands for "Control" in the functional constraint (FC).

Table 3.6-10 Mapping signals required for ISCSO object for GIGO3302

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/GGIO3302$ISCSO$Oper	ctlVal	INT32	CO	540001 700E016D09	GCNT01_CMM_REQ
Ctrl/GGIO3302$ISCSO$Oper	ctlNum	INT8U	CO		
Ctrl/GGIO3302$ISCSO$Oper	T	Timestamp	CO		
Ctrl/GGIO3302$ISCSO$Oper	Test	BOOLEAN	CO		
Ctrl/GGIO3302$ISCSO$Oper	Check	Check	CO		
Ctrl/GGIO3302$ISCSO$Oper$origin	orCat	orCategory	CO		
Ctrl/GGIO3302$ISCSO$Oper$origin	orIdent	Octet64	CO		
Ctrl/GGIO3302$ISCSO	ctlModel	ctlModel	CF		
Ctrl/GGIO3302$ISCSO	sboClass	sboClass	CF		

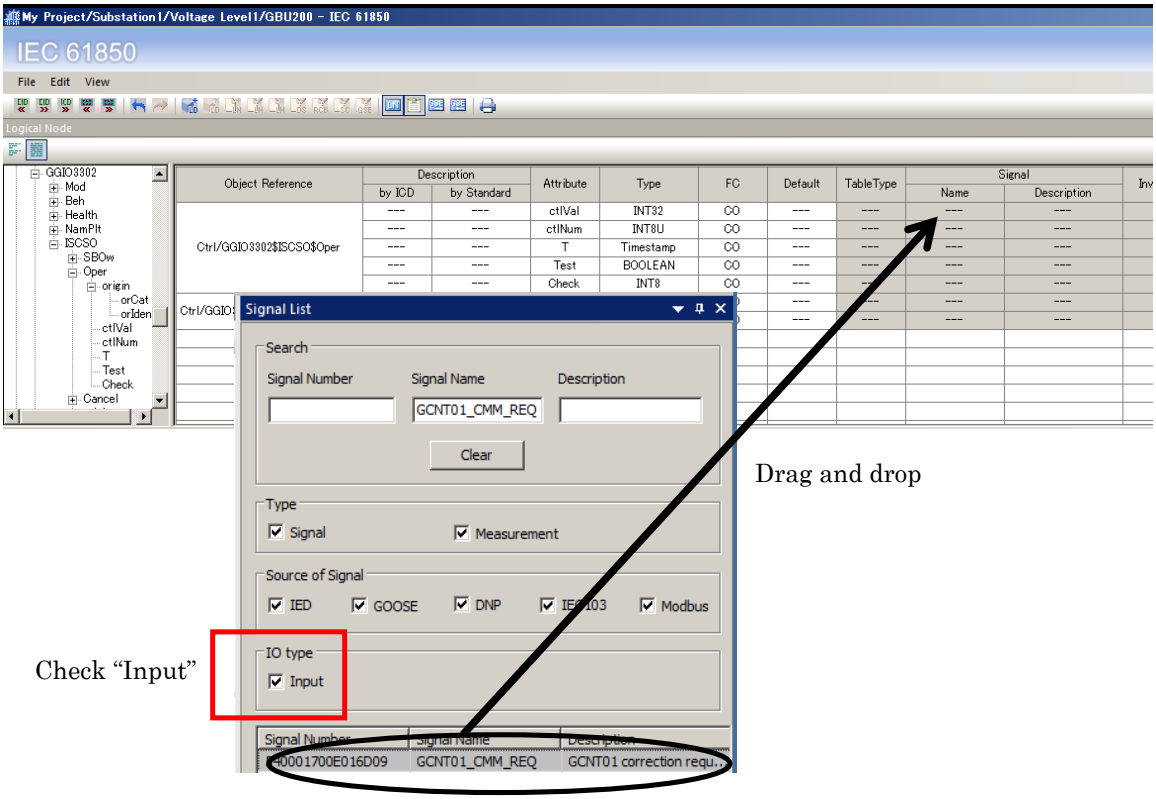


Figure 3.6-19 Input-point mapped for GIGO3302

3.6.5 Setting

Setting list for the GCNT (Function ID: 540001)

Setting device			Range	Units	Contents	Default setting value	Notes
G_CNT	CNT1	GCNT01-EN	Off / On		Counter1 Enable	Off	
		GCNT01-CNTS	NA / On / Off / OnOff		count status	NA	
		GCNT01-SDB	0 to 999	none	Counter1 Sending Dead Band	0	
		GCNT01-CNTRV	0/1		Return value at counter roll up	0	
		GCNT01-CNTMAX	9 to 2147483647	none	counter value maximum	999999	
		GCNT01-HMI	Off/On		Counter1 for HMI	Off	
	CNT2	GCNT02-EN	Off / On		Counter2 Enable	Off	
		GCNT02-CNTS	NA / On / Off / OnOff		count status	NA	
		GCNT02-SDB	0 to 999	none	Counter2 Sending Dead Band	0	
		GCNT02-CNTRV	0/1		Return value at counter roll up	0	
		GCNT02-CNTMAX	9 to 2147483647	none	counter value maximum	999999	
		GCNT02-HMI	Off/On		Counter2 for HMI	Off	
	.....	.....	.....		.....	.....	
	CNTxx	GCNTxx-EN	Off / On		Counter xx Enable	Off	
		GCNTxx-CNTS	NA / On / Off / OnOff		count status	NA	
		GCNTxx-SDB	0 to 999	none	Counter xx Sending Dead Band	0	
		GCNTxx-CNTRV	0/1		Return value at counter roll up	0	
		GCNTxx-CNTMAX	9 to 2147483647	none	counter value maximum	999999	
		GCNTxx-HMI	Off/On		Counter xx for HMI	Off	

Note: The number of counters in the GCNT depends on IED model. We omit the setting tables of GCNT03 to GGNTxx because the setting items are the same except the device number.

3.6.6 Signal

◆ Connection points in PLC logics

GCNT (Function ID: 540001)

Element ID	Name	Description
800E00ED5A	GCNT00IN_TMP_51	GCNT00IN_TMP_51
800E01EDE0	GCNT01_PLC_SGNL	GCNT01 PLC signal
800E02EDE0	GCNT02_PLC_SGNL	GCNT02 PLC signal
800E03EDE0	GCNT03_PLC_SGNL	GCNT03 PLC signal
800E04EDE0	GCNT04_PLC_SGNL	GCNT04 PLC signal
800E05EDE0	GCNT05_PLC_SGNL	GCNT05 PLC signal
800E06EDE0	GCNT06_PLC_SGNL	GCNT06 PLC signal
800E07EDE0	GCNT07_PLC_SGNL	GCNT07 PLC signal
800E08EDE0	GCNT08_PLC_SGNL	GCNT08 PLC signal
800E09EDE0	GCNT09_PLC_SGNL	GCNT09 PLC signal
800E0AEDE0	GCNT10_PLC_SGNL	GCNT10 PLC signal
800E0BEDE0	GCNT11_PLC_SGNL	GCNT11 PLC signal
800E0CEDE0	GCNT12_PLC_SGNL	GCNT12 PLC signal
800E0DEDE0	GCNT13_PLC_SGNL	GCNT13 PLC signal
800E0EEDE0	GCNT14_PLC_SGNL	GCNT14 PLC signal
800E0FEDE0	GCNT15_PLC_SGNL	GCNT15 PLC signal
800E10EDE0	GCNT16_PLC_SGNL	GCNT16 PLC signal
800E11EDE0	GCNT17_PLC_SGNL	GCNT17 PLC signal
800E12EDE0	GCNT18_PLC_SGNL	GCNT18 PLC signal
800E13EDE0	GCNT19_PLC_SGNL	GCNT19 PLC signal
800E14EDE0	GCNT20_PLC_SGNL	GCNT20 PLC signal
800E15EDE0	GCNT21_PLC_SGNL	GCNT21 PLC signal
800E16EDE0	GCNT22_PLC_SGNL	GCNT22 PLC signal
800E17EDE0	GCNT23_PLC_SGNL	GCNT23 PLC signal
800E18EDE0	GCNT24_PLC_SGNL	GCNT24 PLC signal
800E19EDE0	GCNT25_PLC_SGNL	GCNT25 PLC signal
800E1AEDE0	GCNT26_PLC_SGNL	GCNT26 PLC signal
800E1BEDE0	GCNT27_PLC_SGNL	GCNT27 PLC signal
800E1CEDE0	GCNT28_PLC_SGNL	GCNT28 PLC signal
800E1DEDE0	GCNT29_PLC_SGNL	GCNT29 PLC signal
800E1EEDE0	GCNT30_PLC_SGNL	GCNT30 PLC signal
800E1FEDE0	GCNT31_PLC_SGNL	GCNT31 PLC signal
800E20EDE0	GCNT32_PLC_SGNL	GCNT32 PLC signal

◆ Signal monitoring points for the common terms

GCNT (Function ID: 540001)

Element ID	Name	Description
000E001F41	GCNT00_CCTRL_COUNTER	GCNT00 cmnctrl counter correction summarize
800E001D5B	GCNT00_CH_SC_OWS	GCNT00 count change select command by OWS(HMI)
800E001D5D	GCNT00_CH_SC_RCC	GCNT00 count change select command by RCC
800E001D5D	GCNT00_CH_SC_RMT	GCNT00 count change select command by Remote
800E001D54	GCNT00_CH_SC_LCD	GCNT00 count change select command by LCD
800E001D5E	GCNT00_CH_EC_OWS	GCNT00 count change execute command by OWS(HMI)

◆ Signal monitoring points for the common terms

GCNT (Function ID: 540001)

Element ID	Name	Description
800E001D5F	GCNT00_CH_EC_RCC	GCNT00 count change execute command by RCC
800E001D60	GCNT00_CH_EC_RMT	GCNT00 count change execute command by Remote
800E001D58	GCNT00_CH_EC_LCD	GCNT00 count change execute command by LCD
310E001707	Counter	DataID for GCNT Function(Setting)

◆ Signal monitoring points for respective counters (GCNT01 to GCNT32)

GCNT (Function ID: 540001)

Element ID	Name	Description
320E011D20	GCNT01_CNT_VAL	GCNT01 count value
310E011D21	GCNT01_CNT_QLT	GCNT01 count quality
000E011F42	GCNT01_CORR_INS	GCNT01 correction instruction
000E011D91	GCNT01_TMP_01	GCNT01 count change selected signal(stSeld) for SAS
890E011EA2	GCNT01_CTR_SGUCN	GCNT01 control logic stage(under selection)
8A0E011E76	GCNT01_SLD_CSCN	GCNT01 selected condition signal
8B0E011E7B	GCNT01_SLF_CSCN	GCNT01 select fail condition signal
820E011E84	GCNT01_EC_OK_CSCN	GCNT01 execute command OK condition signal
830E011E8B	GCNT01_EC_F_CSCN	GCNT01 execute command fail condition signal
840E011E95	GCNT01_CC_SSCN	GCNT01 cancel success signal
320E021D20	GCNT02_CNT_VAL	GCNT02 count value
310E021D21	GCNT02_CNT_QLT	GCNT02 count quality
000E021F42	GCNT02_CORR_INS	GCNT02 correction instruction
000E021D91	GCNT02_TMP_01	GCNT02 count change selected signal(stSeld) for SAS
890E021EA2	GCNT02_CTR_SGUCN	GCNT02 control logic stage(under selection)
8A0E021E76	GCNT02_SLD_CSCN	GCNT02 selected condition signal
8B0E021E7B	GCNT02_SLF_CSCN	GCNT02 select fail condition signal
820E021E84	GCNT02_EC_OK_CSCN	GCNT02 execute command OK condition signal
830E021E8B	GCNT02_EC_F_CSCN	GCNT02 execute command fail condition signal
840E021E95	GCNT02_CC_SSCN	GCNT02 cancel success signal
320E031D20	GCNT03_CNT_VAL	GCNT03 count value
310E031D21	GCNT03_CNT_QLT	GCNT03 count quality
000E031F42	GCNT03_CORR_INS	GCNT03 correction instruction
000E031D91	GCNT03_TMP_01	GCNT03 count change selected signal(stSeld) for SAS
890E031EA2	GCNT03_CTR_SGUCN	GCNT03 control logic stage(under selection)
8A0E031E76	GCNT03_SLD_CSCN	GCNT03 selected condition signal
8B0E031E7B	GCNT03_SLF_CSCN	GCNT03 select fail condition signal
820E031E84	GCNT03_EC_OK_CSCN	GCNT03 execute command OK condition signal
830E031E8B	GCNT03_EC_F_CSCN	GCNT03 execute command fail condition signal
840E031E95	GCNT03_CC_SSCN	GCNT03 cancel success signal
320E041D20	GCNT04_CNT_VAL	GCNT04 count value
310E041D21	GCNT04_CNT_QLT	GCNT04 count quality
000E041F42	GCNT04_CORR_INS	GCNT04 correction instruction
000E041D91	GCNT04_TMP_01	GCNT04 count change selected signal(stSeld) for SAS
890E041EA2	GCNT04_CTR_SGUCN	GCNT04 control logic stage(under selection)
8A0E041E76	GCNT04_SLD_CSCN	GCNT04 selected condition signal

◆ Signal monitoring points for respective counters (GCNT01 to GCNT32)

GCNT (Function ID: 540001)

Element ID	Name	Description
8B0E041E7B	GCNT04_SLF_CSCN	GCNT04 select fail condition signal
820E041E84	GCNT04_EC_OK_CSCN	GCNT04 execute command OK condition signal
830E041E8B	GCNT04_EC_F_CSCN	GCNT04 execute command fail condition signal
840E041E95	GCNT04_CC_SSCN	GCNT04 cancel success signal
320E051D20	GCNT05_CNT_VAL	GCNT05 count value
310E051D21	GCNT05_CNT_QLT	GCNT05 count quality
000E051F42	GCNT05_CORR_INS	GCNT05 correction instruction
000E051D91	GCNT05_TMP_01	GCNT05 count change selected signal(stSeld) for SAS
890E051EA2	GCNT05_CTR_SGUCN	GCNT05 control logic stage(under selection)
8A0E051E76	GCNT05_SLD_CSCN	GCNT05 selected condition signal
8B0E051E7B	GCNT05_SLF_CSCN	GCNT05 select fail condition signal
820E051E84	GCNT05_EC_OK_CSCN	GCNT05 execute command OK condition signal
830E051E8B	GCNT05_EC_F_CSCN	GCNT05 execute command fail condition signal
840E051E95	GCNT05_CC_SSCN	GCNT05 cancel success signal
320E061D20	GCNT06_CNT_VAL	GCNT06 count value
310E061D21	GCNT06_CNT_QLT	GCNT06 count quality
000E061F42	GCNT06_CORR_INS	GCNT06 correction instruction
000E061D91	GCNT06_TMP_01	GCNT06 count change selected signal(stSeld) for SAS
890E061EA2	GCNT06_CTR_SGUCN	GCNT06 control logic stage(under selection)
8A0E061E76	GCNT06_SLD_CSCN	GCNT06 selected condition signal
8B0E061E7B	GCNT06_SLF_CSCN	GCNT06 select fail condition signal
820E061E84	GCNT06_EC_OK_CSCN	GCNT06 execute command OK condition signal
830E061E8B	GCNT06_EC_F_CSCN	GCNT06 execute command fail condition signal
840E061E95	GCNT06_CC_SSCN	GCNT06 cancel success signal
320E071D20	GCNT07_CNT_VAL	GCNT07 count value
310E071D21	GCNT07_CNT_QLT	GCNT07 count quality
000E071F42	GCNT07_CORR_INS	GCNT07 correction instruction
000E071D91	GCNT07_TMP_01	GCNT07 count change selected signal(stSeld) for SAS
890E071EA2	GCNT07_CTR_SGUCN	GCNT07 control logic stage(under selection)
8A0E071E76	GCNT07_SLD_CSCN	GCNT07 selected condition signal
8B0E071E7B	GCNT07_SLF_CSCN	GCNT07 select fail condition signal
820E071E84	GCNT07_EC_OK_CSCN	GCNT07 execute command OK condition signal
830E071E8B	GCNT07_EC_F_CSCN	GCNT07 execute command fail condition signal
840E071E95	GCNT07_CC_SSCN	GCNT07 cancel success signal
320E081D20	GCNT08_CNT_VAL	GCNT08 count value
310E081D21	GCNT08_CNT_QLT	GCNT08 count quality
000E081F42	GCNT08_CORR_INS	GCNT08 correction instruction
000E081D91	GCNT08_TMP_01	GCNT08 count change selected signal(stSeld) for SAS
890E081EA2	GCNT08_CTR_SGUCN	GCNT08 control logic stage(under selection)
8A0E081E76	GCNT08_SLD_CSCN	GCNT08 selected condition signal
8B0E081E7B	GCNT08_SLF_CSCN	GCNT08 select fail condition signal
820E081E84	GCNT08_EC_OK_CSCN	GCNT08 execute command OK condition signal
830E081E8B	GCNT08_EC_F_CSCN	GCNT08 execute command fail condition signal
840E081E95	GCNT08_CC_SSCN	GCNT08 cancel success signal

◆ Signal monitoring points for respective counters (GCNT01 to GCNT32)

GCNT (Function ID: 540001)

Element ID	Name	Description
320E091D20	GCNT09_CNT_VAL	GCNT09 count value
310E091D21	GCNT09_CNT_QLT	GCNT09 count quality
000E091F42	GCNT09_CORR_INS	GCNT09 correction instruction
000E091D91	GCNT09_TMP_01	GCNT09 count change selected signal(stSeld) for SAS
890E091EA2	GCNT09_CTR_SGUCN	GCNT09 control logic stage(under selection)
8A0E091E76	GCNT09_SLD_CSCN	GCNT09 selected condition signal
8B0E091E7B	GCNT09_SLF_CSCN	GCNT09 select fail condition signal
820E091E84	GCNT09_EC_OK_CSCN	GCNT09 execute command OK condition signal
830E091E8B	GCNT09_EC_F_CSCN	GCNT09 execute command fail condition signal
840E091E95	GCNT09_CC_SSCN	GCNT09 cancel success signal
320E0A1D20	GCNT10_CNT_VAL	GCNT10 count value
310E0A1D21	GCNT10_CNT_QLT	GCNT10 count quality
000E0A1F42	GCNT10_CORR_INS	GCNT10 correction instruction
000E0A1D91	GCNT10_TMP_01	GCNT10 count change selected signal(stSeld) for SAS
890E0A1EA2	GCNT10_CTR_SGUCN	GCNT10 control logic stage(under selection)
8A0E0A1E76	GCNT10_SLD_CSCN	GCNT10 selected condition signal
8B0E0A1E7B	GCNT10_SLF_CSCN	GCNT10 select fail condition signal
820E0A1E84	GCNT10_EC_OK_CSCN	GCNT10 execute command OK condition signal
830E0A1E8B	GCNT10_EC_F_CSCN	GCNT10 execute command fail condition signal
840E0A1E95	GCNT10_CC_SSCN	GCNT10 cancel success signal
320E0B1D20	GCNT11_CNT_VAL	GCNT11 count value
310E0B1D21	GCNT11_CNT_QLT	GCNT11 count quality
000E0B1F42	GCNT11_CORR_INS	GCNT11 correction instruction
000E0B1D91	GCNT11_TMP_01	GCNT11 count change selected signal(stSeld) for SAS
890E0B1EA2	GCNT11_CTR_SGUCN	GCNT11 control logic stage(under selection)
8A0E0B1E76	GCNT11_SLD_CSCN	GCNT11 selected condition signal
8B0E0B1E7B	GCNT11_SLF_CSCN	GCNT11 select fail condition signal
820E0B1E84	GCNT11_EC_OK_CSCN	GCNT11 execute command OK condition signal
830E0B1E8B	GCNT11_EC_F_CSCN	GCNT11 execute command fail condition signal
840E0B1E95	GCNT11_CC_SSCN	GCNT11 cancel success signal
320E0D1D20	GCNT12_CNT_VAL	GCNT12 count value
310E0D1D21	GCNT12_CNT_QLT	GCNT12 count quality
000E0D1F42	GCNT12_CORR_INS	GCNT12 correction instruction
000E0D1D91	GCNT12_TMP_01	GCNT12 count change selected signal(stSeld) for SAS
890E0D1EA2	GCNT12_CTR_SGUCN	GCNT12 control logic stage(under selection)
8A0E0D1E76	GCNT12_SLD_CSCN	GCNT12 selected condition signal
8B0E0D1E7B	GCNT12_SLF_CSCN	GCNT12 select fail condition signal
820E0D1E84	GCNT12_EC_OK_CSCN	GCNT12 execute command OK condition signal
830E0D1E8B	GCNT12_EC_F_CSCN	GCNT12 execute command fail condition signal
840E0D1E95	GCNT12_CC_SSCN	GCNT12 cancel success signal
320E0D1D20	GCNT13_CNT_VAL	GCNT13 count value
310E0D1D21	GCNT13_CNT_QLT	GCNT13 count quality
000E0D1F42	GCNT13_CORR_INS	GCNT13 correction instruction
000E0D1D91	GCNT13_TMP_01	GCNT13 count change selected signal(stSeld) for SAS

◆ Signal monitoring points for respective counters (GCNT01 to GCNT32)

GCNT (Function ID: 540001)

Element ID	Name	Description
890E0D1EA2	GCNT13_CTR_SGUCN	GCNT13 control logic stage(under selection)
8A0E0D1E76	GCNT13_SLD_CSCN	GCNT13 selected condition signal
8B0E0D1E7B	GCNT13_SLF_CSCN	GCNT13 select fail condition signal
820E0D1E84	GCNT13_EC_OK_CSCN	GCNT13 execute command OK condition signal
830E0D1E8B	GCNT13_EC_F_CSCN	GCNT13 execute command fail condition signal
840E0D1E95	GCNT13_CC_SSCN	GCNT13 cancel success signal
320E0E1D20	GCNT14_CNT_VAL	GCNT14 count value
310E0E1D21	GCNT14_CNT_QLT	GCNT14 count quality
000E0E1F42	GCNT14_CORR_INS	GCNT14 correction instruction
000E0E1D91	GCNT14_TMP_01	GCNT14 count change selected signal(stSeld) for SAS
890E0E1EA2	GCNT14_CTR_SGUCN	GCNT14 control logic stage(under selection)
8A0E0E1E76	GCNT14_SLD_CSCN	GCNT14 selected condition signal
8B0E0E1E7B	GCNT14_SLF_CSCN	GCNT14 select fail condition signal
820E0E1E84	GCNT14_EC_OK_CSCN	GCNT14 execute command OK condition signal
830E0E1E8B	GCNT14_EC_F_CSCN	GCNT14 execute command fail condition signal
840E0E1E95	GCNT14_CC_SSCN	GCNT14 cancel success signal
320E0F1D20	GCNT15_CNT_VAL	GCNT15 count value
310E0F1D21	GCNT15_CNT_QLT	GCNT15 count quality
000E0F1F42	GCNT15_CORR_INS	GCNT15 correction instruction
000E0F1D91	GCNT15_TMP_01	GCNT15 count change selected signal(stSeld) for SAS
890E0F1EA2	GCNT15_CTR_SGUCN	GCNT15 control logic stage(under selection)
8A0E0F1E76	GCNT15_SLD_CSCN	GCNT15 selected condition signal
8B0E0F1E7B	GCNT15_SLF_CSCN	GCNT15 select fail condition signal
820E0F1E84	GCNT15_EC_OK_CSCN	GCNT15 execute command OK condition signal
830E0F1E8B	GCNT15_EC_F_CSCN	GCNT15 execute command fail condition signal
840E0F1E95	GCNT15_CC_SSCN	GCNT15 cancel success signal
320E101D20	GCNT16_CNT_VAL	GCNT16 count value
310E101D21	GCNT16_CNT_QLT	GCNT16 count quality
000E101F42	GCNT16_CORR_INS	GCNT16 correction instruction
000E101D91	GCNT16_TMP_01	GCNT16 count change selected signal(stSeld) for SAS
890E101EA2	GCNT16_CTR_SGUCN	GCNT16 control logic stage(under selection)
8A0E101E76	GCNT16_SLD_CSCN	GCNT16 selected condition signal
8B0E101E7B	GCNT16_SLF_CSCN	GCNT16 select fail condition signal
820E101E84	GCNT16_EC_OK_CSCN	GCNT16 execute command OK condition signal
830E101E8B	GCNT16_EC_F_CSCN	GCNT16 execute command fail condition signal
840E101E95	GCNT16_CC_SSCN	GCNT16 cancel success signal
320E111D20	GCNT17_CNT_VAL	GCNT17 count value
310E111D21	GCNT17_CNT_QLT	GCNT17 count quality
000E111F42	GCNT17_CORR_INS	GCNT17 correction instruction
000E111D91	GCNT17_TMP_01	GCNT17 count change selected signal(stSeld) for SAS
890E111EA2	GCNT17_CTR_SGUCN	GCNT17 control logic stage(under selection)
8A0E111E76	GCNT17_SLD_CSCN	GCNT17 selected condition signal
8B0E111E7B	GCNT17_SLF_CSCN	GCNT17 select fail condition signal
820E111E84	GCNT17_EC_OK_CSCN	GCNT17 execute command OK condition signal

◆ Signal monitoring points for respective counters (GCNT01 to GCNT32)

GCNT (Function ID: 540001)

Element ID	Name	Description
830E111E8B	GCNT17_EC_F_CSCN	GCNT17 execute command fail condition signal
840E111E95	GCNT17_CC_SSCN	GCNT17 cancel success signal
310E121D21	GCNT18_CNT_QLT	GCNT18 count quality
000E121F42	GCNT18_CORR_INS	GCNT18 correction instruction
000E121D91	GCNT18_TMP_01	GCNT18 count change selected signal(stSeld) for SAS
890E121EA2	GCNT18_CTR_SGUCN	GCNT18 control logic stage(under selection)
8A0E121E76	GCNT18_SLD_CSCN	GCNT18 selected condition signal
8B0E121E7B	GCNT18_SLF_CSCN	GCNT18 select fail condition signal
820E121E84	GCNT18_EC_OK_CSCN	GCNT18 execute command OK condition signal
830E121E8B	GCNT18_EC_F_CSCN	GCNT18 execute command fail condition signal
840E121E95	GCNT18_CC_SSCN	GCNT18 cancel success signal
320E131D20	GCNT19_CNT_VAL	GCNT19 count value
310E131D21	GCNT19_CNT_QLT	GCNT19 count quality
000E131F42	GCNT19_CORR_INS	GCNT19 correction instruction
000E131D91	GCNT19_TMP_01	GCNT19 count change selected signal(stSeld) for SAS
890E131EA2	GCNT19_CTR_SGUCN	GCNT19 control logic stage(under selection)
8A0E131E76	GCNT19_SLD_CSCN	GCNT19 selected condition signal
8B0E131E7B	GCNT19_SLF_CSCN	GCNT19 select fail condition signal
820E131E84	GCNT19_EC_OK_CSCN	GCNT19 execute command OK condition signal
830E131E8B	GCNT19_EC_F_CSCN	GCNT19 execute command fail condition signal
840E131E95	GCNT19_CC_SSCN	GCNT19 cancel success signal
320E141D20	GCNT20_CNT_VAL	GCNT20 count value
310E141D21	GCNT20_CNT_QLT	GCNT20 count quality
000E141F42	GCNT20_CORR_INS	GCNT20 correction instruction
000E141D91	GCNT20_TMP_01	GCNT20 count change selected signal(stSeld) for SAS
890E141EA2	GCNT20_CTR_SGUCN	GCNT20 control logic stage(under selection)
8A0E141E76	GCNT20_SLD_CSCN	GCNT20 selected condition signal
8B0E141E7B	GCNT20_SLF_CSCN	GCNT20 select fail condition signal
820E141E84	GCNT20_EC_OK_CSCN	GCNT20 execute command OK condition signal
830E141E8B	GCNT20_EC_F_CSCN	GCNT20 execute command fail condition signal
840E141E95	GCNT20_CC_SSCN	GCNT20 cancel success signal
320E151D20	GCNT21_CNT_VAL	GCNT21 count value
310E151D21	GCNT21_CNT_QLT	GCNT21 count quality
000E151F42	GCNT21_CORR_INS	GCNT21 correction instruction
000E151D91	GCNT21_TMP_01	GCNT21 count change selected signal(stSeld) for SAS
890E151EA2	GCNT21_CTR_SGUCN	GCNT21 control logic stage(under selection)
8A0E151E76	GCNT21_SLD_CSCN	GCNT21 selected condition signal
8B0E151E7B	GCNT21_SLF_CSCN	GCNT21 select fail condition signal
820E151E84	GCNT21_EC_OK_CSCN	GCNT21 execute command OK condition signal
830E151E8B	GCNT21_EC_F_CSCN	GCNT21 execute command fail condition signal
840E151E95	GCNT21_CC_SSCN	GCNT21 cancel success signal
320E161D20	GCNT22_CNT_VAL	GCNT22 count value
310E161D21	GCNT22_CNT_QLT	GCNT22 count quality
000E161F42	GCNT22_CORR_INS	GCNT22 correction instruction

◆ Signal monitoring points for respective counters (GCNT01 to GCNT32)

GCNT (Function ID: 540001)

Element ID	Name	Description
000E161D91	GCNT22_TMP_01	GCNT22 count change selected signal(stSeld) for SAS
890E161EA2	GCNT22_CTR_SGUCN	GCNT22 control logic stage(under selection)
8A0E161E76	GCNT22_SLD_CSCN	GCNT22 selected condition signal
8B0E161E7B	GCNT22_SLF_CSCN	GCNT22 select fail condition signal
820E161E84	GCNT22_EC_OK_CSCN	GCNT22 execute command OK condition signal
830E161E8B	GCNT22_EC_F_CSCN	GCNT22 execute command fail condition signal
840E161E95	GCNT22_CC_SSCN	GCNT22 cancel success signal
320E171D20	GCNT23_CNT_VAL	GCNT23 count value
310E171D21	GCNT23_CNT_QLT	GCNT23 count quality
000E171F42	GCNT23_CORR_INS	GCNT23 correction instruction
000E171D91	GCNT23_TMP_01	GCNT23 count change selected signal(stSeld) for SAS
890E171EA2	GCNT23_CTR_SGUCN	GCNT23 control logic stage(under selection)
8A0E171E76	GCNT23_SLD_CSCN	GCNT23 selected condition signal
8B0E171E7B	GCNT23_SLF_CSCN	GCNT23 select fail condition signal
820E171E84	GCNT23_EC_OK_CSCN	GCNT23 execute command OK condition signal
830E171E8B	GCNT23_EC_F_CSCN	GCNT23 execute command fail condition signal
840E171E95	GCNT23_CC_SSCN	GCNT23 cancel success signal
320E181D20	GCNT24_CNT_VAL	GCNT24 count value
310E181D21	GCNT24_CNT_QLT	GCNT24 count quality
000E181F42	GCNT24_CORR_INS	GCNT24 correction instruction
000E181D91	GCNT24_TMP_01	GCNT24 count change selected signal(stSeld) for SAS
890E181EA2	GCNT24_CTR_SGUCN	GCNT24 control logic stage(under selection)
8A0E181E76	GCNT24_SLD_CSCN	GCNT24 selected condition signal
8B0E181E7B	GCNT24_SLF_CSCN	GCNT24 select fail condition signal
820E181E84	GCNT24_EC_OK_CSCN	GCNT24 execute command OK condition signal
830E181E8B	GCNT24_EC_F_CSCN	GCNT24 execute command fail condition signal
840E181E95	GCNT24_CC_SSCN	GCNT24 cancel success signal
320E191D20	GCNT25_CNT_VAL	GCNT25 count value
310E191D21	GCNT25_CNT_QLT	GCNT25 count quality
000E191F42	GCNT25_CORR_INS	GCNT25 correction instruction
000E191D91	GCNT25_TMP_01	GCNT25 count change selected signal(stSeld) for SAS
890E191EA2	GCNT25_CTR_SGUCN	GCNT25 control logic stage(under selection)
8A0E191E76	GCNT25_SLD_CSCN	GCNT25 selected condition signal
8B0E191E7B	GCNT25_SLF_CSCN	GCNT25 select fail condition signal
820E191E84	GCNT25_EC_OK_CSCN	GCNT25 execute command OK condition signal
830E191E8B	GCNT25_EC_F_CSCN	GCNT25 execute command fail condition signal
840E191E95	GCNT25_CC_SSCN	GCNT25 cancel success signal
320E1A1D20	GCNT26_CNT_VAL	GCNT26 count value
310E1A1D21	GCNT26_CNT_QLT	GCNT26 count quality
000E1A1F42	GCNT26_CORR_INS	GCNT26 correction instruction
000E1A1D91	GCNT26_TMP_01	GCNT26 count change selected signal(stSeld) for SAS
890E1A1EA2	GCNT26_CTR_SGUCN	GCNT26 control logic stage(under selection)
8A0E1A1E76	GCNT26_SLD_CSCN	GCNT26 selected condition signal
8B0E1A1E7B	GCNT26_SLF_CSCN	GCNT26 select fail condition signal

◆ Signal monitoring points for respective counters (GCNT01 to GCNT32)

GCNT (Function ID: 540001)

Element ID	Name	Description
820E1A1E84	GCNT26_EC_OK_CSCN	GCNT26 execute command OK condition signal
830E1A1E8B	GCNT26_EC_F_CSCN	GCNT26 execute command fail condition signal
840E1A1E95	GCNT26_CC_SSCN	GCNT26 cancel success signal
320E1B1D20	GCNT27_CNT_VAL	GCNT27 count value
310E1B1D21	GCNT27_CNT_QLT	GCNT27 count quality
000E1B1F42	GCNT27_CORR_INS	GCNT27 correction instruction
000E1B1D91	GCNT27_TMP_01	GCNT27 count change selected signal(stSeld) for SAS
890E1B1EA2	GCNT27_CTR_SGUCN	GCNT27 control logic stage(under selection)
8A0E1B1E76	GCNT27_SLD_CSCN	GCNT27 selected condition signal
8B0E1B1E7B	GCNT27_SLF_CSCN	GCNT27 select fail condition signal
820E1B1E84	GCNT27_EC_OK_CSCN	GCNT27 execute command OK condition signal
830E1B1E8B	GCNT27_EC_F_CSCN	GCNT27 execute command fail condition signal
840E1B1E95	GCNT27_CC_SSCN	GCNT27 cancel success signal
320E1D1D20	GCNT28_CNT_VAL	GCNT28 count value
310E1D1D21	GCNT28_CNT_QLT	GCNT28 count quality
000E1D1F42	GCNT28_CORR_INS	GCNT28 correction instruction
000E1D1D91	GCNT28_TMP_01	GCNT28 count change selected signal(stSeld) for SAS
890E1D1EA2	GCNT28_CTR_SGUCN	GCNT28 control logic stage(under selection)
8A0E1D1E76	GCNT28_SLD_CSCN	GCNT28 selected condition signal
8B0E1D1E7B	GCNT28_SLF_CSCN	GCNT28 select fail condition signal
820E1D1E84	GCNT28_EC_OK_CSCN	GCNT28 execute command OK condition signal
830E1D1E8B	GCNT28_EC_F_CSCN	GCNT28 execute command fail condition signal
840E1D1E95	GCNT28_CC_SSCN	GCNT28 cancel success signal
320E1D1D20	GCNT29_CNT_VAL	GCNT29 count value
310E1D1D21	GCNT29_CNT_QLT	GCNT29 count quality
000E1D1F42	GCNT29_CORR_INS	GCNT29 correction instruction
000E1D1D91	GCNT29_TMP_01	GCNT29 count change selected signal(stSeld) for SAS
890E1D1EA2	GCNT29_CTR_SGUCN	GCNT29 control logic stage(under selection)
8A0E1D1E76	GCNT29_SLD_CSCN	GCNT29 selected condition signal
8B0E1D1E7B	GCNT29_SLF_CSCN	GCNT29 select fail condition signal
820E1D1E84	GCNT29_EC_OK_CSCN	GCNT29 execute command OK condition signal
830E1D1E8B	GCNT29_EC_F_CSCN	GCNT29 execute command fail condition signal
840E1D1E95	GCNT29_CC_SSCN	GCNT29 cancel success signal
320E1E1D20	GCNT30_CNT_VAL	GCNT30 count value
310E1E1D21	GCNT30_CNT_QLT	GCNT30 count quality
000E1E1F42	GCNT30_CORR_INS	GCNT30 correction instruction
000E1E1D91	GCNT30_TMP_01	GCNT30 count change selected signal(stSeld) for SAS
890E1E1EA2	GCNT30_CTR_SGUCN	GCNT30 control logic stage(under selection)
8A0E1E1E76	GCNT30_SLD_CSCN	GCNT30 selected condition signal
8B0E1E1E7B	GCNT30_SLF_CSCN	GCNT30 select fail condition signal
820E1E1E84	GCNT30_EC_OK_CSCN	GCNT30 execute command OK condition signal
830E1E1E8B	GCNT30_EC_F_CSCN	GCNT30 execute command fail condition signal
840E1E1E95	GCNT30_CC_SSCN	GCNT30 cancel success signal
320E1F1D20	GCNT31_CNT_VAL	GCNT31 count value

◆ Signal monitoring points for respective counters (GCNT01 to GCNT32)

GCNT (Function ID: 540001)

Element ID	Name	Description
310E1F1D21	GCNT31_CNT_QLT	GCNT31 count quality
000E1F1F42	GCNT31_CORR_INS	GCNT31 correction instruction
000E1F1D91	GCNT31_TMP_01	GCNT31 count change selected signal(stSeld) for SAS
890E1F1EA2	GCNT31_CTR_SGUCN	GCNT31 control logic stage(under selection)
8A0E1F1E76	GCNT31_SLD_CSCN	GCNT31 selected condition signal
8B0E1F1E7B	GCNT31_SLF_CSCN	GCNT31 select fail condition signal
820E1F1E84	GCNT31_EC_OK_CSCN	GCNT31 execute command OK condition signal
830E1F1E8B	GCNT31_EC_F_CSCN	GCNT31 execute command fail condition signal
840E1F1E95	GCNT31_CC_SSCN	GCNT31 cancel success signal
320E201D20	GCNT32_CNT_VAL	GCNT32 count value
310E201D21	GCNT32_CNT_QLT	GCNT32 count quality
000E201F42	GCNT32_CORR_INS	GCNT32 correction instruction
000E201D91	GCNT32_TMP_01	GCNT32 count change selected signal(stSeld) for SAS
890E201EA2	GCNT32_CTR_SGUCN	GCNT32 control logic stage(under selection)
8A0E201E76	GCNT32_SLD_CSCN	GCNT32 selected condition signal
8B0E201E7B	GCNT32_SLF_CSCN	GCNT32 select fail condition signal
820E201E84	GCNT32_EC_OK_CSCN	GCNT32 execute command OK condition signal
830E201E8B	GCNT32_EC_F_CSCN	GCNT32 execute command fail condition signal
840E201E95	GCNT32_CC_SSCN	GCNT32 cancel success signal

3.7 Mode control function (MDCTRL)

For the user, mode control (MDCTRL) function can provide test function (TEST-FB) interface, which is a command to change the mode in the function. MDCTRL function consists of two parts: (1) On-mode or Test-mode sensing in IED and (2) interface between IED and SAS.

Note: The implementation of particular features is dependent upon the selection of hardware and the configuration of functions. Several IED models do not support certain features. To determine whether a particular feature has been implemented within an IED, identify the IED ordering number; and check the order number for the "G&T position" whilst referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 3.7-1 Comparative table in respective ordering numbers

Sec.	Feature		Ordering No. at "G&T"			
		10	11	13	19	22
–	Main features	✓	✓	✓	✓	✓

✓: Applicable NA: Not applicable

3.7.1 Function

(i) Mode sensor

The MDCTRL function can monitor the state change (On to TEST / TEST to Off) in the IED. To use this monitoring function, **On** should be set for the scheme switch [**MDCTRL-EN**] prior to operation. During the operation, a select signal and an operate signal are provided for the TEST-FB when the SAS provides a test command for the IED; hence, the MDCTRL function comes with two time-out timers. Setting [**MDCTRL-SELRST**] provides a time-out timer for canceling a select command; setting [**MDCTRL-EXERST**] provides a time-out timer for canceling an operate command.

(ii) Interface for IEC61850

The MDCTRL function can fulfil the two operation modes (On and Test) specified in the IEC 61850 communication, as shown in Table 3.7-2; the MDCTRL function can carry a signal for changing for the TEST-FB; the signal is generated in the select and control logics in the MDCTRL function. The change signal is initiated by the mode change command that is received at the communication interface. Note that control operations from a SAS is only taken account.

Table 3.7-2 Values of mode and behavior in IEC 61850

Value	Mode	Definition in IEC 61850
1	On	The application represented by the LN works. All communication services work and get updated values.
3	Test	The application represented by the LN works. All communication services work and get updated values. Data objects will be transmitted with quality “test”. Control commands with quality test will be accepted only by LNs in “test” or “test-blocked” mode. “Processed as valid” means that the application should react in the manner what is foreseen for “test”.

3.7.2 Mapping for IEC61850 communication

The user can operate the MDCTRL function over the IEC61850 communication after the mapping using GR-TIEMS. The user should follow steps,

Step1: Editing Logical Node

Step2: Mapping output data

Step3: Mapping input data

(i) Editing Logical Node

The user should make a logical node (LN) for the MDCTRL function. Figure 3.7-1exemplifies LN editing; the LN "LLNO" is chosen for the MDCTRL01 for IEC61850 communication. After the user defining an object "MOD", the MDCTRL01 logical node can be saved with the name "LLNO". Make a definition of the object "MOD" in MDCTRL01 logical node. Either the SBO mode or the DIR mode can be chosen in the LN editing.

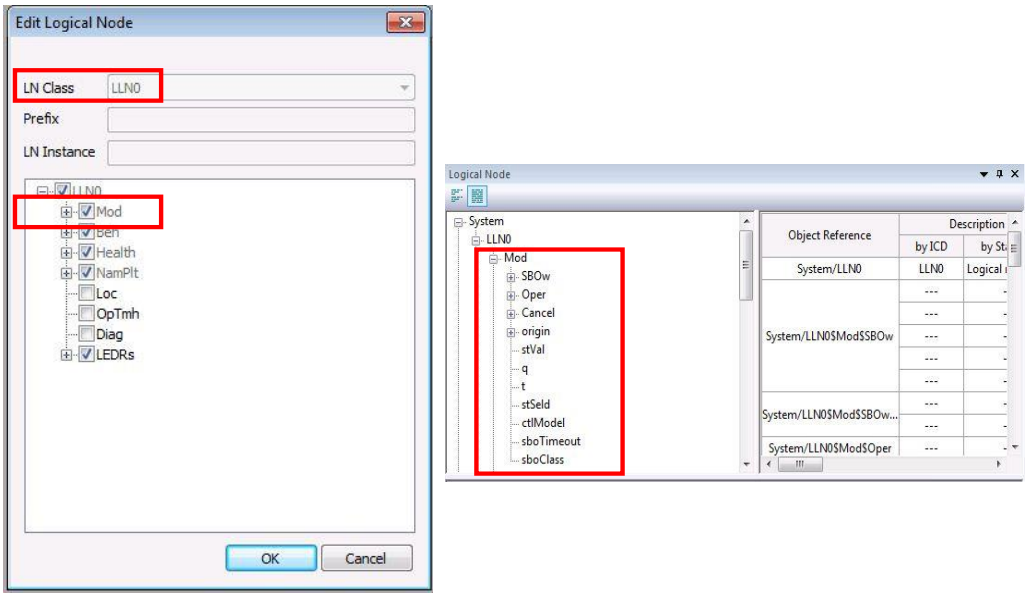
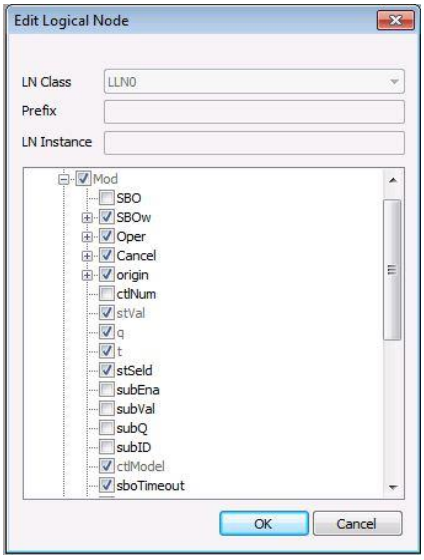


Figure 3.7-1 Defining "MOD" object in LLNO logic node

(i)-1 Defining SBO mode

Figure 3.7-2 exemplifies the settings in LN "LLNO" when the SBO mode is required for the MDCTRL01 function. In the SBO control, the user should select the following items for the "LLNO$MOD" using the GR-TIEMS;



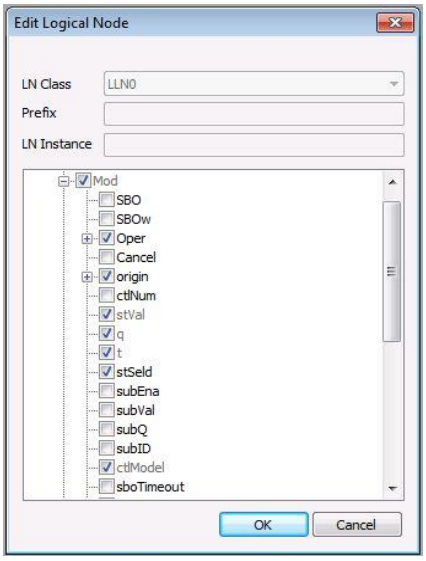
SBOw
Oper
Cancel
Origin
stSeld
sboClass† (choice ”operate-once”)
ctlmodel (choice ”SBOes or SBOns”)

†”sboClass” can be found by scrolling down.

Figure 3.7-2 LN editing screen for SBO mode (for example)

(i)-2 Defining DIR mode

Figure 3.7-3 exemplifies the settings in LN “LLNO” when the DIR mode is required for the MDCTRL01 function. In the DIR mode, the following three items should be selected using the GR-TIEMS:



Oper
origin
ctlmodel (choice ”DOes or DOns”)

Figure 3.7-3 LN editing screen for DIR mode (for example)

(ii) Mapping output data

The user should group the MDCTRL01 signals with regard to GOOSE and REPORT; the user should map them for the IEC 61850 communication using GR-TIEMS.

Table 3.7-3 shows the required mapping signals in MDCTRL01 function to the IEC 61850 communications. Figure below shows how to map a signal.

Note: “Status (ST)” is defined in the function constraint (FC) of the IEC 61850 standard.

Table 3.7-3 Mapping signals for MOD object.

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
System/LLN0Modorigin	orCat	orCategory	ST	5500013013011000	MDCTRL01_ORCAT
System/LLN0Modorigin	orIdent	Octet64	ST	5500016A13011009	MDCTRL01_ORIDENT
System/LLN0$Mod	stSeld	BOOLEAN	ST	5500010013011D90	MDCTRL01_SLD_RPT

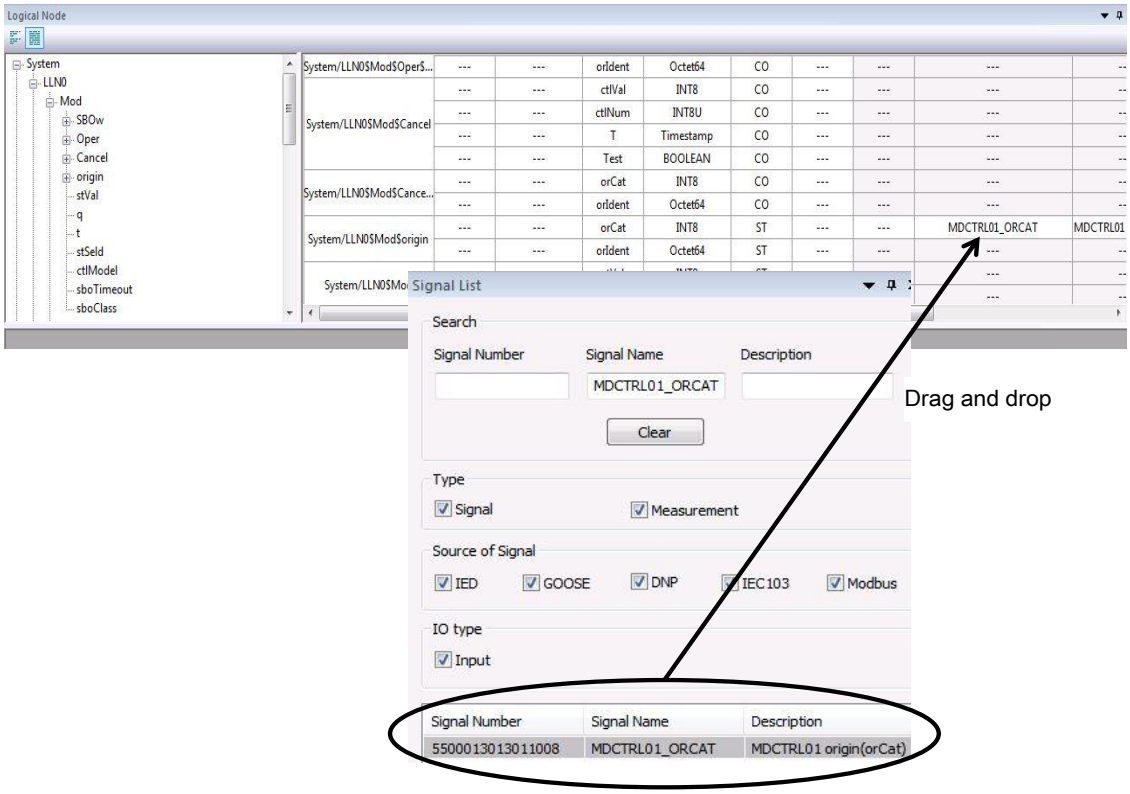


Figure 3.7-4 orCat attribute mapped into MOD object of LLNO

(iii) Mapping input data

The MDCTRL01 function can receive three commands “select, operate, and cancel. Thus, the user should map the input-point “MDCTRL01_CONTROL_REQ”. Table 3.7-4 shows the input-point “MDCTRL01_CONTROL_REQ” and the Object reference “System/LLN0Mod”; the user should map the Object reference having attributes CO and CF in FC to the input-point. Note that the user should map the input-point to all attributes having CO and CF. Figure below shows how to map a signal.

Table 3.7-4 Mapping signals required for LLNO object in MDCTRL01 function

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
System/LLN0ModSBOw	ctlVal	Mod	CO		
System/LLN0ModSBOw	ctlNum	INT8U	CO		
System/LLN0ModSBOw	T	Timestamp	CO		
System/LLN0ModSBOw	Test	BOOLEAN	CO		
System/LLN0ModSBOw	Check	Check	CO		
System/LLN0ModSBOw$origin	orCat	orCategory	CO		
System/LLN0ModSBOw$origin	orIdent	Octet64	CO		
System/LLN0ModOper	ctlVal	Mod	CO		
System/LLN0ModOper	ctlNum	INT8U	CO		
System/LLN0ModOper	T	Timestamp	CO		
System/LLN0ModOper	Test	BOOLEAN	CO		
System/LLN0ModOper	Check	Check	CO	5500017013016D08	MDCTRL01_CONTROL_REQ
System/LLN0ModOper$origin	orCat	orCategory	CO		
System/LLN0ModOper$origin	orIdent	Octet64	CO		
System/LLN0ModCancel	ctlVal	Mod	CO		
System/LLN0ModCancel	ctlNum	INT8U	CO		
System/LLN0ModCancel	T	Timestamp	CO		
System/LLN0ModCancel	Test	BOOLEAN	CO		
System/LLN0ModCancel$origin	orCat	orCategory	CO		
System/LLN0ModCancel$origin	orIdent	Octet64	CO		
System/LLN0$Mod	ctlModel	ctlModel	CF		
System/LLN0$Mod	sboTimeout	INT32U	CF		
System/LLN0$Mod	sboClass	sboClass	CF		

†Note: The attribute is defined in the IEC 61850 standard; "CO" stands for "Control" and "CF" stands for "Configuration" in the functional constraint (FC).

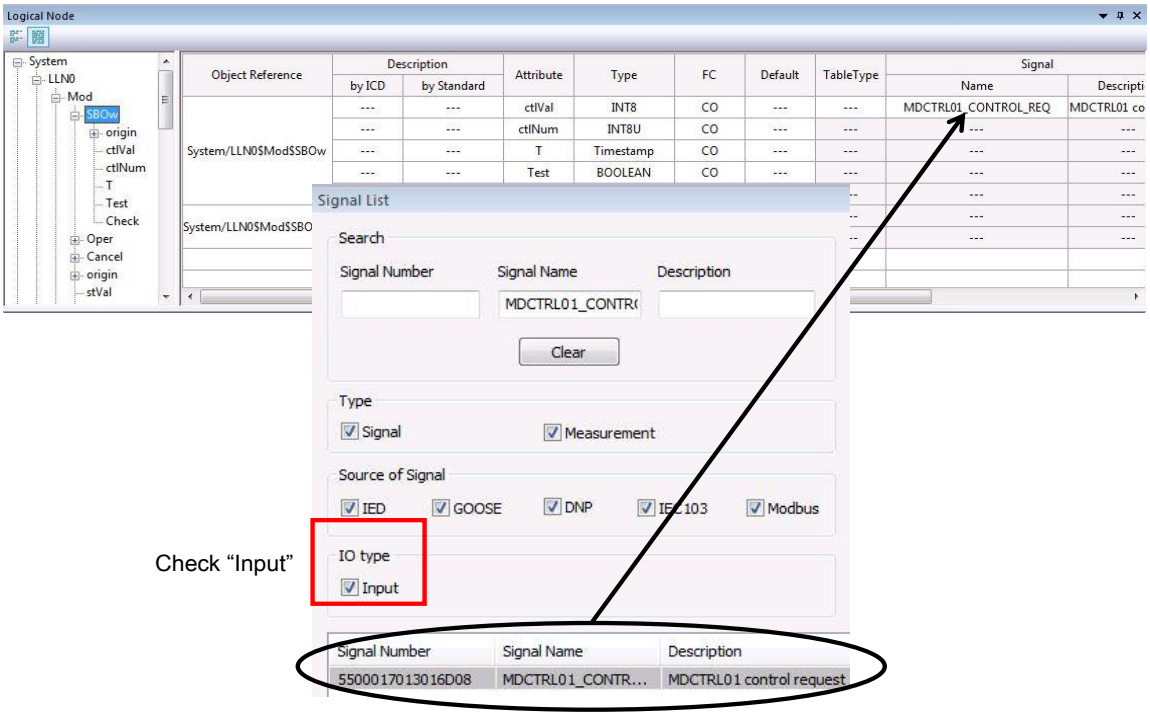


Figure 3.7-5 Input-point mapped for LLNO

3.7.3 Setting

Setting of MDCTRL (Function ID: 550001)

Setting item		Range	Units	Contents	Default setting value	Notes
	MDCTRL-EN	Off/On	–	Switch for operation	On	
	MDCTRL-SELRST	10-100	s	Selection cancel time-out timer	30	
	MDCTRL-EXERST	10-100	s	Waiting execute operation time-out timer	30	

3.7.4 Signal

◆ Signal monitoring point

MDCTRL(Function ID: 550001)

Element ID	Name	Description
8013011D51	MDCTRL01_SC_OWS	MDCTRL01 select command by OWS(HMI)
8013011D52	MDCTRL01_SC_RCC	MDCTRL01 select command by RCC
8013011D53	MDCTRL01_SC_RMT	MDCTRL01 select command by Remote
8013011D55	MDCTRL01_EC_OWS	MDCTRL01 execute command by OWS(HMI)
8013011D56	MDCTRL01_EC_RCC	MDCTRL01 execute command by RCC
8013011D57	MDCTRL01_EC_RMT	MDCTRL01 execute command by Remote
8713011E98	MODE01_SLF_FCT_EIS	MDCTRL01 select fail factor signal
8013011F56	MODE01_NSL_CS06	MDCTRL01 no direction select condition signal 06
8613011F5E	MODE01_NSL_CS07	MDCTRL01 no direction select condition signal 07
8B13011EA2	MODE01_CTR_SGU	MDCTRL01 control logic stage(under selection)
8213011F5F	MODE01_NSL_CS10	MDCTRL01 no direction select condition signal 10
8313011F41	MODE01_NSD_CSF	MDCTRL01 no direction selected condition signal
8513011F60	MODE01_FSL_CS19	MDCTRL01 On direction select condition signal 19
8A13011F61	MODE01_FSL_CS20	MDCTRL01 On direction select condition signal 20
8113011F64	MODE01_FSL_CS21	MDCTRL01 On direction select condition signal 21
8D13011F42	MODE01_FSD_CSF	MDCTRL01 On direction selected condition signal
8513011F65	MODE01_OSL_CS40	MDCTRL01 Test direction select condition signal 40
8813011F5D	MODE01_OSL_CS41	MDCTRL01 Test direction select condition signal 41
8513011F5B	MODE01_OSL_CS42	MDCTRL01 Test direction select condition signal 42
8F13011F43	MODE01_OSD_CSF	MDCTRL01 Test direction selected condition signal
8013011E76	MODE01_SLD_CS	MDCTRL01 selected condition signal
8113011E7B	MODE01_SLF_CS	MDCTRL01 select fail condition signal
8013011F54	MODE01_SC_ST_ERR	MDCTRL01 select command mode err
8813011F6B	MODE01_SLF_FCT_FLG07	MDCTRL01 select fail factor signal by fixed logic 07
8613011F62	MODE01_SLF_FCT_FLG03	MDCTRL01 select fail factor signal by fixed logic 03
8713011F63	MODE01_SLF_FCT_FLG04	MDCTRL01 select fail factor signal by fixed logic 04
8E13011F57	MODE01_SLD_TMO	MDCTRL01 time out after selected
8F13011F58	MODE01_EX_CMP_TMO	MDCTRL01 timeout after execute completion
8313011E9D	MODE01_CTR_SGN	MDCTRL01 control logic stage(unselected)
8013011F66	MODE01_SLD_CS04	MDCTRL01 selected condition signal 04
8013011E7D	MODE01_SLR_CS	MDCTRL01 select release condition signal
8113011E9A	MODE01_ECF_FCT_EIS	MDCTRL01 execute command fail factor signal check
8013011E81	MODE01_FEC_OK_CS	MDCTRL01 On direction execute command OK condition signal
8113011E82	MODE01_OEC_OK_CS	MDCTRL01 Test direction execute command OK condition signal
8213011E88	MODE01_FEC_F_CS	MDCTRL01 On direction execute command fail condition signal
8313011E89	MODE01_OEC_F_CS	MDCTRL01 Test direction execute command fail condition signal
8013011F55	MODE01_EC_ST_ERR	MDCTRL01 execute command mode err
8213011F44	MODE01_EX_OUT	MDCTRL01 execute output signal
8913011F6C	MODE01_EX_CS01	MDCTRL01 execute condition signal 01
8A13011F6D	MODE01_EX_CS02	MDCTRL01 execute condition signal 02
8513011E8F	MODE01_EX_SFL	MDCTRL01 execute success signal
8613011E91	MODE01_EX_FFL	MDCTRL01 execute fail signal
8013011E93	MODE01_EX_CMP	MDCTRL01 execute complete signal

◆ Signal monitoring point

MDCTRL(Function ID: 550001)

Element ID	Name	Description
8913011F72	MODE01_SLF_FCT_FLG08	MDCTRL01 select fail factor signal by fixed logic 08
8B13011F6E	MODE01_EX_CS03	MDCTRL01 execute condition signal 03
8813011E9B	MODE01_CC_ST_ERR	MDCTRL01 cancel command mode err
8313011E9C	MODE01_CCF_FCT_CS	MDCTRL01 cancel command fail factor condition signal
8613011E95	MODE01_CC_SS	MDCTRL01 cancel command success signal
8713011E96	MODE01_CC_FS	MDCTRL01 cancel command fail signal

◆ Connection point in PLC logic

MDCTRL(Function ID: 550001)

Element ID	Name	Description
8313002F52	MDCTRL00IN_TMP_16	MDCTRL00IN_TMP_16
821301ED50	MDCTRL01IN_TMP_28	MDCTRL01IN_TMP_28

4 Control and monitoring application

4.1 Single position device function (SPOS)

The single position device function (SPOS) is used when the user wishes to control a device from On or Off state. When a select command is provided for the IED, the SPOS function can issue a control command if the SPOS function obtains the response from the device. The SPOS function also can accept a cancel command after issuing the selection command. In the SPOS function, issuing and receiving a command and a response are performed via a binary IO module †; hence, the user should connect the BI and BO circuits with the SPOS function. The SPOS function includes three logic groups: 1. Select logic, 2. Cancel logic, and 3. Operate logic.

Ten devices can be controlled separately, i.e. the SPOS function has separate sets of logic for control (i.e., SPOS01, SPOS02 etc. functions). For simplicity, only the SPOS01 function is discussed here; the features in the SPOS02 etc. functions are identical to the SPOS01 function.

†Note: A binary IO module has binary input circuits (BIs) and binary output circuits (BOs); the user makes the connection between the SPOS01 function and the binary IO module using a signal number (is made of a function ID and an "Element ID").The signal name and number of the SPOS01 function are listed later.

Tips: If the user wishes to apply the SPOS function quickly, go to sections 4.1.4 and 4.1.5, where setting of the BI and BO circuits and the mapping of signals for IEC 61850 communication is described.

Note: The implementation of such features depends on the selection of hardware and the configuration of functions. Several IED models do not have its features. To determine whether its features are implemented in the IED, locate the IED ordering number; and check the order number at the "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 4.1-1 Comparative table in respective ordering numbers

Sec.	Feature	Ordering No. at "G&T"				
		10	11	13	19	22
–	Main features	NA	NA	NA	NA	✓
–	Number of functions	–	–	–	–	10

✓: Applicable NA: Not applicable

4.1.1 Selection logic for SBO/DIR modes

The user should set scheme switch [**SPOS01-CTREN**] to **On** prior to SPOS01 operation. Table 4.1-10 shows all of the scheme switches in the SPOS function.

(i) Receiving "select command ON" from the remote-end

Figure 4.1-1 outlines the reception of the select command 'On' from the remote-end.

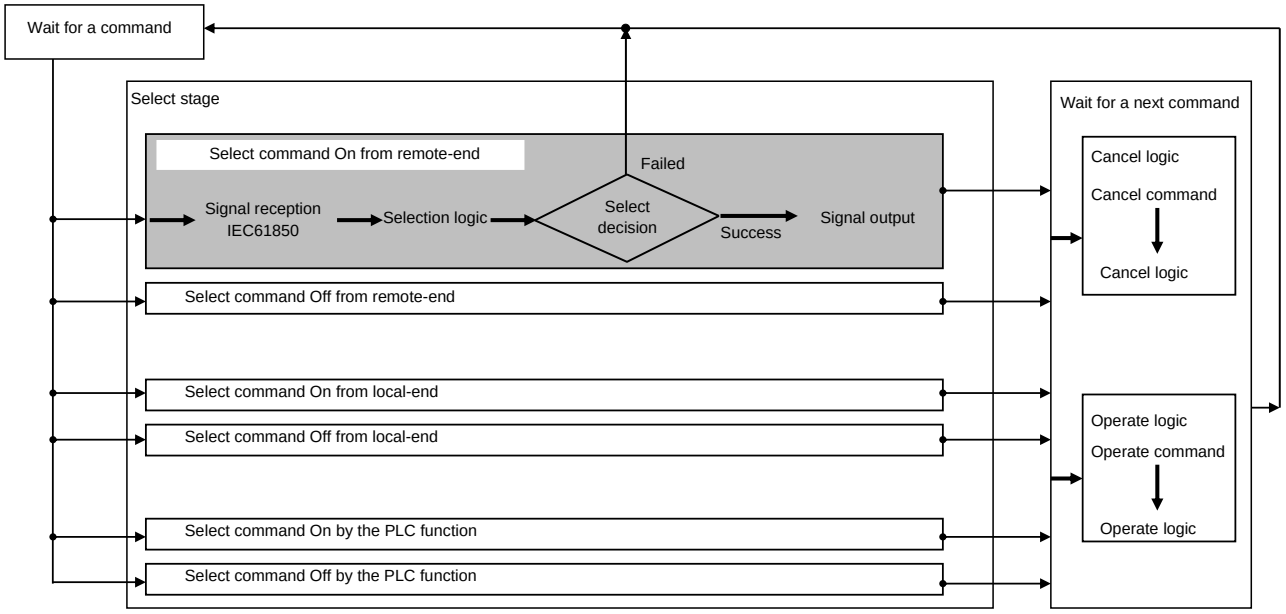


Figure 4.1-1 Outline of select command 'On'

(i)-1 Input point required mapping

Figure 4.1-2 shows the select logic when a "Select command ON (Remote-ON-Control)" signal applied to the SPOS01 function. This logic has the input-point "DEV01_CONTROL_REQ" for the reception of the selection command. That is, the input-point must be mapped for IEC 61850 communication. The function will fail to operate if mapping is not performed correctly. We will discuss how to map the input-points for IEC61850 communication in section 4.1.5.

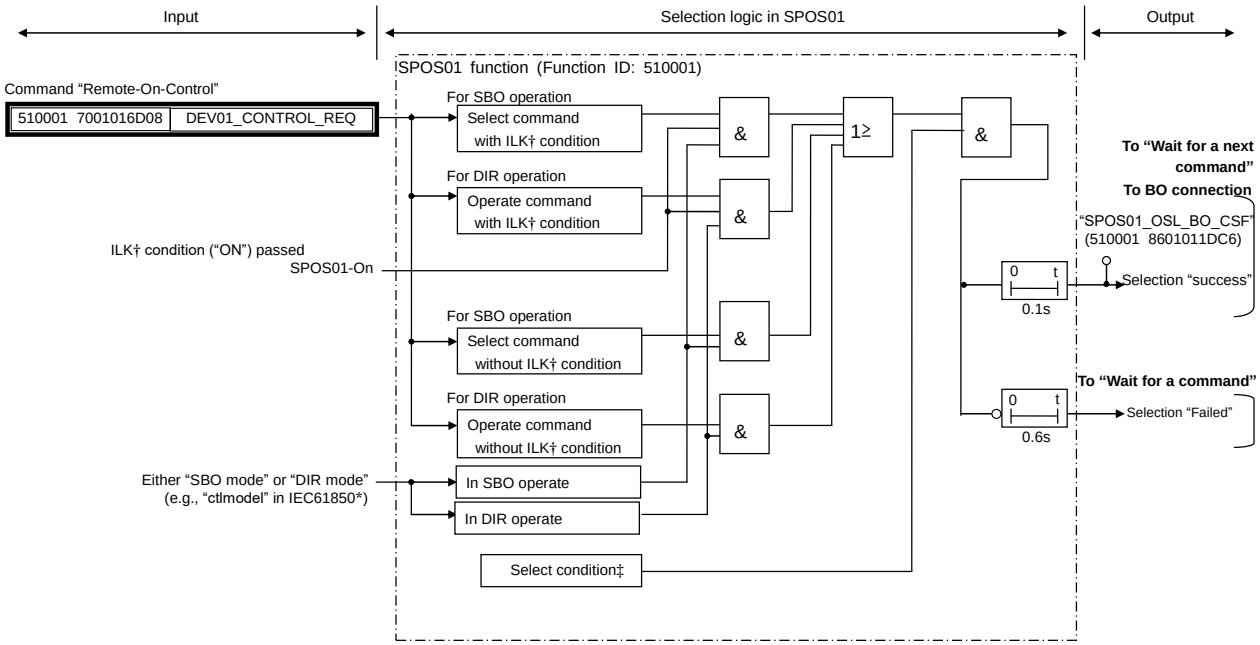


Figure 4.1-2 Select ON from the remote-end in SPOS01††

†Note: The software interlocking (ILK) function can provide the operation criteria for "On". The ILK function is discussed separately; note that the operation criteria is defined by the ILK function itself (i.e., the user cannot set the condition).

‡Note: A "select condition" signal is provided from the select condition scheme. For more information, see Figure 4.1-13.

*Note: The SPOS01 function can run in either the "SBO mode" or the "DIR mode". The user can use a signal called "ctlmodel" when communication is implemented using IEC61850. To use this signal, the user must map it for IEC61850 communication.

††Note: To identify the input and output points of the other SPOS logics, see Table 4.1-5 and Table 4.1-9.

(i)-2 Output signal to BO

The SPOS01 function can issue an output "Selection success" signal at the output point "SPOS01_OSL_BO_CSF", when the SPOS01 function determines that the "Remote-ON-Control" signal received is true. If the SPOS01 function determines that the "Remote-ON-Control" signal is not true, the SPOS01 function returns to the "Wait for a command" stage.

(ii) Receiving “select command Off” from the remote-end

Figure 4.1-3 outlines the reception of the select command ‘Off’ from the remote- end.

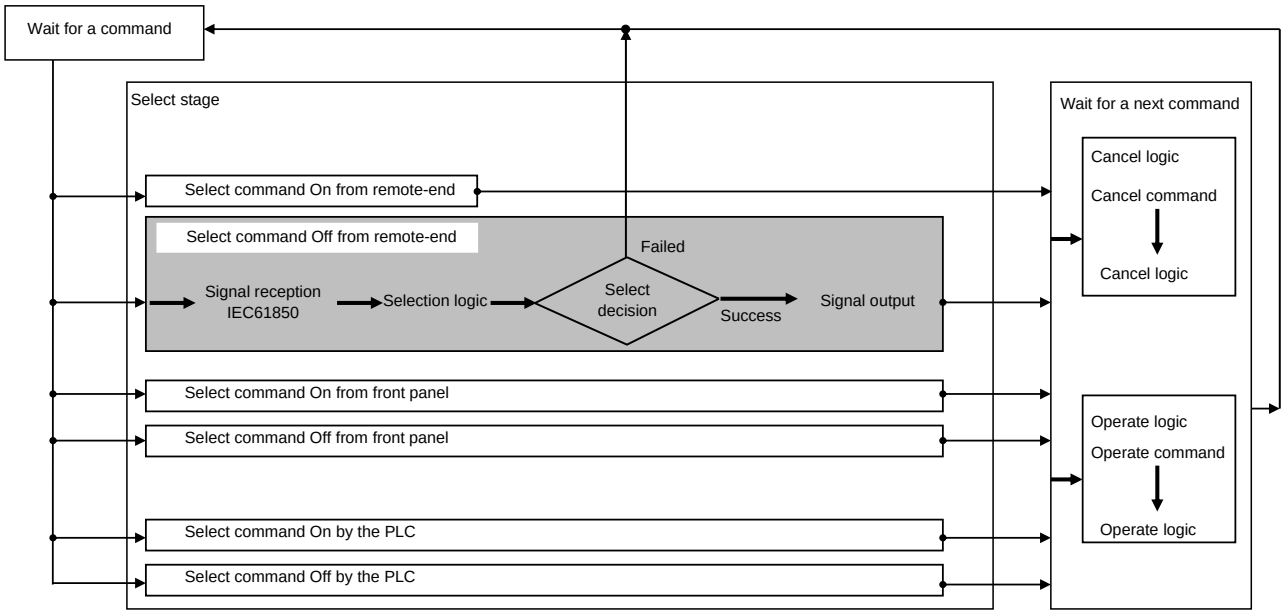


Figure 4.1-3 Outline of select command ‘Off’

(ii)-1 Input point required mapping

Figure 4.1-4 shows the select logic when a “Select command Off (Remote-OFF-Control)” signal is received at the input-point “DEV01_CONTROL_REQ”.

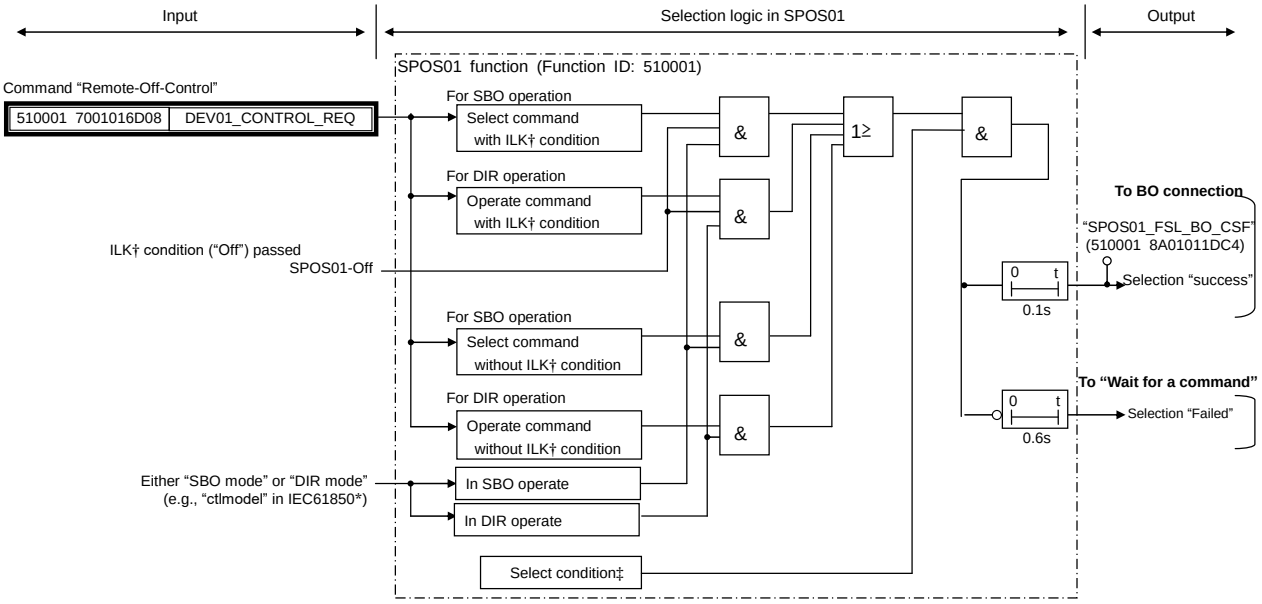


Figure 4.1-4 Select ‘OFF’ from the remote-end in SPOS01††

†Note:The ILK function provides the operation criteria for “Off”.

‡Note:The “select condition” signal is provided. See Figure 4.1-13.

††Note: To identify the input and output points of the other SPOS logics, see Table 4.1-5 and Table 4.1-9.

(ii)-2 Output signal to BO

The SPOS01 function, in Figure 4.1-4, can issue a "Select success" signal at the output point "SPOS01_FSL_BO_CSF" when the SPOS01 function determines that the "Select command Off (Remote-OFF-Control)" signal is true. If the SPOS01 function determines that the "Remote-OFF-Control" signal is not true, the SPOS01 function returns to the "Wait for a command" stage.

(iii) Receiving "Selection command On" from the local-end

Figure 4.1-5 outlines the reception of the selection command 'On' from the local-end.

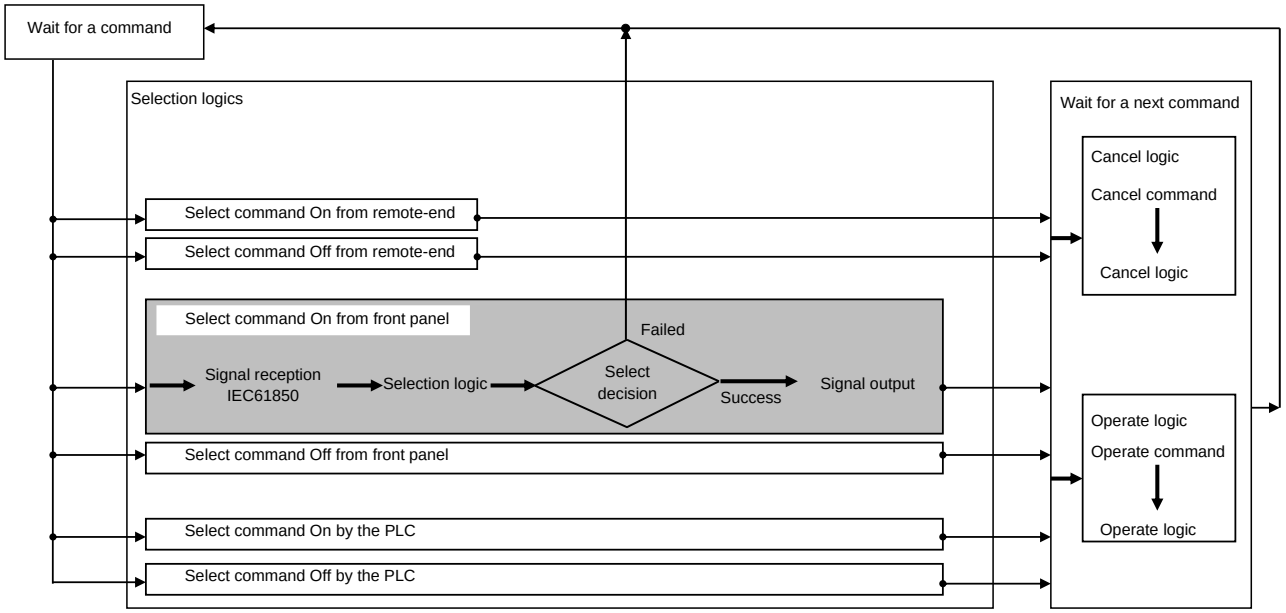


Figure 4.1-5 Outline of selection command 'On'

(iii)-1 Input signal generated at the local-end.

Figure 4.1-6 shows the select logic when a "Select command On (Local-ON-Control)" signal is applied to the SPOS01 function. The signal is provided when an "On" key is pressed on the IED front panel; the user is not required to map the signal from the IEC61850 communication. Note that the user should set the scheme switch [**SPOS01-CTRAHMI**] to **SBO** when operation from the IED front panel is required, we discuss how to set this in chapter *User interface: Control sub-menu*.

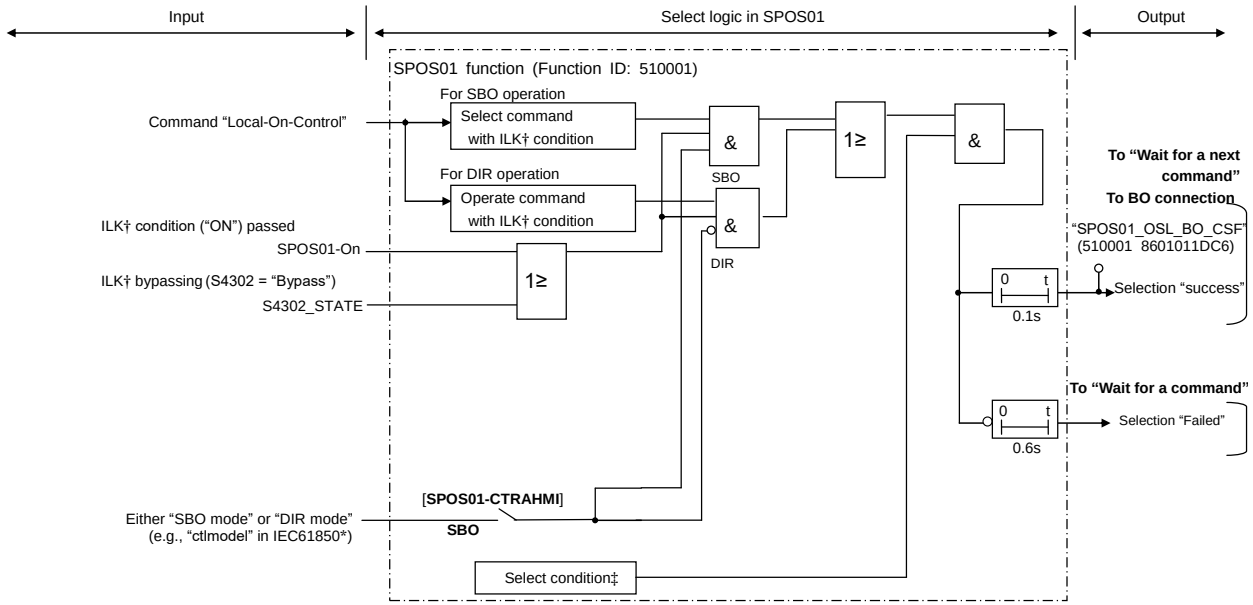


Figure 4.1-6 Select 'On' on the front panel in SPOS01††

†Note: The ILK function provides the operation criteria for "On". For testing, nullifying the ILK function is possible using "Interlock bypassing". "Interlock bypassing" is indicated by the status "S4302" in a software switch controller (SOFTSW).

‡Note: A "select condition" signal is provided from the select condition scheme. For more information, see Figure 4.1-13.

††Note: To identify the output signals of the other SPOS logic, see Table 4.1-9.

(iii)-2 Output signal to BO

When the "select condition" signal is true, the SPOS01 function can issue a "Selection success" signal at the output-point "SPOS01_OSL_BO_CSF".

Note: The signal "SPOS01_OSL_BO_CSF" is the same as the signal shown in Figure 4.1-2. If the "Local-ON-Control" signal is not true, the SPOS01 function returns to the "Wait for a command" stage.

(iv) Receiving "Select command Off" from the local-end

Figure 4.1-7 outlines the reception of the select command 'Off' from the local-end.

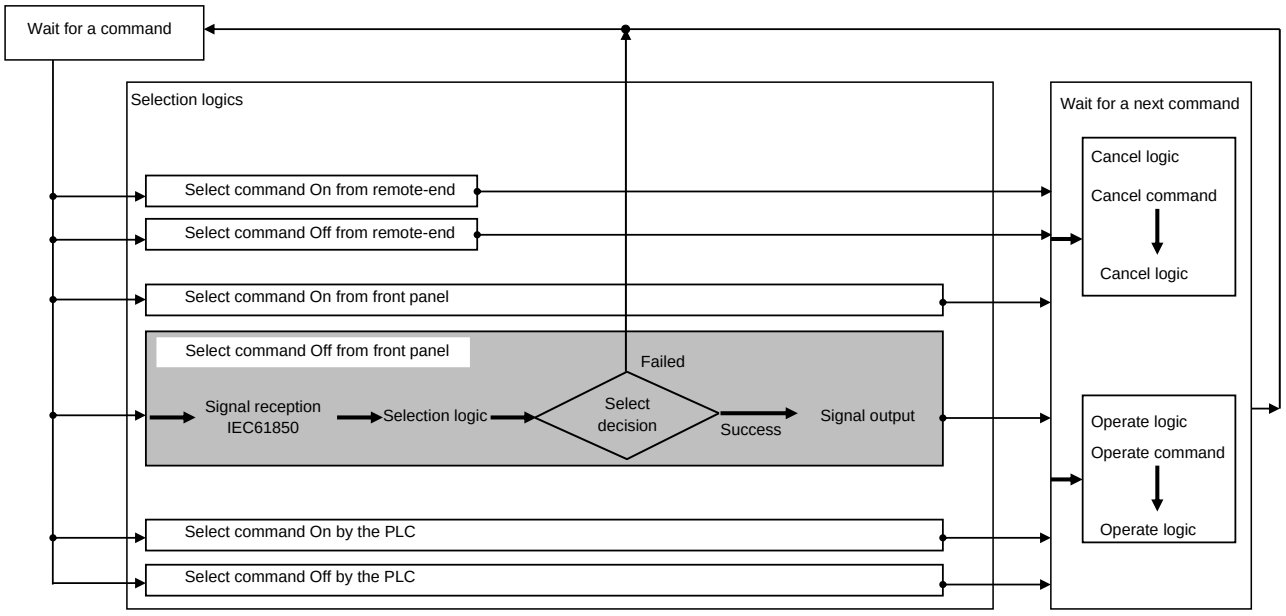


Figure 4.1-7 Outline of select command 'Off'

(iv)-1 Input signal generated at the local-end.

Figure 4.1-8 shows the select logic when a "Select command Off (Local-OFF-Control)" signal is applied to the SPOS01 function. The signal is provided when the user presses an "OFF" key on the IED front panel; the user is not required to map the signal from IEC61850 communication.

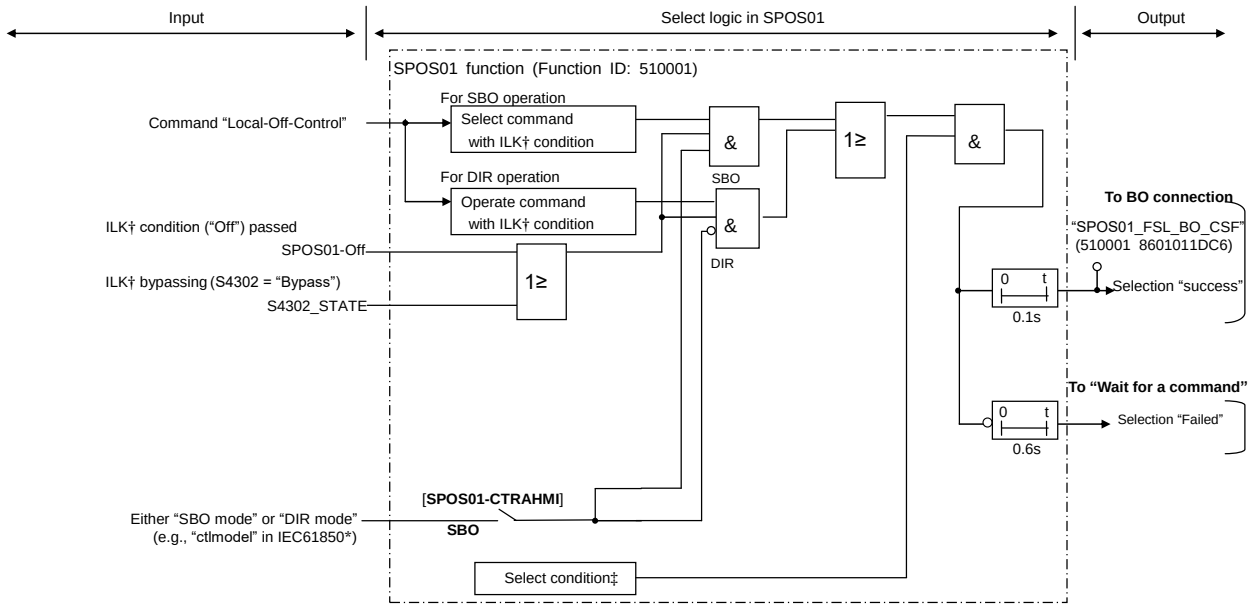


Figure 4.1-8 Select 'Off' on the front panel in SPOS01††

‡Note: A "select condition" signal is provided from the select condition scheme. For more information, see Figure 4.1-13.

††Note: To identify the output signals of the other SPOS logics, see Table 4.1-9.

(iv)-2 Output signal to BO

When the "select condition" signal is true, the SPOS01 function can issue a "Selection success" signal at the output-point "SPOS01_FSL_BO_CSF".

[1]Note: The signal "SPOS01_FSL_BO_CSF" is the same as the signal shown in Figure 4.1-4. If the "Local-OFF-Control" signal is not true, the SPOS01 function returns to the "Wait for a command" stage.

(v) Receiving "Selection command for ON" by PLC function

Figure 4.1-9 outlines the reception of the select command 'On' by the PLC function.

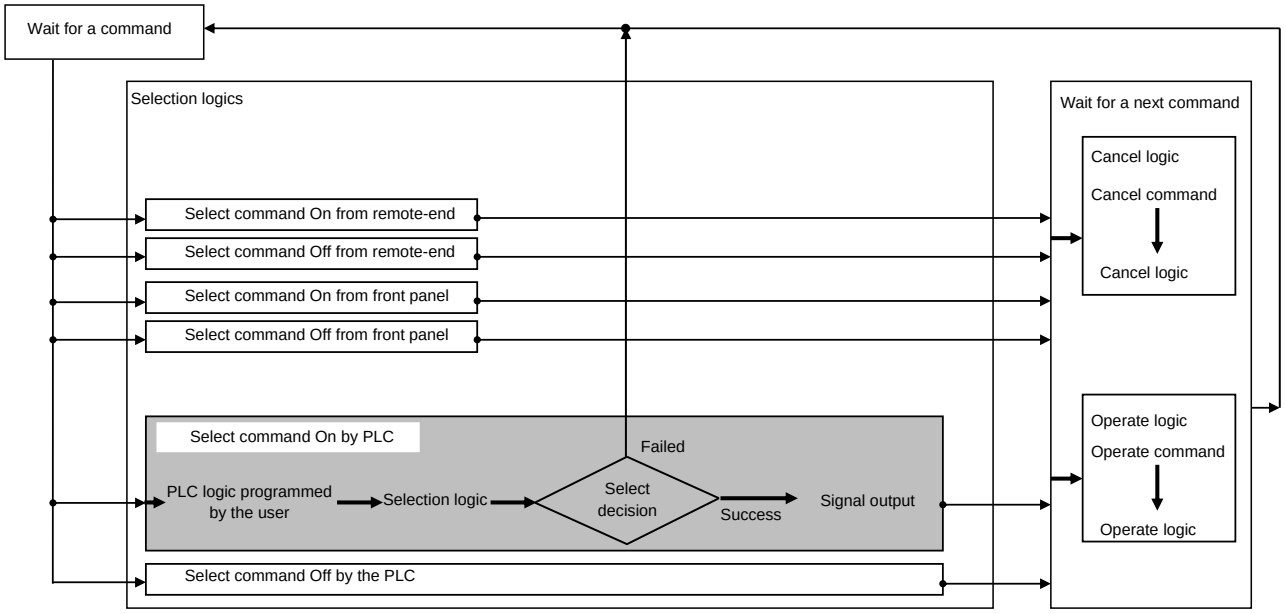


Figure 4.1-9 Outline of select command 'On'

(v)-1 Input signal required from the PLC function.

Figure 4.1-10 shows the select logic when a "Select command On (PLC-ON-Control)" signal is generated by the PLC function. There are two input points for reception of this signal: The former connection point (PLC#1) is used for the reception of the select-command requiring the interlock check, the latter connection point (PLC#2) is used for the reception of the select-command not requiring the interlock check. That is, for the SPOS01 function, when the "select command 'On' (PLC-On-Control) signal generated in the user-programmed logic is applied, and when the interlock check is required in the select logic, use the connection point (PLC#1; e.g., PLC-BIT_0014). Alternatively, if the interlock check is not required, use the connection point (PLC#2); e.g., PLC_BIT_0013". PLC#1 and PLC#2 are shown in Table 4.1-2.

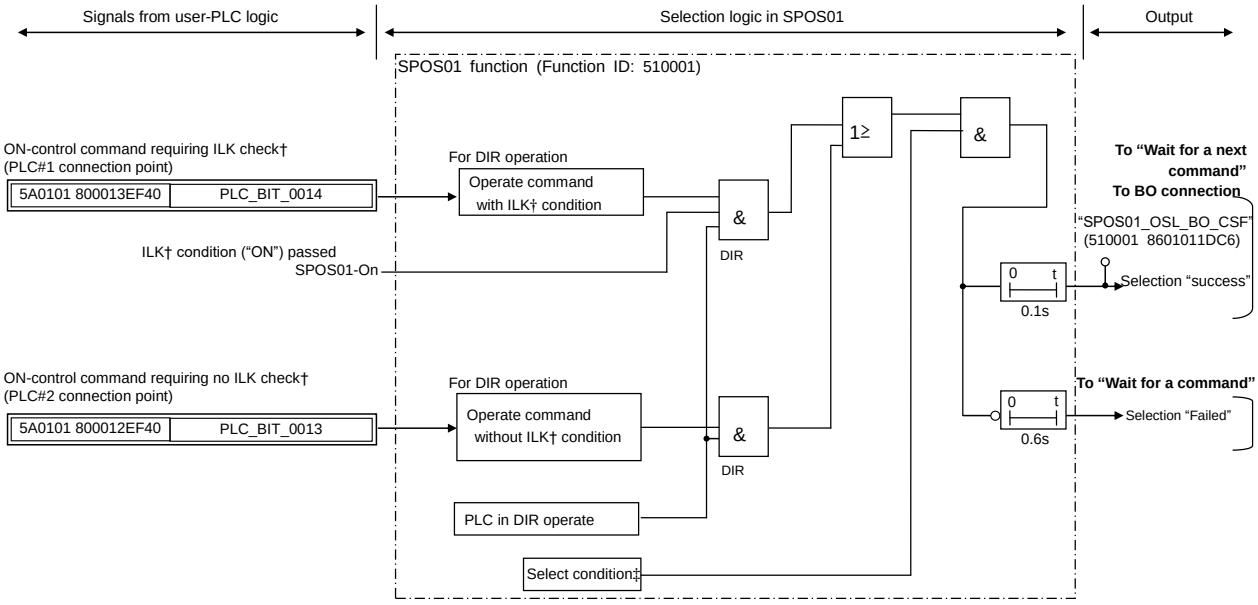


Figure 4.1-10 Select 'On' using the PLC function in SPOS01††

††Note: To identify the input and output signals of the other SPOS logics, see Table 4.1-2 and Table 4.1-9.

†Note: The software interlocking (ILK) function can provide the operation criteria for "On". The ILK function is discussed separately; note that the operation criteria is defined in the ILK function itself (i.e., the user cannot set the condition).

‡Note: A "select condition" signal is provided from the select condition scheme. For more information, see Figure 4.1-13.

(v)-2 Output signal to BO

The SPOS01 function, in Figure 4.1-10, can issue a "Select success" signal at the output-point "SPOS01_OSL_BO_CSF"[1].

[1]Note: The signal "SPOS01_OSL_BO_CSF" is the same as that shown in Figure 4.1-2.

(vi) Receiving "Select command Off" by PLC function

Figure 4.1-9 outlines the reception of the select command 'Off' by the PLC function.

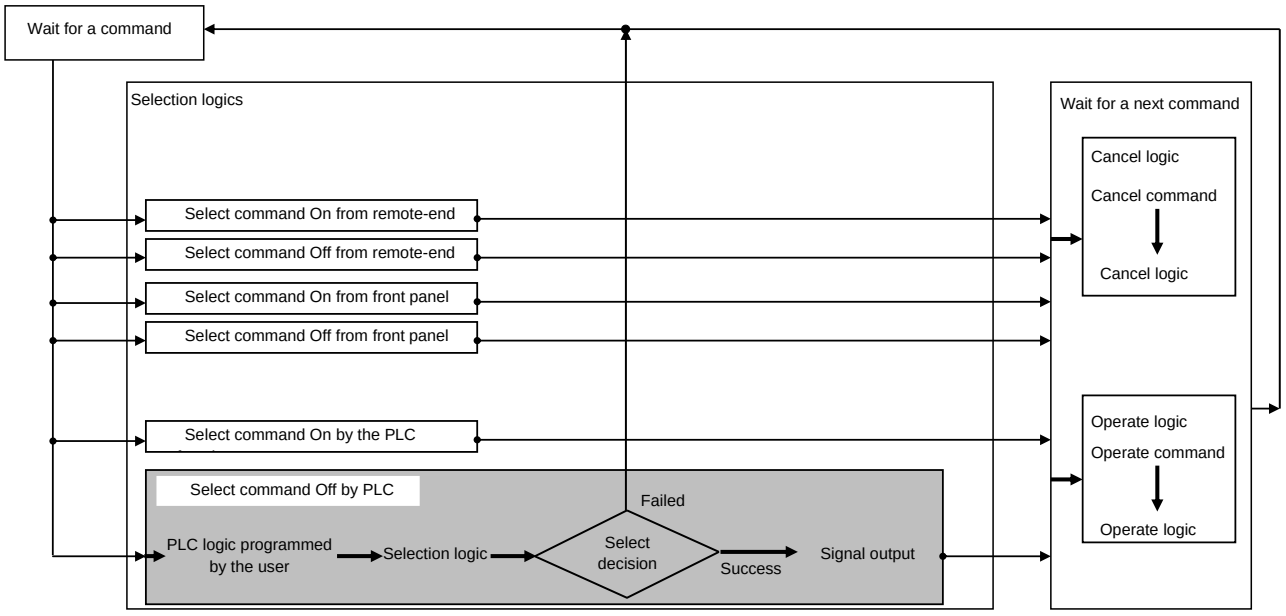


Figure 4.1-11 Outline of select command 'Off'

(vi)-1 Input signal from the PLC function

Figure 4.1-12 shows the select logic when a "Select command Off (PLC-OFF-Control)" signal is generated by the PLC function. There are two input points for the reception of this signal, like in the signal "Select command On (PLC-On-Control)" where four are available. That is, if interlock checking is required, use the connection point (PLC#1:e.g., PLC_BIT_0012). Alternatively, if the interlock-check is not required, use the connection point (PLC#2:e.g.,PLC_BIT_0011). PLC#1 and PLC#2 are shown in Table 4.1-3.

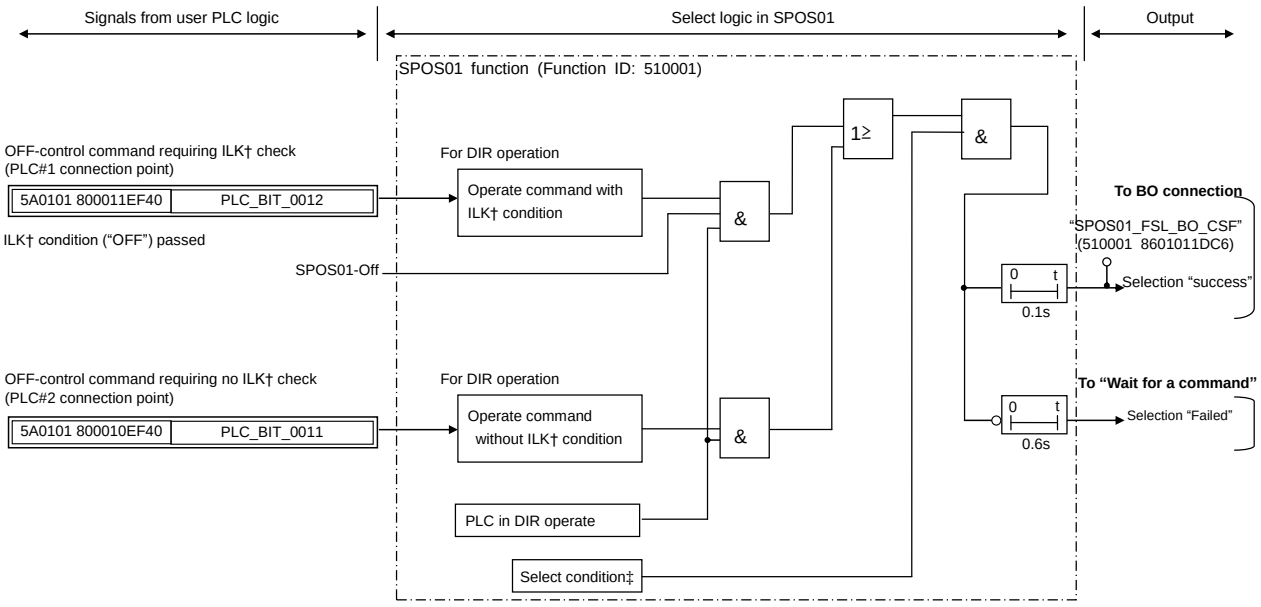


Figure 4.1-12 Selection logic for 'Off' by PLC in SPOS01††

††Note: To identify the input and output points of the other SPOS logic, see Table 4.1-3 for the input (PLC#1 and PLC#2) and Table 4.1-9 for the outputs.

(vi)-2 Output signal to BO

The SPOS01 function, in Figure 4.1-12, can issue a "Select success" signal at the output point "SPOS01_FSL_BO_CSF"[1].

[1]Note: The output point "SPOS01_FSL_BO_CSF" is the same signal as shown in Figure 4.1-4.

(vii) Select condition

Figure 4.1-13 shows the select condition logic in the SPOS01 function. The SPOS01 function checks the condition for the select command using the signal "SPOS1_STATE" (Table 4.1-25). If the original logic does not meet with the requirements of the user, the following alternatives are available:

1. The user can replace the original logic with alternative logic.
2. The user can add additional logic to the original logic.

(vii)-1 How to add another select condition signal

If adding another condition is required, the user can add a signal to the select condition logic using the PLC connection point "User Additional condition".

1. Add a user-preferred signal using PLC_BIT_0053, which is listed as PLC#1 in Table 4.1-7.
2. Set the scheme switch [**SPOS01-LGSLFFCT**] to **Fixed logic**.

(vii)-2 How to replace the original logic

If the user wishes to replace the select condition logic completely, the user can replace it using the PLC connection point "User configurable condition".

1. Connect the user-customized logic using PLC_BIT_0052, which is listed as PLC#2 in Table 4.1-7.
2. Set the scheme switch [**SPOS01-LGSLFFCT**] to **PLC**.

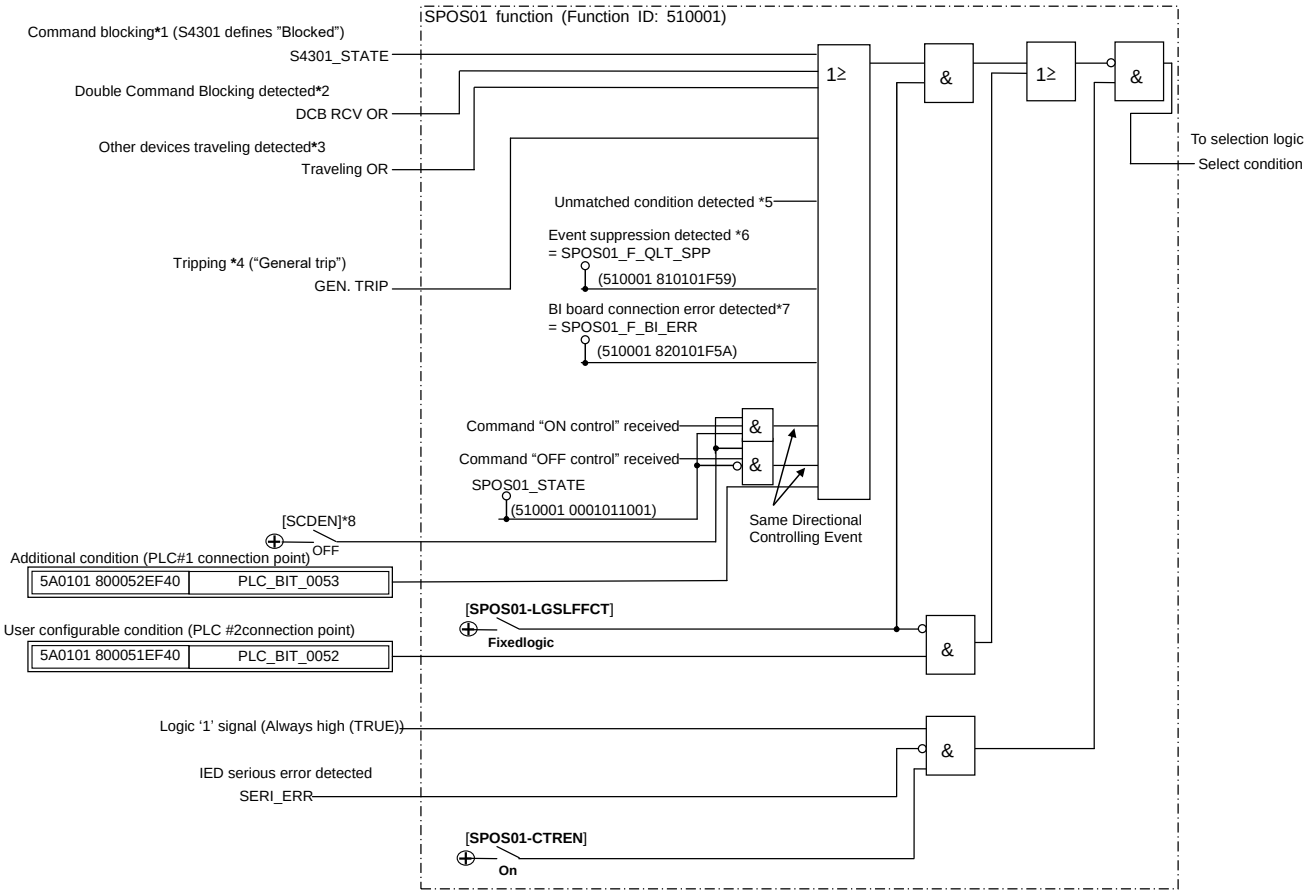


Figure 4.1-13 Select condition logic for ON/OFF in SPOS01*10

[1]Note: "Command blocking" disables any operation except its own; the "Command blocking" is initiated by the status of "S4301" in a software switch controller (SOFTSW).The IEC 61850 standard defines command blocking as "CmdBlk". For more information on "S4301", see Chapter *Control and monitoring application: Software switch controller. See the signal "S4301_STAEE of* Table 4.1-6.

[2]Note: "Double Command Blocking (DCB)" is an operation philosophy. It can be used to protect the substation. The user can program it using GR-TIEMS.

[3]Note: If the event "device-travelling is detected, it indicates that another operator is changing the statuses of a device. Thus, the IED should inhibit the operation of any device for the duration that the event is detected. The detecting signal is donated as "Travelling OR" in Table 4.1-6.

[4]Note: If the issue of a trip command is executed by the IED, any control operation is blocked until the trip operation is completed. If an IED includes a relay application, the trip command is issued at the output point "GEN_TRIP" in Table 4.1-6.

[5]Note: Criteria "unmatched conditions" are decided when "Test-bit status" in a command is not identical to "IED test status".

[6]Note: The "Event suppression" function can detect chattering on BI circuits. (See section 4.1.4(i)-2)

[7]Note: A supervision of the Binary IO module can detect connection errors for BI circuits.

[8]Note: The common control (CMNCTRL) function can test and check the 'On' and 'Off" operations performed by the logic. When the user sets **Off** for scheme switch (SCDEN), the operation of the logic is blocked if the logic is running in the same operation- direction compared with the previous operation direction. (i.e., when On (Off) is performed sequentially). On the other hand, if **On** is set for the scheme switch, the logic is not blocked.

[9]Note: To identify the input point of the other SPOS, see Table 4.1-7 for PLC#1 and PLC#2.

(viii) Signal name and number

Note: The user should note the following descriptions shown in the column "M/O" for each table:

"O" indicates that the signal is provided for optional use.

"M" indicates that the user should map/set/configure the signal; otherwise, the user may experience an operational failure if the default settings are used.

"N/A" indicates that the user cannot change the state of the signal.

Table 4.1-2 PLC connection points (Input points for command 'On')

Signal Number	Signal Name	Description	M/O
5A0101 800013EF40	PLC_BIT_0014	SPOS1 PLC On-control checking with interlock	O
5A0101 800012EF40	PLC_BIT_0013	SPOS1 PLC On-control without checking	O
5A0101 800017EF40	PLC_BIT_0018	SPOS2 PLC On-control checking with interlock	O
5A0101 800016EF40	PLC_BIT_0017	SPOS2 PLC On-control without checking	O
5A0101 800021EF40	PLC_BIT_0022	SPOS3 PLC On-control checking with interlock	O
5A0101 800020EF40	PLC_BIT_0021	SPOS3 PLC On-control without checking	O
5A0101 800025EF40	PLC_BIT_0026	SPOS4 PLC On-control checking with interlock	O
5A0101 800024EF40	PLC_BIT_0025	SPOS4 PLC On-control without checking	O
5A0101 800029EF40	PLC_BIT_0030	SPOS5 PLC On-control checking with interlock	O
5A0101 800028EF40	PLC_BIT_0029	SPOS5 PLC On-control without checking	O
5A0101 800033EF40	PLC_BIT_0034	SPOS6 PLC On-control checking with interlock	O
5A0101 800032EF40	PLC_BIT_0033	SPOS6 PLC On-control without checking	O
5A0101 800037EF40	PLC_BIT_0038	SPOS7 PLC On-control checking with interlock	O
5A0101 800036EF40	PLC_BIT_0037	SPOS7 PLC On-control without checking	O
5A0101 800041EF40	PLC_BIT_0042	SPOS8 PLC On-control checking with interlock	O
5A0101 800040EF40	PLC_BIT_0041	SPOS8 PLC On-control without checking	O
5A0101 800045EF40	PLC_BIT_0046	SPOS9 PLC On-control checking with interlock	O
5A0101 800044EF40	PLC_BIT_0045	SPOS9 PLC On-control without checking	O
5A0101 800049EF40	PLC_BIT_0050	SPOS10 PLC On-control checking with interlock	O
5A0101 800048EF40	PLC_BIT_0049	SPOS10 PLC On-control without checking	O

Table 4.1-3 PLC connection points (Input points for command 'Off')

Signal Number	Signal Name	Description	M/O
5A0101 800011EF40	PLC_BIT_0012	SPOS1 PLC Off-control checking with interlock	O
5A0101 800010EF40	PLC_BIT_0011	SPOS1 PLC Off-control without checking	O
5A0101 800015EF40	PLC_BIT_0016	SPOS2 PLC Off-control checking with interlock	O

Signal Number	Signal Name	Description	M/O
5A0101 800014EF40	PLC_BIT_0015	SPOS2 PLC Off-control without checking	O
5A0101 800019EF40	PLC_BIT_0020	SPOS3 PLC Off-control checking with interlock	O
5A0101 800018EF40	PLC_BIT_0019	SPOS3 PLC Off-control without checking	O
5A0101 800023EF40	PLC_BIT_0024	SPOS4 PLC Off-control checking with interlock	O
5A0101 800022EF40	PLC_BIT_0023	SPOS4 PLC Off-control without checking	O
5A0101 800027EF40	PLC_BIT_0028	SPOS5 PLC Off-control checking with interlock	O
5A0101 800026EF40	PLC_BIT_0027	SPOS5 PLC Off-control without checking	O
5A0101 800031EF40	PLC_BIT_0032	SPOS6 PLC Off-control checking with interlock	O
5A0101 800030EF40	PLC_BIT_0031	SPOS6 PLC Off-control without checking	O
5A0101 800035EF40	PLC_BIT_0036	SPOS7 PLC Off-control checking with interlock	O
5A0101 800034EF40	PLC_BIT_0035	SPOS7 PLC Off-control without checking	O
5A0101 800039EF40	PLC_BIT_0040	SPOS8 PLC Off-control checking with interlock	O
5A0101 800038EF40	PLC_BIT_0039	SPOS8 PLC Off-control without checking	O
5A0101 800043EF40	PLC_BIT_0044	SPOS9 PLC Off-control checking with interlock	O
5A0101 800042EF40	PLC_BIT_0043	SPOS9 PLC Off-control without checking	O
5A0101 800047EF40	PLC_BIT_0048	SPOS10 PLC Off-control checking with interlock	O
5A0101 800046EF40	PLC_BIT_0047	SPOS10 PLC Off-control without checking	O

Table 4.1-4 PLC connection points (Interlock for command 'On/Off')

Signal Number	Signal Name	Description	M/O
570001 3101011DA0	SPOS01-Off	SPOS1 interlock condition for Off control.	N/A
570001 3101021DA0	SPOS02-Off	SPOS2 interlock condition for Off control.	N/A
570001 3101031DA0	SPOS03-Off	SPOS3 interlock condition for Off control.	N/A
570001 3101041DA0	SPOS04-Off	SPOS4 interlock condition for Off control.	N/A
570001 3101051DA0	SPOS05-Off	SPOS5 interlock condition for Off control.	N/A
570001 3101061DA0	SPOS06-Off	SPOS6 interlock condition for Off control.	N/A
570001 3101071DA0	SPOS07-Off	SPOS7 interlock condition for Off control.	N/A
570001 3101081DA0	SPOS08-Off	SPOS8 interlock condition for Off control.	N/A
570001 3101091DA0	SPOS09-Off	SPOS9 interlock condition for Off control.	N/A
570001 31010A1DA0	SPOS010-Off	SPOS10 interlock condition for Off control.	N/A
570001 3101011DA2	SPOS01-On	SPOS1 interlock condition for On control.	N/A
570001 3101011DA2	SPOS02-On	SPOS2 interlock condition for On control.	N/A
570001 3101011DA2	SPOS03-On	SPOS3 interlock condition for On control.	N/A
570001 3101011DA2	SPOS04-On	SPOS4 interlock condition for On control.	N/A
570001 3101011DA2	SPOS05-On	SPOS5 interlock condition for On control.	N/A
570001 3101011DA2	SPOS06-On	SPOS6 interlock condition for On control.	N/A
570001 3101011DA2	SPOS07-On	SPOS7 interlock condition for On control.	N/A
570001 3101011DA2	SPOS08-On	SPOS8 interlock condition for On control.	N/A
570001 3101011DA2	SPOS09-On	SPOS9 interlock condition for On control.	N/A
570001 3101011DA2	SPOS10-On	SPOS10 interlock condition for On control.	N/A

Table 4.1-5 Mapping points for the reception of control commands

Signal Number	Signal Name	Description	M/O
510001 7001016D08	DEV01_CONTROL_REQ	SPOS1 control command received. (Mapping Data)	M
510001 7001026D08	DEV02_CONTROL_REQ	SPOS2 control command received. (Mapping Data)	M
510001 7001036D08	DEV03_CONTROL_REQ	SPOS3 control command received. (Mapping Data)	M
510001 7001046D08	DEV04_CONTROL_REQ	SPOS4 control command received. (Mapping Data)	M
510001 7001056D08	DEV05_CONTROL_REQ	SPOS5 control command received. (Mapping Data)	M
510001 7001066D08	DEV06_CONTROL_REQ	SPOS6 control command received. (Mapping Data)	M
510001 7001076D08	DEV07_CONTROL_REQ	SPOS7 control command received. (Mapping Data)	M
510001 7001086D08	DEV08_CONTROL_REQ	SPOS8 control command received. (Mapping Data)	M
510001 7001096D08	DEV09_CONTROL_REQ	SPOS9 control command received. (Mapping Data)	M

Signal Number	Signal Name	Description	M/O
510001 70010A6D08	DEV10_CONTROL_REQ	SPOS10 control command received. (Mapping Data)	M

Table 4.1-6 Input signals to condition logic

Signal Number	Signal Name	Description	M/O
522001 000A011001	S4301_STATE	Command Blocking status (Off / Blocked)	N/A
522001 000A021001	S4302_STATE	Interlock bypassing status(On / Bypass)	N/A
5A0001 0008001F41	DCB RCV OR	Double Command Blocking(DCB) is in progress.	N/A
5A0001 0008001F40	Traveling OR	Travelling events are detected.	N/A
4A0001 8300001B6F	GEN. TRIP	General trip	N/A
5A0001 3108003F40	SDCEN	(This is setting of CMNCTRL)	N/A
5A0101 3100001F43	SERI_ERR	Serious Error detected	N/A

Table 4.1-7 PLC connection points (Input signal for select condition logic)

Signal Number	Signal Name	Description	M/O
5A0101 800052EF40	PLC_BIT_0053	SPOS1 additional failure condition (PLC#1)	O
5A0101 800067EF40	PLC_BIT_0068	SPOS2 additional failure condition (PLC#1)	O
5A0101 800082EF40	PLC_BIT_0083	SPOS3 additional failure condition (PLC#1)	O
5A0101 800097EF40	PLC_BIT_0098	SPOS4 additional failure condition (PLC#1)	O
5A0101 800112EF40	PLC_BIT_0113	SPOS5 additional failure condition (PLC#1)	O
5A0101 800127EF40	PLC_BIT_0128	SPOS6 additional failure condition (PLC#1)	O
5A0101 800142EF40	PLC_BIT_0143	SPOS7 additional failure condition (PLC#1)	O
5A0101 800157EF40	PLC_BIT_0158	SPOS8 additional failure condition (PLC#1)	O
5A0101 800172EF40	PLC_BIT_0173	SPOS9 additional failure condition (PLC#1)	O
5A0101 800187EF40	PLC_BIT_0188	SPOS10 additional failure condition (PLC#1)	O
5A0101 800051EF40	PLC_BIT_0052	SPOS1 user configurable select condition (PLC#2)	O
5A0101 800066EF40	PLC_BIT_0067	SPOS2 user configurable select condition (PLC#2)	O
5A0101 800081EF40	PLC_BIT_0082	SPOS3 user configurable select condition (PLC#2)	O
5A0101 800096EF40	PLC_BIT_0097	SPOS4 user configurable select condition (PLC#2)	O
5A0101 800111EF40	PLC_BIT_0112	SPOS5 user configurable select condition (PLC#2)	O
5A0101 800126EF40	PLC_BIT_0127	SPOS6 user configurable select condition (PLC#2)	O
5A0101 800141EF40	PLC_BIT_0142	SPOS7 user configurable select condition (PLC#2)	O
5A0101 800156EF40	PLC_BIT_0157	SPOS8 user configurable select condition (PLC#2)	O
5A0101 800171EF40	PLC_BIT_0172	SPOS9 user configurable select condition (PLC#2)	O
5A0101 800186EF40	PLC_BIT_0187	SPOS10 user configurable select condition (PLC#2)	O

Table 4.1-8 PLC monitoring points (Output signal for select condition logic)

Signal Number	Signal Name	Description
510001 8001011F54	SPOS01_SC_ST_ERR	SPOS01 select command mode is invalid.
510001 8001021F54	SPOS02_SC_ST_ERR	SPOS01 select command mode is invalid.
510001 8001031F54	SPOS03_SC_ST_ERR	SPOS01 select command mode is invalid.
510001 8001041F54	SPOS04_SC_ST_ERR	SPOS01 select command mode is invalid.
510001 8001051F54	SPOS05_SC_ST_ERR	SPOS01 select command mode is invalid.
510001 8001061F54	SPOS06_SC_ST_ERR	SPOS01 select command mode is invalid.
510001 8001071F54	SPOS07_SC_ST_ERR	SPOS01 select command mode is invalid.
510001 8001081F54	SPOS08_SC_ST_ERR	SPOS01 select command mode is invalid.
510001 8001091F54	SPOS09_SC_ST_ERR	SPOS01 select command mode is invalid.
510001 80010A1F54	SPOS10_SC_ST_ERR	SPOS01 select command mode is invalid.
510001 8101011F59	SPOS01_F_QLT_SPP	Event suppression detected (SPOS01)
510001 8101021F59	SPOS02_F_QLT_SPP	Event suppression detected (SPOS02)
510001 8101031F59	SPOS03_F_QLT_SPP	Event suppression detected (SPOS03)

510001 8101041F59	SPOS04_F_QLT_SPP	Event suppression detected (SPOS04)
510001 8101051F59	SPOS05_F_QLT_SPP	Event suppression detected (SPOS05)
510001 8101061F59	SPOS06_F_QLT_SPP	Event suppression detected (SPOS06)
510001 8101071F59	SPOS07_F_QLT_SPP	Event suppression detected (SPOS07)
510001 8101081F59	SPOS08_F_QLT_SPP	Event suppression detected (SPOS08)
510001 8101091F59	SPOS09_F_QLT_SPP	Event suppression detected (SPOS09)
510001 81010A1F59	SPOS10_F_QLT_SPP	Event suppression detected (SPOS10)
510001 8201011F5A	SPOS01_F_BI_ERR	BI connection error detected(SPOS01)
510001 8201021F5A	SPOS02_F_BI_ERR	BI connection error detected(SPOS02)
510001 8201031F5A	SPOS03_F_BI_ERR	BI connection error detected(SPOS03)
510001 8201041F5A	SPOS04_F_BI_ERR	BI connection error detected(SPOS04)
510001 8201051F5A	SPOS05_F_BI_ERR	BI connection error detected(SPOS05)
510001 8201061F5A	SPOS06_F_BI_ERR	BI connection error detected(SPOS06)
510001 8201071F5A	SPOS07_F_BI_ERR	BI connection error detected(SPOS07)
510001 8201081F5A	SPOS08_F_BI_ERR	BI connection error detected(SPOS08)
510001 8201091F5A	SPOS09_F_BI_ERR	BI connection error detected(SPOS09)
510001 82010A1F5A	SPOS10_F_BI_ERR	BI connection error detected(SPOS10)

Table 4.1-9 PLC monitoring points (On/Off Output-signal)

Signal Number	Signal Name	Description
510001 8601011DC6	SPOS01_OSL_BO_CSF	SPOS1 select (ON) command for Binary Output.
510001 8601021DC6	SPOS02_OSL_BO_CSF	SPOS2 select (ON) command for Binary Output.
510001 8601031DC6	SPOS03_OSL_BO_CSF	SPOS3 select (ON) command for Binary Output.
510001 8601041DC6	SPOS04_OSL_BO_CSF	SPOS4 select (ON) command for Binary Output.
510001 8601051DC6	SPOS05_OSL_BO_CSF	SPOS5 select (ON) command for Binary Output.
510001 8601061DC6	SPOS06_OSL_BO_CSF	SPOS6 select (ON) command for Binary Output.
510001 8601071DC6	SPOS07_OSL_BO_CSF	SPOS7 select (ON) command for Binary Output.
510001 8601081DC6	SPOS08_OSL_BO_CSF	SPOS8 select (ON) command for Binary Output.
510001 8601091DC6	SPOS09_OSL_BO_CSF	SPOS9 select (ON) command for Binary Output.
510001 86010A1DC6	SPOS10_OSL_BO_CSF	SPOS10 select (ON) command for Binary Output.
510001 8A01011DC4	SPOS01_FSL_BO_CSF	SPOS1 select (OFF) command for Binary Output.
510001 8A01021DC4	SPOS02_FSL_BO_CSF	SPOS2 select (OFF) command for Binary Output.
510001 8A01031DC4	SPOS03_FSL_BO_CSF	SPOS3 select (OFF) command for Binary Output.
510001 8A01041DC4	SPOS04_FSL_BO_CSF	SPOS4 select (OFF) command for Binary Output.
510001 8A01051DC4	SPOS05_FSL_BO_CSF	SPOS5 select (OFF) command for Binary Output.
510001 8A01061DC4	SPOS06_FSL_BO_CSF	SPOS6 select (OFF) command for Binary Output.
510001 8A01071DC4	SPOS07_FSL_BO_CSF	SPOS7 select (OFF) command for Binary Output.
510001 8A01081DC4	SPOS08_FSL_BO_CSF	SPOS8 select (OFF) command for Binary Output.
510001 8A01091DC4	SPOS09_FSL_BO_CSF	SPOS9 select (OFF) command for Binary Output.
510001 8A010A1DC4	SPOS010_FSL_BO_CSF	SPOS10 select (OFF) command for Binary Output.

(ix) Setting names

Note: The “xx” of “SPOSxx” represents the SPOS function number. (e.g., if the SPOS03 is considered, the “xx” is equal to “03”. The suffix “xx” can be represented from “01” to “10”.)

Table 4.1-10 Setting of SBO control in SPOSxx

Setting Name	Description	Default	Setting item or value
SPOSxx-CTREN	Activate control function in SPOSxx	On	Off / On
SPOSxx-LGSLFFCT	Logic selector for select condition in SPOSxx	Fixedlogic	Fixedlogic / PLC
SPOSxx-CTRAHMI	Activate local panel control in SPOSxx	SBO	DIR / SBO

4.1.2 Cancel logic for SBO mode

In SBO control mode the reception of a cancel command is possible; the function can discard the select command when the cancel conditions are satisfied; finally, the operation returns to the initial stage (i.e., waiting state "Wait for a command".)

(i) Receiving "Cancel" from the remote-end

Figure 4.1-14 depicts the cancel command procedure for a cancel command initiated from the remote-end.

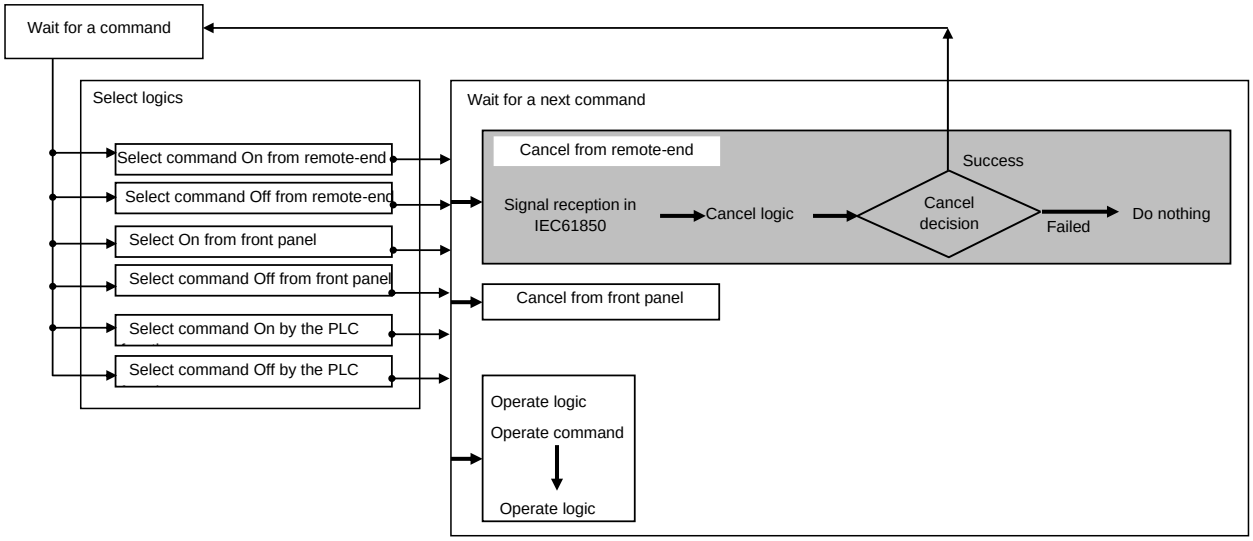


Figure 4.1-14 Outline of 'cancel' command from the remote-end

(i)-1 Input point required mapping

Figure 4.1-15 depicts the cancel logic when a "Cancel command (Remote-Cancel)" signal is applied to the SPOS01 function. The input-point "DEV01_CONTROL_REQ" is the same as that for the signal "Select command On (Remote-On-Control)".

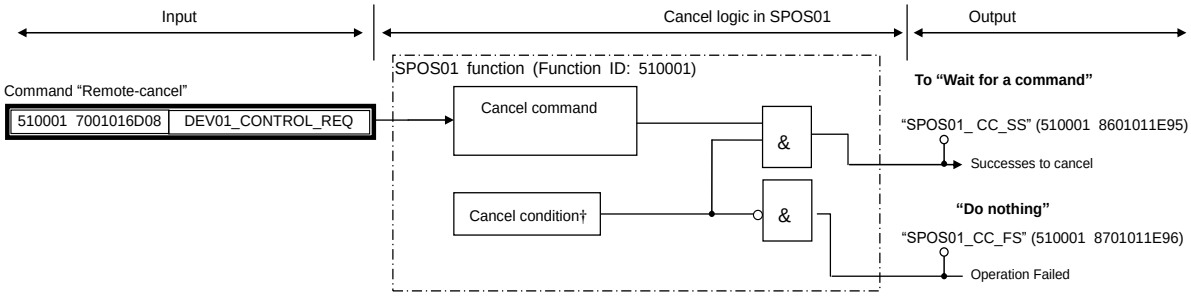


Figure 4.1-15 'Cancel' from the remote-end in SPOS01

†Note: The logic "cancel condition" is shown in Figure 4.1-18

(i)-2 Output signal to BO

The SPOS01 function can issue an output signal "Success to cancel" at the monitoring point "SPOS01_CC_SS", when the SPOS01 function has determined that the "Remote-cancel" signal

is true. Another "Operation failed" signal is issued at the monitoring point "SPOS01_CC_FS" if the SPOS01 function is able to determine that the "Remote-cancel" signal is not true.

(ii) Receiving "Cancel" from the local-end

Figure 4.1-16 outlines the reception of the cancel command from the local end.

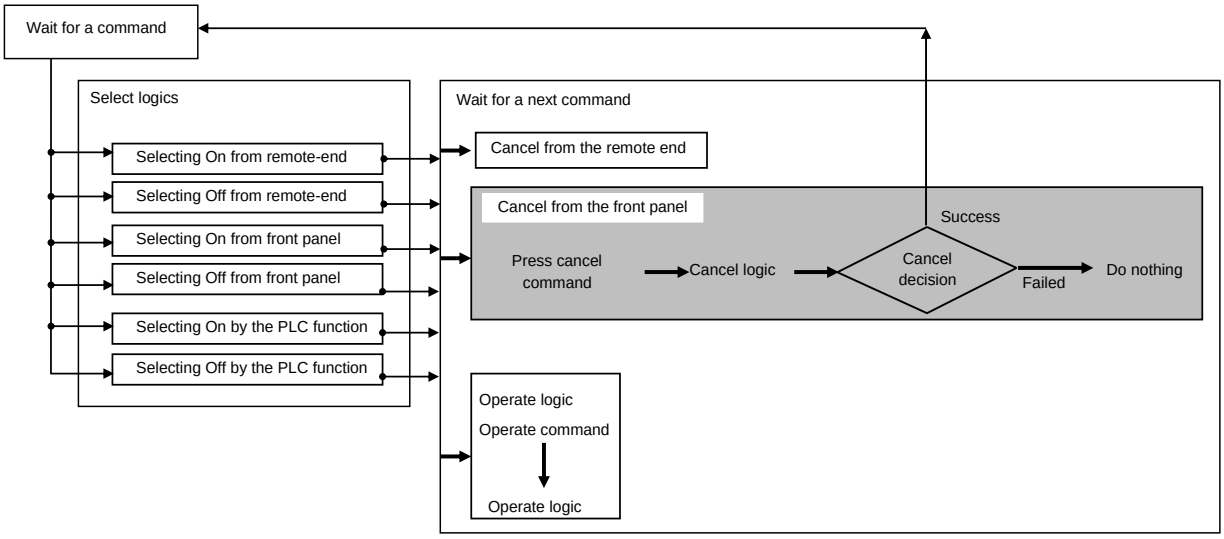


Figure 4.1-16 Outline of 'cancel' command from the local-end

(ii)-1 Input signal generated at the local-end

Figure 4.1-17 depicts the cancel logic when a "Cancel command (Local-cancel)" signal is applied to the SPOS01 function. The signal is generated when the "Cancel" key is pressed on the IED front panel; the user is not required to take account of mapping. When the logic receives the "Local-cancel" signal, the logic is able to output a result signal; provided that the "cancel condition" checking is satisfied.

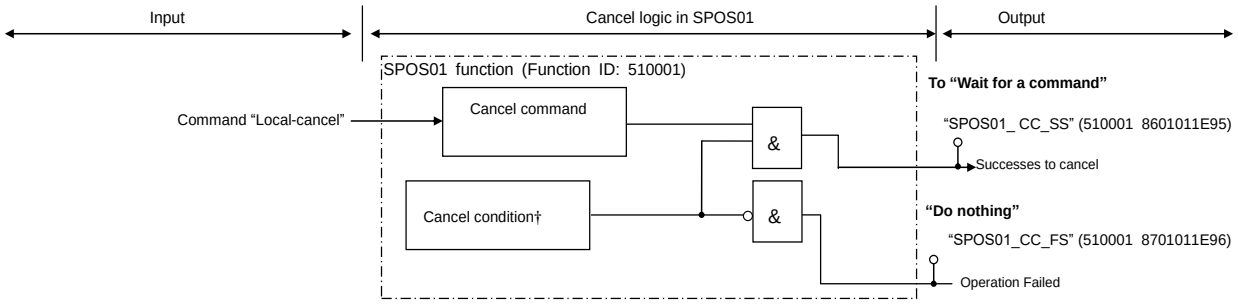


Figure 4.1-17 'Cancel' from the front panel

(ii)-2 Output signal to BO

The SPOS01 function, illustrated in Figure 4.1-17, is able to issue a "Select to cancel" signal at the monitoring point "SPOS01_CC_SS", when the SPOS01 function determines that the "Local-Cancel" signal is true.

(iii) Cancel condition logic

Figure 4.1-18 shows the cancel condition logic. As the criteria, "unmatched condition detected" is connected normally for the cancel logic, set **Fixlogic** for the scheme switch [**SPOS01_LGCNFFC**].

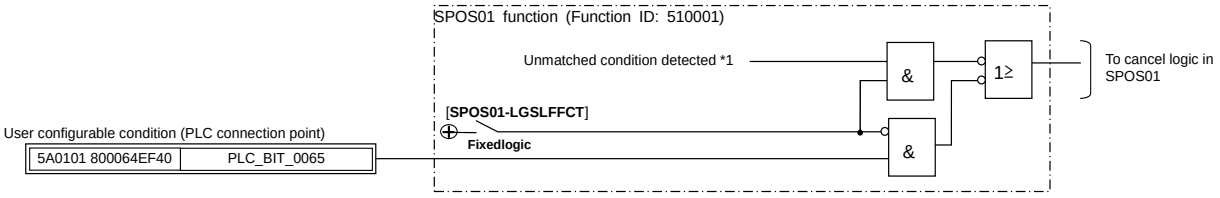


Figure 4.1-18 Logic "Cancel condition" in SPOS01

[1]Note: The Criteria "unmatched conditions" are determined when the "Test-bit status" in the cancel command is not identical to the "IED test status", like in Figure 4.1-13.

[2]Note: With the exception of the above 'cancel' condition logic, there is operate-condition logic within the SPOS01 function; the operate-condition logic will always checks conditions. That is, the user is required to set either the "operate-condition" or the "cancel-condition" logic.

If the original logic does not meet with the requirements of the user, it can be replaced with another logic using the connection point "User Configurable condition":

1. Connect the user-customized logic with the "PLC_BIT0065".
2. Set scheme switch [**SPOS01-LGCNFFCT**] to **PLC**.

(iv) Signal name and number

Note: The user should note the following descriptions shown in the column "M/O" in each table:

"O" indicates that the signal is provided for optional use.

"M" indicates that the user should map/set/configure using the signal; otherwise, the user may experience an operational failure for the default settings.

"N/A" indicates that the user cannot change the state of the signal.

Table 4.1-11 PLC connection points (Input signal for 'cancel' condition)

Signal Number	Signal Name	Description	M/O
5A0101 800064EF40	PLC_BIT_0065	SPOS1 user configurable cancel condition	O
5A0101 800079EF40	PLC_BIT_0080	SPOS2 user configurable cancel condition	O
5A0101 800094EF40	PLC_BIT_0095	SPOS3 user configurable cancel condition	O
5A0101 800109EF40	PLC_BIT_0110	SPOS4 user configurable cancel condition	O
5A0101 800124EF40	PLC_BIT_0125	SPOS5 user configurable cancel condition	O
5A0101 800139EF40	PLC_BIT_0140	SPOS6 user configurable cancel condition	O
5A0101 800154EF40	PLC_BIT_0155	SPOS7 user configurable cancel condition	O
5A0101 800169EF40	PLC_BIT_0170	SPOS8 user configurable cancel condition	O
5A0101 800184EF40	PLC_BIT_0185	SPOS9 user configurable cancel condition	O
5A0101 800199EF40	PLC_BIT_0200	SPOS10 user configurable cancel condition	O

Table 4.1-12 PLC monitoring points (Output signal for 'cancel' condition)

Signal Number	Signal Name	Description
510001 8601011E95	SPOS01_CC_SS	Cancel succeed in SPOS01
510001 8601021E95	SPOS02_CC_SS	Cancel succeed in SPOS02
510001 8601031E95	SPOS03_CC_SS	Cancel succeed in SPOS03
510001 8601041E95	SPOS04_CC_SS	Cancel succeed in SPOS04
510001 8601051E95	SPOS05_CC_SS	Cancel succeed in SPOS05
510001 8601061E95	SPOS06_CC_SS	Cancel succeed in SPOS06
510001 8601071E95	SPOS07_CC_SS	Cancel succeed in SPOS07
510001 8601081E95	SPOS08_CC_SS	Cancel succeed in SPOS08
510001 8601091E95	SPOS09_CC_SS	Cancel succeed in SPOS09
510001 86010A1E95	SPOS10_CC_SS	Cancel succeed in SPOS10
510001 8601011E95	SPOS01_CC_SS	Cancel succeed in SPOS01
510001 8701011E96	SPOS01_CC_FS	Cancel failed in SPOS01
510001 8701021E96	SPOS02_CC_FS	Cancel failed in SPOS02
510001 8701031E96	SPOS03_CC_FS	Cancel failed in SPOS03
510001 8701041E96	SPOS04_CC_FS	Cancel failed in SPOS04
510001 8701051E96	SPOS05_CC_FS	Cancel failed in SPOS05
510001 8701061E96	SPOS06_CC_FS	Cancel failed in SPOS06
510001 8701071E96	SPOS07_CC_FS	Cancel failed in SPOS07
510001 8701081E96	SPOS08_CC_FS	Cancel failed in SPOS08
510001 8701091E96	SPOS09_CC_FS	Cancel failed in SPOS09
510001 87010A1E96	SPOS10_CC_FS	Cancel failed in SPOS10

(v) Setting name

Note: The "xx" within of "SPOSxx" represents the SPOS function number. (e.g., if SPOS03 is considered, the "xx" is equal to "03". The numbers used for "xx" can be represented by "01" to "10".)

Table 4.1-13 Setting for 'Cancel' in SPOSxx

Setting Name	Description	Default	Setting item or value
SPOSxx-LGCNFFCT	Logic selector for cancel condition in SPOSxx	Fixedlogic	Fixedlogic / PLC

4.1.3 Operate logic for SBO/DIR modes

Once the operation of the select logic is completed, the operate logic start to control the device.

(i) Receiving "operate command On" from the remote- end

Figure 4.1-19 depicts the reception of the operate command 'On' from the remote- end.

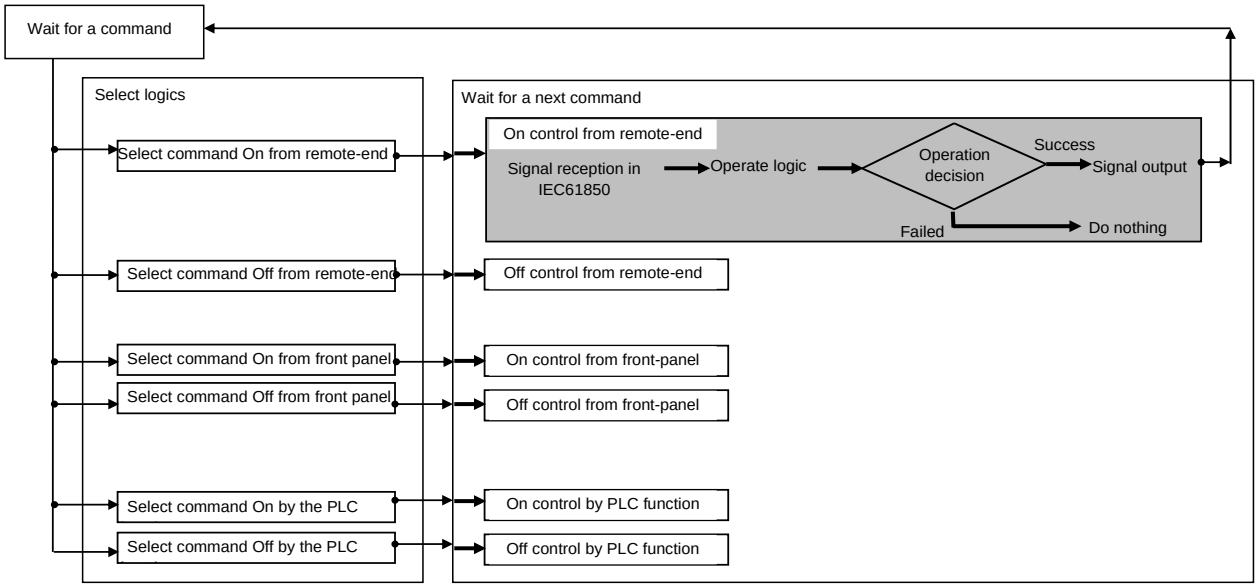


Figure 4.1-19 Outline of operate command for 'On'

(i)-1 Mapping required for Input point

Figure 4.1-20 illustrates the operate logic when an "Operate command On (Remote-ON-Control)" signal is applied to the SPOS01 function. The input-point "DEV01_CONTROL_REQ" is used for the reception of the "Operate command On (Remote-On-Control)".

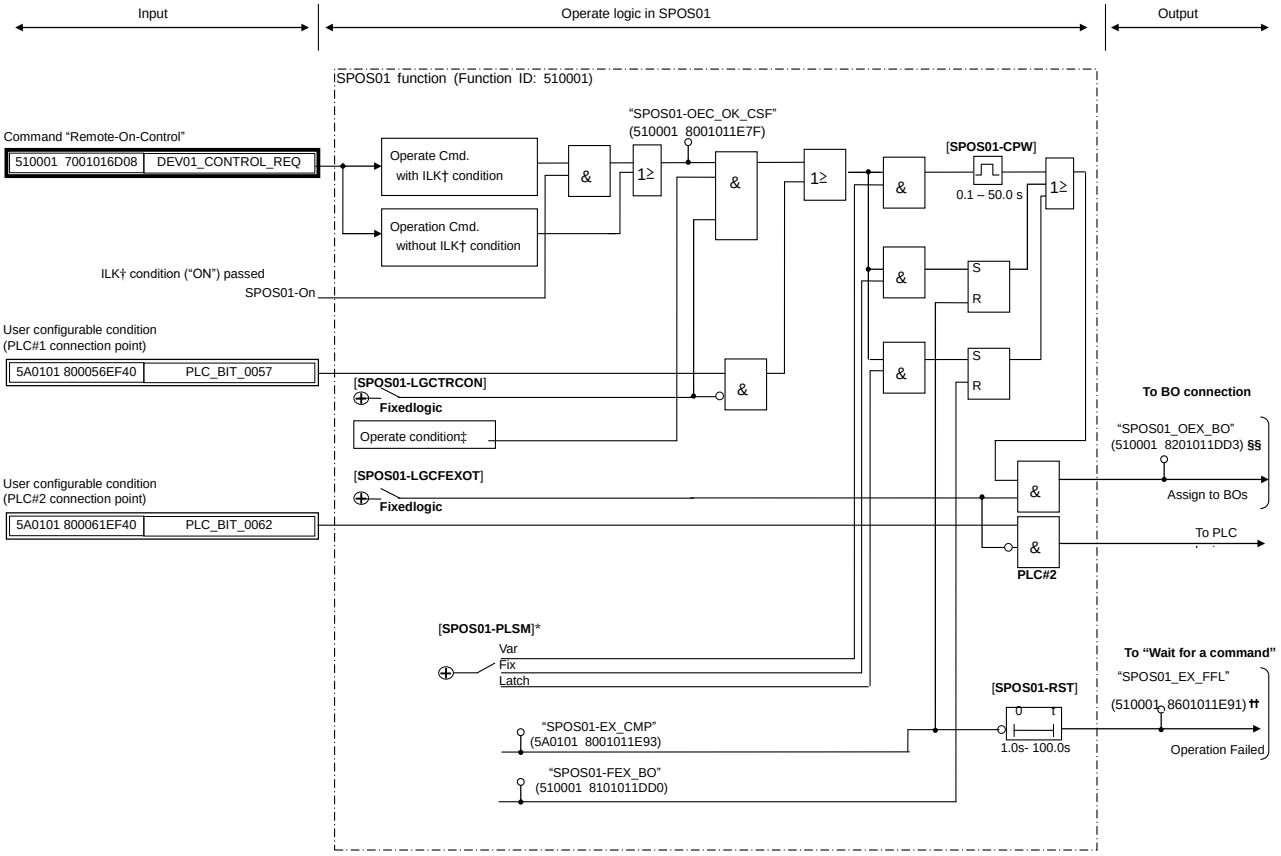


Figure 4.1-20 Operate 'On' logic by remote SAS in SPOS01††

†Note:The ILK function can provide the operation criteria for "ON".

‡Note:An "operate condition" signal is generated in the operate-condition logic (see Figure 4.1-29) when **Fixlogic** is set for scheme switch [**SPOS01-LGCTRCON**]. If an alternative "Operate-condition" is required, it can be programmed by the user and used to replace the signal generated by the original operate-condition logic. The alternative "Operate-condition" can be connected to the above logic using connection point #1 "User configurable condition". That is, set the scheme switch [**SPOS01-LGCTRCON**] to **PLC** and use "PLC_BIT_0057".

*Note:The user can set the type of the output signal. When **Var** is set for scheme switch [**SPOS01-PLSM**], the output period of the signal is defined by the setting [**SPOS01-CPW**]. When **Fix** is set, the signal ceases when the 43-switch is changed. When **Latch** is set, the output signal is kept issuing until the reception of "Command Off".

††Note: To identify the input and output signal-points of the other SPOS logics, see Table 4.1-14 for PLC#1, Table 4.1-15 for PLC#2, Table 4.1-19, and Table 4.1-20 for output signals.

‡‡Note: The "Operate failed" signal is issued when the state-change is not detected when the time set by [**SPOS01-RST**] has been reached.

§§Note: The "SPOS01_OEX-BO" signal is issued when **Fixlogic** is set for scheme switch

[**SPOS01-LGCFEXOT**]. The “Operate completed “signal can also be issued from logic programmed by the user, in place of the logic shown in Figure 4.1-20 The user-programmed logic is connected internally to the signal “Operate completed”, hence this signal is now generated by the user-programmed logic at connection point # 2 “user-configurable condition”. That is, set the scheme switch [**SPOS01-LGCFEXOT**] to **PLC** and use “PLC_BIT_0062”.

(i)-2 Output signal to BO

The SPOS01 function, in Figure 4.1-20, can issue an “Operate” signal at the output point “SPOS01_OEX_BO”, when the SPOS01 function determines that the received signal “Remote-On-Control” is true.

(ii) Receiving "operate command Off" from the remote end

Figure 4.1-21 depicts the reception of the operate command for 'Off' from the remote-end.

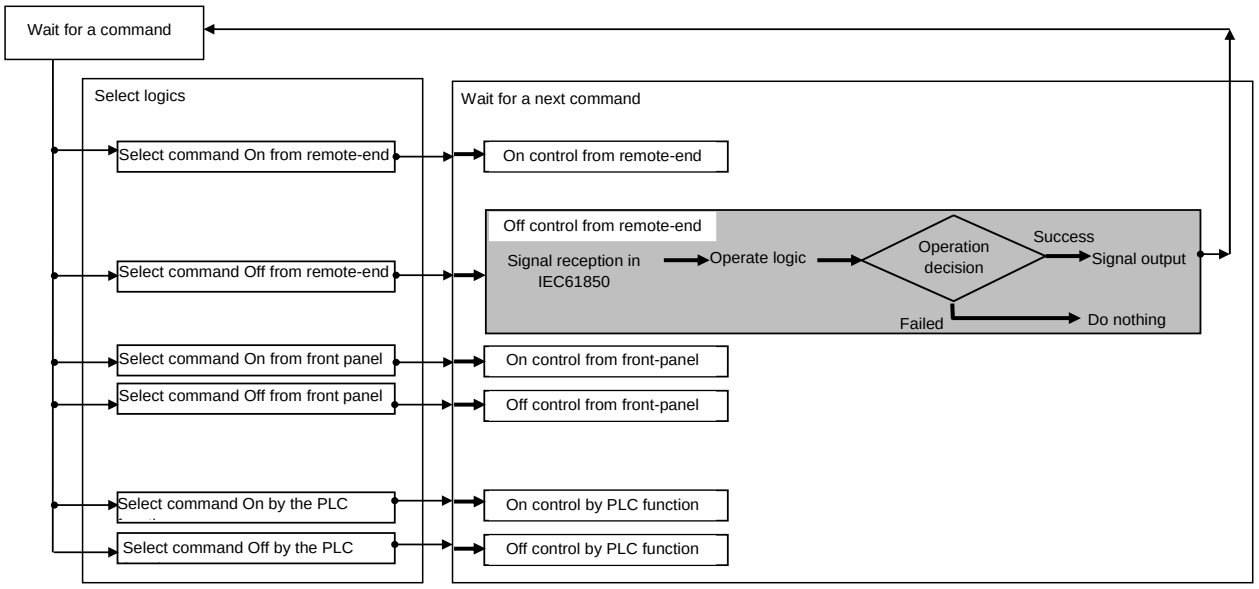


Figure 4.1-21 Outline of operate command 'Off'

(ii)-1 Mapping required for Input point from communication

Figure 4.1-22 illustrates the operate logic when an "Operate command Off (Remote-Off-Control)" signal is applied to the SPOS01 logic. The input-point "DEV01_CONTROL_REQ" is used for the reception of the "Operate command Off (Remote-Off-Control)".

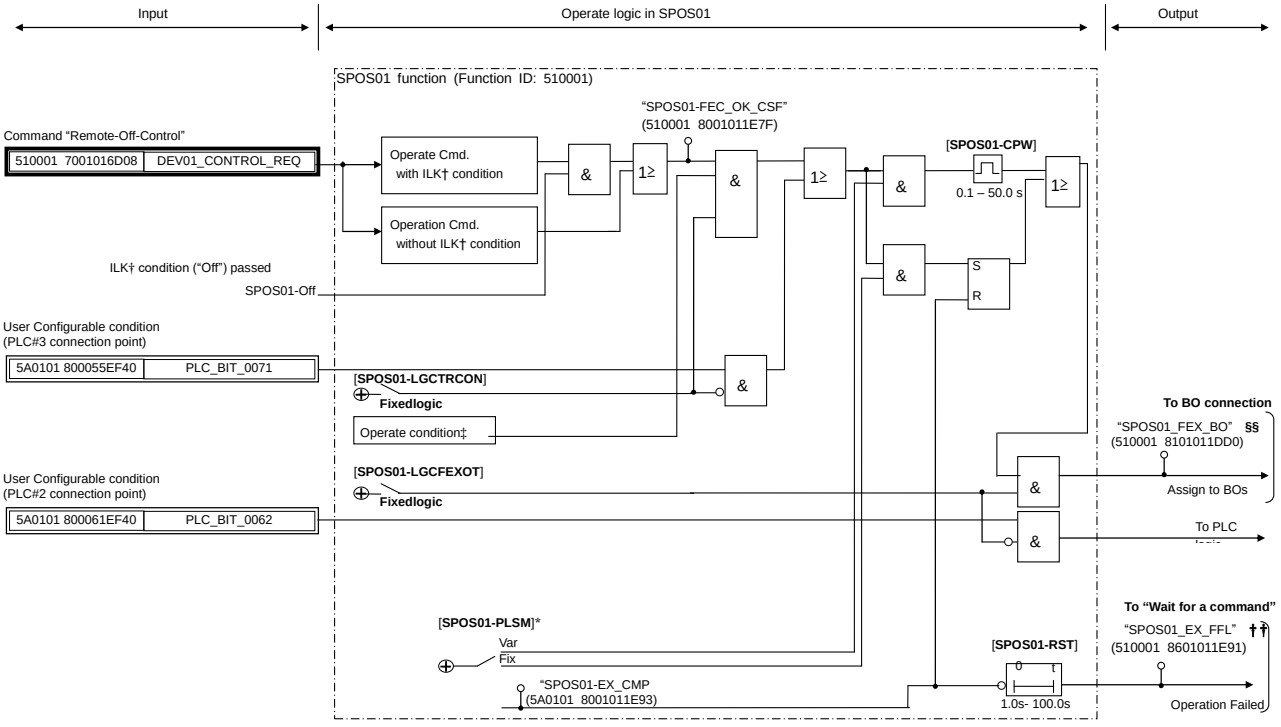


Figure 4.1-22 Operate 'Off' from the remote -end in SPOS01††

†Note:The ILK function can provide the operation criteria for "Off".

‡Note:An "operate condition" is generated in the operate-condition logic(see Figure 4.1-29) when **Fixlogic** is set for scheme switch[**SPOS01-LGCTRCON**], If an alternative "Operate-condition" is required, it can be programmed by the user and used to replace the signal generated by the original operate-condition logic. The alternative "Operate-condition" can be connected to the above logic using connection point # 3 "User configurable condition". That is, set the scheme switch [**SPOS01-LGCTRCON**] to PLC and use PLC_BIT_0071.

‡‡Note: The "Operate failed" signal is issued when the state-change is not detected when the time set by [**SPOS01-RST**] has been reached.

§§Note: The signal "SPOS01_OEX-BO" is issued when **Fixlogic** is set for scheme switch [**SPOS01-LGCFEXOT**]. The "Operate completed "signal can also be issued from logic programmed by the user in place of the logic shown in Figure 4.1-20 . The user-programmed logic is connected internally to the signal "Operate completed". Hence, this signal is now generated by the user-programmed logic at connection point # 2 "user-configurable condition". That is, set the scheme switch [**SPOS01-LGCFEXOT**] to **PLC** and use "PLC_BIT_0062".

*Note:The user can set the type of the output signal. When **Var** is set for scheme switch [**SPOS01-PLSM**], the output period of the signal is defined by the setting [**SPOS01-CPW**]. When **Fix** is set, the signal ceases when the 43-switch is changed. When **Latch** is set, the output signal is kept issuing until the reception of "Command Off".

††Note: To identify the input and output signal-points of the other SPOS logics, see Table 4.1-14, Table 4.1-15, Table 4.1-19, and Table 4.1-20.

(ii)-2 Output signal to BO

The SPOS01 function, in Figure 4.1-22, can issue an "Operate" signal at the output-point "SPOS01_FEX_BO", when the SPOS01 function determines that the signal "Remote-Off-Control" is true.

(iii) Receiving "operate command On" from the local-end

Figure 4.1-23 depicts the reception of the operate command for 'On' from the local-end.

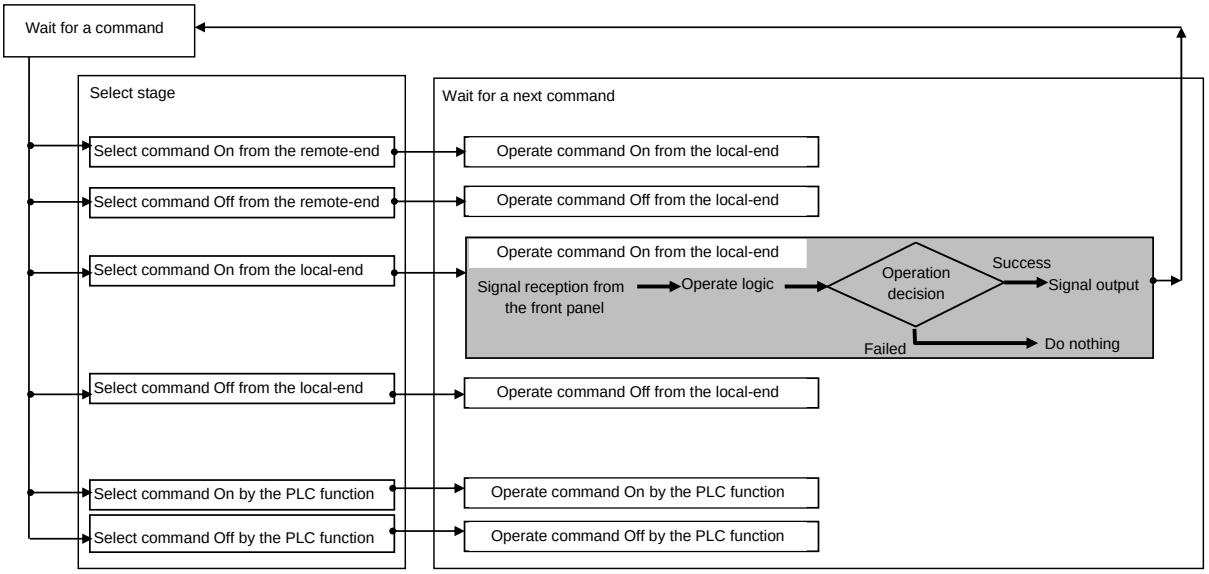


Figure 4.1-23 Outline of operate command 'On'

(iii)-1 Input signal generated at the local-end.

Figure 4.1-24 illustrates the operate logic when an "Operate command On (Local-ON-Control)" signal is applied to the SPOS01 function. The signal is generated when "Execution of On" is keyed on the IED front panel.

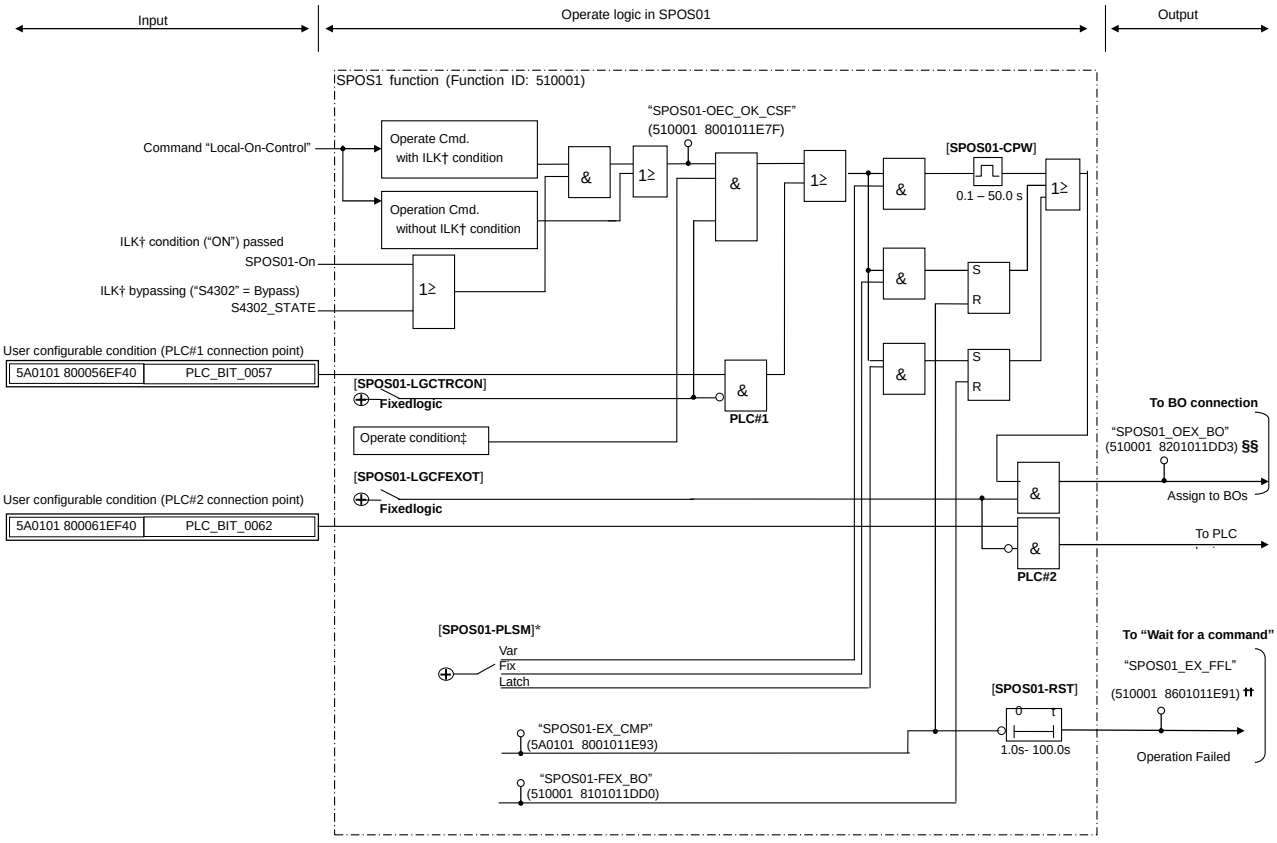


Figure 4.1-24 Operate 'On' on the front panel

‡Note:An "operate condition" signal is generated in the operate-condition logic(see

Figure 4.1-29) when **Fixlogic** is set for scheme switch [**SPOS01-LGCTRCON**], If an alternative "Operate-condition" is required, it can be programmed by the user and used to replace the signal generated by the original operate-condition logic. The alternative "Operate-condition" can be connected to the above logic using connection point #1 "User configurable condition". That is, set the scheme switch [**SPOS01-LGCTRCON**] to **PLC** and use PLC_BIT_0057.

*Note:The user can set the type of output signal. When **Var** is set for scheme switch [**SPOS01-PLSM**], the output period of the signal is defined by the setting [**SPOS01-CPW**]. When **Fix** is set, the signal ceases when the 43-switch is changed. When **Latch** is set, the output signal is kept issuing until the reception of "Command Off".

††Note: To identify the input and output signal-points of the other SPOS logics, see Table 4.1-14, Table 4.1-15, Table 4.1-19, and Table 4.1-20.

‡‡Note: The "Operate failed" signal is issued when the state-change is not detected until after reaching the time set by the [**SPOS01-RST**].

§§Note: The signal "SPOS01_OEX-BO" is issued when **Fixlogic** is set for the scheme logic [**SPOS01-LGCFEXOT**]. If the signal is to be issued from the logic programmed by the user in place of the logic shown in Figure 4.1-20, connect the signal "Operate completed" generated in the user-programmed logic at the connection point # 2 "user configurable condition". That is, set the scheme switch [**SPOS01-LGCFEXOT**] to **PLC** and use "PLC_BIT_0062".

(iii)-2 Output signal to BO

The SPOS01 function, in Figure 4.1-24, can issue an "Operate" signal at the output point "SPOS01_OEX_BO", when the SPOS01 function determines that the signal "Local-On-Control" is true.

(iv) Receiving "operate command Off" from the local-end

Figure 4.1-25 depicts the reception of the operate command for 'Off' from the local-end.

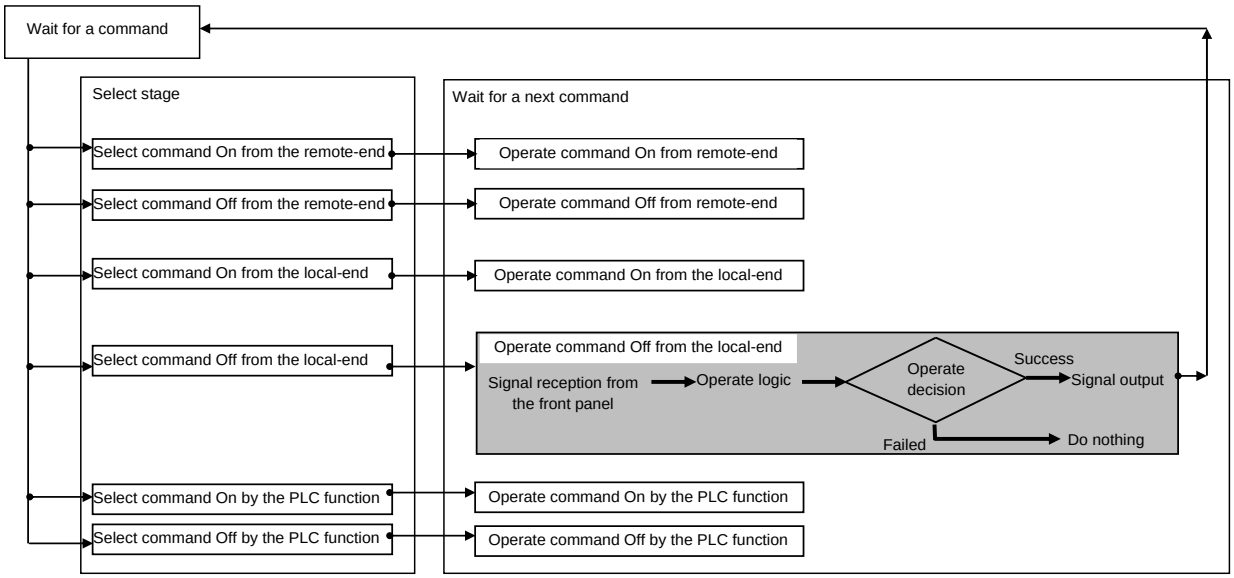


Figure 4.1-25 Outline of operate command 'Off'

(iv)-1 Input signal generated at the local-end.

Figure 4.1-26 illustrates the operate logic when an "Operate command Off (Local-OFF-Control)" signal is applied to the SPOS01 function. The input signal is generated when "Execution for Off" is keyed on the IED front panel.

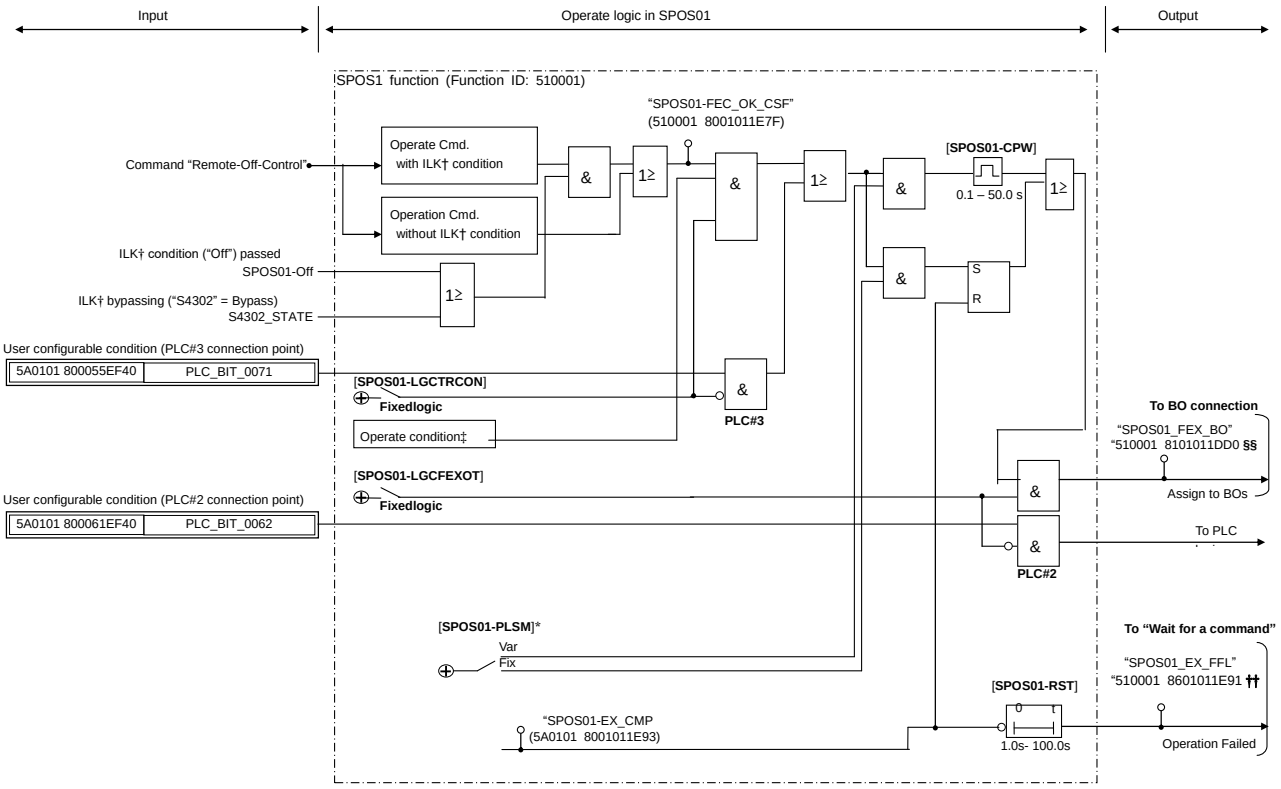


Figure 4.1-26 Operate 'Off' on the front panel in SPOS01††

‡Note:An "operate condition" signal is generated in the operate-condition logic(see Figure 4.1-29), when **Fixlogic** is set for scheme switch [**SPOS01-LGCTRCON**], If an alternative "Operate-condition" is required it can be programmed by the user and used to replace the signal generated by the original operated-condition logic. The alternative "Operate-condition" can be connected to the above logic using connection point #3 "User configurable condition". That is, set the scheme switch [**SPOS01-LGCTRCON**] to **PLC** and use PLC_BIT_0071.

*Note:The user can set the type of output signal. When **Var** is set for the scheme switch [**SPOS01-PLSM**], the output period of the signal is defined by the setting [**SPOS01-CPW**]. When **Fix** is set, the signal ceases when the 43-switch is changed. When **Latch** is set, the output signal is kept issuing until the reception of "Command Off".

††Note: To identify the input and output signal-points of the other SPOS logics, see Table 4.1-14, Table 4.1-15, Table 4.1-19, and Table 4.1-20.

‡‡Note: The "Operate failed" signal is issued when the state-change is not detected until after reaching the time set by the [**SPOS01-RST**].

§§Note: The signal "SPOS01_OEX-BO" is issued when **Fixlogic** is set for scheme switch [**SPOS01-LGCFEXOT**]. The "Operate completed" signal can also be issued from logic programmed by the user in place of the logic shown in Figure 4.1-20.. The user-programmed logic is connected internally to the signal "Operate completed", hence this signal is now generated by the user-programmed logic at connection

point # 2 “user- configurable condition”. That is, set the scheme switch [**SPOS01-LGCFEXOT**] to **PLC** and use “PLC_BIT_0062”.

(iv)-2 Output signal to BO

The SPOS01 function, in Figure 4.1-26, can issue a signal “Operate” at the output point “SPOS01_FEX_BO”, when the SPOS01 function determines that the input signal “Local-Off-Control” is true.

(v) Receiving “operate command On” using the PLC function

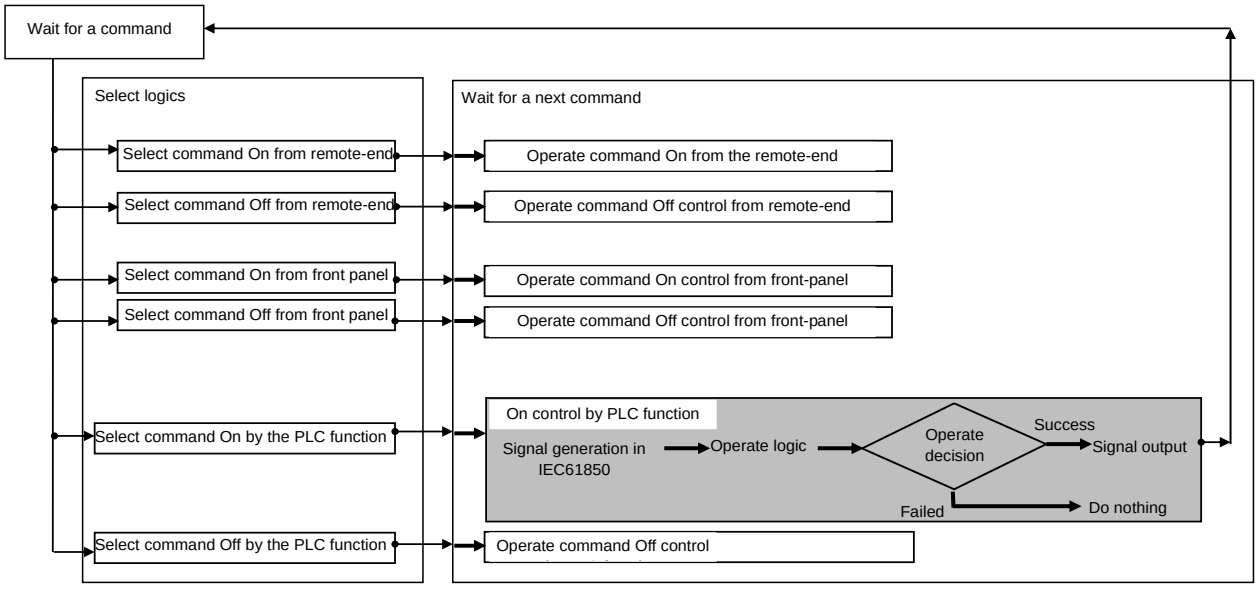


Figure 4.1-27 Outline of operate command for ‘On’

Figure 4.1-27 outlines the reception of the operate command ‘On’ with the PLC function; it describes the operate logic when an “Operate command On (PLC-On Control)” signal is generated by the PLC function. There are two input points for reception of this command signal, unlike the signal “operate command closing” (PLC-On Control).; the former connection point (PLC#3) is used for the reception of the operate-command requiring the interlock check, the latter connection point (PLC#4) is used or the reception of the operate-command not requiring interlocking check. That is, for the SPOS01 function, when the user wishes to apply for the operate logic the signal “Operate command On (PLC-On-Control)” generated in the user-programmed logic and when the interlock check is required in the operate logic, apply the signal at the connection point (PLC#3; is PLC_BIT_0013). Alternatively, if the interlock check is not required, apply the signal at the other connection point (PLC#4 i.e. PLC_BIT_0014); The PLC#3 and PLC#4 is denoted as the PLC#1 and PLC#2 in Table 4.1-2. Note that the user should set **PLC** for scheme switch [**SPOS01-LGCTRCON**].

(vi) Receiving "operate command Off" using PLC logic

Figure 4.1-28 outlines the reception of the operate command for Off using the PLC function.

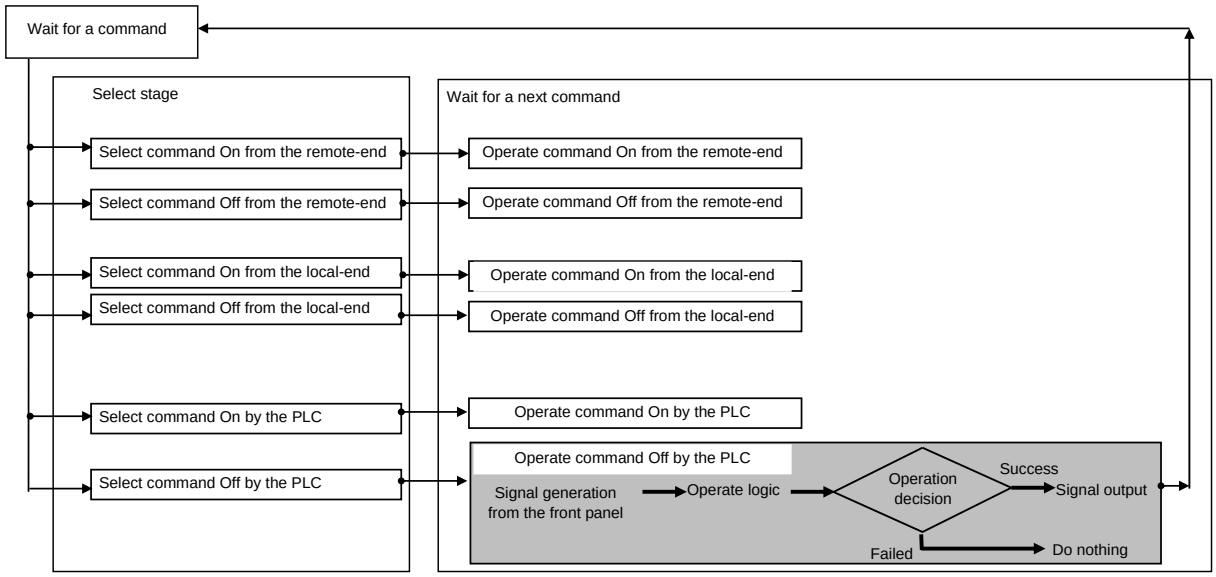


Figure 4.1-28 Outline of operate command for Off

Figure 4.1-28 depicts the operate logic when a signal "Operate Command Off (PLC-Off-Control)" is generated by the PLC function. There are two input points for reception of this command signal, unlike the signal "Operate Command On (PLC-On-Control)". That is, if an inter-lock check is required, apply the signal at connection point (PLC#3; i.e., PLC_BIT_0012). If, on the other hand an interlock check is not required, apply the signal at connection point (PLC#4; i.e., PLC_BIT_0011).

PLC#1 an PLC#2 shown in Table 4.1-3 should be treated as PLC#3 and PLC#4 here. Note that the user should set PLC for scheme switch [**SPOS01-LGCFEXOT**]

(vii) Operate condition

In a manner similar to which the conditions have been examined for the select command, the conditions for an operate command should be understood. Figure 4.1-29 illustrates the logic to examine an operate condition; the operate condition is determined by signal "SPOS01_STATE", if the functionality of the original logic does not meet with user-requirements, the following alternatives are available:

1. The user can replace the original logic with alternative logic.
2. The user can add another signal to the original logic.

(vii)-1 Adding another operate condition signal

If the addition of another signal is required, the user can add the signal to the operate condition logic using connection point "Additional Condition"

1. Add a user-preferred signal using "PLC_BIT_0053", listed as PLC#1 in Table 4.1-17.

2. Set scheme switch [**SPOS01-LGEXFFCT**] to **Fixedlogic.**

(vii)-2 Replacing the original logic

If the user wishes to replace the operate condition logic completely, it can be achieved using PLC connection point "User configurable condition":

1. Connect the user-customized logic using "PLC_BIT_0061", listed as PLC#2 in Table 4.1-17.
2. Set scheme switch [**SPOS01-LGEXFFCT**] to **PLC**.

Note: The output of the operate condition logic is provided separately for On-execution and for Off-execution. To see the outputs, refer to Table 4.1-18.

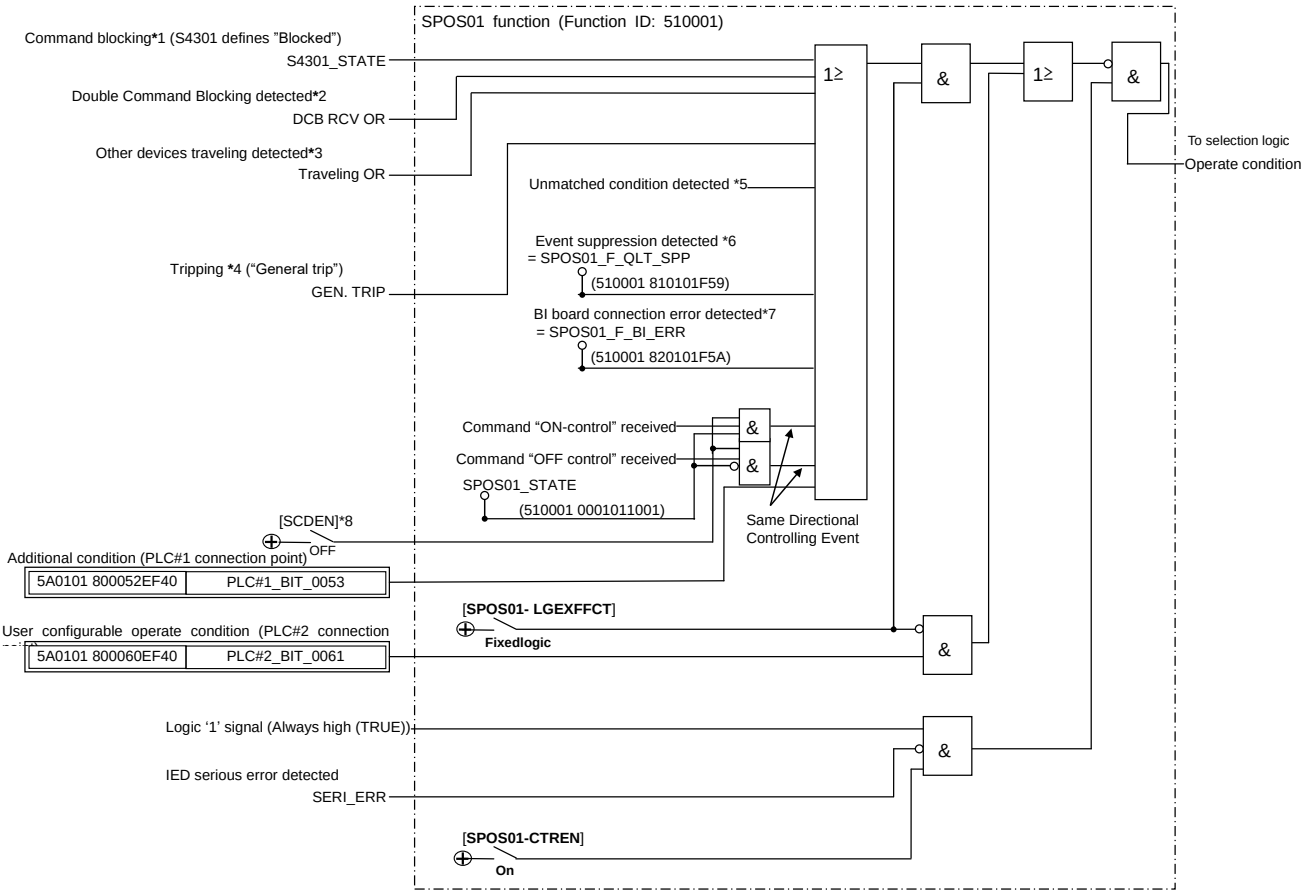


Figure 4.1-29 Operate condition logic for ON/OFF in SPOS01

[1]Note: "Command blocking" disables any operation except for itself; "Command Blocking" is implemented as "S4301"in software switch controller (SOFTSW).The IEC 61850 standard defines communication blocking as "CmdBlk". For more information, see Chapter *Control and monitoring application: Software switch controller. See the signal "S4301_STAEE in* Table 4.1-6.

[2]Note: "Double Command Blocking (DCB)" is an operation philosophy. It can be used to protect the substation. The user can program it using GR-TIEMS.

[3]Note: Detection of event "device-travelling , signifies that other operators are changing

the status of one or more devices. Thus, device operation by the IED should be inhibited whilst ever the events is detected. The detection signal is donated as "Travelling OR" in Table 4.1-6.

[4]Note: If an IED is in the process of issuing a trip command, all control operation is blocked until the trip operation has been completed. If the IED has a relay application, the trip command is issued at the output point.

[5]Note: The criteria "unmatched conditions" is determined when "Test-bit status" in a "GEN_TRIP" in Table 4.1-6 command is not identical to "IED test status".

[6]Note: The function "Event suppression" can detect chattering in BI circuits. (See section 4.1.4(i)-2)

[7]Note: A supervision of the Binary IO module can detect connection errors for BI circuits.

[8]Note: The common control (CMNCTRL) function can test and check the operation – direction of logic. When the user sets off for scheme switch (SCDEN), operation of the logic is blocked if the logic is running in the same operation – direction compared with the previous operation direction. Alternatively, if **On** is set for the scheme switch, the logic is not blocked.

(viii) Signal name and number

Note: The user should note the meaning of the following abbreviations shown in column "M/O" of each table:

"O" signifies that the signal is provided for optional use.

"M" signifies that the user should map/set/configure the signal; otherwise, the user may experience an operational failure if the default setting is used.

"N/A" signifies that the user cannot change the state of the signal.

Table 4.1-14 PLC connection points (Input point for PLC#1 user a configurable condition)

Signal Number	Signal Name	Description	M/O
5A0101 800056EF40	PLC_BIT_0057	SPOS01 user configurable condition(PLC#1)	O
5A0101 800071EF40	PLC_BIT_0072	SPOS02 user configurable condition(PLC#1)	O
5A0101 800086EF40	PLC_BIT_0087	SPOS03 user configurable condition(PLC#1)	O
5A0101 800101EF40	PLC_BIT_0102	SPOS04 user configurable condition(PLC#1)	O
5A0101 800116EF40	PLC_BIT_0117	SPOS05 user configurable condition(PLC#1)	O
5A0101 800131EF40	PLC_BIT_0132	SPOS06 user configurable condition(PLC#1)	O
5A0101 800146EF40	PLC_BIT_0147	SPOS07 user configurable condition(PLC#1)	O
5A0101 800161EF40	PLC_BIT_0162	SPOS08 user configurable condition(PLC#1)	O
5A0101 800176EF40	PLC_BIT_0177	SPOS09 user configurable condition(PLC#1)	O
5A0101 800191EF40	PLC_BIT_0192	SPOS10 user configurable condition(PLC#1)	O

Table 4.1-15 PLC connection points (Input point for PLC#2 user configurable condition)

Signal Number	Signal Name	Description	M/O
5A0101 800061EF40	PLC_BIT_0062	SPOS01 user configurable condition(PLC#2)	O
5A0101 800076EF40	PLC_BIT_0077	SPOS02 user configurable condition(PLC#2)	O
5A0101 800091EF40	PLC_BIT_0092	SPOS03 user configurable condition(PLC#2)	O

Signal Number	Signal Name	Description	M/O
5A0101 800106EF40	PLC_BIT_0107	SPOS04 user configurable condition(PLC#2)	O
5A0101 800121EF40	PLC_BIT_0122	SPOS05 user configurable condition(PLC#2)	O
5A0101 800136EF40	PLC_BIT_0137	SPOS06 user configurable condition(PLC#2)	O
5A0101 800151EF40	PLC_BIT_0152	SPOS07 user configurable condition(PLC#2)	O
5A0101 800166EF40	PLC_BIT_0167	SPOS08 user configurable condition(PLC#2)	O
5A0101 800181EF40	PLC_BIT_0182	SPOS09 user configurable condition(PLC#2)	O
5A0101 800196EF40	PLC_BIT_0197	SPOS10 user configurable condition(PLC#2)	O

Table 4.1-16 PLC connection points (Input point for PLC#3 user configurable condition)

Signal Number	Signal Name	Description	M/O
5A0101 800055EF40	PLC_BIT_0071	SPOS01 user configurable condition(PLC#3)	O
5A0101 800070EF40	PLC_BIT_0086	SPOS02 user configurable condition(PLC#3)	O
5A0101 800085EF40	PLC_BIT_0101	SPOS03 user configurable condition(PLC#3)	O
5A0101 800100EF40	PLC_BIT_0116	SPOS04 user configurable condition(PLC#3)	O
5A0101 800115EF40	PLC_BIT_0131	SPOS05 user configurable condition(PLC#3)	O
5A0101 800130EF40	PLC_BIT_0146	SPOS06 user configurable condition(PLC#3)	O
5A0101 800145EF40	PLC_BIT_0161	SPOS07 user configurable condition(PLC#3)	O
5A0101 800160EF40	PLC_BIT_0176	SPOS08 user configurable condition(PLC#3)	O
5A0101 800175EF40	PLC_BIT_0191	SPOS09 user configurable condition(PLC#3)	O
5A0101 800190EF40	PLC_BIT_0071	SPOS10 user configurable condition(PLC#3)	O

Table 4.1-17 PLC connection points (Input point PLC#1 and #2 of additional and operate conditions)

Signal Number	Signal Name	Description	M/O
5A0101 800052EF40	PLC_BIT_0053	SPOS01 additional failure condition (PLC#1)	O
5A0101 800067EF40	PLC_BIT_0068	SPOS02 additional failure condition (PLC#1)	O
5A0101 800082EF40	PLC_BIT_0083	SPOS03 additional failure condition (PLC#1)	O
5A0101 800097EF40	PLC_BIT_0098	SPOS04 additional failure condition (PLC#1)	O
5A0101 800112EF40	PLC_BIT_0113	SPOS05 additional failure condition (PLC#1)	O
5A0101 800127EF40	PLC_BIT_0128	SPOS06 additional failure condition (PLC#1)	O
5A0101 800142EF40	PLC_BIT_0143	SPOS07 additional failure condition (PLC#1)	O
5A0101 800157EF40	PLC_BIT_0158	SPOS08 additional failure condition (PLC#1)	O
5A0101 800172EF40	PLC_BIT_0173	SPOS09 additional failure condition (PLC#1)	O
5A0101 800187EF40	PLC_BIT_0188	SPOS10 additional failure condition (PLC#1)	O
5A0101 800060EF40	PLC_BIT_0061	SPOS01 user configurable operate condition (PLC#2)	O
5A0101 800075EF40	PLC_BIT_0076	SPOS02 user configurable operate condition (PLC#2)	O
5A0101 800090EF40	PLC_BIT_0091	SPOS03 user configurable operate condition (PLC#2)	O
5A0101 800105EF40	PLC_BIT_0106	SPOS04 user configurable operate condition (PLC#2)	O
5A0101 800120EF40	PLC_BIT_0121	SPOS05 user configurable operate condition (PLC#2)	O
5A0101 800135EF40	PLC_BIT_0136	SPOS06 user configurable operate condition (PLC#2)	O
5A0101 800150EF40	PLC_BIT_0151	SPOS07 user configurable operate condition (PLC#2)	O
5A0101 800165EF40	PLC_BIT_0166	SPOS08 user configurable operate condition (PLC#2)	O
5A0101 800180EF40	PLC_BIT_0181	SPOS09 user configurable operate condition (PLC#2)	O
5A0101 800195EF40	PLC_BIT_0196	SPOS10 user configurable operate condition (PLC#2)	O

Table 4.1-18 PLC monitoring points (Output signal for BIO)

Signal Number	Signal Name	Description
510001 8201011DD3	SPOS01_OEX_BO	SPOS01 operate (ON) command for Binary Output.
510001 8201021DD3	SPOS02_OEX_BO	SPOS02 operate (ON) command for Binary Output.
510001 8201031DD3	SPOS03_OEX_BO	SPOS03 operate (ON) command for Binary Output.

Signal Number	Signal Name	Description
510001 8201041DD3	SPOS04_OEX_BO	SPOS04 operate (ON) command for Binary Output.
510001 8201051DD3	SPOS05_OEX_BO	SPOS05 operate (ON) command for Binary Output.
510001 8201061DD3	SPOS06_OEX_BO	SPOS06 operate (ON) command for Binary Output.
510001 8201071DD3	SPOS07_OEX_BO	SPOS07 operate (ON) command for Binary Output.
510001 8201081DD3	SPOS08_OEX_BO	SPOS08 operate (ON) command for Binary Output.
510001 8201091DD3	SPOS09_OEX_BO	SPOS09 operate (ON) command for Binary Output.
510001 82010A1DD3	SPOS10_OEX_BO	SPOS10 operate (ON) command for Binary Output.
510001 8101011DD0	SPOS01_FEX_BO	SPOS01 operate (OFF) command for Binary Output.
510001 8101021DD0	SPOS02_FEX_BO	SPOS02 operate (OFF) command for Binary Output.
510001 8101031DD0	SPOS03_FEX_BO	SPOS03 operate (OFF) command for Binary Output.
510001 8101041DD0	SPOS04_FEX_BO	SPOS04 operate (OFF) command for Binary Output.
510001 8101051DD0	SPOS05_FEX_BO	SPOS05 operate (OFF) command for Binary Output.
510001 8101061DD0	SPOS06_FEX_BO	SPOS06 operate (OFF) command for Binary Output.
510001 8101071DD0	SPOS07_FEX_BO	SPOS07 operate (OFF) command for Binary Output.
510001 8101081DD0	SPOS08_FEX_BO	SPOS08 operate (OFF) command for Binary Output.
510001 8101091DD0	SPOS09_FEX_BO	SPOS09 operate (OFF) command for Binary Output.
510001 81010A1DD0	SPOS010_FEX_BO	SPOS10 operate (OFF) command for Binary Output.

Table 4.1-19 PLC monitoring points (signals with in operate logic)

Signal Number	Signal Name	Description
510001 8101011E82	SPOS01_OEC_OK_CS	SPOS01 on direction execute command
510001 8101021E82	SPOS02_OEC_OK_CS	SPOS02 on direction execute command
510001 8101031E82	SPOS03_OEC_OK_CS	SPOS03 on direction execute command
510001 8101041E82	SPOS04_OEC_OK_CS	SPOS04 on direction execute command
510001 8101051E82	SPOS05_OEC_OK_CS	SPOS05 on direction execute command
510001 8101061E82	SPOS06_OEC_OK_CS	SPOS06 on direction execute command
510001 8101071E82	SPOS07_OEC_OK_CS	SPOS07 on direction execute command
510001 8101081E82	SPOS08_OEC_OK_CS	SPOS08 on direction execute command
510001 8101091E82	SPOS09_OEC_OK_CS	SPOS09 on direction execute command
510001 81010A1E82	SPOS10_OEC_OK_CS	SPOS10 on direction execute command
510001 8001011E81	SPOS01_FEC_OK_CS	SPOS01 off direction execute command
510001 8001021E81	SPOS02_FEC_OK_CS	SPOS02 off direction execute command
510001 8001031E81	SPOS03_FEC_OK_CS	SPOS03 off direction execute command
510001 8001041E81	SPOS04_FEC_OK_CS	SPOS04 off direction execute command
510001 8001051E81	SPOS05_FEC_OK_CS	SPOS05 off direction execute command
510001 8001061E81	SPOS06_FEC_OK_CS	SPOS06 off direction execute command
510001 8001071E81	SPOS07_FEC_OK_CS	SPOS07 off direction execute command
510001 8001081E81	SPOS08_FEC_OK_CS	SPOS08 off direction execute command
510001 8001091E81	SPOS09_FEC_OK_CS	SPOS09 off direction execute command
510001 80010A1E81	SPOS10_FEC_OK_CS	SPOS10 off direction execute command

Table 4.1-20 PLC monitoring points (Output signal for response)

Signal Number	Signal Name	Description
510001 8601011E91	SPOS01_EX_FFL	SPOS01 execute fail signal by fixedlogic
510001 8601021E91	SPOS02_EX_FFL	SPOS02 execute fail signal by fixedlogic
510001 8601031E91	SPOS03_EX_FFL	SPOS03 execute fail signal by fixedlogic
510001 8601041E91	SPOS04_EX_FFL	SPOS04 execute fail signal by fixedlogic
510001 8601051E91	SPOS05_EX_FFL	SPOS05 execute fail signal by fixedlogic
510001 8601061E91	SPOS06_EX_FFL	SPOS06 execute fail signal by fixedlogic
510001 8601071E91	SPOS07_EX_FFL	SPOS07 execute fail signal by fixedlogic
510001 8601081E91	SPOS08_EX_FFL	SPOS08 execute fail signal by fixedlogic
510001 8601091E91	SPOS09_EX_FFL	SPOS09 execute fail signal by fixedlogic

Signal Number	Signal Name	Description
510001 86010A1E91	SPOS10_EX_FFL	SPOS10 execute fail signal by fixedlogic

(ix) Setting names

Note: The "xx" of "SPOSxx" represents the SPOS function number. (e.g., if the SPOS03 is considered, the "xx" is equal to "03". The suffix "xx" can be represented by "01" to "10").

Table 4.1-21 Setting of Operate in SPOSxx

Setting Name	Description	Default	Setting item or value
SPOSxx-PLSM	Method of command output(SPOS1-10)	Fix	Fix/Var/Latch
SPOSxx-CPW	Duration of command output(SPOS1-10)	1.0[sec]	0.1~50.0[sec]
SPOSxx-RST	Detection time for terminating control (SPOS1-10)	30.0[sec]	0.1~100.0[sec]
SPOSxx-LGCTRCON	Logic selector for operate condition (SPOS01-10)	Fixedlogic	Fixedlogic/PLC
SPOSxx-LGCFEXOT	Logic selector for command output (SPOS01-10)	Fixedlogic	Fixedlogic/PLC
SPOSxx-CTREN	Activate control function of SPOS01-10	On	Off / On
SPOSxx-LGEXFFCT	Logic selector for operate condition (SPOS01-10)	Fixedlogic	Fixedlogic / PLC

4.1.4 Setup for BIO module

The user should connect the SPOS input/output points with the BI and the BO circuits; subsequently, the SPOS function is able to issue select and operate commands. The user should execute the following four steps below.

i BI connection for status-signals

ii BO connection for "Select command On/Off"

iii BO connection for "operate command"

iv Contact health check

Note that the SPOS01 function commences operation when the scheme switch [**SPOS01-EN**] is set to **On**.

(i) BI connection for status-signals

Figure 4.1-30 exemplifies the reception of signals at the SPOS01 function; the user can set a input-point using the setting [**SPOS01-NOPSG**]†.

†Note: Normally an input-signal corresponding to phase-A is generated using a normally-open contact (NO). If the signal is generated by the normally-closed contact, the user is required to set scheme switch [**SPOS01-NSOSGI**] **On** in order that the input-signal should be decided in inversion.

(i)-1 Connection with Binary input circuit

Suppose an input signal is provided on the first BI circuit at IO#1 slot. In this case, the user should set the input point (200B01 8001001110†) for the setting [**SPOS01-NOPSG**], otherwise, the SPOS01 function cannot run correctly.

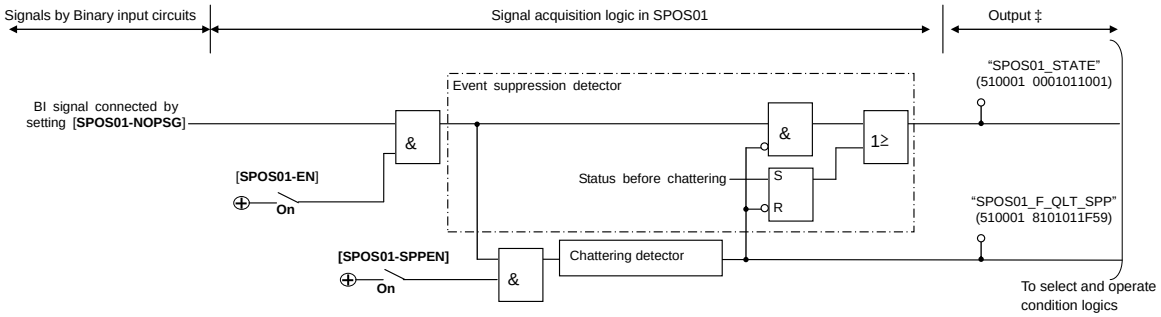


Figure 4.1-30 Acquisition of binary input signal in SPOS01

†Note: The user should set the actual input-points. For input points, see in Chapter *Technical description: Binary IO module*.

‡Note: In Figure 4.1-30 two signals can be issued: "SPOS01_STATE" and "SPOS01_F_QLT_SPP". One is used in the select condition logic and the operate condition logic (see Figure 4.1-13 and Figure 4.1-29). Another is used for operation in the event suppression detector.

(i)-2 Event suppression

If the status of a device "chatters" for a short time, the SPOS function will receive iterative signals from the device. Such iterative signals can cause extra burden for the SPOS function; hence, event suppression can be required to reduce the additional burden created.

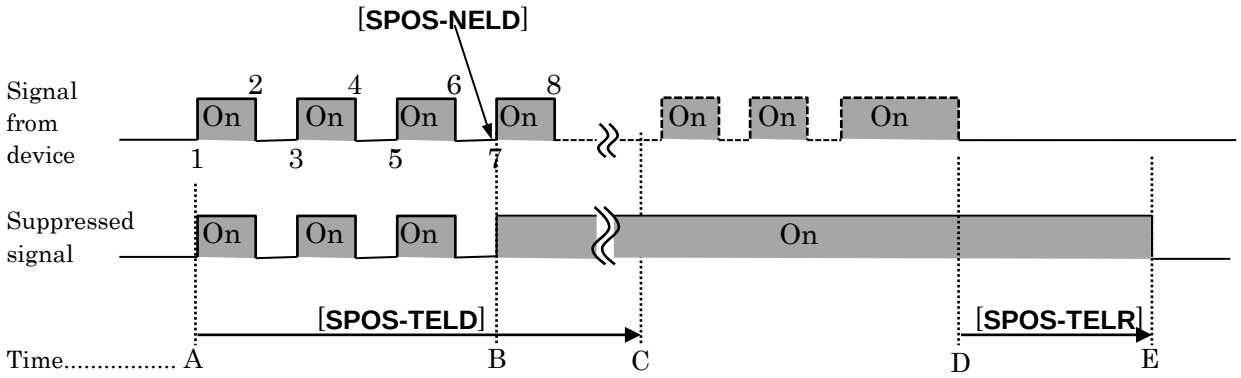


Figure 4.1-31 Iterative signals and signals suppressed

Figure 4.1-31 shows that the iterative signals received from the device have been suppressed by the event suppression function. The suppression commences on receipt of the seventh signal (at Time B). This is because the function can count the iterative number of incoming signals. Detection commences at Time A, the setting [**SPOS-NELD**] is provided so that the suppression commences at Time B. The setting [**SPOS-TELD**] is pertains to the operation of the detection function from Time A (e.g., Time A to Time C).

The event suppression ceases when the iterative signals stop. The user can adjust the point at which event suppression stops using the setting [**SPOS-TELR**]; as a result, no suppressed signal is output after the end of the iterative signals (e.g., Time D to E).

To initiate event suppression the user should set **On** for scheme switch [**SPOS01-SPPEN**].

(ii) BO connection for "Select command On/Off"

Figure 4.1-32 exemplifies the connection for the select command On and Off. Suppose that connection with the BOs is achieved by the PLC function using connection point "SPOS01_SL_BO_FLG"†; as a result, the "Select command On" and the "Select command Off" signals are issued at the BOI.

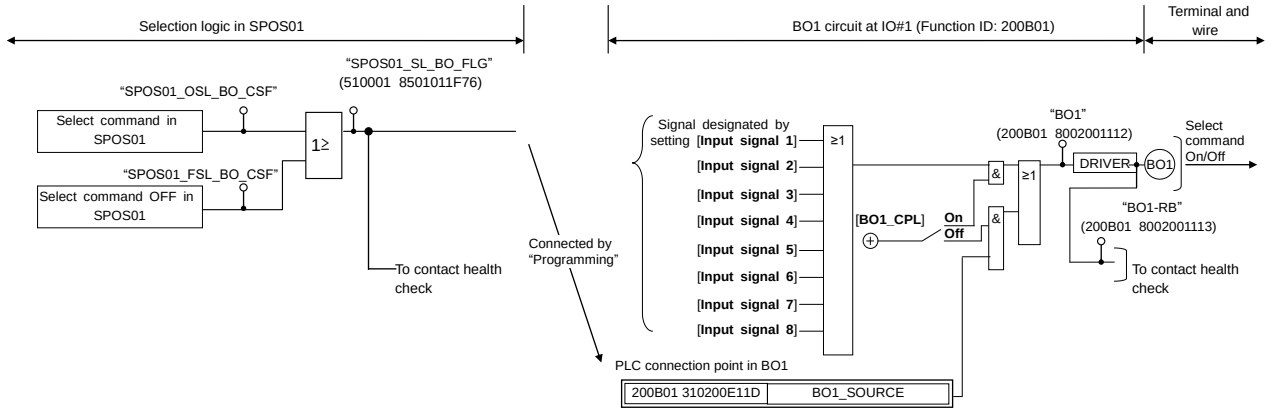


Figure 4.1-32 Example of select command connection with BO1

†Note: Table 4.1-26 shows the remaining signals with the excepting "SPOS01_SL_BO_FLG".

(iii) BO connection for "operate command On/Off"

Figure 4.1-33 exemplifies the connection for operate command On/Off. Suppose that connections with the BOs is achieved by the PLC function using connection point "SPOS01_OEX_BO" and "SPOS01_FEX_BO" as a result, the "Operate command On" and the "Operate command Off" signal is issued at BO2 or BO3.

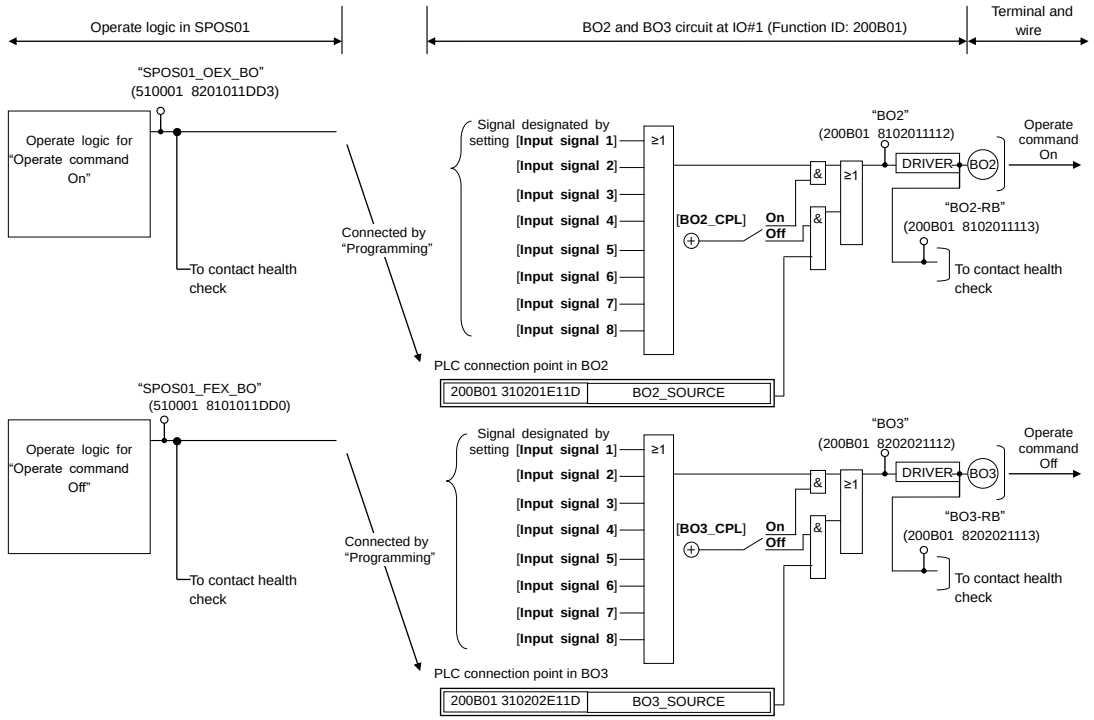


Figure 4.1-33 Example of operate commands connected with BO2 and BO3 at IO#1

†Note:Table 4.1-27 shows the remaining signals excepting "SPOS01_OEX_BO" and "SPOS01_FEX_BO".

(iv) Contact health check

The SPOS01 function has contact health check feature for the BO circuits; hence, the user is able to connect an output signal to the contact health check function when **Fixedlogic** is set for scheme switch [**SPOS01-LGXFEOT**]†. Consequently, the SPOS01 function can determine whether the signal has been successfully output from the BO. If a failure is reported, the SPOS01 function determines that the signal has not been output successfully to the BO; then, the command On or Off is canceled immediately and the SPOS01 function returns to the "Wait for a command" stage.

†Note:Table 4.1-29 shows settings for the health check feature in the other SPOS functions.

(iv)-1 Setting for "Select command On/Off"

For example, the point "SPOS01_SL_BO_FLG" is connected to the BO1 circuit for the issuing of the command, the user can connect point "BO1-RB" with the contact health check function using the setting [**SPOS01-SLBORD**]. Do not key the point "SPOS01_SL_BO_FLG".

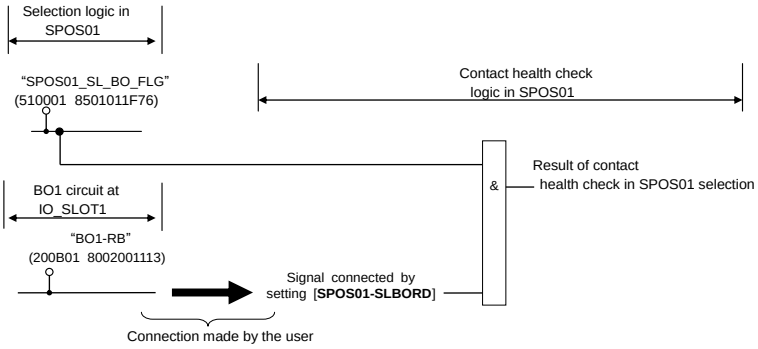


Figure 4.1-34 Example of connection of "Select command On" for the health check feature

(iv)-2 Setting for "Operate Command ON"

Similarly the point "BO2-RB" must be applied for the setting [**SPOS01-OEXBORD**].

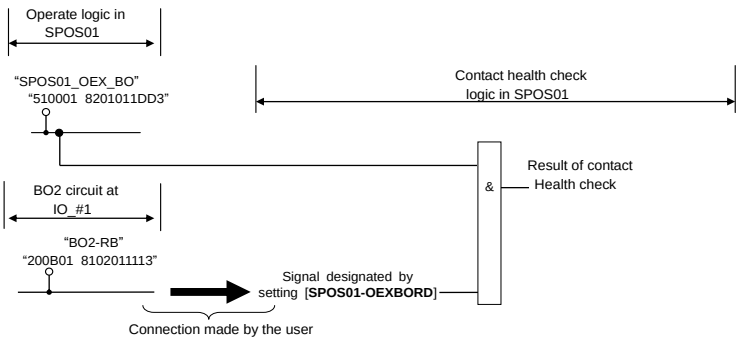


Figure 4.1-35 Example connection of "Operate Command On" for the health check

(iv)-3 Operate-Off command check

Similarly, the point "BO3-RB" must be applied for the setting [**SPOS01-FEXBORD**].

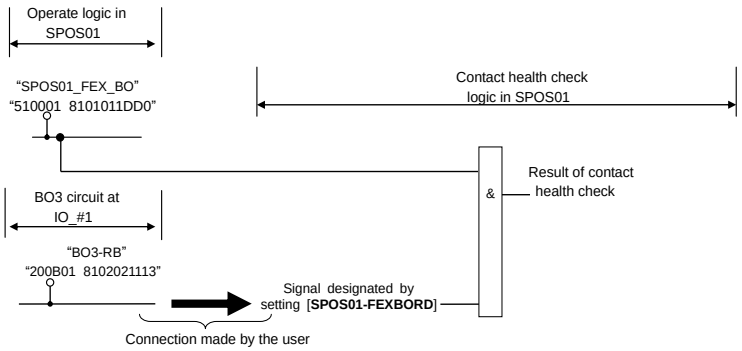


Figure 4.1-36 Example connection of "Operate command off" for the health check feature

(iv)-4 Proper setting for the contact health check (normal setting, example #1)

Figure 4.1-37 shows a setting example for the 43SW scheme. Select and operate commands drive the BO1, BO2 and BO3 contacts. To check that the contact health check function is working correctly, the respective points of the BO-RBs should be connected as shown in Table 4.1-22, to demonstrate that the settings are physically matched with the BO contacts.

Table 4.1-22 Setting example for contact health check

Example #1		Health check setting for Example #1	
"SPOS01_SL_BO_FLG" is connected to "BO1" at IO#1	⇨	200B01 8002001113(BO1-RB) set for [**SPOS01-SLBORD**]	OK
"SPOS01_OEX_BO_CSF" is connected to "BO2" at IO#1	⇨	200B01 8102011113(BO2-RB) set for [**SPOS01-OEXBORD**]	OK
"SPOS01_FEX_BO_CSF" is connected to "BO3" at IO#1	⇨	200B01 8202021113 (BO3-RB) set for [**SPOS01-FEXBORD**]	OK

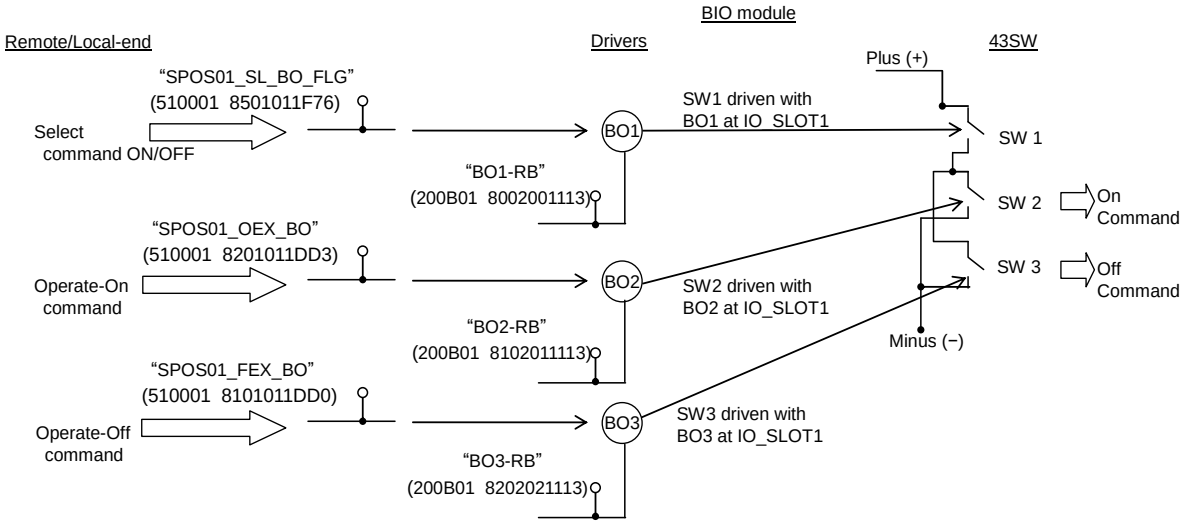


Figure 4.1-37 Contact health check setting and 43SW scheme for example #1

(iv)-5 Setting for erroneous contact health check (improper setting, example #2)

Figure 4.1-38 shows a setting example for an improper setting of the 43SW scheme. The settings are implemented incorrectly, as shown in Table 4.1-23. BO1-RB is not chosen, instead BO1 is actually chosen. In this case, the setting [**SPOS01-SLBORD**] is meaningless; hence, the issue of a select command is blocked.

Table 4.1-23 Erroneous setting example for contact health check

Example #2		Health check setting for example #2	
"SPOS01_SL_BO_FLG" is connected to "BO1" at IO#1	⇨	200B01 8002001112(BO1) set for [**SPOS01-SLBORD**]	NG
"SPOS01_OEX_BO_CSF" is connected to "BO2" at IO#1	⇨	200B01 8102011113(BO2-RB) set for [**SPOS01-OEXBORD**]	OK
"SPOS01_FEX_BO_CSF" is connected to "BO3" at IO#1	⇨	200B01 8202021113 (BO3-RB) set for [**SPOS01-FEXBORD**]	OK

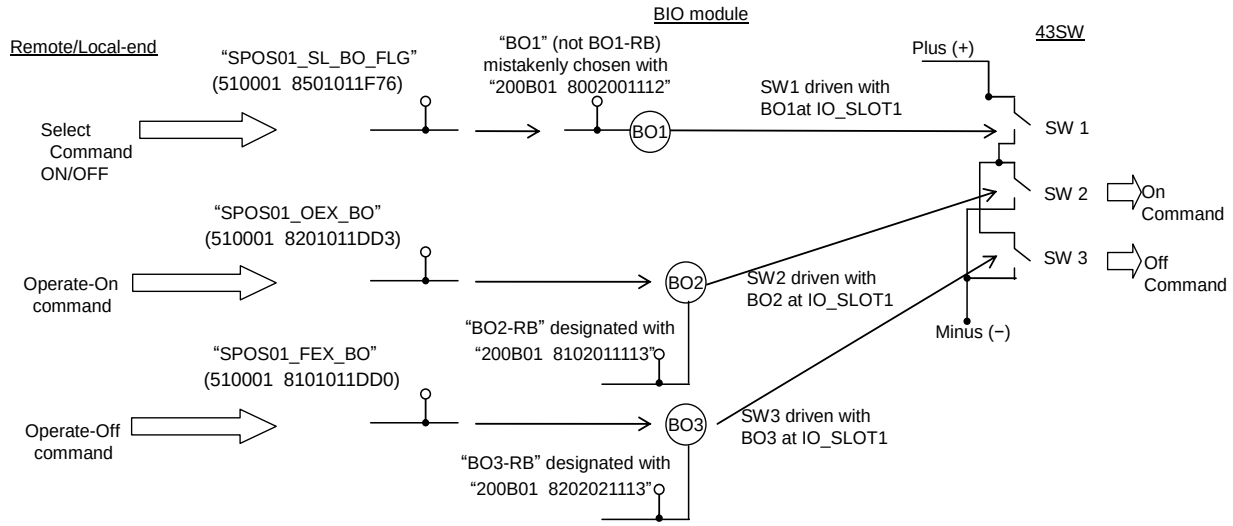


Figure 4.1-38 Contact health check setting and 43SW diagram for example #2

(iv)-6 Setting for extra contact health check (special setting, example #3)

Figure 4.1-39 shows an additional setting example for the 43SW scheme; one of the settings is made hypothetically. That is, the point "SPOS01_SL_BO_FLG" is actually chosen for the setting [**SPOS01-SLBORD**]; i.e. BO1-RB is not chosen for this selection. This special example can issue a select command; which is called "operated by internal select function". The user does not need to consider a BO circuit for a select command, when there are no BO circuits available.

Table 4.1-24 Extra setting example for contact health check

Example #3		Setting for example #3	
"SPOS01_SL_BO_FLG" is not connected to any "BO"	⇨	"SPOS01_SL_BO_FLG" set for [**SPOS01-SLBORD**]	OK
"SPOS01_OEX_BO_CSF" is connected to "BO2" at IO#1	⇨	200B01 8102011113(BO2-RB) set for [**SPOS01-OEXBORD**]	OK
"SPOS01_FEX_BO_CSF" is connected to "BO3" at IO#1	⇨	200B01 8202021113 (BO3-RB) set for [**SPOS01-FEXBORD**]	OK

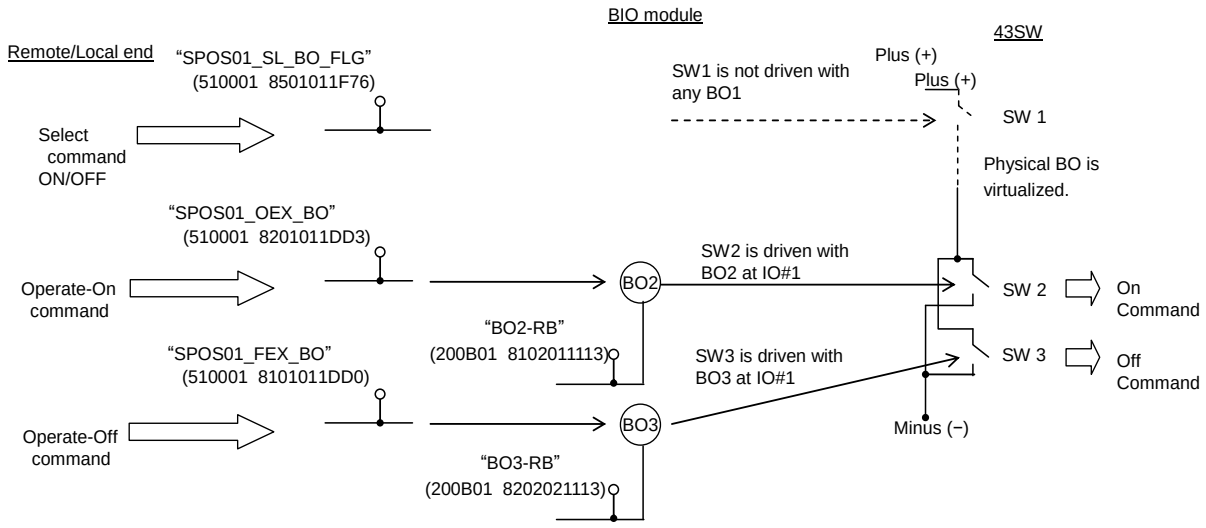


Figure 4.1-39 Contact health check setting and 43SW diagram for example #3

Table 4.1-25 PLC monitoring points (Output signal for event suppression function in SPOSxx)

Signal Number	Signal Name	Description
510001 0001011001	SPOS01_STATE	Status of SPOS01
510001 0001021001	SPOS02_STATE	Status of SPOS02
510001 0001031001	SPOS03_STATE	Status of SPOS03
510001 0001041001	SPOS04_STATE	Status of SPOS04
510001 0001051001	SPOS05_STATE	Status of SPOS05
510001 0001061001	SPOS06_STATE	Status of SPOS06
510001 0001071001	SPOS07_STATE	Status of SPOS07
510001 0001081001	SPOS08_STATE	Status of SPOS08
510001 0001091001	SPOS09_STATE	Status of SPOS09
510001 00010A1001	SPOS10_STATE	Status of SPOS10
510001 8101011F59	SPOS01_F_QLT_SPP	Event suppression detected (SPOS01)
510001 8101021F59	SPOS02_F_QLT_SPP	Event suppression detected (SPOS02)
510001 8101031F59	SPOS03_F_QLT_SPP	Event suppression detected (SPOS03)
510001 8101041F59	SPOS04_F_QLT_SPP	Event suppression detected (SPOS04)
510001 8101051F59	SPOS05_F_QLT_SPP	Event suppression detected (SPOS05)
510001 8101061F59	SPOS06_F_QLT_SPP	Event suppression detected (SPOS06)
510001 8101071F59	SPOS07_F_QLT_SPP	Event suppression detected (SPOS07)
510001 8101081F59	SPOS08_F_QLT_SPP	Event suppression detected (SPOS08)
510001 8101091F59	SPOS09_F_QLT_SPP	Event suppression detected (SPOS09)
510001 81010A1F59	SPOS10_F_QLT_SPP	Event suppression detected (SPOS10)

Table 4.1-26 PLC monitoring points (Output of select signal in SPOSxx)

Signal Number	Signal Name	Description
510001 8501011F76	SPOS01_SL_BO_FLG	Select command signal in SPOS01
510001 8501021F76	SPOS02_SL_BO_FLG	Select command signal in SPOS02
510001 8501031F76	SPOS03_SL_BO_FLG	Select command signal in SPOS03
510001 8501041F76	SPOS04_SL_BO_FLG	Select command signal in SPOS04
510001 8501051F76	SPOS05_SL_BO_FLG	Select command signal in SPOS05
510001 8501061F76	SPOS06_SL_BO_FLG	Select command signal in SPOS06
510001 8501071F76	SPOS07_SL_BO_FLG	Select command signal in SPOS07
510001 8501081F76	SPOS08_SL_BO_FLG	Select command signal in SPOS08
510001 8501091F76	SPOS09_SL_BO_FLG	Select command signal in SPOS09

Signal Number	Signal Name	Description
510001 85010A1F76	SPOS10_SL_BO_FLG	Select command signal in SPOS10

Table 4.1-27 PLC monitoring points (Output of operate signal in SPOSxx)

Signal Number	Signal Name	Description
510001 8201011DD3	SPOS01_OEX_BO	SPOS01 operate (ON) command for Binary Output.
510001 8201021DD3	SPOS02_OEX_BO	SPOS02 operate (ON) command for Binary Output.
510001 8201031DD3	SPOS03_OEX_BO	SPOS03 operate (ON) command for Binary Output.
510001 8201041DD3	SPOS04_OEX_BO	SPOS04 operate (ON) command for Binary Output.
510001 8201051DD3	SPOS05_OEX_BO	SPOS05 operate (ON) command for Binary Output.
510001 8201061DD3	SPOS06_OEX_BO	SPOS06 operate (ON) command for Binary Output.
510001 8201071DD3	SPOS07_OEX_BO	SPOS07 operate (ON) command for Binary Output.
510001 8201081DD3	SPOS08_OEX_BO	SPOS08 operate (ON) command for Binary Output.
510001 8201091DD3	SPOS09_OEX_BO	SPOS09 operate (ON) command for Binary Output.
510001 82010A1DD3	SPOS10_OEX_BO	SPOS10 operate (ON) command for Binary Output.
510001 8101011DD0	SPOS01_FEX_BO	SPOS01 operate (OFF) command for Binary Output.
510001 8101021DD0	SPOS02_FEX_BO	SPOS02 operate (OFF) command for Binary Output.
510001 8101031DD0	SPOS03_FEX_BO	SPOS03 operate (OFF) command for Binary Output.
510001 8101041DD0	SPOS04_FEX_BO	SPOS04 operate (OFF) command for Binary Output.
510001 8101051DD0	SPOS05_FEX_BO	SPOS05 operate (OFF) command for Binary Output.
510001 8101061DD0	SPOS06_FEX_BO	SPOS06 operate (OFF) command for Binary Output.
510001 8101071DD0	SPOS07_FEX_BO	SPOS07 operate (OFF) command for Binary Output.
510001 8101081DD0	SPOS08_FEX_BO	SPOS08 operate (OFF) command for Binary Output.
510001 8101091DD0	SPOS09_FEX_BO	SPOS09 operate (OFF) command for Binary Output.
510001 81010A1DD0	SPOS010_FEX_BO	SPOS10 operate (OFF) command for Binary Output.

(v) Setting names

Note: The “xx” of “SPOSxx” represents the SPOS function number. (e.g., if the SPOS03 is considered, the “xx” is equal to “03”. The suffix “xx” can be represented from “01” to “10”.)

Table 4.1-28 Settings for Binary input signals in SPOSxx

Setting Name	Description	Default	Setting item or value
SPOSxx-EN	Activate monitoring function of SPOS01-10	On	Off / On
SPOSxx-NOPSG	BI position for SPOS01-10	*none	BI signal
SPOSxx-SPPEN	Activate event suppression for SPOS01-10	On	Off / On
SPOS-NELD	Number of change to lock status	10	0~99
SPOS-TELD	Time to lock status(sliding window)	10[sec]	1~99[sec]
SPOS-TELR	Time to unlock status(sliding window)	10[sec]	1~99[sec]

Table 4.1-29 Settings for health check function in SPOSxx

Setting Name	Description	Default	Setting item or value
SPOSxx-SLBORD	Select BO signal (BO*-RB) from signal list	*user-preferred	BO readback signal
SPOSxx-OEXBORD	Select BO signal (BO*-RB) from signal list	*user-preferred	BO readback signal
SPOSxx-FEXBORD	Select BO signal (BO*-RB) from signal list	*user-preferred	BO readback signal

4.1.5 Mapping for IEC 61850 communication

The user can operate the SPOS function over IEC 61850 communications† following mapping using GR-TIEMS. Note that the SPOS function is designed for the class of "Single Point Controller (SPC)" in the IEC 61850 standard for communication. The user should follow these steps, each of which is discussed below,

Step1: Editing Logical Node

Step2: Mapping output data

Step3: Mapping input data

(i) Editing Logical Node

The user will need to create a logical node (LN) for the SPOS01 function. Figure 4.1-40 exemplifies the editing of a LN; the LN "General Input/output (GGIO)" is chosen for the SPOS01 function. After the user has defined an object "SPCSO", the SPOS01 logical node can be available with the name "GGIO" plus "LN Instance". Create a definition of the object "SPCSO" in the SPOS01 logical node. Either the SBO mode or the DIR mode can be chosen in the editing for the LN.

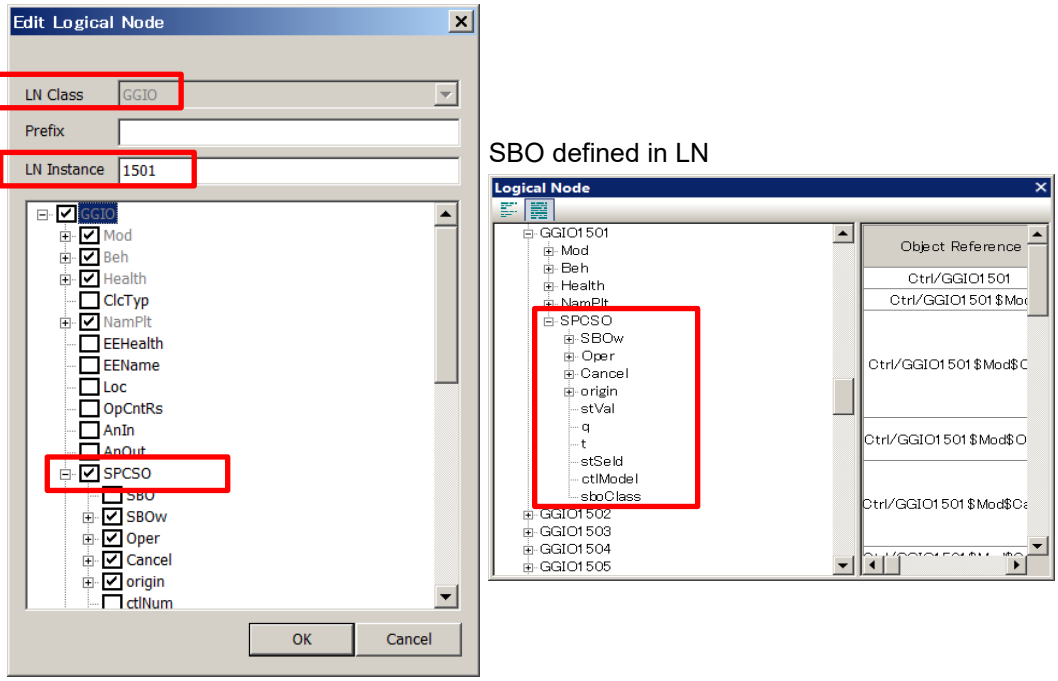
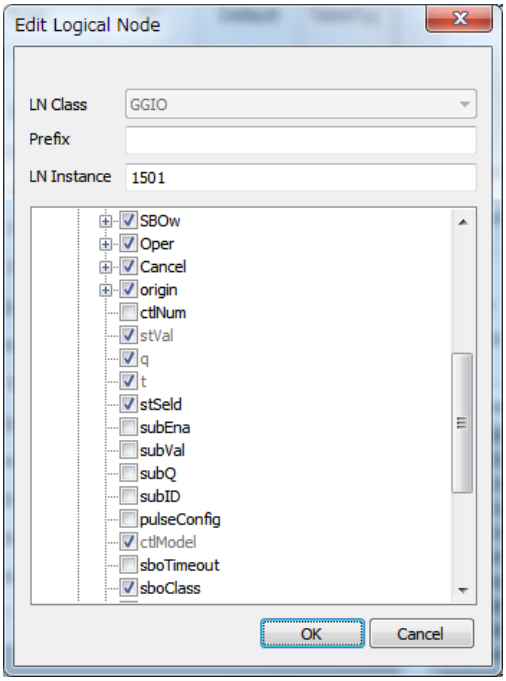


Figure 4.1-40 Defining "SPCSO" object in GGIO1501 logic node

(i)-1 Defining SBO mode

Figure 4.1-41 exemplifies the SPOS01 logic node saved as "GGIO1501". In the SBO mode, the user should select the following items for the "GGIO1501$SPCSO" using GR-TIEMS:

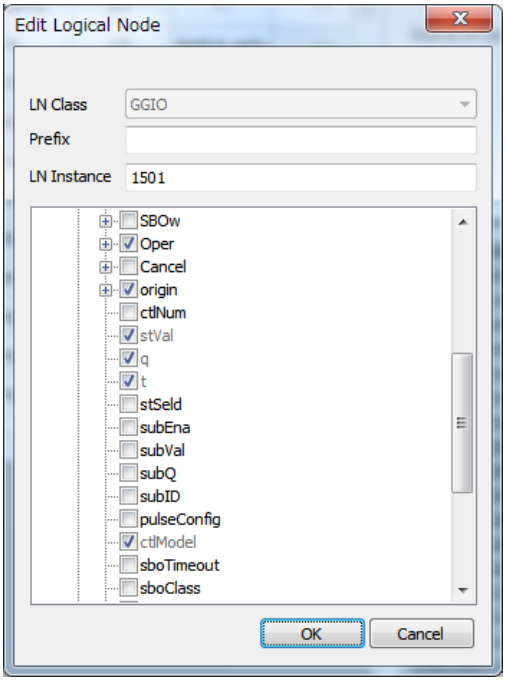


- ✓ SBOw
- ✓ Oper
- ✓ Cancel
- ✓ Origin
- ✓ stSeld
- ✓ sboClass (choice ”operate-once”)
- ✓ ctlmodel (choice ”SBOes or SBOns”)

Figure 4.1-41 LN editing screen for SBO (for example)

(i)-2 Defining DIR setting mode

Figure 4.1-42 exemplifies the SPOS01 logic node saved as “GGIO1501”. In the DIR mode, the following three items should be selected using GR-TIEMS:



- ✓ Oper
- ✓ origin
- ✓ ctlmodel (choice ”DOes or DOns”)

Figure 4.1-42 LN editing screen for DIR mode (for example)

(ii) Mapping output data

The user should group the SPOS01 signals with regard to GOOSE and Report; the user should map them for IEC 61850 communication using GR-TIEMS. Figure 4.1-43 illustrates how to map a signal; it indicates that the signals for the SPOS01 function are required to be mapped for IEC 61850 communication.

Table 4.1-30 Mapping signals for SPCSO object

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/GGIO1501$SPCSO$origin	orCat	orCategory	ST	510001 3001011008	SPOS01_ORCAT
Ctrl/GGIO1501$SPCSO$origin	orIdent	Octet64	ST	510001 6A01011009	SPOS01_ORIDENT
Ctrl/GGIO1501$SPCSO	stVal	BOOLEAN	ST	510001 0001011001	SPOS01_STATE
Ctrl/GGIO1501$SPCSO	q	Quality	ST	510001 3101011005	SPOS01_QUALITY
Ctrl/GGIO1501$SPCSO	t	Timestamp	ST	510001 9001011006	SPOS01_TIMESTAMP
Ctrl/GGIO1501$SPCSO	stSeld	BOOLEAN	ST	510001 0001011D90	SPOS01_STD_RPT

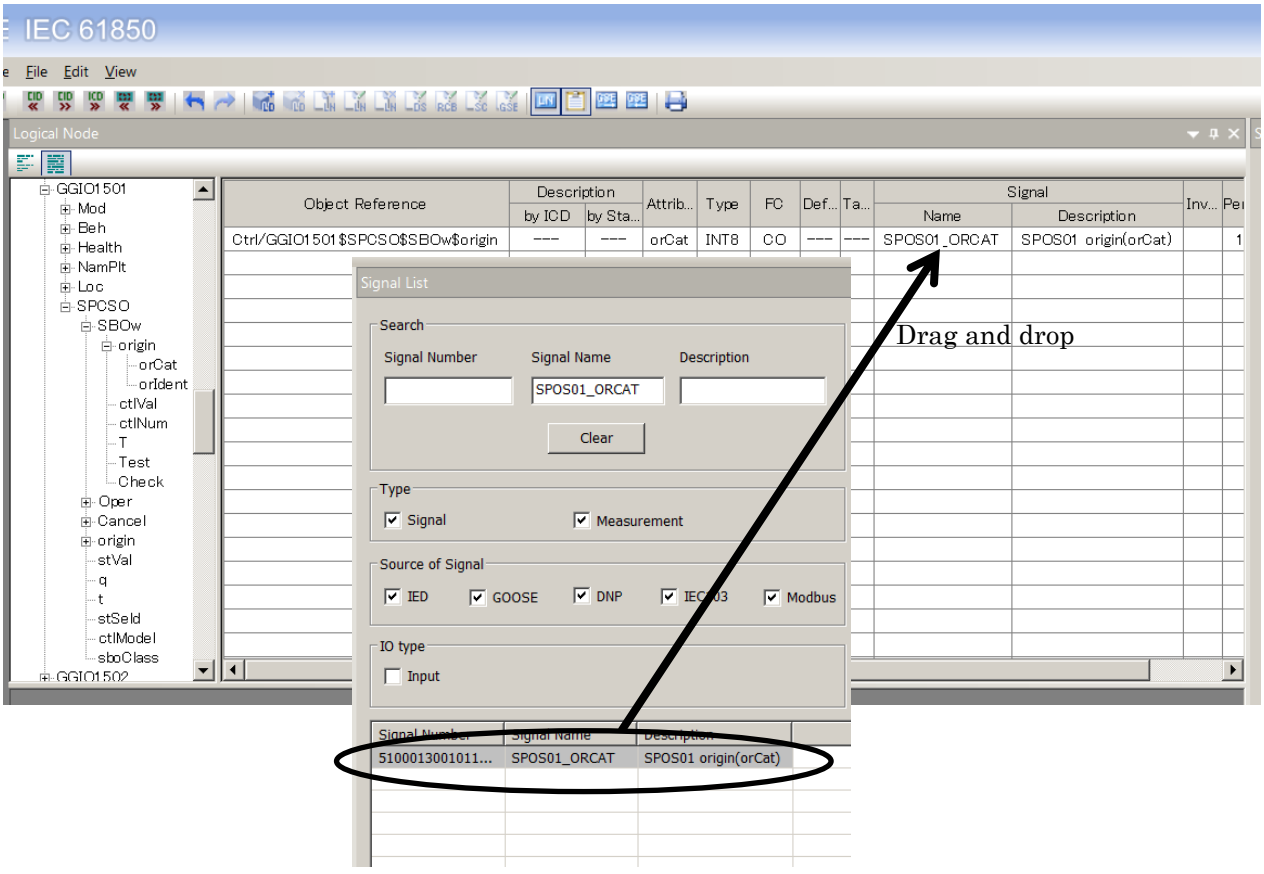


Figure 4.1-43 ocCat attribute mapped for SPCSO object of GGIO1501

(iii) Mapping input data

The SPOS01 function can receive three commands “select, operate, and cancel”. Thus, the user should map the input-point “DEV01_CONTROL_REQ” to the IEC 61850 communication. Table 4.1-31 shows the input-point “DEV01_CONTROL_REQ” and the Object reference

"Ctrl/GGIO1501$SPCSO"; the user should map the input point to the Object reference having attributes CO and CF. Note the user should map the input-point to all attributes CO and CF. Figure 4.1-44 shows how to map a signal.

Table 4.1-31 Mapping signals required for SPCSO object for GIG01501

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/GGIO1501$SPCSO$SBOw	ctlVal	BOOLEAN	CO	5100017 001016D08	DEV01_CONTROL_REQ
Ctrl/GGIO1501$SPCSO$SBOw	ctlNum	INT8U	CO		
Ctrl/GGIO1501$SPCSO$SBOw	T	Timestamp	CO		
Ctrl/GGIO1501$SPCSO$SBOw	Test	BOOLEAN	CO		
Ctrl/GGIO1501$SPCSO$SBOw	Check	Check	CO		
Ctrl/GGIO1501$SPCSO$SBOw$origin	orCat	orCategory	CO		
Ctrl/GGIO1501$SPCSO$SBOw$origin	orIdent	Octet64	CO		
Ctrl/GGIO1501$SPCSO$Oper	ctlVal	BOOLEAN	CO		
Ctrl/GGIO1501$SPCSO$Oper	ctlNum	INT8U	CO		
Ctrl/GGIO1501$SPCSO$Oper	T	Timestamp	CO		
Ctrl/GGIO1501$SPCSO$Oper	Test	BOOLEAN	CO		
Ctrl/GGIO1501$SPCSO$Oper	Check	Check	CO		
Ctrl/GGIO1501$SPCSO$Oper$origin	orCat	orCategory	CO		
Ctrl/GGIO1501$SPCSO$Oper$origin	orIdent	Octet64	CO		
Ctrl/GGIO1501$SPCSO$Cancel	ctlVal	BOOLEAN	CO		
Ctrl/GGIO1501$SPCSO$Cancel	ctlNum	INT8U	CO		
Ctrl/GGIO1501$SPCSO$Cancel	T	Timestamp	CO		
Ctrl/GGIO1501$SPCSO$Cancel	Test	BOOLEAN	CO		
Ctrl/GGIO1501$SPCSO$Cancel$origin	orCat	orCategory	CO		
Ctrl/GGIO1501$SPCSO$Cancel$origin	orIdent	Octet64	CO		
Ctrl/GGIO1501$SPCSO	ctlModel	ctlModel	CF		
Ctrl/GGIO1501$SPCSO	sboClass	sboClass	CF		

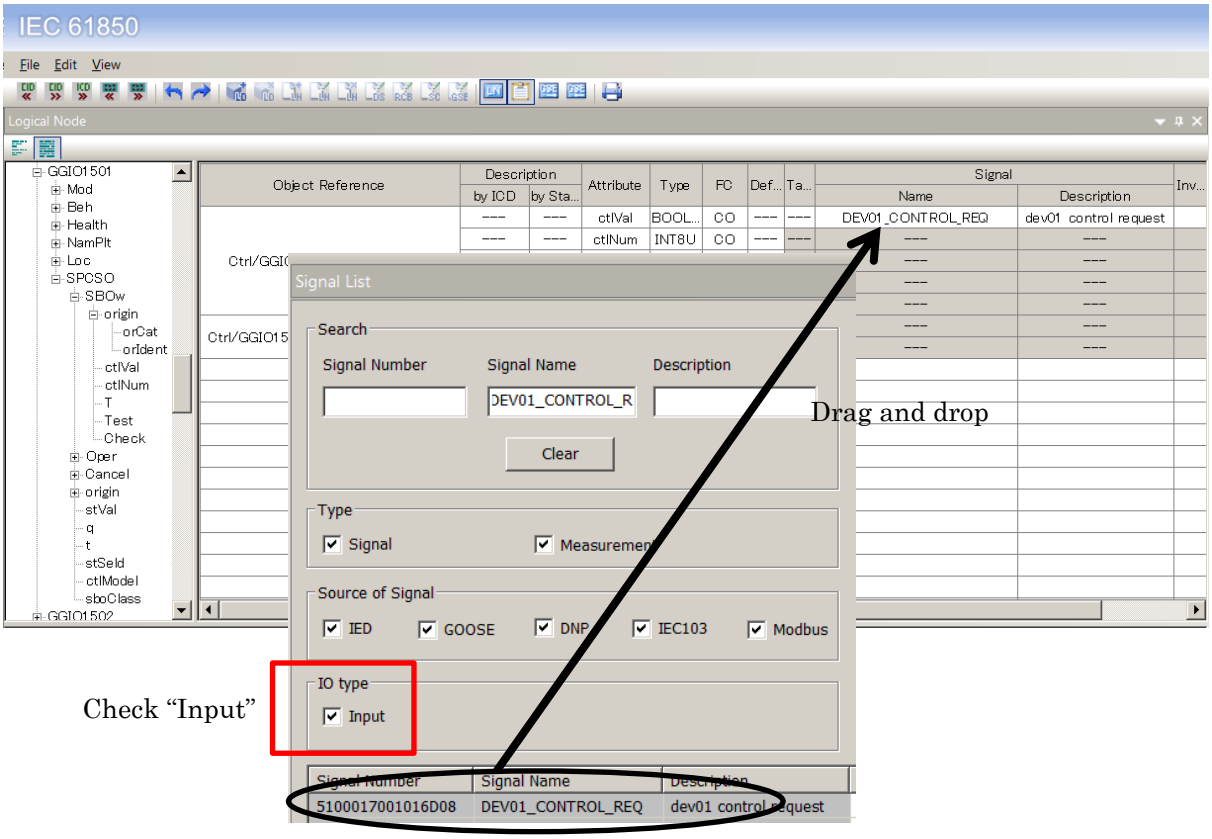


Figure 4.1-44 Input-point mapped for GGIO1501

4.1.6 Setting

Common settings list for the SPOS(FunctionID:510001)

Setting item			Range	Units	Contents	Default setting value	Notes
	common	SPOS-NELD	0 - 99	-	Number of Event lock detect time	10	
		SPOS-TELD	1 - 99	s	Timer for detection of event lock	10	
		SPOS-TELR	1 - 99	s	Timer for recovery from event lock	10	

SPOS01 settings list (FunctionID:510001)

Setting item			Range	Units	Contents	Default setting value	Notes
	DEV1	SPOS01-EN	Off/On		DEV1 Enable	Off	
		SPOS01-NOPSG			Normally Open Signal for Dev1		
		SPOS01-NSOSGI	Off/On		Signal inverse or not inversed	Off	
		SPOS01-SPPEN	Off/On		Automatic event suppression function	Off	
		SPOS01-CTREN	Off/On		control mode (control enable)	Off	
		SPOS01-CTRMENU	Off/On		control from MENU enable	Off	
		SPOS01-CTRAHMI	DIR/SBO		control action(Direct or SBO)by HMI	SBO	
		SPOS01-SLBORD			select binary output read data(DataID)		
		SPOS01-OEXBORD			on direction execute binary output read data(DataID)		
		SPOS01-FEXBORD			off direction execute binary output read data(DataID)		
		SPOS01-OFEXBORD			on/off direction execute binary output read data(DataID)		
		SPOS01-LGCTRCON	FixedLogic/PLC		Change logic for control condition	FixedLogic	
		SPOS01-LGSLFFCT	FixedLogic/PLC		Change logic for select fail factor	FixedLogic	
		SPOS01-LGEXFFCT	FixedLogic/PLC		Change logic for execute command fail factor	FixedLogic	
		SPOS01-LGFEXOT	FixedLogic/PLC		Change logic for off direction execute output	FixedLogic	
		SPOS01-LGCNFFCT	FixedLogic/PLC		Change logic for cancel command fail factor	FixedLogic	
		SPOS01-PLSM	Fix/Var/Latch		pulse mode	Latch	
		SPOS01-CPW	0.1-50.0	s	control pulse width	1	
		SPOS01-RST	1.0-100.0	s	response check timer	30	
		SPOS01-CTRDIR	Off/On		Capable control direction	On	
		SPOS01-APBD	Process/Bay		status change origin	Process	

Note: The SPOS function is available for a 2nd Device and other devices. We have omitted the others because their setting tables are the same as the 1st device table with the exception of the device number.

4.1.7 Signal

◆ Signal monitoring points in SPOS01

SPOS(FunctionID:510001)

Element ID	Name	Description
8001011DE0	DEV1PLCCTRLFAIL	DEV1PLCCTRLFAIL
8001011D51	SPOS01_SC_OWS	SPOS01 select command by OWS(HMI)
8001011D52	SPOS01_SC_RCC	SPOS01 select command by RCC
8001011D53	SPOS01_SC_RMT	SPOS01 select command by Remote
8001011D54	SPOS01_SC_LCD	SPOS01 select command by LCD
8001011D55	SPOS01_EC_OWS	SPOS01 execute command by OWS(HMI)
8001011D56	SPOS01_EC_RCC	SPOS01 execute command by RCC
8001011D57	SPOS01_EC_RMT	SPOS01 execute command by Remote
8001011D58	SPOS01_EC_LCD	SPOS01 execute command by LCD
8001011D59	SPOS01_EC_PLC	SPOS01 execute command by PLC
8701011E98	SPOS01_SLF_FCT_EIS	SPOS01 select fail factor signal except interlock/synchronism check
8B01011EA2	SPOS01_CTR_SGU	SPOS01 control logic stage(under selection)
8301011E9D	SPOS01_CTR_SGN	SPOS01 control logic stage(unselected)
8101011E9A	SPOS01_ECF_FCT_EIS	SPOS01 execute command fail factor signal except interlock/synchronism check
8001011F55	SPOS01_EC_ST_ERR	SPOS01 execute command mode err
8001011E93	SPOS01_EX_CMP	SPOS01 execute complete signal
8901011F6C	SPOS01_EX_CS01	SPOS01 execute condition signal 01
8A01011F6D	SPOS01_EX_CS02	SPOS01 execute condition signal 02
8B01011F6E	SPOS01_EX_CS03	SPOS01 execute condition signal 03
8E01011F67	SPOS01_EX_CS04	SPOS01 execute condition signal 04
8B01011F68	SPOS01_EX_CS05	SPOS01 execute condition signal 05
8601011E91	SPOS01_EX_FFL	SPOS01 execute fail signal by fixedlogic
8501011E8F	SPOS01_EX_SFL	SPOS01 execute success signal by fixedlogic
8001011F56	SPOS01_NSL_CS06	SPOS01 no direction select condition signal 06
8601011F5E	SPOS01_NSL_CS07	SPOS01 no direction select condition signal 07
8201011F5F	SPOS01_NSL_CS10	SPOS01 no direction select condition signal 10
8101011E7B	SPOS01_SLF_CS	SPOS01 no direction select fail condition signal
8101011DD0	SPOS01_FEX_BO	SPOS01 off direction execute binary output signal
8001011E81	SPOS01_FEC_OK_CS	SPOS01 off direction execute command OK condition signal
8001011E7E	SPOS01_FEC_OK_CSF	SPOS01 off direction execute command OK condition signal by fixedlogic
8201011E88	SPOS01_FEC_F_CS	SPOS01 off direction execute command fail condition signal
8101011E85	SPOS01_FEC_F_CSF	SPOS01 off direction execute command fail condition signal by fixedlogic
8A01011DC4	SPOS01_FSL_BO_CSF	SPOS01 off direction select binary output condition signal by fixedlogic
8501011F60	SPOS01_FSL_CS19	SPOS01 off direction select condition signal 19
8A01011F61	SPOS01_FSL_CS20	SPOS01 off direction select condition signal 20
8101011F64	SPOS01_FSL_CS21	SPOS01 off direction select condition signal 21
8201011DD3	SPOS01_OEX_BO	SPOS01 on direction execute binary output signal
8101011E82	SPOS01_OEC_OK_CS	SPOS01 on direction execute command OK condition signal
8001011E7F	SPOS01_OEC_OK_CSF	SPOS01 on direction execute command OK condition signal by fixedlogic
8301011E89	SPOS01_OEC_F_CS	SPOS01 on direction execute command fail condition signal
8101011E86	SPOS01_OEC_F_CSF	SPOS01 on direction execute command fail condition signal by fixedlogic
8601011DC6	SPOS01_OSL_BO_CSF	SPOS01 on direction select binary output condition signal by fixedlogic
8501011F65	SPOS01_OSL_CS40	SPOS01 on direction select condition signal 40
8801011F5D	SPOS01_OSL_CS41	SPOS01 on direction select condition signal 41
8501011F5B	SPOS01_OSL_CS42	SPOS01 on direction select condition signal 42
8601011F5C	SPOS01_OSL_CS43	SPOS01 on direction select condition signal 43
8401011F77	SPOS01_OFEX_BO	SPOS01 on/off direction execute binary output signal
8901011DC0	SPOS01_NSL_BO_CSF	SPOS01 select binary output condition signal by fixedlogic
8501011F76	SPOS01_SL_BO_FLG	SPOS01 select binary output signal by fixedlogic
8001011F54	SPOS01_SC_ST_ERR	SPOS01 select command mode err
8601011F62	SPOS01_SLF_FCT_FLG03	SPOS01 select fail factor signal by fixedlogic 03

◆ Signal monitoring points in SPOS01

SPOS(FunctionID:510001)

Element ID	Name	Description
8701011F63	SPOS01_SLF_FCT_FLG04	SPOS01 select fail factor signal by fixedlogic 04
8801011F6B	SPOS01_SLF_FCT_FLG07	SPOS01 select fail factor signal by fixedlogic 07
8901011F72	SPOS01_SLF_FCT_FLG08	SPOS01 select fail factor signal by fixedlogic 08
8001011E7D	SPOS01_SLR_CS	SPOS01 select release condition signal
8001011E76	SPOS01_SLD_CS	SPOS01 selected condition signal
8001011F66	SPOS01_SLD_CS04	SPOS01 selected condition signal 04
8E01011F57	SPOS01_SLD_TMO	SPOS01 time out after selected
8F01011F58	SPOS01_EX_CMP_TMO	SPOS01 timeout after execute completion

Note: In the table above, the user will only find Element IDs and their names for the 1st device, but a 2nd and other devices are also provided in the SPOS function. We have omitted the Element IDs and their names for the other devices to improve readability. Use the rule described below when the user wishes to obtain the Element IDs and their names for the other devices.

Rule: The same types of signal monitoring points are provided in every device; hence, the user can find the same ones for all of the other devices. For example, when the user wishes to find the "SPOS01_SC_OWS" point for the 2nd device, use the description of "SPOS02_SC_OWS" in place of "SPOS01_SC_OWS". The user can obtain the ID value of "SPOS02_SC_OWS" by using the following steps:

Step 1 Find the element ID for SPOS01_SC_OWS (i.e., "8001011D51")

Step 2 Identify the number at the fifth digit from the ID. (i.e., "1")

Step 3 Choose a new device number. (i.e., pick the number "2" for the 2nd device)

Step 4 Replace the number that occurs at the fifth digit with the new device number. (i.e., get new ID "8001021D51" of "SPOS02_SC_OWS") The ID is expressed in hexadecimal notation. Thus, the user must change the device number from decimal notation to hexadecimal notation.

4.2 Double position controller with synchronizing-checking (DPSY)

The double position controller with synchronizing-check (DPSY†) function is used when the user wishes to control a device from the "Closed" or "Open" condition. Generally, the device controlled by the DPSY function is either a 43-switch or a CB. The DPSY function has two measurements: an operation counter and an operation timer. The two features are useful when the user wishes to assess the operating time of the device and the total service duration in the operated state; these features are performed by counting the state-changes for the device.

†Note:The DPSY function is similar to the DPOS function; the DPSY function is required to operate together with the synchronizing function (SYNDIF), which has relay elements corresponding to voltages, and can coordinate the timing for closing or opening. For more detailed information with regard to the SYNDIF function, see Chapter *Control and monitoring application: Synchronizing check for different network*.

The BO circuits are used for issuing commands; the BI circuits are used for receiving responses; hence, the user should set the BIO† together with the DPSY function. The DPSY function includes three logic groups: 1. Selection logic, 2. Cancel logic, and 3. Operate logic.

Tips: If the user wishes to apply the DPSY function quickly, go to sections 4.2.6 and 4.2.7, where setting of the BI and BO circuits and the mapping of signals for IEC61850 communication is described.

Note: The implementation of such features depends on the selection of hardware and the configuration of functions. Several IED models do not have its features. To determine whether its features are implemented in the IED, locate the IED ordering number; and check the order number at the "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 4.2-1 Comparative table in respective ordering numbers

Sec.	Feature	Ordering No. at "G&T"				
		10	11	13	19	22
–	Main features	NA	NA	NA	NA	✓
–	Number of functions	–	–	–	–	2

✓: Applicable NA: Not applicable

Two devices can be controlled separately; i.e., the DPSY function has two separate sets of logic

for control (i.e., DPSY01 and DPSY02 functions). For simplicity, only the DPSY01 function is discussed here; the features in the DPSY02 function are identical to the DPSY01 function.

4.2.1 Select logic for SBO/DIR modes

The user should set scheme switch [**DPSY01-CTREN**] **On** prior to DPSY01 operation. Table 4.2-11 shows all of the scheme switches in the DPSY function.

(i) Receiving "select command Closing" from the remote-end

Figure 4.2-1 outlines the reception of the select command 'Closing' from the remote- end.

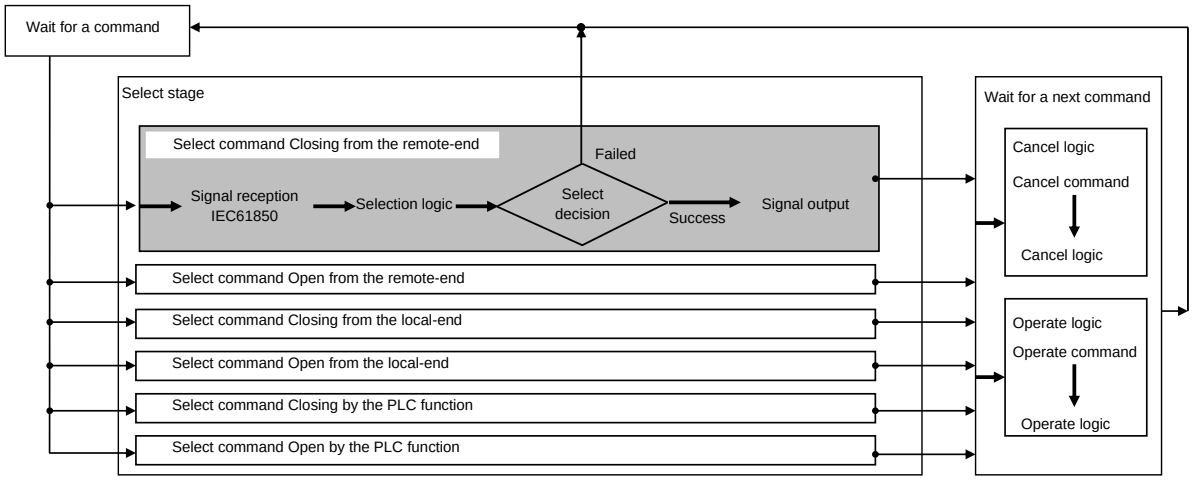


Figure 4.2-1 Outline of select command 'Closing'

(i)-1 Input point required mapping

Figure 4.2-2 shows the select logic when a "Select command closing (Remote-Closing-Control)" signal is applied to the DPSY01 function.

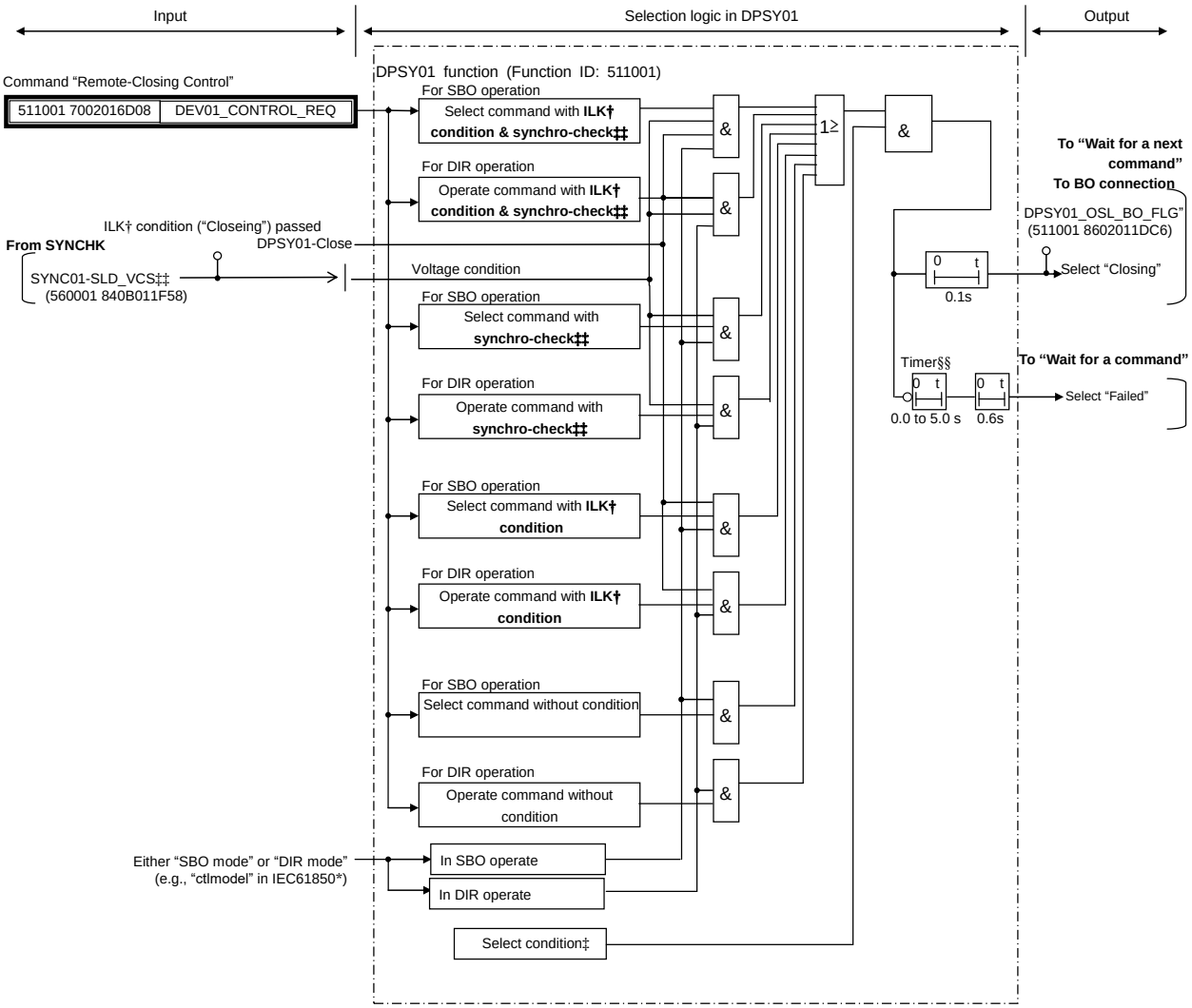


Figure 4.2-2 Select logic 'Closing' from the remote-end in DPSY01††

†Note:The Software interlocking (ILK) function can provide the operation criteria for "Closing". The ILK function is discussed separately; note that the operation criteria is defined by the ILK function itself (i.e., the user cannot set the condition).

‡Note:A "select condition" signal is provided from the select condition scheme. For more information, see Figure 4.2-13.

*Note:The DPSY01 function can run in either the "SBO mode" or the "DIR mode". The user can use a signal called "ctlmodel" when communication is implemented using IEC61850. To use this signal, the user must map it for IEC61850 communication.

††Note: To identify the input and output points of the DPSY02 logic, see Table 4.2-6 and Table 4.2-10.

‡‡Note: The synchronism voltage check is executed by the SYNCHK function.

§§Note: A timer is provided to determine an operation failure. The maximum value of the settings [**SYNC01_TLRDIDRLI**] or [**SYNC01_TDRDI**] is used as the decision time. For more information on settings, see the SYNCHK function.

This logic has the input-point "DEV01_CONTROL_REQ" for the reception of a select command. That is, the input-point must be mapped for communication. The function will fail to operate if mapping is not performed correctly. We will discuss how to map the input-points for IEC61850 communication in section 4.2.7.

(i)-2 Output signal to BO

The DPSY01 function can issue an output signal "Selection success" at the output point "DPSY01_OSL_BO_FLG", when the DPSY01 function determines that the "Remote-Closing-Control" signal received is true. If the DPSY01 function determines that the "Remote-Closing-Control" signal is not true, the DPSY01 function returns to the "Wait for a command" stage.

The user should note that the operation decision of the SYNCHK01 function is required for the DPSY01 function; the operation decision is determined by the measurement of running voltage and incoming voltage. Table 4.2-2 shows the relay-elements used in the SYNCHK01 function.

Table 4.2-2 Voltage checking elements in SYNCHK01

Relay-Element	Description
SyncRy1-VR	Running Voltage channel selector for DPSY01
SyncRy1-VI	Incoming Voltage channel selector for DPSY01
OVR1	Voltage for checking Live-Running Voltage for DPSY01
UVR1	Voltage for checking Dead-Running Voltage for DPSY01
OVI1	Voltage for checking Live-Incoming Voltage for DPSY01
UVI1	Voltage for checking Dead-Incoming Voltage for DPSY01

(ii) Receiving "select command Open" from the remote-end

Figure 4.2-3 outlines the reception of the select command 'Open' from the remote-end.

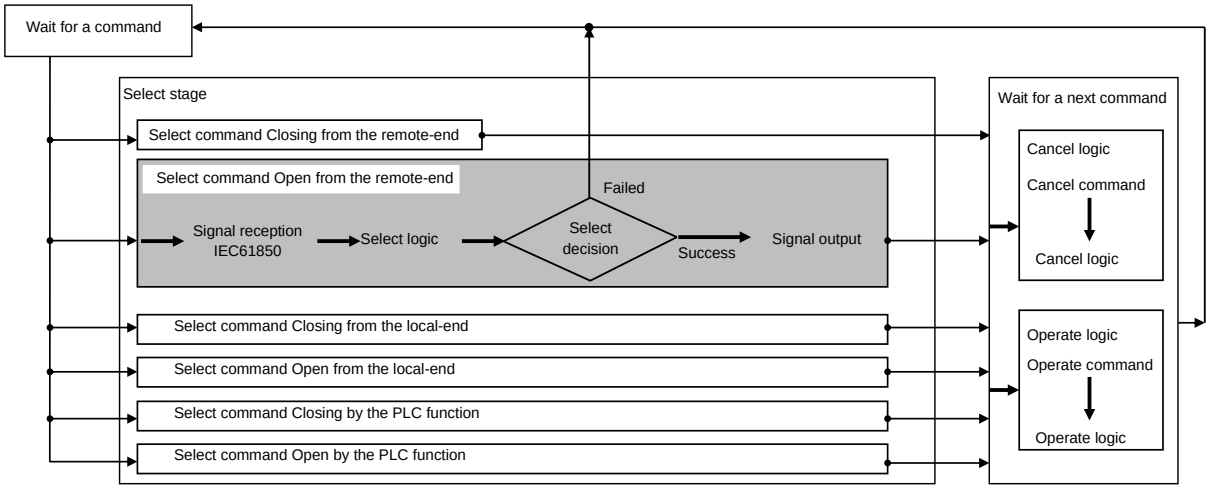


Figure 4.2-3 Outline of select command for Open

(ii)-1 Input point required mapping

Figure 4.2-4 shows the select logic when a "Select command (Remote-Open-Control)" signal is applied to the DPSY01 function. The input-point "DEV01_CONTROL_REQ" is used for the reception of the "select command (Remote-Open-Control)" signal.

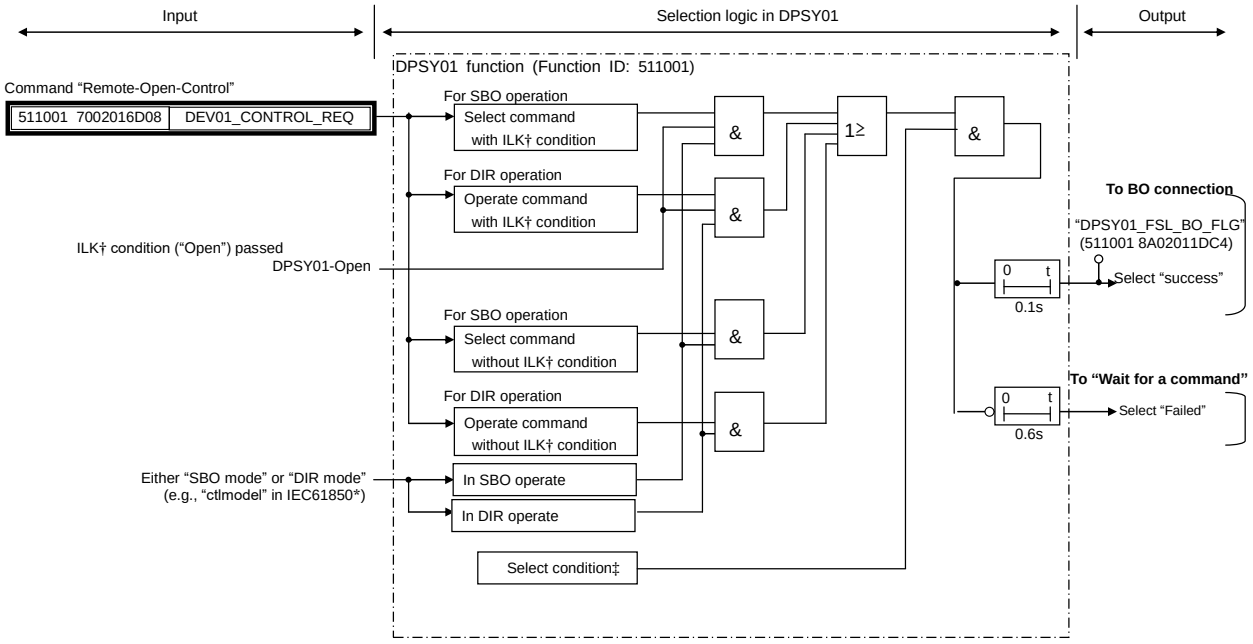


Figure 4.2-4 Select 'Open' from the remote-end in DPSY01††

†Note:The ILK function can provide the operation criteria for "Open".

‡Note:A "select condition" signal is provided from the select condition scheme. For more information, see Figure 4.2-13.

††Note: To know the input and output points of the DPSY02 logic, see Table 4.2-6 and Table 4.2-10.

(ii)-2 Output signal to BO

The DPSY01 function, in Figure 4.2-4, can issue a "Select success" signal at the output point "DPSY01_FSL_BO_FLG" when the DPSY01 function determines that the "Selection command Open (Remote-Open-Control)" signal is true. If the DPSY01 function determines that the "Remote-Open-Control" signal is not true, the DPSY01 function returns to the "Wait for a command" stage.

(iii) Receiving "Select command Closing" from the local-end

Figure 4.2-5 outlines the reception of the select command 'Closing' from the local-end.

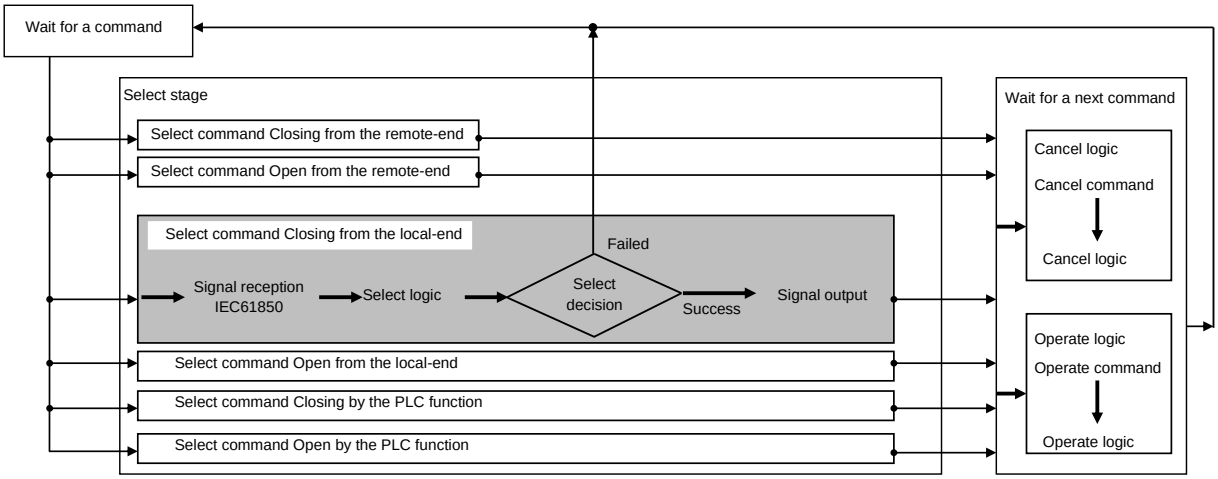


Figure 4.2-5 Outline of select command for 'Closing'

(iii)-1 Input signal generated at the local-end

Figure 4.2-6 shows the select logic when a "Select command Closing (Local-Closing-Control)" signal is applied to the DPSY01 function. The signal is provided when a "Selection for Closing" key is pressed on the IED front panel; the user is not required to map the signal from the IEC61850 communication. Note that the user should set the scheme switch [**DPSY01-CTRAHMI**] to **SBO** when operation from the IED front panel is required, we discuss how to set this in chapter *User interface: Control sub-menu*.

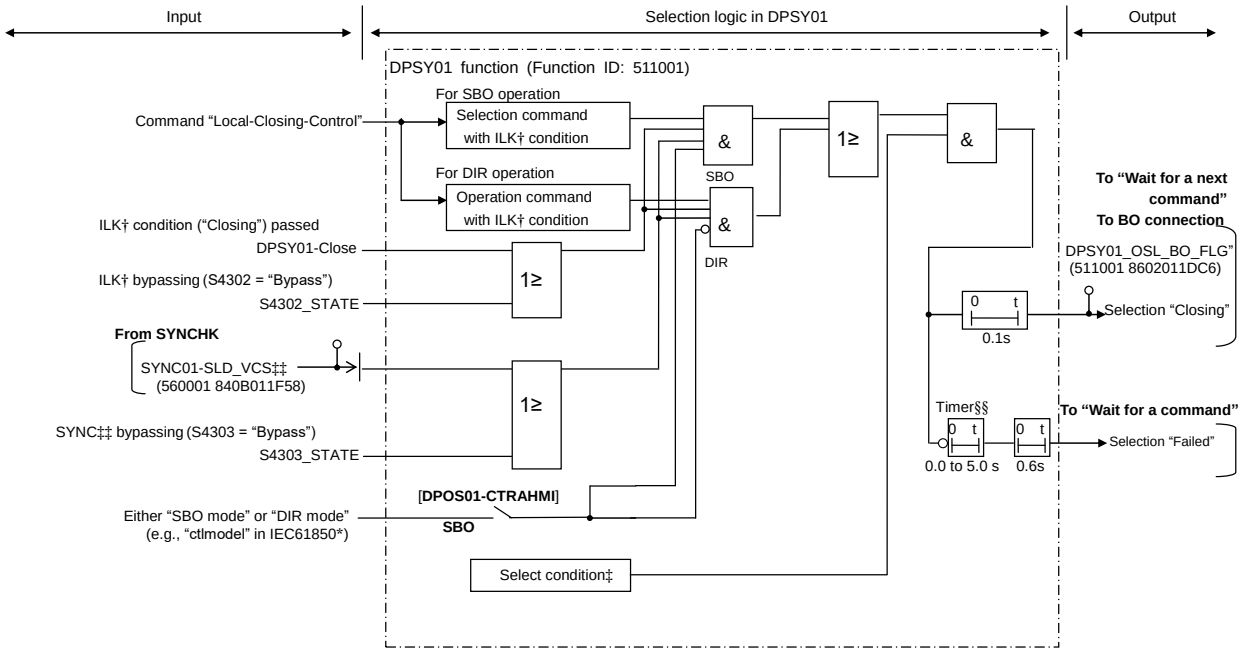


Figure 4.2-6 Select 'Closing' on the front panel in DPSY01††

†Note: The ILK function provides the operation criterion for "On". For testing, nullifying the ILK function is possible using "Interlock bypassing". "Interlock bypassing" is indicated by the status "S4302" in a software switch controller (SOFTSW).

‡Note: A "select condition" signal is provided from the select condition scheme. For more information, see Figure 4.2-13.

††Note: To identify the output signals of the DPSY02 logic, see Table 4.2-10.

‡‡Note: The SYNCHK function provides the synchronism criteria for "Closing". For testing, nullifying the SYNCHK function is possible using "Synchro-check bypassing". "Synchro-check bypassing" is indicated by the status "S4303" in the SOFTSW.

(iii)-2 Output signal to BO

When the signal "select condition" is true, the DPSY01 function can issue a "Selection success" signal at the output-point "DPSY01_OSL_BO_CSF".

Note: The signal "DPSY01_OSL_BO_CSF" is the same as the signal shown in Figure 4.2-2. If the "Local-Closing-Control" signal is not true, the DPSY01 function returns to the "Wait for a command" stage.

(iv) Receiving “Select command Open” from the local-end

Figure 4.2-7 outlines the reception of the select command ‘Open’ from the local-end.

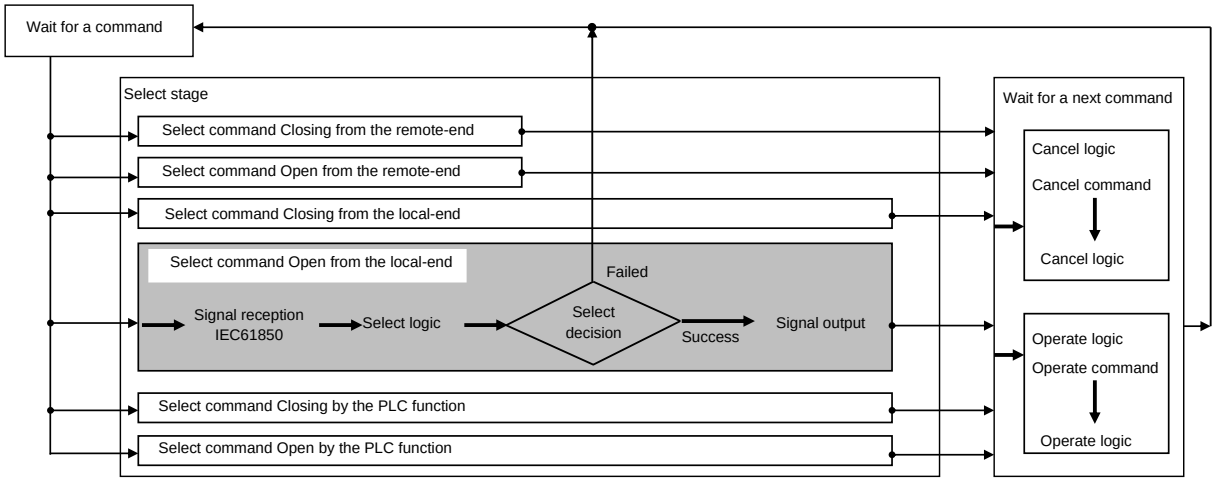


Figure 4.2-7 Outline of select command ‘Open’

(iv)-1 Input signal generated at the local-end

Figure 4.2-8 shows the select logic when a “Select command open (Local-Open-Control)” signal is applied to the DPSY01 function. The signal is provided when the user presses a “Selection for Open” key on the IED front panel; the user is not required to map the signal from IEC61850 communication.

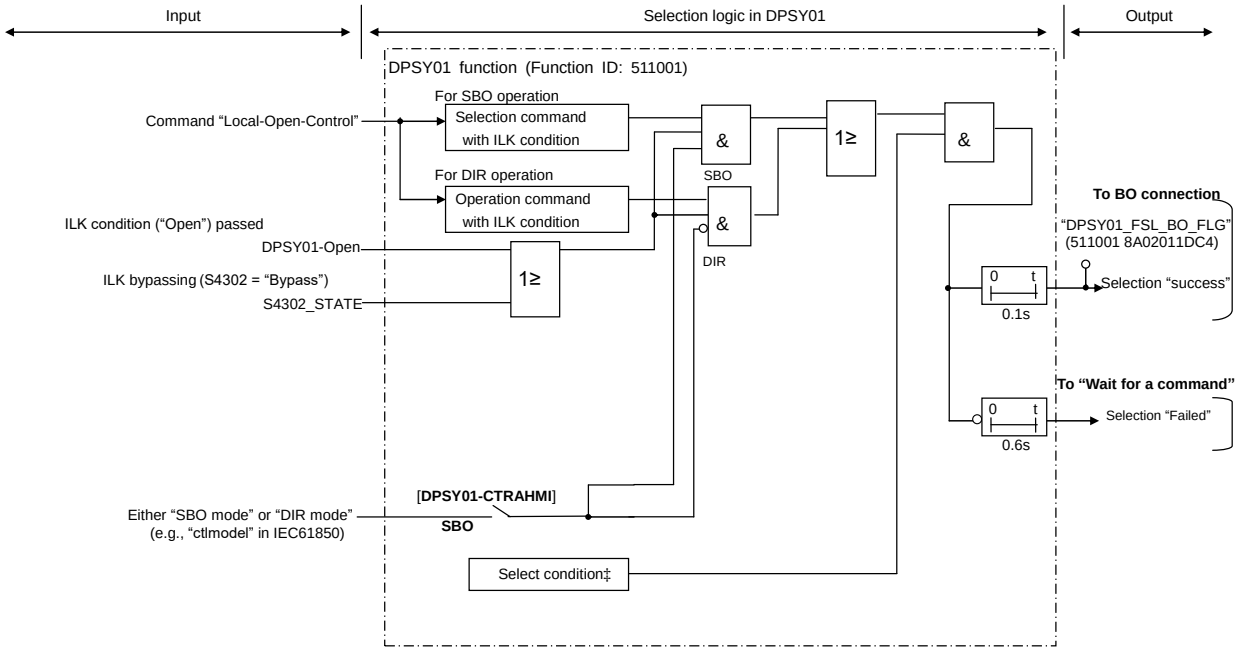


Figure 4.2-8 Select ‘Open’ on the front panel in DPSY01††

‡Note: A “select condition” signal is provided from the select condition scheme. For more information, see Figure 4.2-13.

††Note: To identify the output signals of the DPSY02 logic, see Table 4.2-10.

(iv)-2 Output signal to BO

When the "select condition" signal is true, the DPSY01 function can issue a "Select success" signal at the output-point "DPSY01_FSL_BO_FLG".

[1]Note: The signal "DPSY01_FSL_BO_FLG" is the same as the signal shown in Figure 4.2-4. If the signal "Local-Open-Control" is not true, the DPSY01 function returns to the "Wait for a command" stage.

(v) Receiving "Select command Closing" by PLC function

Figure 4.2-9 outlines the reception of the select command 'Closing' by the PLC function.

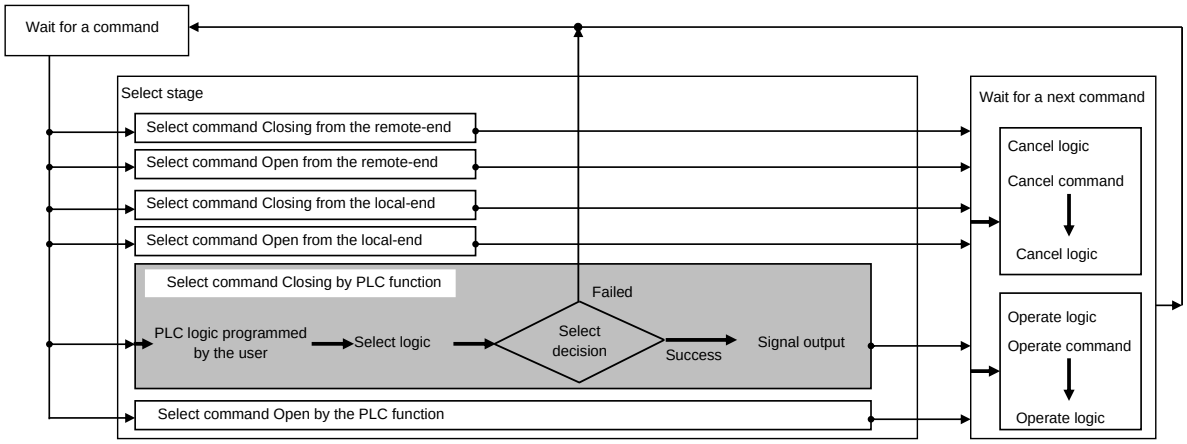


Figure 4.2-9 Outline of select command 'Closing'

(v)-1 Input signal from the PLC function

Figure 4.2-10 shows the select logic when a "Select command Closing (PLC-Closing-Control)" signal is generated by the PLC function. There are four input points for reception of this signal. The first connecting point, (PLC#1) is used for the reception of the select-command requiring the ILK and the SYNCHK check. The second connection point, (PLC#2) is used for the reception of the select-command requiring the SYNCHK check only. The third connection point (PLC#3) is used for the reception of the select-command requiring the ILK check only and the fourth connection point (PLC#4) is used for the reception of the select command with no check. That is, for example, for the DPSY01 function, when the "Select command 'Closing' (PLC-Closing-Control)" signal generated in the user-programmed logic is applied and when the ILK and the SYNCHK checks are both required in the select logic, use the connection point (PLC#1: e.g., PLC_BIT_0528). PLC#1 to PLC#4 are shown in Table 4.2-3.

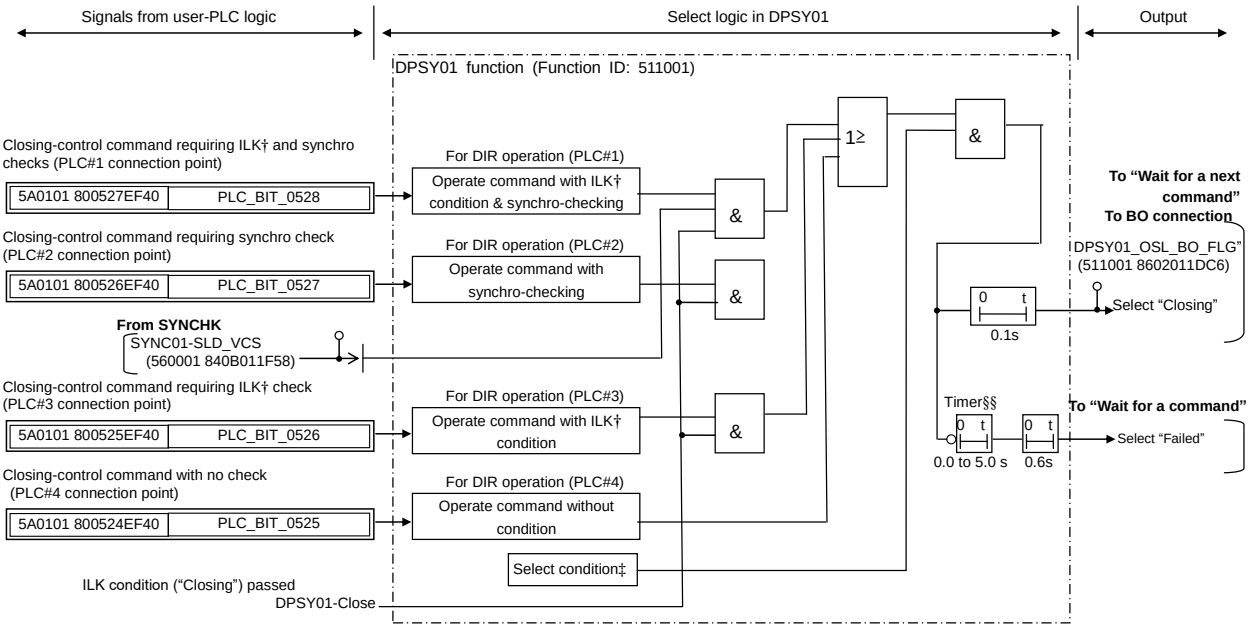


Figure 4.2-10 Select 'Closing' using the PLC function in DPSY01††

††Note: To identify the input and output signals of the DPSY02 logic, see Table 4.2-3 and Table 4.2-10.

†Note: The Software interlocking (ILK) function can provide the operation criteria for "Closing". The ILK function is discussed separately; note that the operation criteria is defined in the ILK function itself (i.e., the user cannot set the condition).

‡Note: A "select condition" signal is provided from the select condition scheme. For more information, see Figure 4.2-13.

§§Note: A timer is provided to determine a failure to operate. The maximum value of the settings [**SYNC01_TLRDIDRLI**] or [**SYNC01_TDRDI**] is used for the decision time. For more information on settings, see the SYNCHK function.

(v)-2 Output signal to BO

The DPSY01 function, in Figure 4.2-10, can issue a "Select success" signal at the output-point "DPSY01_OSL_BO_CSF"[1].

[1]Note: The signal "DPSY01_OSL_BO_CSF" is the same signal as that shown in Figure 4.2-2.

(vi) Receiving "Select command Open" by PLC function

Figure 4.2-11 outlines the reception of the select command 'Open' by the PLC function.

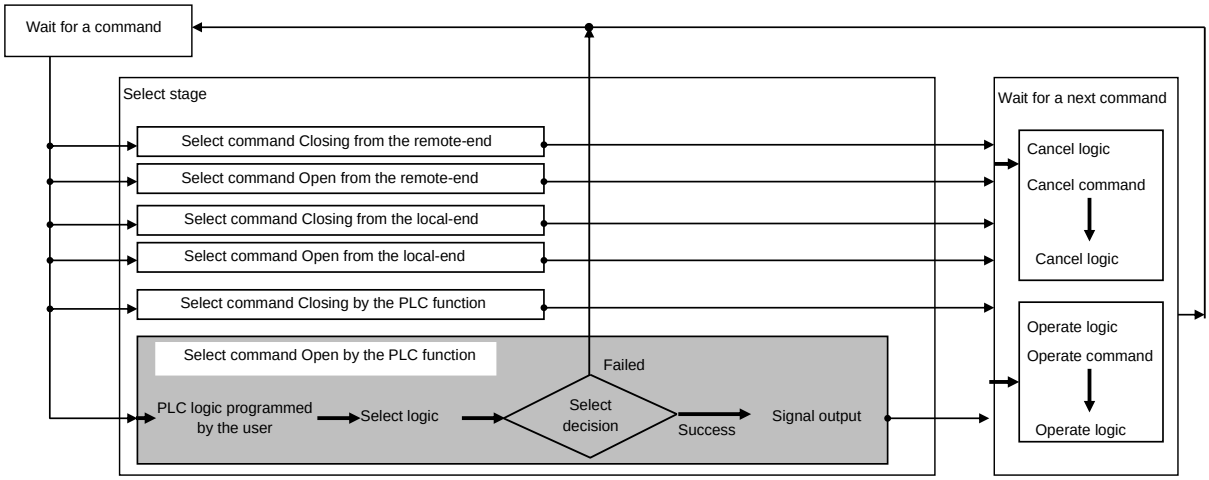


Figure 4.2-11 Outline of select command 'Open'

(vi)-1 Input signal from the PLC function

Figure 4.2-12 shows the select logic when a "Select command Open (PLC-Open-Control)" signal is generated by the PLC function There are two input-points for the reception of this signal, unlike in the signal "Select command Closing (PLC-Closing-Control)" where four are available. That is, if interlock checking is required, use the connection point (PLC#1:e.g., PLC_BIT_0524). Alternatively, if the interlock check is not required, use the connection point (PLC#2:e.g., PLC_BIT_0523). PLC#1 and the PLC#2 are shown in Table 4.2-4.

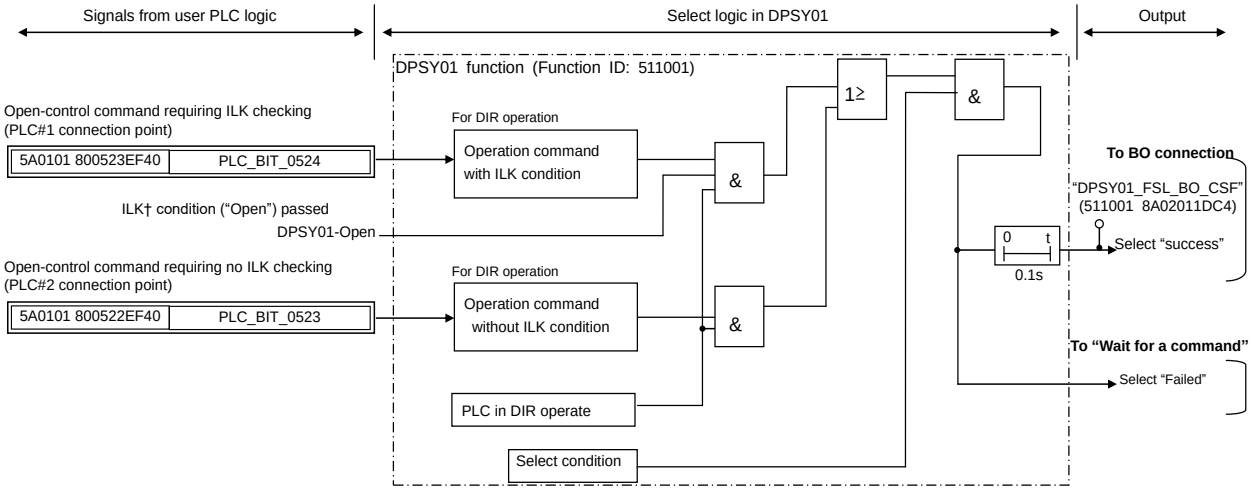


Figure 4.2-12 Select Open by PLC function in DPSY01††

††Note: To identify the input and output points of the DPSY02 logic, see Table 4.2-4 for the inputs (PLC#1 and PLC#2) and Table 4.2-11 for the outputs.

(vi)-2 Output signal to BO

The DPSY01 function, in Figure 4.2-12, can issue a "Select success" signal at the output point "DPSY01_FSL_BO_CSF"[1].

[1]Note: The output point "DPSY01_FSL_BO_CSF" is the same signal as shown in Figure 4.2-4.

(vii) Select condition

Figure 4.2-13 shows the select condition logic in the DPSY01 function. The DPSY01 function checks the condition for the select command using the signal "DPSY01_3PH_STATE" (See Table 4.2-33). If the original logic does not meet with the requirements of the user, the following alternatives are available:

1. The user can replace the original logic with alternative logic.
2. The user can add additional logic to the original logic.

(vii)-1 How to replace the original logic

If the user wishes to replace the select condition logic completely, the user can replace it using the PLC connection point "User Configurable Condition".

1. Connect the user-customized logic using "PLC_BIT_0533", which is listed as PLC#2 in Table 4.2-8.
2. Set the scheme switch [**DPSY01-LGSLFFCT**] to **PLC**.

(vii)-2 How to add another select condition signal

If adding another condition is required, the user can add a signal to the select condition logic using the PLC condition point "User Additional Condition".

1. Add a user-preferred signal using "PLC_BIT_0532", which is listed as PLC#1 in Table 4.2-8.
2. Set the scheme switch [**DPSY01-LGSLFFCT**] to **Fixedlogic**.

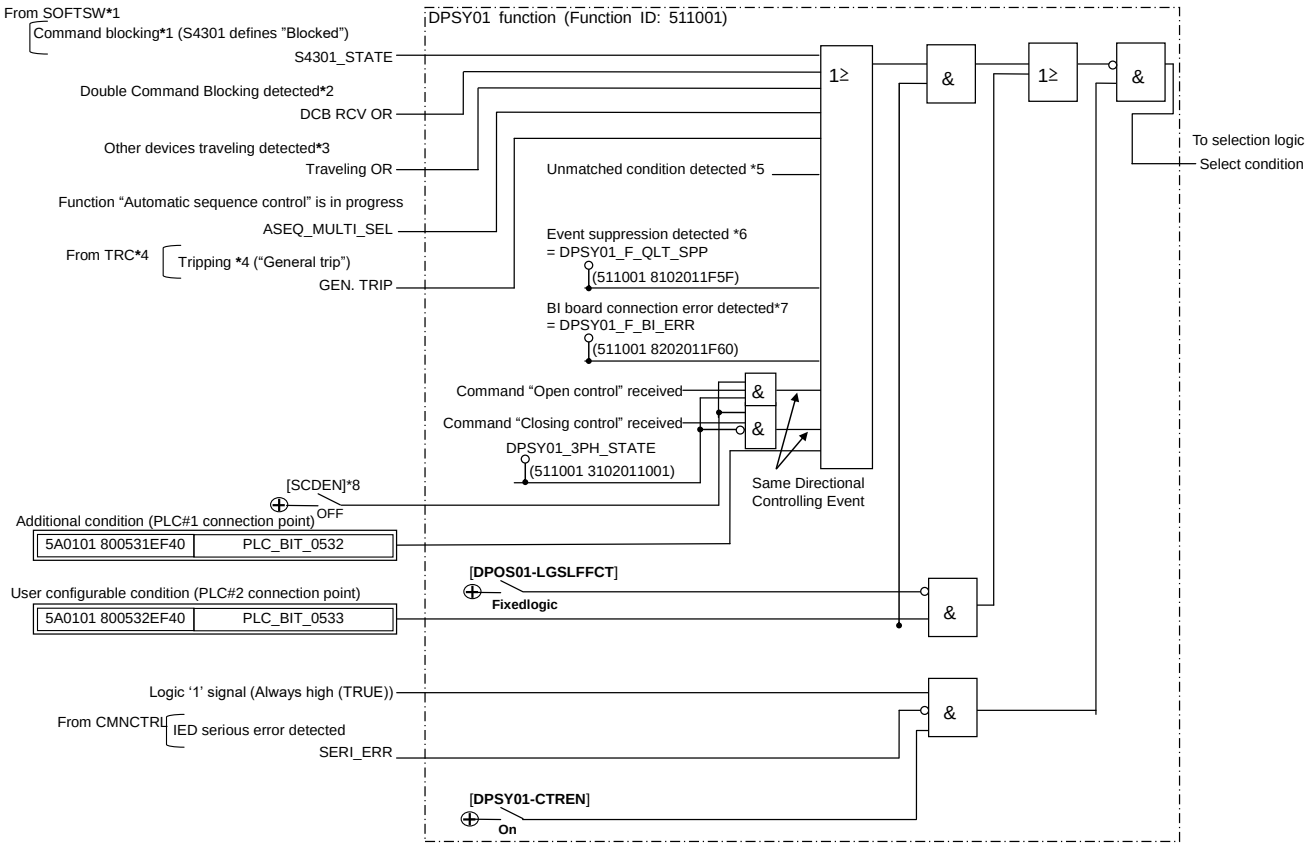


Figure 4.2-13 Select condition logic for 'Closing/Open' in DPSY01*10

[1]Note: "Command Blocking" disables any operation except its own; the "Command Blocking" is initiated by the status of "S4301" in a software switch controller (SOTFSW). The IEC 61850 standard defines "Command Blocking" as "CmdBlk". For more information on "S4301", see Chapter *Control and monitoring application: Software switch controller. See the signal "*"S4301_STATE" of Table 4.2-7.

[2]Note: "Double Command Blocking" (DCB) is an operation philosophy. It can be used to protect the substation. The user can program it using GR-TIEMS. The DCB operating signal is denoted as "DCB RCV OR) in Table 4.2-7.

[3]Note: If the event "device-travelling" is detected, it indicates that another operator is changing the status of a device. Thus, the IED should inhibit the operation of any device for the duration that the event is detected. The detecting signal is denoted as "Travelling OR" in Table 4.2-7.

[4]Note: If the issue of a trip command is executed by the IED, any control operation is blocked until the trip operation is completed. If an IED includes a relay application, the trip command is issued at the output-point "GEN.TRIP" in Table 4.2-7.

[5]Note: Criteria "unmatched conditions" are decided when "Test-bit status" in a command is not identical to the "IED test status".

[6]Note: The "Event suppression" function can detect chattering on BI circuits. (See section

4.2.6(i)-3)

[7]Note: A supervision of the Binary IO module can detect connection errors for BI circuits.

[8]Note: The Common control (CMNCTRL) function can test and check the 'Opening' and 'Closing' operations performed by the logic. When the user sets **Off** for scheme switch [**SCDEN**], the operation of the logic is blocked if the logic is running in the same operation-direction compared with the previous operation-direction (i.e., when closing (opening) is performed sequentially). On the other hand, if **On** is set for the scheme switch, the logic is not blocked.

[9]Note: To identify the input points of the DPSY02, see Table 4.2-8.

(viii) Signal name and number

Note: The user should note the following descriptions shown in the column "M/O" for each table:

"O" indicates that the signal is provided for optional use.

"M" indicates that the user should map/set/configure the signal; otherwise, the user may experience an operational failure if the default settings are used.

"N/A" indicates that the user cannot change the state of the signal.

Table 4.2-3 PLC connection points (Input points for Command 'Closing')

Signal Number	Signal Name	Description	M/O
5A0101 800527EF40	PLC_BIT_0528	DPSY01 PLC Close-control checking with interlock & Sync (PLC#1)	O
5A0101 800551EF40	PLC_BIT_0552	DPSY02 PLC Close-control checking with interlock & Sync (PLC#1)	O
5A0101 800526EF40	PLC_BIT_0527	DPSY01 PLC Close-control with Sync (PLC#2)	O
5A0101 800550EF40	PLC_BIT_0551	DPSY02 PLC Close-control with Sync (PLC#2)	O
5A0101 800525EF40	PLC_BIT_0526	DPSY01 PLC Close-control checking with interlock(PLC#3)	O
5A0101 800549EF40	PLC_BIT_0550	DPSY02 PLC Close-control checking with interlock(PLC#3)	O
5A0101 800524EF40	PLC_BIT_0525	DPSY01 PLC Close-control none checking (PLC#4)	O
5A0101 800548EF40	PLC_BIT_0549	DPSY02 PLC Close-control none checking (PLC#4)	O

Table 4.2-4 PLC connection points (Input points for Command 'Open')

Signal Number	Signal Name	Description	M/O
5A0101 800523EF40	PLC_BIT_0524	DPSY01 PLC Open-control checking with interlock(PLC#1)	O
5A0101 800547EF40	PLC_BIT_0548	DPSY02 PLC Open-control checking with interlock(PLC#1)	O
5A0101 800522EF40	PLC_BIT_0523	DPSY01 PLC Open-control without checking(PLC#2)	O
5A0101 800546EF40	PLC_BIT_0547	DPSY02 PLC Open-control without checking(PLC#2)	O

Table 4.2-5 PLC connection points (Interlock for Command 'Closing/Open')

Signal Number	Signal Name	Description	M/O
570001 3102011DA2	DPSY01-Open	DPSY01 interlock condition for Open control.	N/A
570001 3102021DA2	DPSY02-Open	DPSY02 interlock condition for Open control.	N/A
570001 3102011DA0	DPSY01-Close	DPSY01 interlock condition for Close control.	N/A
570001 3102021DA0	DPSY02-Close	DPSY02 interlock condition for Close control.	N/A

Table 4.2-6 Mapping points for the reception of control commands

Signal Number	Signal Name	Description	M/O
511001 7002016D08	DEV01_CONTROL_REQ	DPSY01 control command received.(Mapping Data)	M
511001 7002026D08	DEV02_CONTROL_REQ	DPSY02 control command received. (Mapping Data)	M

Table 4.2-7 Input signals to condition logic

Signal Number	Signal Name	Description	M/O
522001 000A011001	S4301_STATE	Command Blocking status (Open / Blocked)	N/A
522001 000A021001	S4302_STATE	Interlock-Bypassing Switch	N/A
522001 000A031001	S4303_STATE	Synch-Bypassing Switch	N/A
5A0001 0008001F41	DCB RCV OR	Double Command Blocking(DCB) is in progress.	N/A
5A0001 0008001F40	Traveling OR	Travelling events are detected.	N/A
4A0001 8300001B6F	GEN. TRIP	General trip	N/A
5A0001 3108003F40	SDCEN	(This is setting of CMNCTRL)	N/A
5A0101 3100001F43	SERI_ERR	Serious Error detected	N/A

Table 4.2-8 PLC connection points (Input signals for select condition logic)

Signal Number	Signal Name	Description	M/O
5A0101 800531EF40	PLC_BIT_0532	DPSY01 additional failure condition(PLC#1)	O
5A0101 800554EF40	PLC_BIT_0555	DPSY02 additional failure condition(PLC#1)	O
5A0101 800532EF40	PLC_BIT_0533	DPSY01 user configurable select condition(PLC#2)	O
5A0101 800555EF40	PLC_BIT_0556	DPSY02 user configurable select condition(PLC#2)	O

Table 4.2-9 PLC monitoring points (Output signal for select condition logic)

Signal Number	Signal Name	Description
511001 8002011F5A	DPSY01_SC_ST_ERR	DPSY01 Unmatched condition.
511001 8002021F5A	DPSY02_SC_ST_ERR	DPSY02 Unmatched condition.
511001 8102011F5F	DPSY01_F_QLT_SPP	Event suppression detected (DPSY01)
511001 8102021F5F	DPSY02_F_QLT_SPP	Event suppression detected (DPSY02)
511001 8202011F60	DPSY01_F_BI_ERR	BI connection error detected(DPSY01)
511001 8202021F60	DPSY02_F_BI_ERR	BI connection error detected(DPSY02)

Table 4.2-10 PLC monitoring points (Closing/Open output signals for BIO)

Signal Number	Signal Name	Description
511001 8602011DC6	DPSY01_OSL_BO_FLG	DPSY01 select (Closing) command for Binary Output.
511001 8602021DC6	DPSY02_OSL_BO_FLG	DPSY02 select (Closing) command for Binary Output.
511001 8A02011DC4	DPSY01_FSL_BO_FLG	DPSY01 select (Open) command for Binary Output.
511001 8A02021DC4	DPSY02_FSL_BO_FLG	DPSY02 select (Open) command for Binary Output.

(ix) Setting names

Table 4.2-11 Setting of SBO control in DPSY

Setting Name	Description	Default	Setting item or value
DPSY01-CTREN	Activate control function	Close	Open / Close
DPSY01-LGSLFFCT	Logic selector for select condition	Fixedlogic	Fixedlogic / PLC
DPSY01-CTRAHMI	Activate local panel control	SBO	DIR / SBO
DPSY02-CTREN	Activate control function	Close	Open / Close
DPSY02-LGSLFFCT	Logic selector for select condition	Fixedlogic	Fixedlogic / PLC
DPSY02-CTRAHMI	Activate local panel control	SBO	DIR / SBO

4.2.2 Cancel logic for SBO mode

In the SBO control mode, the reception of a cancel command is possible; when the cancel conditions are satisfied, accordingly, the IED can discard the select command; finally, the operation returns to the initial stage (i.e., "Wait for a command".)

(i) Receiving "Cancel" from the remote-end

Figure 4.2-14 depicts the cancel command procedure for a cancel command initiated from the remote-end.

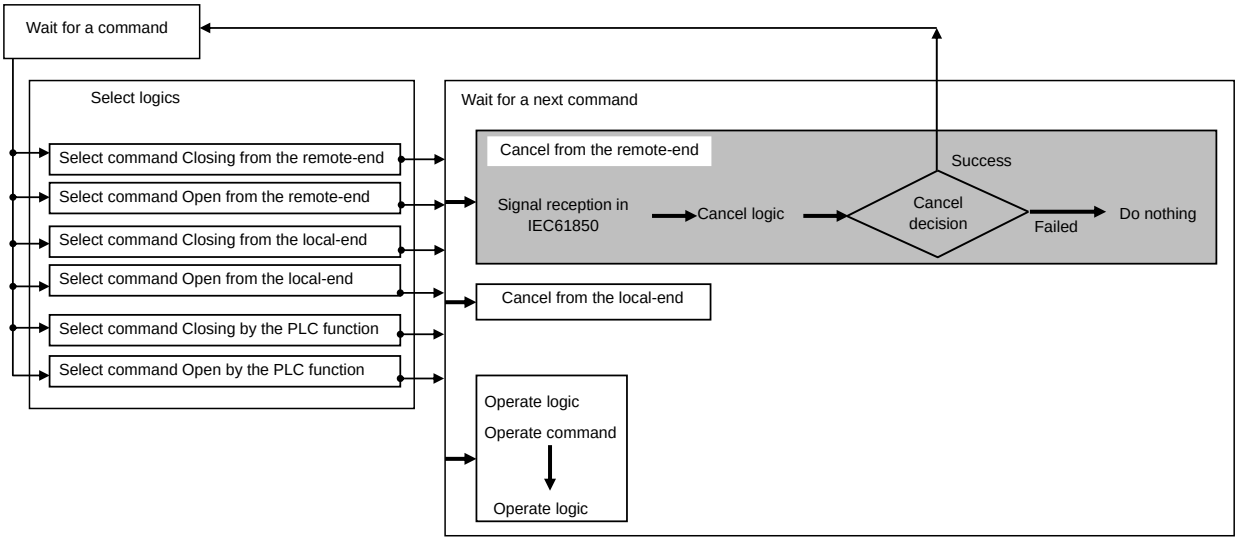


Figure 4.2-14 Outline of 'cancel' command from the remote-end

(i)-1 Input point required mapping

Figure 4.2-15 depicts the cancel logic when a "Cancel command (Remote-Cancel)" signal is applied to the DPSY01 function. The input-point "DEV01_CONTROL_REQ" is the same as that for the signal "Select command Closing (Remote-Closing-Control)".

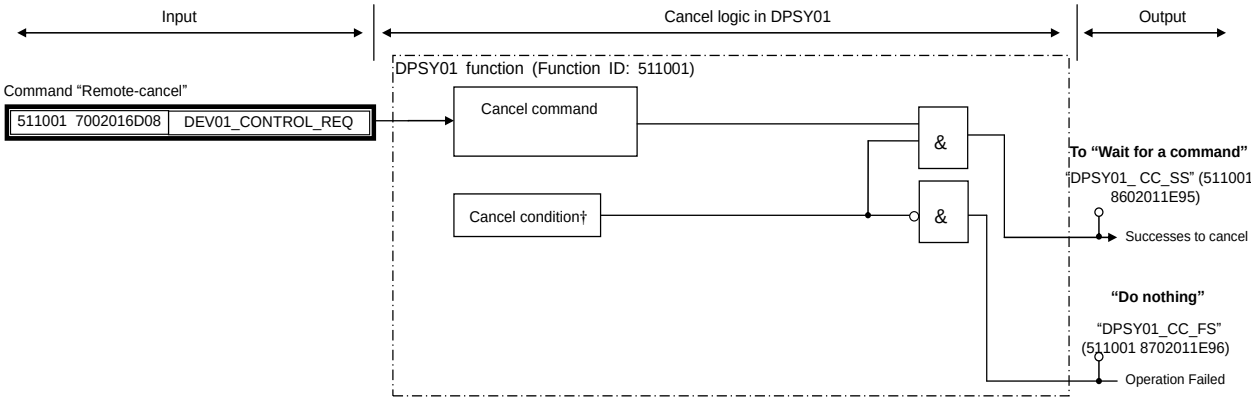


Figure 4.2-15 'Cancel' from the remote-end in DPSY01

†Note: The "cancel condition" logic is shown in Figure 4.2-18.

(i)-2 Output signal to BO

The DPSY01 function can issue a "Success to cancel" signal at the monitoring point "DPSY01_CC_SS", when the DPSY01 function has determined that the "Remote-cancel" signal is true. Another "Operation failed" signal is issued at monitoring point DPSY01_CC_FS" "if the DPSY01 function is able to determine that the "Remote-cancel" signal is not true.

(ii) Receiving "Cancel" from the local-end

Figure 4.2-16 outlines the reception of the cancel command from the local-end.

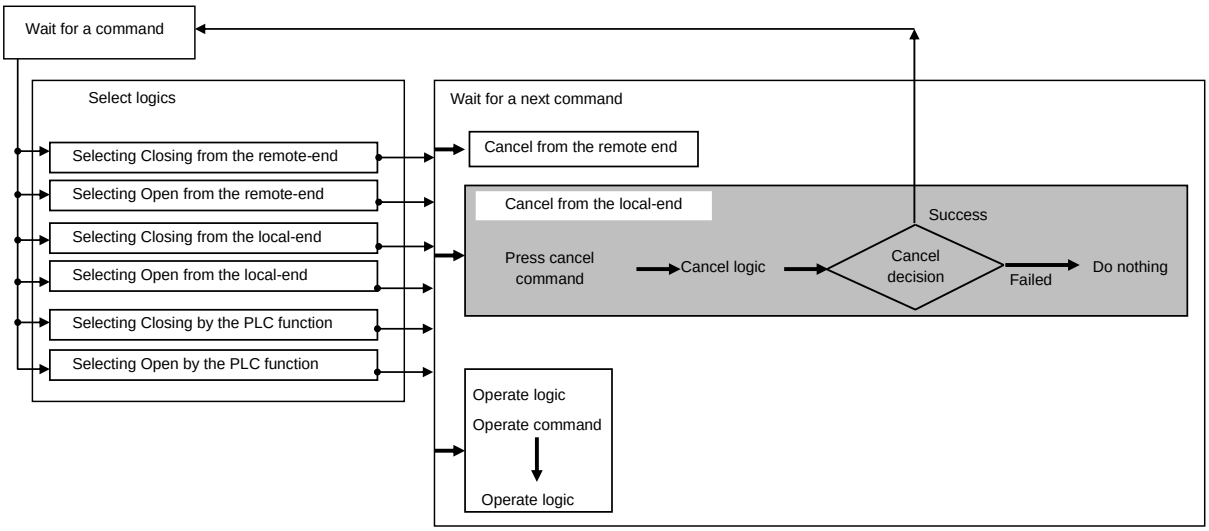


Figure 4.2-16 Outline of 'cancel' command from the local-end

(ii)-1 Input signal generated at the local-end

Figure 4.2-17 depicts the cancel logic when a "Cancel command (Local-cancel)" signal is applied to the DPSY01 function. The signal is generated when the "Cancel" key is pressed on the IED front panel; the user is not required to take account of mapping. When the logic receives the "Local-cancel" signal, the logic is able to output a result signal, provided that the "cancel condition" checking is satisfied.

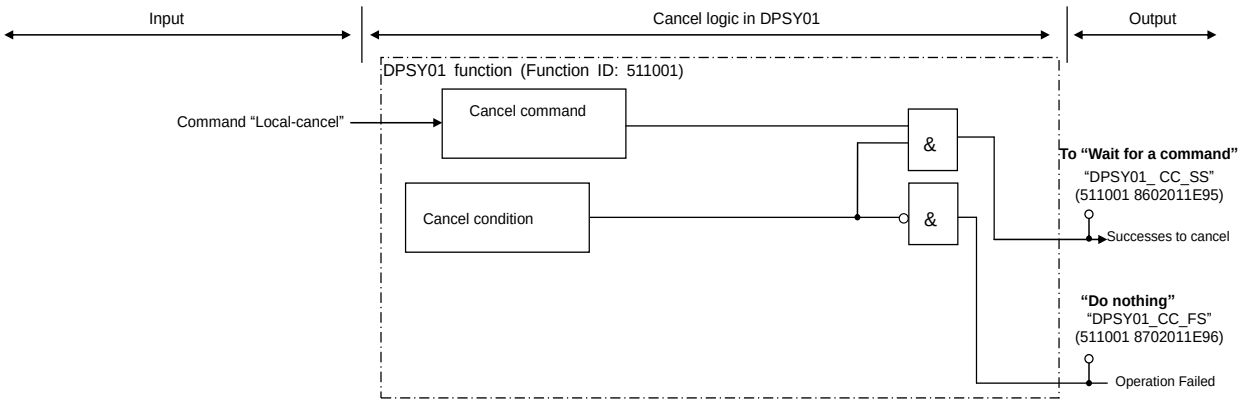


Figure 4.2-17 'Cancel' from the front panel

(ii)-2 Output signal to BO

The DPSY01 function, illustrated in Figure 4.2-17, is able to issue a "Select to cancel" signal at the monitoring point "DPSY01_CC_SS", when the DPSY01 function determines that the "Local-Cancel" signal is true.

(iii) Cancel condition logic

Figure 4.2-18 shows the cancel condition logic. As the criteria "Unmatched condition detected" is connected normally for the cancel logic, set **Fixlogic** for the scheme switch [**DPSY01-LGCNFFCT**].

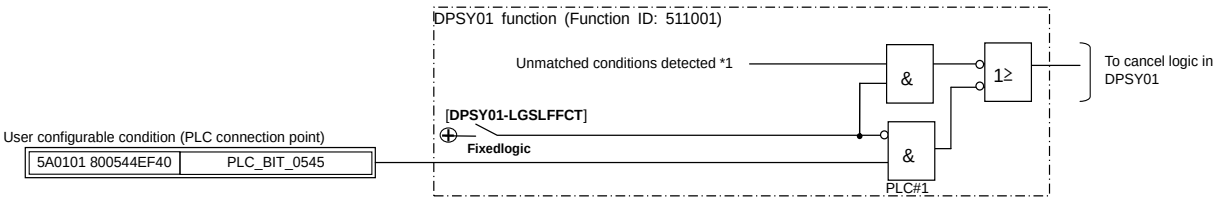


Figure 4.2-18 Logic "Cancel condition" in DPSY01

[1]Note: The criteria "unmatched conditions" are determined when the "Test-bit status" in the 'cancel' command is not identical to the "IED test status".

[2]Note: With the exception of the above 'cancel' logic, there is an operate-condition logic within the DPSY01 function; the operate-condition logic will always checks conditions. That is, the user is only required to set either the "operate-condition" or the "cancel-condition" logic.

If the original logic does not meet with the requirements of the user, it can be replaced using the connection point "User configurable condition":

1. Connect the user-customized logic with the "PLC_BIT_0545", which is listed in Table 4.2-12.
2. Set scheme switch [**DPSY01-LGCNFFCT**] to **PLC**.

(iv) Signal name and number

Note: The user should note the following descriptions shown in the column "M/O" in each table:

"O" indicates that the signal is provided for optional usage.

"M" indicates that the user should map/set/configure using the signal; otherwise, the user may experience an operational failure for the default settings.

"N/A" indicates that the user cannot change the state of the signal.

Table 4.2-12 PLC connection points (Input signal for 'cancel' condition)

Signal Number	Signal Name	Description	M/O
5A0101 800544EF40	PLC_BIT_0545	DPSY1 user configurable cancel condition	O
5A0101 800567EF40	PLC_BIT_0568	DPSY2 user configurable cancel condition	O

Table 4.2-13 PLC monitoring points (Output signal for 'cancel' condition)

Signal Number	Signal Name	Description
511001 8602011E95	DPSY01_CC_SS	DPSY1 cancel succeed
511001 8602021E95	DPSY02_CC_SS	DPSY2 cancel succeed
511001 8702011E96	DPSY01_CC_FS	DPSY1 cancel failed
511001 8702021E96	DPSY02_CC_FS	DPSY2 cancel failed

(v) Setting name

Note: The "xx" within "DPSYxx" represents the DPSY function number. (e.g., if DPSY01 is considered, the "xx" is equal to "01". The numbers used for "xx" can be represented by either "01" or "02".)

Table 4.2-14 Setting for 'Cancel' in DPSYxx

Setting Name	Description	Default	Setting item or value
DPSYxx-LGCNFFCT	Logic selector for cancel condition (DPSY01-02)	Fixedlogic	Fixedlogic / PLC

4.2.3 Operate logic for SBO/DIR modes

Once the operation of the select logic is complete, the operate logic start to control the device.

(i) Receiving "operate command Closing" from the remote-end

Figure 4.2-19 depicts the reception of the operate command 'Closing' from the remote-end.

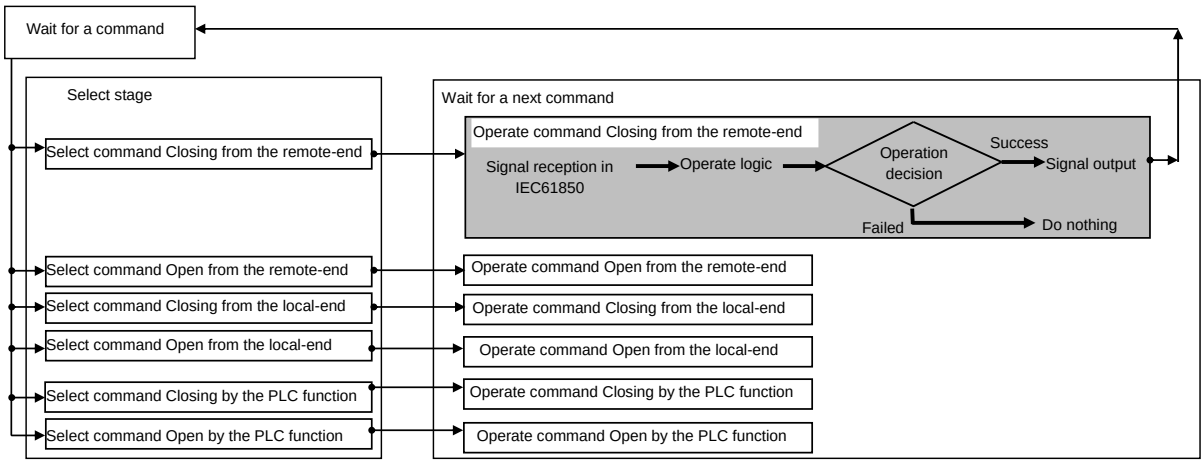


Figure 4.2-19 Outline of operate command 'Closing'

(i)-1 Mapping required for Input point

Figure 4.2-20 illustrates the operate logic when an "Operate command (Remote-Closing-Control)" signal is applied to the DPSY01 function. The input-point "DEV01_CONTROL_REQ" is used for the reception of the "Operate command Closing (Remote-Closing-Control)".

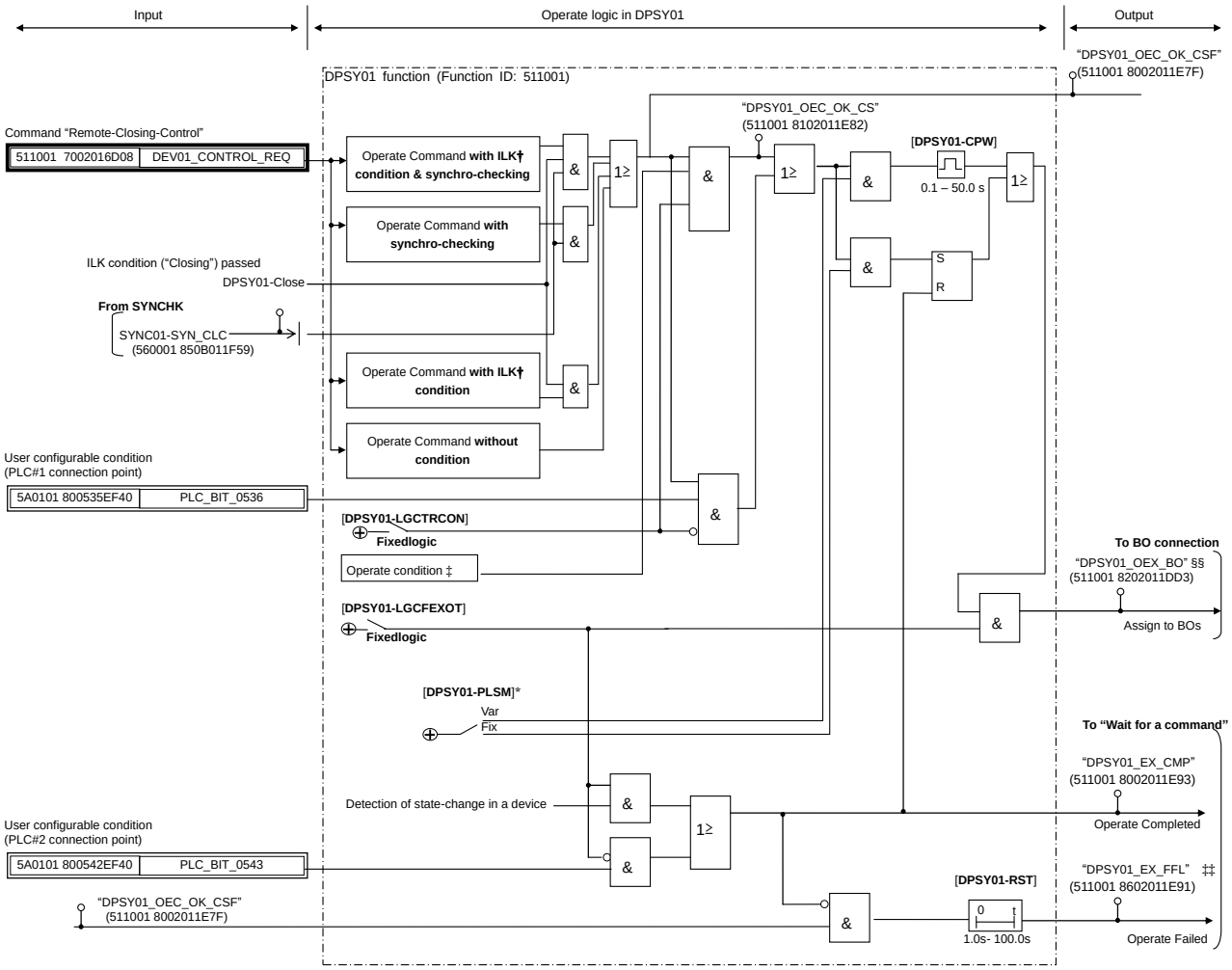


Figure 4.2-20 Operate 'Closing' from the remote-end in DPSY01††

†Note:The ILK function can provide the operation criteria for "Closing".

‡Note:An "operate condition" signal is generated in the operate-condition logic (see Figure 4.2-31) when **Fixlogic** is set for scheme switch [**DPSY01-LGCTRCON**]. If an alternative "operate-condition" is required, it can be programmed by the user and used to replace the signal generated by the original operated-condition logic. The alternative "operate-condition" can be connected to the above logic using connection point #1 "User-configurable condition". That is, set the scheme switch [**DPSY01-LGCTRCON**] to **PLC** and use "PLC_BIT_0536".

§§Note: The signal "DPSY01_OEX_BO" is issued when **Fixlogic** is set for scheme switch [**DPSY01-LGCFEXOT**]. The "Operate completed" signal can also be issued from logic programmed by the user, in place of the logic shown in Figure 4.2-20. The user-programmed logic is connected internally to the signal "Operate completed", hence this signal is now generated by the user-programmed logic at connection point #2 "User-configurable condition". That is, set the scheme switch [**DPSY01-LGCFEXOT**] to **PLC** and use "PLC_BIT_0543".

*Note:The user can set the type of the output signal. When **Var** is set for scheme switch

[**DPSY01-PLSM**], the output period of the signal is defined by the setting [**DPSY01-CPW**]. When **Fix** is set, the signal ceases when the 43-switch is changed.

††Note: To identify the input and output signal-points of the DPSY02 logic, see Table 4.2-15 for PLC#1, Table 4.2-16 for PLC#2, Table 4.2-20, and Table 4.2-21 for output signals.

‡‡Note: The "Operate failed" signal is issued when the state-change is not detected when the time set by the [**DPSY01-RST**] has been reached.

(i)-2 Output signal to BO

The DPSY01 function, in Figure 4.2-20, can issue an "Operate" signal at the output point "DPSY01_OEX_BO", when the DPSY01 function determines that the received signal "Remote-Closing-Control" is true.

(ii) Receiving "operate command Open" from the remote-end

Figure 4.2-21 depicts the reception of the operate command 'Open' from the remote-end.

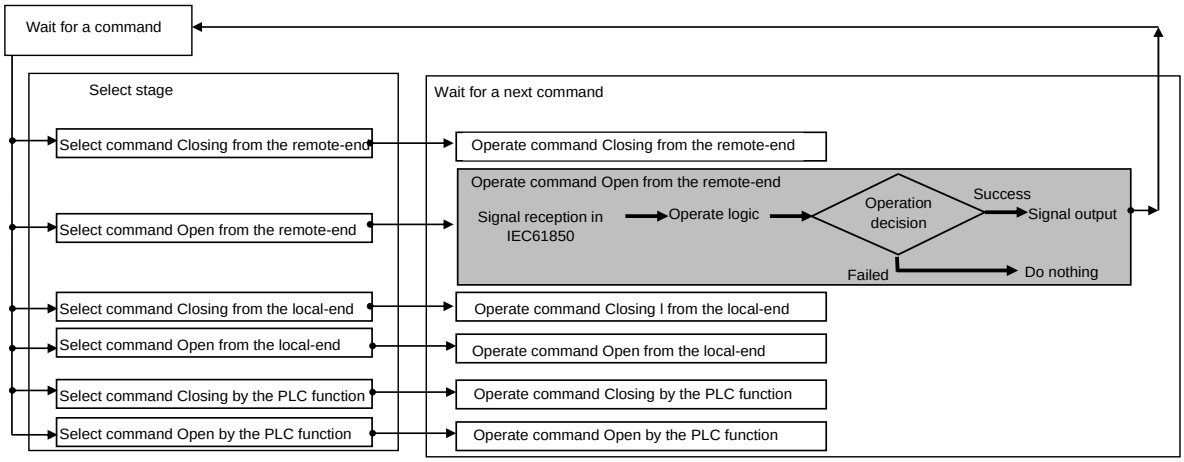


Figure 4.2-21 Outline of operate command 'Open'

(ii)-1 Mapping required for Input point from communication

Figure 4.2-22 illustrates the operate logic when an "Operate command (Remote-Open-Control)" signal is applied to the DPSY01 logic. The input-point "DEV01_CONTROL_REQ" is used for the reception of the "Operate command Open (Remote-Open-Control)".

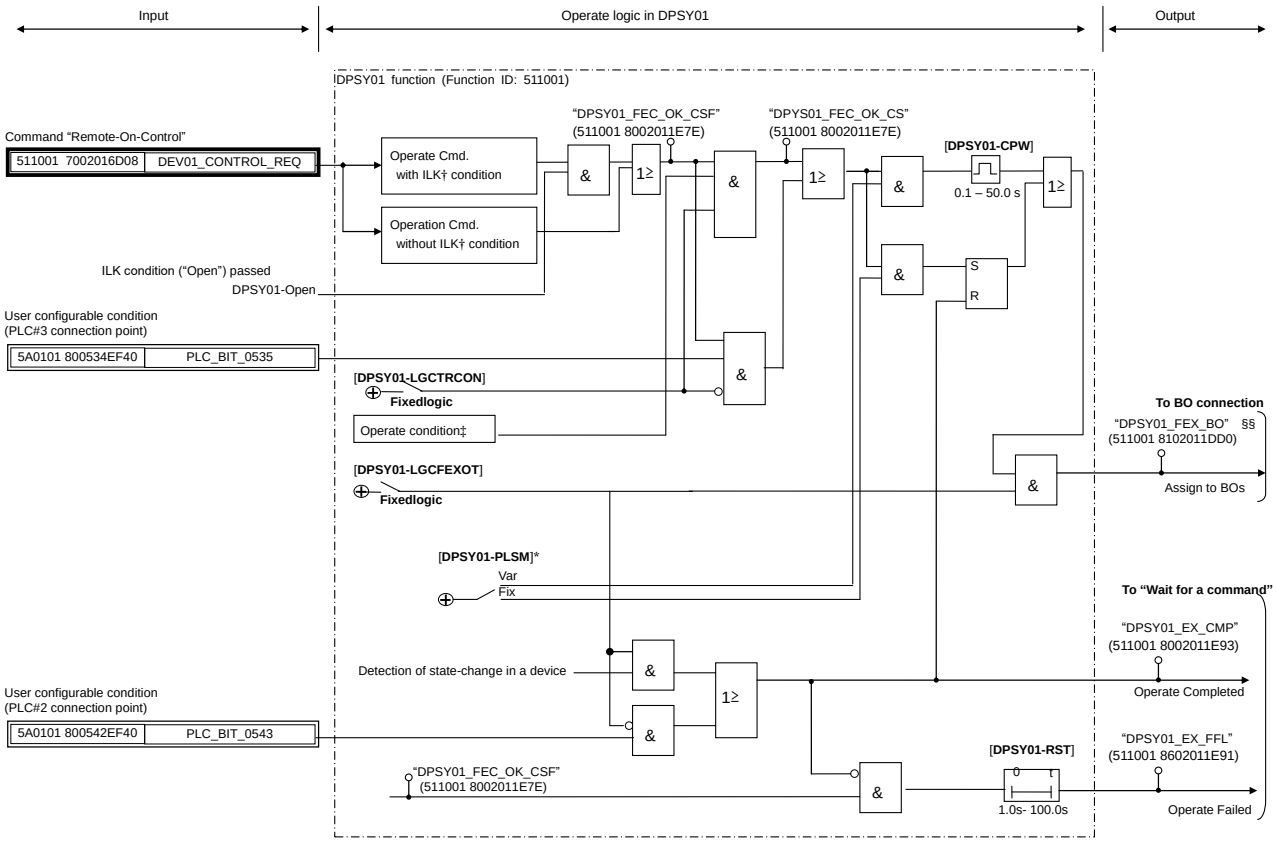


Figure 4.2-22 'Open' operate from the remote-end in DPSY01††

†Note:The ILK function can provide the operation criteria for "Open".

‡Note:An "operate condition" signal is generated in the operate-condition logic (see Figure 4.2-31) when **Fixlogic** is set for scheme switch [**DPSY01-LGCTRCON**]. If an alternative "operate-condition" is required, it can be programmed by the user and used to replace the signal generated by the original operated-condition logic. The alternative "operate-condition" can be connected to the above logic using connection point #3 "User-configurable condition". That is, set the scheme switch [**DPSY01-LGCTRCON**] to **PLC** and use "PLC_BIT_0535".

§§Note: The signal "DPSY01_OEX_BO" is issued when **Fixlogic** is set for scheme switch [**DPSY01-LGCFEXOT**]. The "Operate completed" signal can also be issued from logic programmed by the user, in place of the logic shown in Figure 4.2-20. The user-programmed logic is connected internally to the signal "Operate completed", hence this signal is now generated by the user-programmed logic at connection point #2 "User-configurable condition". That is, set the scheme switch [**DPSY01-LGCFEXOT**] to **PLC** and use "PLC_BIT_0543".

*Note:The user can set the type of output signal. When **Var** is set for scheme switch [**DPSY01-PLSM**], the output period of the signal is defined by the setting [**DPSY01-CPW**]. When **Fix** is set, the signal ceases when the 43-switch is changed.

††Note: To identify the input and output signals of the DPSY02 logic, see Table 4.2-16 for PLC#2, Table 4.2-17 for PLC#3, Table 4.2-19, and Table 4.2-21 for the outputs.

(ii)-2 Output signal to BO

The DPSY01 function, in Figure 4.2-22, can issue an "Operate" signal at the output-point "DPSY01_FEX_BO", when the DPSY01 function determines that the input signal "Remote-Open-Control" is true.

(iii) Receiving "operate command Closing" from the local-end

Figure 4.2-23 depicts the reception of the operate command 'Closing' from the local-end.

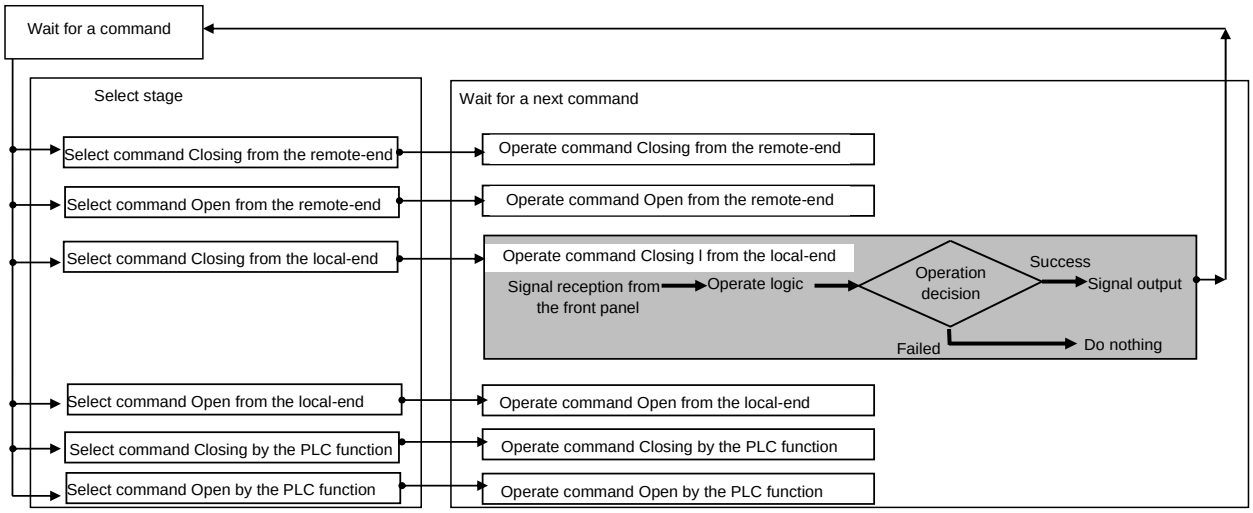


Figure 4.2-23 Outline of operate command Closing

(iii)-1 Input signal generated at the local-end

Figure 4.2-24 illustrates the operate logic when an "Operate command Closing (Local-Closing-Control)" signal is applied to the DPSY01 function. The signal is generated when "Execution of Closing" is keyed on the IED front panel.

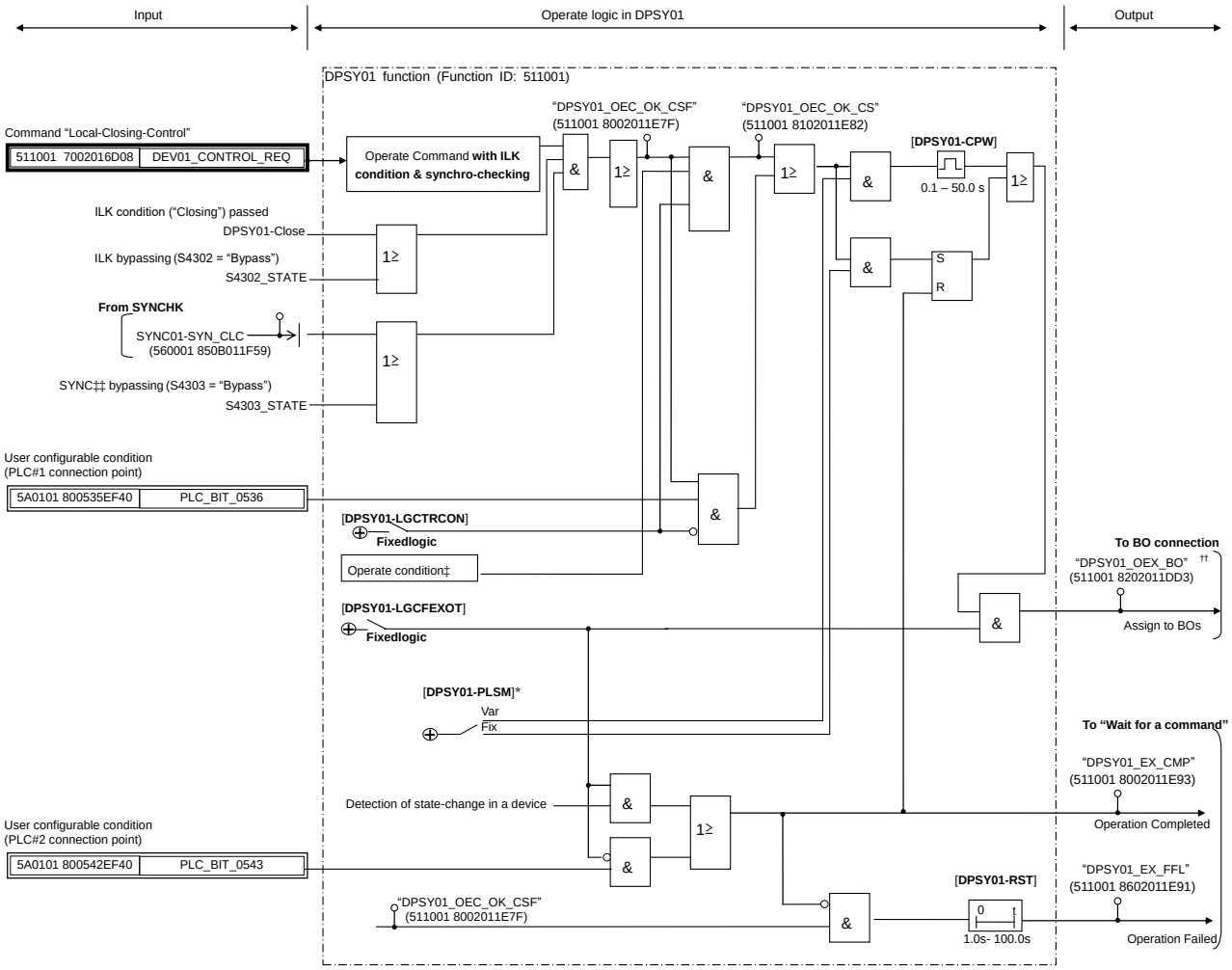


Figure 4.2-24 Operate closing on the front panel in DPSY01

†Note:The ILK function can provide the operation criteria for "Closing".

‡Note:An "operate condition" signal is generated in the operate-condition logic (see Figure 4.2-31) when **Fixlogic** is set for scheme switch [**DPSY01-LGCTRCON**]. If an alternative "operate-condition" is required, it can be programmed by the user and used to replace the signal generated by the original operated-condition logic. The alternative "operate-condition" can be connected to the above logic using connection point #1 "User-configurable condition". That is, set the scheme switch [**DPSY01-LGCTRCON**] to **PLC** and use "PLC_BIT_0536".

§§Note: The signal "DPSY01_OEX_BO" is issued when **Fixlogic** is set for scheme switch [**DPSY01-LGCFEXOT**]. The "Operate completed" signal can also be issued from logic programmed by the user in place of the logic shown in Figure 4.2-20., The user-programmed logic is connected internally to the signal "Operate completed", hence this signal is now generated by the user-programmed logic at connection point #2 "User-configurable condition". That is, set the scheme switch [**DPSY01-LGCFEXOT**] to **PLC** and use "PLC_BIT_0543".

*Note:The user can set the type of output signal. When **Var** is set for scheme switch

[**DPSY01-PLSM**], the output period of the signal is defined by the setting [**DPSY01-CPW**]. When **Fix** is set, the signal ceases when the 43-switch is changed.

††Note: To identify the input and output signal-points of the DPSY02 logic, see Table 4.2-15 for PLC#1, Table 4.2-16 for PLC#2, Table 4.2-20, and Table 4.2-21 for output signals.

‡‡Note: The "Operate failed" signal is issued when the state-change is not detected until after reaching the time set by the [**DPSY01-RST**].

(iii)-2 Output signal to BO

The DPSY01 function, in Figure 4.2-24, can issue an "Operate" signal at the output point "DPSY01_OEX_BO", if the DPSY01 function determines that the signal "Local-Closing-Control" is true.

(iv) Receiving "operate command Open" from front panel

Figure 4.2-25 depicts the reception of the operate command for 'Open' from the front panel. These input and output signals and the procedure are highlighted in the figure below.

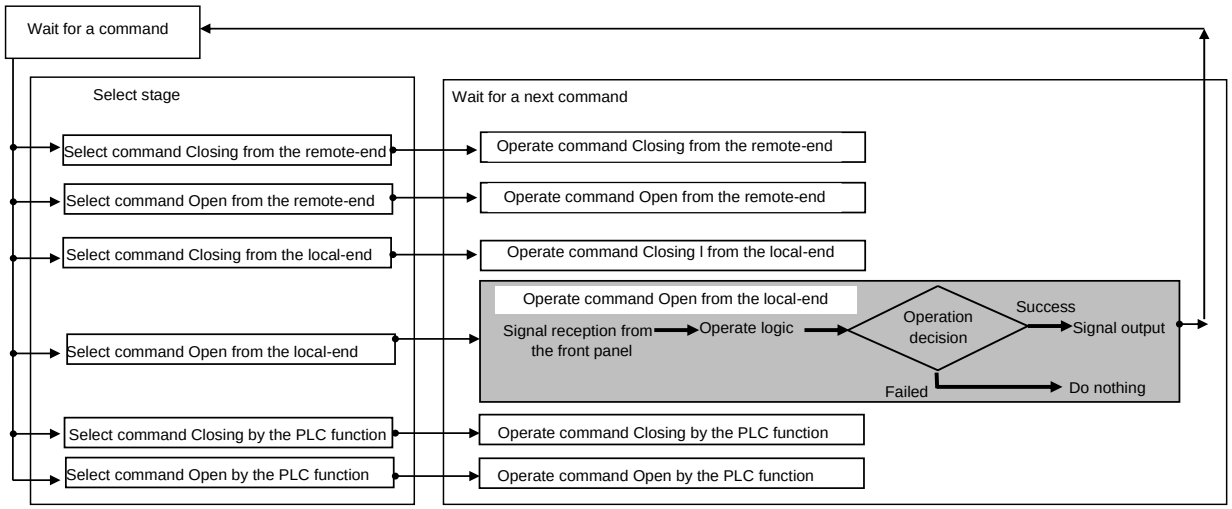


Figure 4.2-25 Outline of operate command Open

(iv)-1 Input signal generated at the local-end

Figure 4.2-26 illustrates the operate logic when an "Operate command Open (Local-Open-Control)" signal is applied to the DPSY01 function. The signal is generated when "Execution for Open" is keyed on the IED front panel.

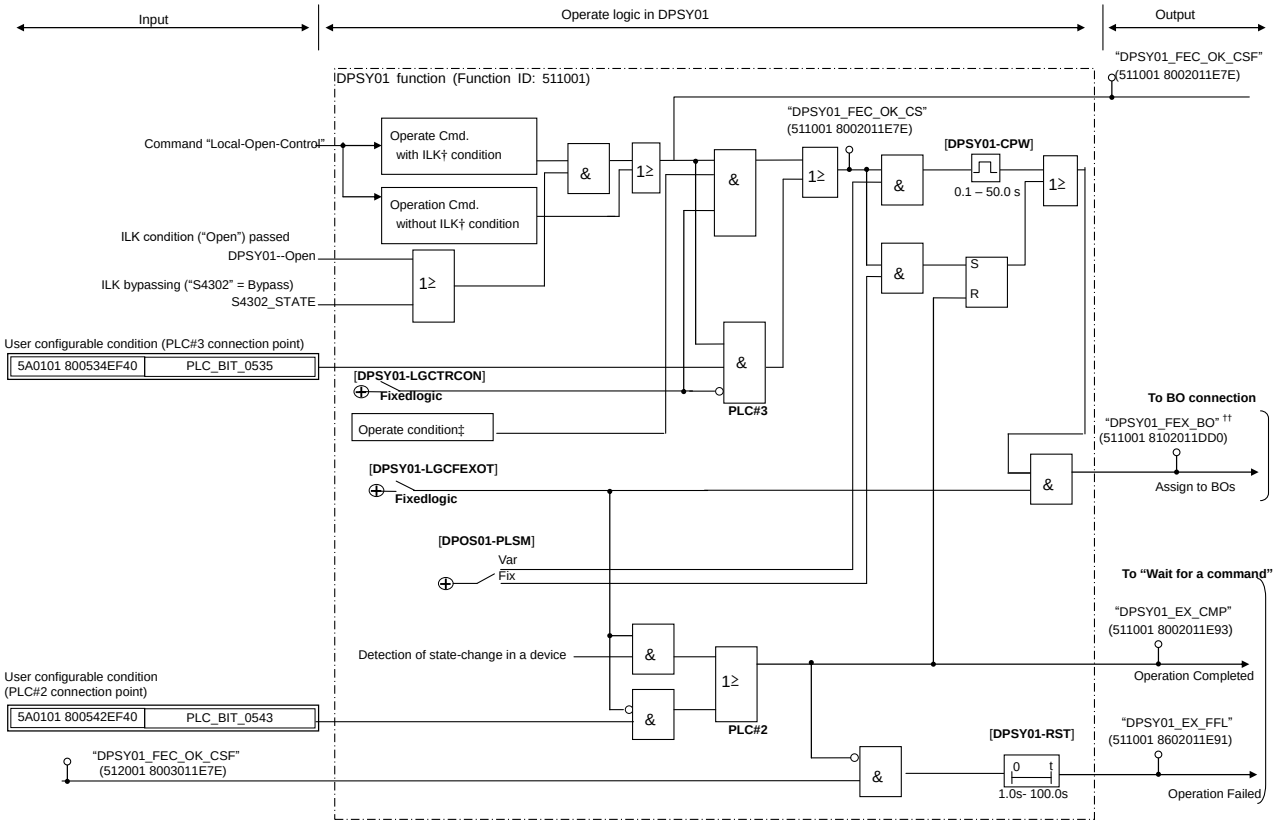


Figure 4.2-26 Operate Open logic at local in DPSY01

†Note:The ILK function can provide the operation criteria for "Open".

‡Note:An "operate condition" signal is generated in the operate-condition logic (see Figure 4.2-31) when **Fixlogic** is set for scheme switch [**DPSY01-LGCTRCON**]. If an alternative "operate-condition" is required it can be programmed by the user and used to replace the signal generated by the original operated-condition logic. The alternative "operate-condition" can be connected to the above logic using connection point #3 "User-configurable condition". That is, set the scheme switch [**DPSY01-LGCTRCON**] to **PLC** and use "PLC_BIT_0535".

§§Note: The signal "DPSY01_OEX_BO" is issued when **Fixlogic** is set for the scheme switch [**DPSY01-LGCFEXOT**]. The "Operate completed" signal can also be issued from the logic programmed by the user in place of the logic shown in Figure 4.2-20. The user-programmed logic is connected internally to the signal "Operate completed", hence this signal is now generated by the user-programmed logic at connection point #2 "User configurable condition". That is, set the scheme switch [**DPSY01-LGCFEXOT**] to **PLC** and use "PLC_BIT_0543".

*Note:The user can set the type of output signal. When **Var** is set for scheme switch [**DPSY01-PLSM**], the output period of the signal is defined by the setting [**DPSY01-CPW**]. When **Fix** is set, the signal ceases when the 43-switch is changed.

††Note: To identify the input and output signals of the DPSY02 logic, see Table 4.2-16 for PLC#2, Table 4.2-17 for PLC#3, Table 4.2-19, and Table 4.2-21 for the outputs.

(iv)-2 Output signal to BO

The DPSY01 function, in Figure 4.2-31, can issue an "Operate" signal at the output point "DPSY01_FEX_BO", when the DPSY01 function determines that the signal "Local-Open-Control" is true.

(v) Receiving "operate command Closing" using the PLC logic

Figure 4.2-27 outlines the reception of the operate command closing with the PLC function.

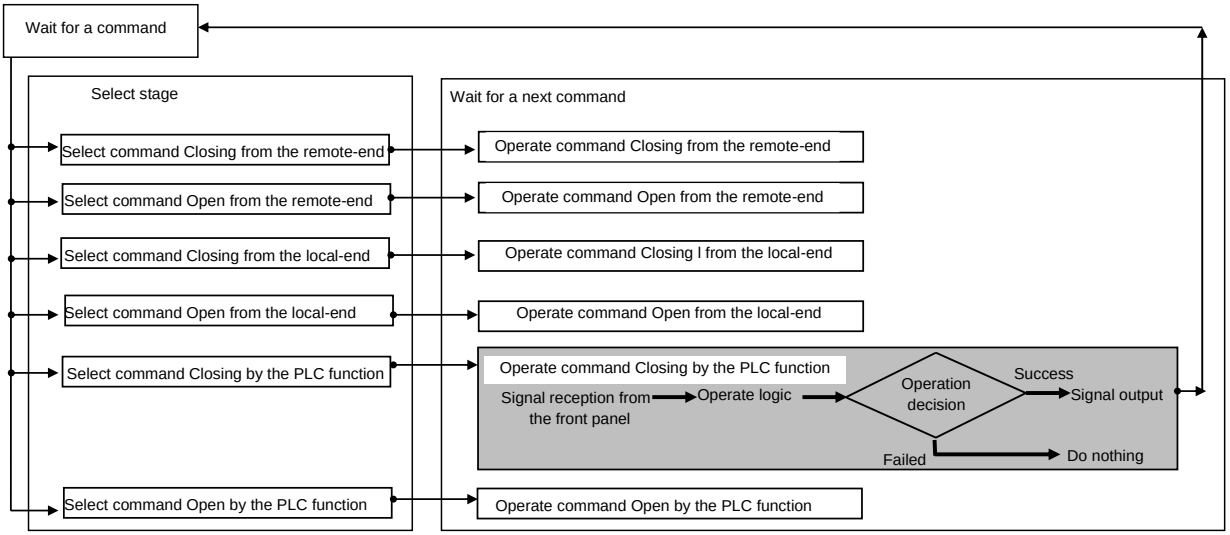


Figure 4.2-27 Outline of operate command closing

(v)-1 Input signal from the PLC function

Figure 4.2-28 describes the operate logic when an "Operate command Closing (PLC-Closing-Control)" signal is generated by the PLC function. There are four input points for reception of the signal "operate command closing". The input point is selected in accordance with one of the following four conditions: for the first condition, the issue of the operate command to the device is decided in coordination with checks for both the ILK and the SYNCHK functions, the signal is applied at connection point (PLC#1: i.e., "PLC_BIT_0528") (Table 4.2-3). For the second condition, the issue of the operate command for the device is determined in coordination with a check using the SYCHK function only, the signal is applied at connection point ("PLC#2: i.e., "PLC_BIT_0527") (Table 4.2-3). If the third condition is used, the issue of the operate command for the device is determined in coordination with a check using the ILK function only, apply the signal at connection point ("PLC#3: i.e., PLC_BIT_0526") (Table 4.2-3). Regarding the fourth condition, the issue of the operate command to the device is made with no check, the signal is applied at connection point ("PLC#4: i.e., PLC_BIT_0525") (Table 4.2-3). Note that the user should set **PLC** for scheme switch [**DPSY-LGCTRCON**].

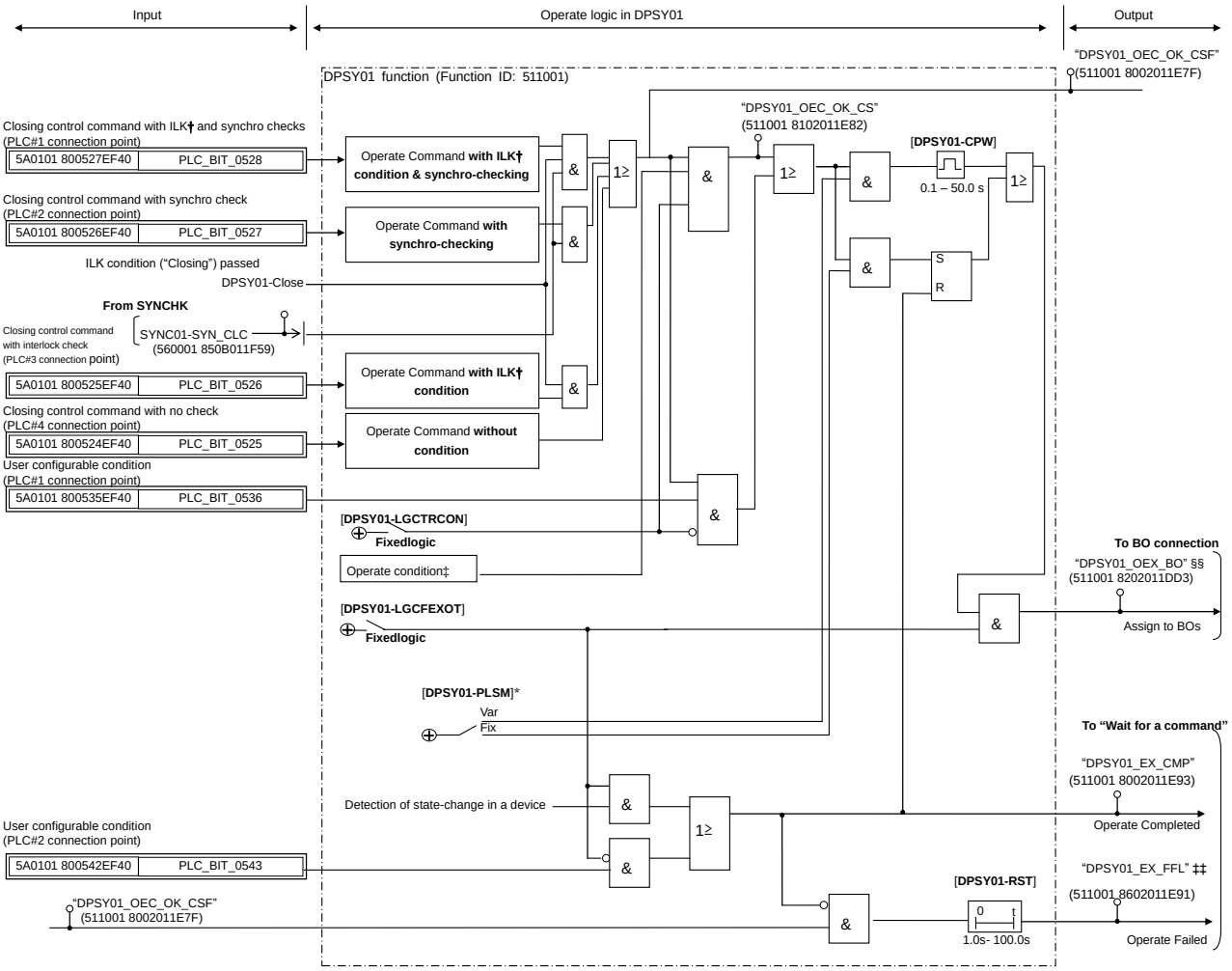


Figure 4.2-28 Closing operation logic with PLC in DPSY01††

†Note:The ILK function can provide the criteria for operation for "Closing" control.

‡Note:An "operate condition" signal is generated in the operate-condition logic (see Figure 4.2-31) when **Fixlogic** is set for scheme switch [**DPSY01-LGCTRCON**]. If an alternative "operate-condition" programmed by the user is required in place of the signal generated by the original operated-condition logic, connect the alternative "operate-condition" to the logic shown in Figure 1.10-28 using connection point #1 "User-configurable condition". That is, set the scheme switch [**DPSY01-LGCTRCON**] to **PLC** and use "PLC_BIT_0536".

§§Note: The signal "DPSY01_OEX_BO" is issued when **Fixlogic** is set for scheme switch [**DPSY01-LGCFEXOT**]. If the signal to be issued from the logic programmed by the user instead of the logic shown in Figure 4.2-20, connect the signal "Operate completed" generated in the user-programmed logic to connection point #2 "User configurable condition". That is, set the scheme switch [**DPSY01-LGCFEXOT**] to **PLC** and use "PLC_BIT_0543".

*Note:The user can set the type of output signal. When **Var** is set for scheme switch [**DPSY01-PLSM**], the output period of the signal is defined by the setting applied

to [**DPSY01-CPW**]. When **Fix** is set, the signal ceases when the 43-switch is changed.

††Note: To identify the input and output signal-points in the DPSY02 logic, see Table 4.2-3 and Table 4.2-4 for PLC#1 to PLC#4, Table 4.2-15 and Table 4.2-16 for PLC#1/#2 for user configurable conditions, Table 4.2-20, and Table 4.2-21 for the outputs.

‡‡Note: The "Operate failed" signal is issued when a state-change remains undetected following expiration of the setting applied to timer [**DPSY01-RST**].

(v)-2 Output signal to BO

The DPSY01 function, in Figure 4.2-28, can issue an "Operate" signal at output point "DPSY01_OEX_BO", when the DPSY01 function determines that the "PLC-Closing-Control" signal is true.

(vi) Receiving "operate command Open" using PLC logic

Figure 4.2-29 depicts the reception of the operate command for Open using the PLC function. These input and output signals and the process are highlighted in the figure below.

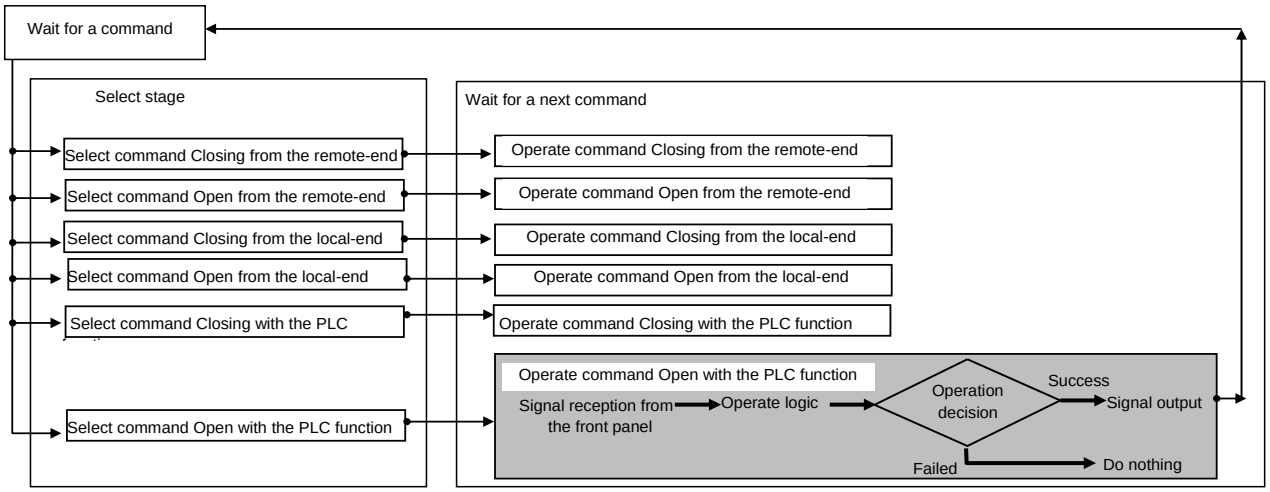


Figure 4.2-29 Outline of operate command for Open

(vi)-1 Input signal from the PLC function

Figure 4.2-30 depicts the operate logic when an "Operate command Open (PLC-Open-Control)" signal is generated by the PLC function. There are two points for reception of this command signal, unlike the signal ("Operate command Closing (PLC-Closing-Control)". That is, if an interlock check is required, apply the signal at connection point ("PLC#4: i.e., PLC_BIT_0524"). If, on the other hand an interlock check is not required, apply the signal at connection point ("PLC#5: i.e., PLC_BIT_0523"). PLC#1 and PLC#2 shown in Table 4.2-4 should be treated as PLC#3 and PLC#4 here.

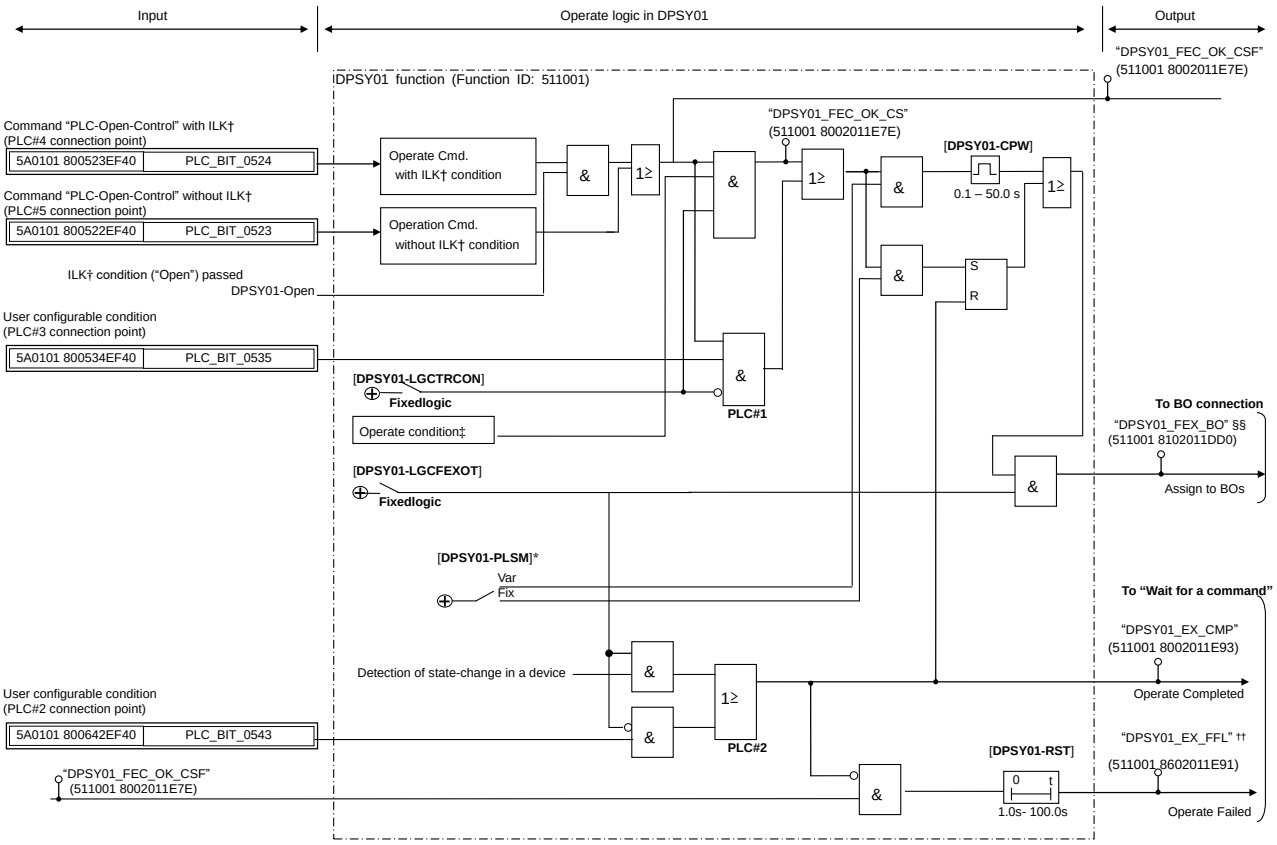


Figure 4.2-30 Open operation logic by PLC in DPSY01††

†Note: The ILK function can provide the criteria for operation for control of the "Open" operation.

‡Note: An "operate condition" signal is generated in the operate-condition logic (see Figure 4.2-31) when **Fixlogic** is set for scheme switch [**DPSY01-LGCTRCON**]. If an alternative "operate-condition" programmed by the user is required in place of the signal generated by the original operated-condition logic, connect the alternative "operate-condition" to the logic shown in Figure 1.10-30 using connection point #3 "User-configurable condition". That is, set the scheme switch [**DPSY01-LGCTRCON**] to **PLC** and use "PLC_BIT_0535".

§§Note: The signal "DPSY01_OEX_BO" is issued when **Fixlogic** is set for the scheme switch [**DPSY01-LGCFEXOT**]. If the signal to be issued from the programmed logic by the user in place of Figure 4.2-20 logic, connect the signal "Operate completed" generated in the programmed logic to the connection point #2 "User configurable condition". That is, the set the scheme switch [**DPSY01-LGCFEXOT**] to **PLC** and use "PLC_BIT_0543".

*Note: The user can set the type of the output signal. When **Var** is set for scheme switch [**DPSY01-PLSM**], the output period of the signal is defined by the setting applied to [**DPSY01-CPW**]. When **Fix** is set, the signal ceases when the 43-switch is changed.

††Note: To identify the input and output signal-points in the DPSY02 logic, see Table

4.2-16 for PLC#2, Table 4.2-17 for PLC#3, Table 4.2-19, and Table 4.2-21 for the outputs.

(vi)-2 Output signal to BO

The DPSY01 function, in Figure 4.2-30, can issue an "Operate" signal at output-point "DPSY01_FEX_BO", when the DPSY01 function determines that the "PLC-Open-Control" signal is true.

(vii) Operate condition

In a manner similar to which the conditions have been examined for the select command, the conditions for an operate command should be understood. Figure 4.2-31 illustrates the logic to examine an operate condition; the operate condition is determined by signal "DPSY01_STATE". If the functionality of the original logic does not meet with user-requirements, the following alternatives are available:

1. The user can replace the original logic with alternative logic.
2. The user can add another signal to the original logic.

(vii)-1 Replacing the original logic

If the user wishes to replace the operate condition logic completely, it can be achieved using PLC connection point "User configurable condition":

1. Connect the user-customized logic using PLC-BIT-0540, listed as PLC#2 in Table 4.2-18.
2. Set scheme switch [**DPSY01-LGEXFFCT**] to **PLC**.

(vii)-2 Adding another operate condition signal

If the addition of another operate condition is required, the user can add the signal to the operate condition logic using PLC connection point "Additional condition":

1. Add a user-preferred signal using "PLC-BIT-0539", listed as PLC#1 in Table 4.2-18.
2. Set scheme switch [**DPSY01-LGEXFFCT**] to **Fixedlogic**. (Table 4.2-22)

Note: The output of the operate condition logic is provided separately for Closing-execution and for Open-execution. To see the outputs, refer to Table 4.2-19.

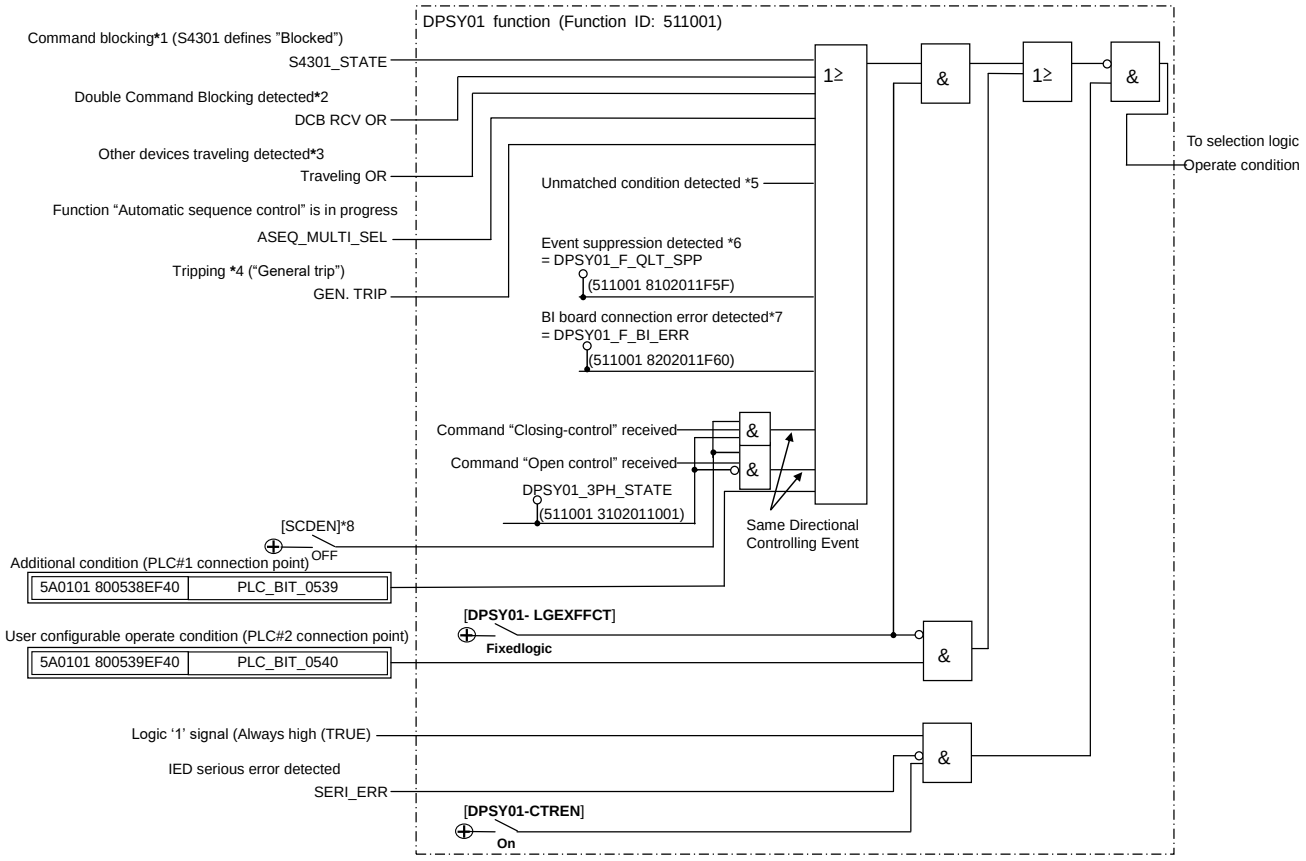


Figure 4.2-31 Operate condition logic for 'Closing/Open' in DPSY01

[1]Note: "Command Blocking" disables any operation except for itself; "Command Blocking" is implemented as "S4301" in a software switch controller (SOTFSW). The IEC 61850 standard defines "Command Blocking" as "CmdBlk". For more information on "S4301", see Chapter *Control and monitoring application: Software switch controller. See the signal "*"S4301_STATE" in Table 4.2-7.

[2]Note: "Double Command Blocking" (DCB) is an operation philosophy. It can be used to protect the substation. The user can program it using GR-TIEMS. The DCB operating signal is denoted as "DCB RCV OR) in Table 4.2-7.

[3]Note: Detection of event "device-travelling", signifies that other operators are changing the status of one or more devices. Thus, device operation by the IED should be inhibited whilst ever the event is detected. The detection signal is denoted as "Travelling OR" in Table 4.2-7.

[4]Note: If an IED is in the process of issuing a trip command, all control operation is blocked until the trip operation has been completed. If the IED has a relay application, the trip command is issued at the output-point "GEN.TRIP" in Table 4.2-7.

[5]Note: The criteria "unmatched conditions" is determined when "Test-bit status" in a command is not identical to the "IED test status".

[6]Note: The "Event suppression" function can detect chattering in BI circuits. (See section

4.2.6(i)-3)

[7]Note: A supervision of the Binary IO module can detect connection errors for BI circuits.

[8]Note: The "Common control" (CMNCTRL) function can test and check the operation-direction of logic. When the user sets **Off** for scheme switch [**SCDEN**], operation of the logic is blocked if the logic is running in the same operation-direction compared with the previous operation-direction. Alternatively, if **On** is set for the scheme switch, the logic is not blocked.

(viii) Signal name and number

Note: The user should note the meaning of the following abbreviations shown in column "M/O" of each table:

"O" signifies that the signal is provided for optional use.

"M" signifies that the user should map/set/configure the signal; otherwise, the user may experience an operational failure if the default settings are used.

"N/A" signifies that the user cannot change the state of the signal.

Table 4.2-15 PLC connection points (Input point for PLC#1 user a configurable condition)

Signal Number	Signal Name	Description	M/O
5A0101 800535EF40	PLC_BIT_0536	DPSY01 user configurable condition(PLC#1)	O
5A0101 800558EF40	PLC_BIT_0559	DPSY02 user configurable condition(PLC#1)	O

Table 4.2-16 PLC connection points (Input point for PLC#2 operate command Closing)

Signal Number	Signal Name	Description	M/O
5A0101 800542EF40	PLC_BIT_0543	DPSY01 user configurable condition(PLC#2)	O
5A0101 800565EF40	PLC_BIT_0566	DPSY02 user configurable condition(PLC#2)	O

Table 4.2-17 PLC connection points (Input point for PLC#3 operate command Closing)

Signal Number	Signal Name	Description	M/O
5A0101 800534EF40	PLC_BIT_0535	DPSY01 user configurable condition(PLC#3)	O
5A0101 800557EF40	PLC_BIT_0558	DPSY02 user configurable condition(PLC#3)	O

Table 4.2-18 PLC connection points (Input point for operate condition logic)

Signal Number	Signal Name	Description	M/O
5A0101 800538EF40	PLC_BIT_0539	DPSY01 user additional condition(PLC#1)	O
5A0101 800561EF40	PLC_BIT_0562	DPSY02 user additional condition(PLC#1)	O
5A0101 800539EF40	PLC_BIT_0540	DPSY01 user configurable operate condition(PLC#2)	O
5A0101 800562EF40	PLC_BIT_0563	DPSY02 user configurable operate condition(PLC#2)	O

Table 4.2-19 PLC monitoring points (Output signal for BIO)

Signal Number	Signal Name	Description
511001 8202011DD3	DPSY01_OEX_BO	DPSY01 operate (CLOSE) command for Binary Output.
511001 8202021DD3	DPSY02_OEX_BO	DPSY02 operate (CLOSE) command for Binary Output.
511001 8102011DD0	DPSY01_FEX_BO	DPSY01 operate(OPEN) command for Binary Output.
511001 8102021DD0	DPSY02_FEX_BO	DPSY02 operate(OPEN) command for Binary Output.

Table 4.2-20 PLC monitoring points (Signals within operate logic)

Signal Number	Signal Name	Description
511001 8002011E7F	DPSY01_OEC_OK_CSF	DPSY01 Close direction execute command
511001 8002021E7F	DPSY02_OEC_OK_CSF	DPSY02 Close direction execute command
511001 8102011E82	DPSY01_OEC_OK_CS	DPSY01 Close direction execute command
511001 8102021E82	DPSY02_OEC_OK_CS	DPSY02 Close direction execute command
511001 8002011E7E	DPSY01_FEC_OK_CSF	DPSY01 Open direction execute command
511001 8002021E7E	DPSY02_FEC_OK_CSF	DPSY02 Open direction execute command
511001 8002011E7E	DPSY01_FEC_OK_CS	DPSY01 Open direction execute command
511001 8002021E7E	DPSY02_FEC_OK_CS	DPSY02 Open direction execute command

Table 4.2-21 PLC monitoring points (Output signal for response)

Signal Number	Signal Name	Description
511001 8002011E93	DPSY01_EX_CMP	DPSY01 completed control
511001 8002021E93	DPSY02_EX_CMP	DPSY02 completed control
511001 8602011E91	DPSY01_EX_FFL	DPSY01 failed control
511001 8602021E91	DPSY02_EX_FFL	DPSY02 failed control

(ix) Setting names

Note: The “xx” of “DPSYxx” represents the DPSY function number. (e.g., if the DPSY01 is considered, the “xx” is equal to “01”. The suffix “xx” can be represented by either a “01” or “02”.)

Table 4.2-22 Setting of Operate in DPSYxx

Setting Name	Description	Default	Setting item or value
DPSYxx-PLSM	Method of command output (DPSY01-02)	Fix	Fix/Var
DPSYxx-CPW	Duration of command output (DPSY01-02)	1.0[sec]	0.1~50.0[sec]
DPSYxx-RST	Detection time for terminating control (DPSY01-02)	30.0[sec]	0.1~100.0[sec]
DPSYxx-LGCTRCON	Logic selector for operate condition (DPSY01 -02)	Fixedlogic	Fixedlogic/PLC
DPSYxx-LGCFEXOT	Logic selector for command output (DPSY01 -02)	Fixedlogic	Fixedlogic/PLC
DPSYxx-CTREN	Activate control function (DPSY01 -02)	Close	Open / Close
DPSYxx-LGEXFFCT	Logic selector for operate condition (DPSY01 -02)	Fixedlogic	Fixedlogic / PLC

4.2.4 Operation counter

The DPSY01 function has an operation-counter†; the user can utilize the operation-counter to predict the lifespan of switchgear and other functions. The user can select a count mode using a setting. Table 4.2-23 and Figure 4.2-32 show the modes for which a user is required to change a mode in response to a device signal. For instance in the DPSY01 function, a user can select the mode using scheme switch [**DPSY01-CNTS**] ,which is set to **C-On**; counting-up is performed when a switchgear signal gives rise to a change in state from "Open to Closing".

Table 4.2-23 Mode of operation counter

Mode	Description
C-On	Counting-up is performed when a signal changes to closed (ON). When the signal is changed from "Open to Closed", the counter value is incremented.
C-Off	Counting-up is performed when a signal changes to open (OFF). When the signal is changed from "Closed to Open", the counter value is incremented.
C-OnOff	Counting-up occurs when any state change occurs: "Open to Closed" and "Closed to Open".
NA	Stops the count function

†Note:The operation-counter value is not cleared when power is removed from the IED. This counter is available in the DPSY01 and DPSY02 functions.

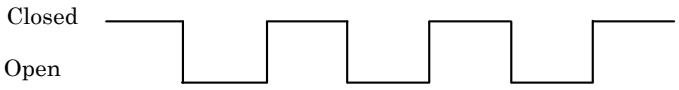


Figure 4.2-32 Device Signal

The user can change the value of the operation-counter from either the front panel or remotely. For example, in the sub-menu for "Operation Counter, the user can set a user-preferred value for the operation-counter. See Chapter *User interface: Monitoring sub-menu* on how to operate the sub-menu.

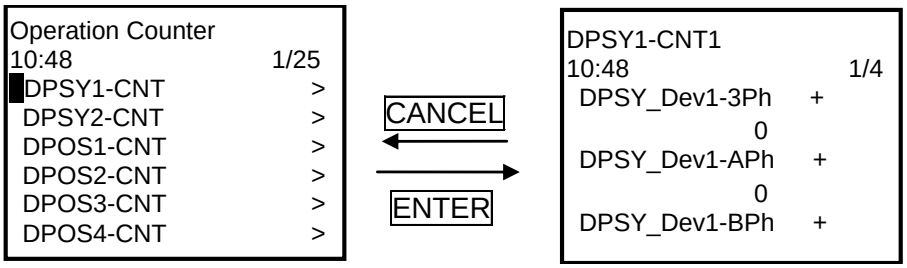


Figure 4.2-33 Operation counter sub-menu

Note: With regard to the signal "DPSY01_3PH_STATE", the sub-menu represents it as "DPSY_Dev1-3Ph". Analogous to signal "DPSY01_3PH_STATE", the signal "DPSY01_APH_STATE" is represented as "DPSY_Dev1-APh". The signals "DPSY01_BPH_STATE" and "DPSY01_CPH_STATE" are displayed in a similar manner.

(i) Receiving “change value for counter” from the remote end

(i)-1 Mapping of Input point required

Figure 4.2-34 depicts the logic when a “change value for counter” command is received at the DPSY01 logic. With regard to a three-phase counter, the input-point “DEV01_3PH_CONTROL_REQ” is used. With regard to a phase-A counter, the input-point “DEV01_APH_CONTROL_REQ” is used. For phase-B and phase-C, the input-points “DEV01_BPH_CONTROL_REQ” and “DEV01_CPH_CONTROL_REQ” are used.

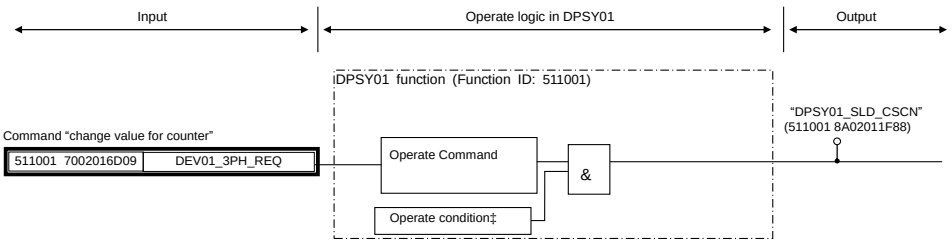


Figure 4.2-34 Change counter value for three-phase† with operation from the remote-end in DPSY01

‡Note: The “operate condition” signal is provided from the operate condition logic shown in Figure 4.2-36.

†Note: The user can apply other counter change commands for phase-A, -B, and –C as shown in Table 4.2-24. The resultant signals for the DPSY02 logic are shown in Table 4.2-25.

(i)-2 Output signal to BO

The DPSY01 function can issue a “Result” signal at output point “DPSY01_SLD_CSCN”. The counter values are issued at points “DPSY01_CNT_VAL", “DPSY01A_CNT_VAL", “DPSY01B_CNT_VAL", and “DPSY01C_CNT_VAL".

(ii) Receiving “change value for counter” from the local-end

(ii)-1 Input signal from the front panel

Figure 4.2-35 depicts the logic when a “change value for counter” command is provided in the DPSY01 function. The command is provided from the sub-menu (see Figure 4.2-33).

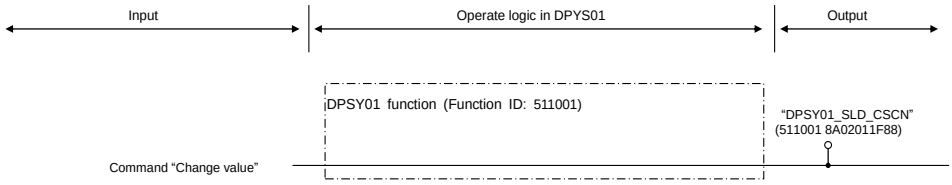


Figure 4.2-35 Changing counter value by operation from the front panel in DPSY01

(ii)-2 Output signal to BO

The DPSY01 function can issue a “Result” signal at the output point “DPSY01_SLD_CSCN”.

(iii) Operate condition for the counter

Figure 4.2-36 illustrates the operate condition logic for the counter..

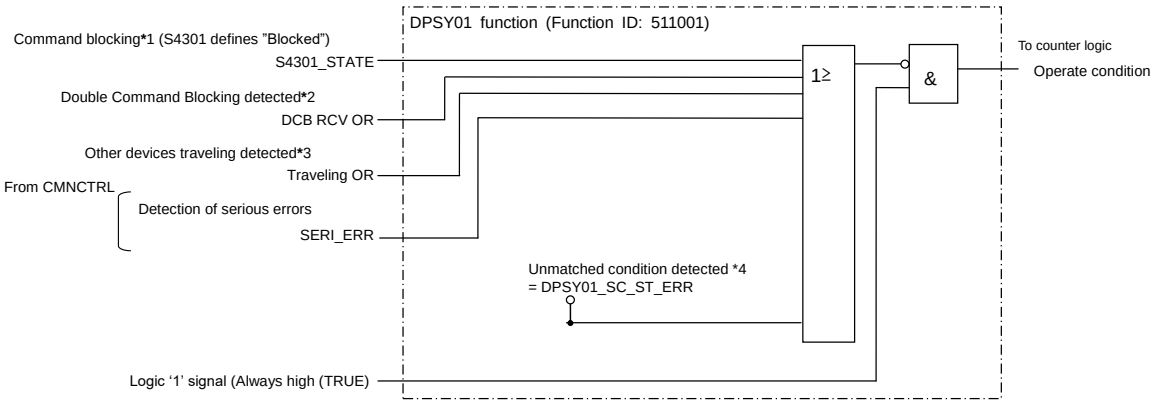


Figure 4.2-36 Operate condition logic for changing the counter in DPSY01

[1]Note: “Command Blocking” disables all operation except for its own; the “Command Blocking” function is initiated by the status of “S4301” in a software switch controller (SOTFSW). The IEC 61850 standard defines the “Command Blocking” function as “CmdBlk”. For more information on “S4301”, see Chapter *Control and monitoring application: Software switch controller*. *See the signal “*“S4301_STATE” of Table 4.2-7.

[2]Note: “Double Command Blocking” (DCB) is an operation philosophy. It can be used to protect the substation. The user can program it using GR-TIEMS. The DCB operating signal is denoted as “DCB RCV OR) in Table 4.2-7.

[3]Note: If the event “device-travelling” is detected, it indicates that another operator is changing the status of a device. Thus, the IED should inhibit the operation of any device for the duration that the event is detected. The detecting signal is denoted as “Travelling OR” in Table 4.2-7.

[4]Note: If the issue of a trip command is executed by the IED, any control operation is blocked until the trip operation is completed. If an IED includes a relay application, the trip command is issued at the output-point “GEN.TRIP” in Table 4.2-7.

(iv) Signal names and number

Table 4.2-24 Mapping points

Signal Number	Signal Name	Description
511001 7002016D09	DEV01_3PH_REQ	DPSY01 change command received.(Mapping Data) for 3-phase counter value
511001 7002016D0A	DEV01_APH_REQ	DPSY01 change command received.(Mapping Data) for phase-A counter value
511001 7002016D0B	DEV01_BPH_REQ	DPSY01 change command received.(Mapping Data) for phase-B counter value
511001 7002016D0C	DEV01_CPH_REQ	DPSY01 change command received.(Mapping Data) for phase-C counter value
511001 7002026D09	DEV02_3PH_REQ	DPSY02 change command received.(Mapping Data) for 3-phase counter value
511001 7002026D0A	DEV02_APH_REQ	DPSY02 change command received.(Mapping Data) for phase-A counter value
511001 7002026D0B	DEV02_BPH_REQ	DPSY02 change command received.(Mapping Data) for phase-B counter value
511001 7002026D0C	DEV02_CPH_REQ	DPSY02 change command received.(Mapping Data) for phase-C counter value

Table 4.2-25 PLC monitoring points and output results

Signal Number	Signal Name	Description
511001 8A02011F88	DPSY01_SLD_CSCN	DPSY01 select command for Binary Output.
511001 3202011D20	DPSY01_CNT_VAL	DPSY01 operation counter value
511001 3202011D24	DPSY01A_CNT_VAL	DPSY01 phase-A operation counter value
511001 3202011D28	DPSY01B_CNT_VAL	DPSY01 phase-B operation counter value
511001 3202011D2C	DPSY01C_CNT_VAL	DPSY01 phase-C operation counter value
511001 8A02021F88	DPSY02_SLD_CSCN	DPSY02 select command for Binary Output.
511001 3202021D20	DPSY02_CNT_VAL	DPSY02 operation counter value
511001 3202021D24	DPSY02A_CNT_VAL	DPSY02 phase-A operation counter value
511001 3202021D28	DPSY02B_CNT_VAL	DPSY02 phase-B operation counter value
511001 3202021D2C	DPSY02C_CNT_VAL	DPSY02 phase-C operation counter value

(v) Setting name

Table 4.2-26 Setting for pulse counter in DPSYxx

Setting Name	Description	Default	Setting item or value
DPSYxx-CNTS	Mode selection of the counter in DPSYxx	*user-preferred	NA / C-Close / C-Open / C-OnOff

4.2.5 Measurement of operation intervals

The DPSY01 function can measure operation intervals (OT1 to OT4)†; the intervals OT1 to OT2 can represent the period of time when a switch changes from "Closed" to "open". In the DPSY01 function the operation period is grouped into sub-time periods, as shown in Table 4.2-27. The user should set scheme switch [**DPSY01-OPETMEN**] to **On**.

Table 4.2-27 Intervals measured in the DPSY01 function

Intervals	Trigger	Events for measurement
OT1	Start	Signal "DPSY01_FEX_BO" sensed
	End	Switch status is changed from "Closed" to "Intermediate"
OT2	Start	Switch status "Intermediate" sensed
	End	Switch status is changed from "Intermediate" to "Open"
OT3	Start	Signal "DPSY01_OEX_BO" sensed
	End	Switch status is changed from "Open" to "Intermediate"
OT4	Start	Switch status "Intermediate" sensed
	End	Switch status is changed from "Intermediate" to "Closed"

†Note:The function "operation time measurement" is also available in the DPSY02 function.

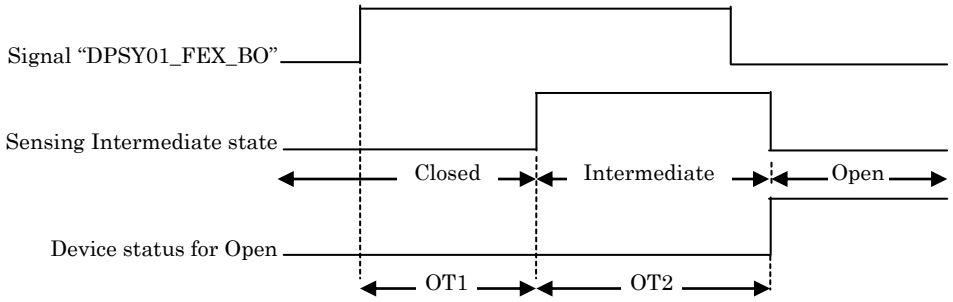


Figure 4.2-37 Two intervals (OT1 and OT2) for Open-control

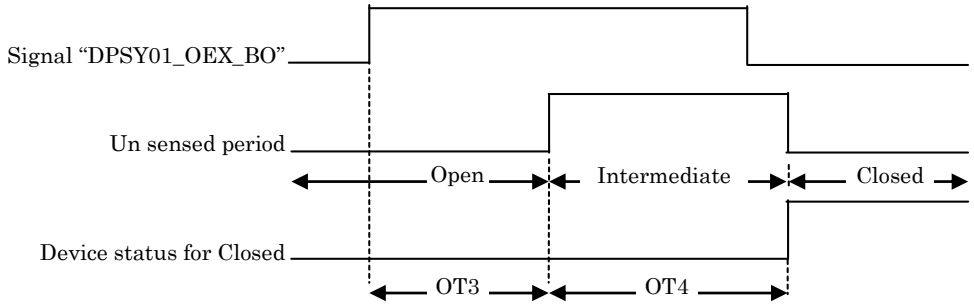


Figure 4.2-38 Two intervals (OT3 and OT4) for Closing-control

The user can clear the operation interval (OT1 to OT4) by key-operation of the "Operation time" sub-menu (Figure 4.2-39) or operation from the remote-end. See chapter *User interface:*

Monitoring sub-menu.

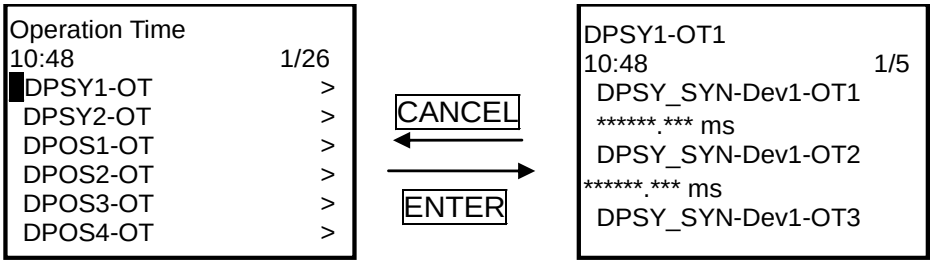


Figure 4.2-39 Operation time sub-menu

(i) Signal names and numbers

Table 4.2-28 Mapping points

Signal Number	Signal Name	Description
511001 7002016D0D	DEV01_RESET_REQ	DPSY01 operation time reset command received (Mapping Data)
511001 7002026D0D	DEV02_RESET_REQ	DPSY02 operation time reset command received (Mapping Data)

(ii) Setting names

Table 4.2-29 Setting of operation time function in DPSY

Setting Name	Description	Default	Setting item or value
DPSY01-OPETMEN	Activation of the operation time measurement in DPSY01	On	Off / On
DPSY02-OPETMEN	Activation of the operation time measurement in DPSY02	On	Off / On

4.2.6 Setup for BIO module

The user should connect the DPSY input/output points with the BI and the BO circuits; subsequently, the DPSY function is able to issue select and operate commands. In order to set up the DPSY function the user should execute the following four steps. Do not confuse setting BOs between step (ii) and step (iii).

i BI connection for status
ii BO connection for "select command"
iii BO connection for "operate command"
iv Contact health check

Note that the DPSY01 function commences operation when the scheme switch [**DPSY01-EN**] is set to **On**.

(i) BI connection for status signals

Figure 4.2-40 exemplifies the reception of signals at the DPSY01 function; to acquire the status signal§ for phase-A, the user should set two input-points for settings [**DPSY01A-NOPSG**] and [**DPSY01A-NCLSG**]†.

†Note: Normally an input-signal corresponding to phase-A is generated using a normally-open contact (NO) and a normally-closed contact (NC). If a NO and a NC contact are exchanged, the input-signal should be determined by inversion; that is, the user is required to set **On** for both scheme switches [**DPSY01A-NOPSGI**] and [**DPSY01A-NCLSGI**].

§Note: The state signal acquired can be monitored. For more information, see Chapter *Automatic supervision*.

(i)-1 Grouping three-phase signals corresponding to a state

Suppose that status signals are acquired on the six BI circuits at IO#1 slot. The signals corresponding to phase-A can be acquired via N/C and N/O contacts; thus, the user should set two input-points (8001001110 and 810101110 in 200B01†) for the settings [**DPSY01A-NOPSG**] and [**DPSY01A-NCLSG**], respectively, as shown in Figure 4.2-40. For input points corresponding to phase-B and phase-C, the user must also apply input-points via settings. The user sets **And** for scheme switches [**DPSY01-OPC**] and [**DPSY01-CLC**], respectively; finally, the scheme switch [**DPSY01-DEVTYPE**] should be set to **3-Pole**.

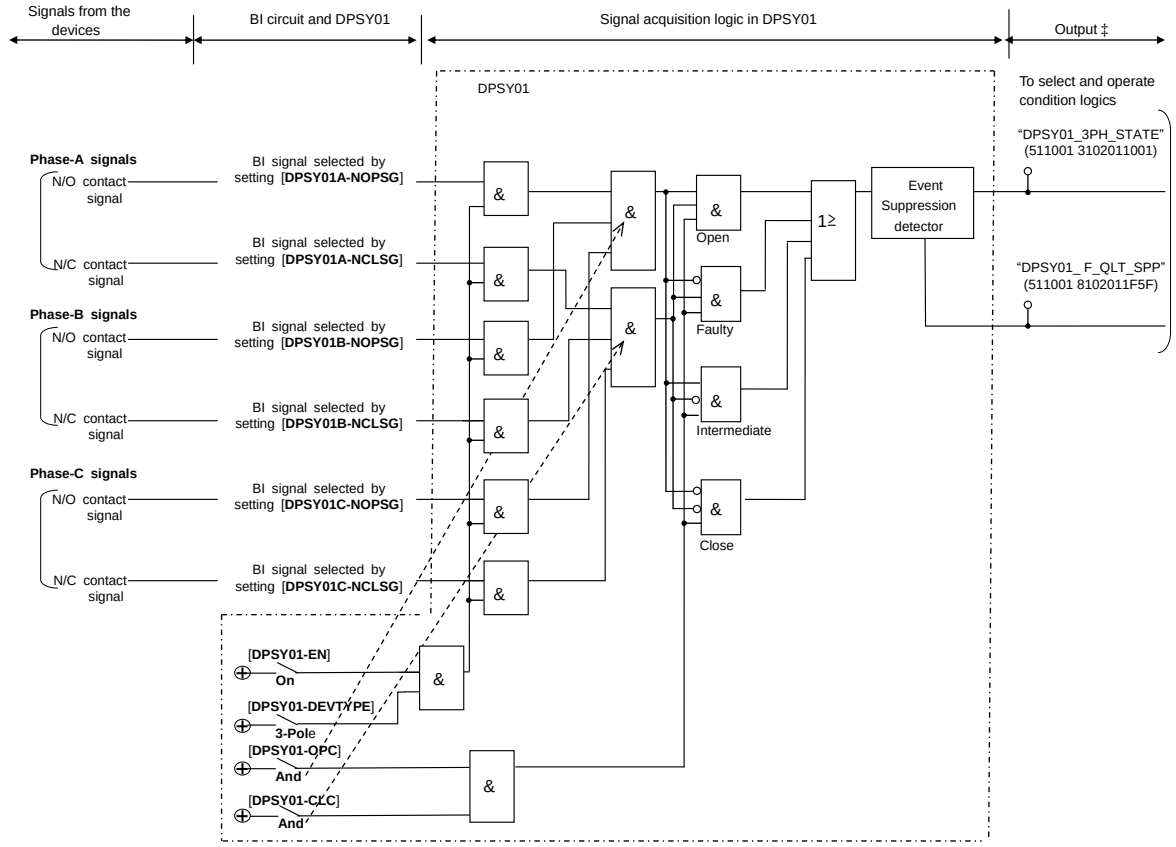


Figure 4.2-40 Acquisition of a state signal

†Note: The user should set the actual input-points. See chapter *Technical description: Binary IO module*.

‡Note: In Figure 4.2-40 two signals can be issued: "DPSY01_3PH_STATE" and "DPSY01_F_QLT_SPP". One is used in the select condition logic and operate condition logic (see Figure 4.2-13 and Figure 4.2-28). Another is used for operation in the event suppression function. Other signals are also provided: DPSY01_APH_STATE, DPSY01_BPH_STATE, and DPSY01_CPH_STATE.

(i)-2 Acquisition of a signal corresponding to a phase

Suppose that a state-signal is acquired on the two BI circuits at IO#1 slot. An individual phase signal can be taken using the N/C and the N/O contacts; thus, the user should set two input-points (8001001110 and 810101110 in 200B01†) for the settings [**DPSY01A-NOPSG**] and [**DPSY01A-NCLSG**], respectively, as shown in Figure 4.2-41. The user should set the scheme switch [**DPSY01-DEVTYPE**] to **1-Pole**.

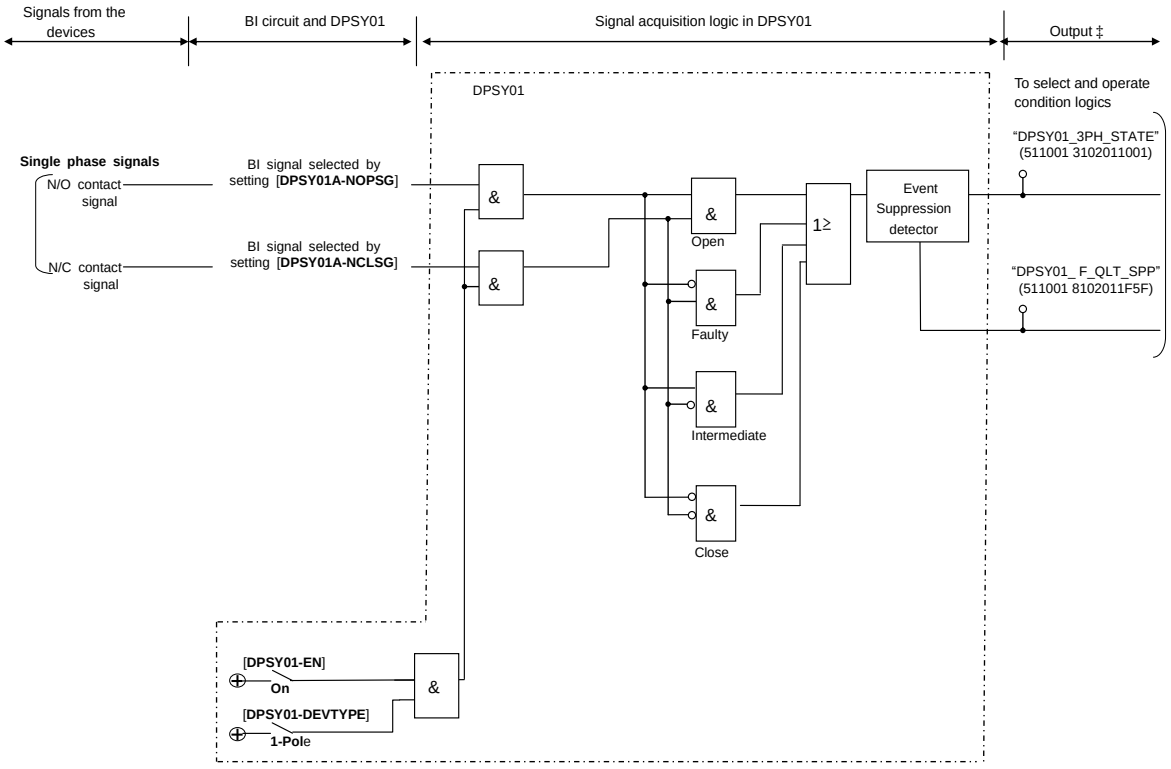


Figure 4.2-41 Acquisition of single-phase signal at DPSY01

‡Note:In Figure 4.2-41 two signals can be issued "DPSY01_3PH_STATE" and "DPSY01_F_QLT_SPP", which are the same as the signals in the Figure 4.2-40.

(i)-3 Event suppression

If the status of a device "chatters" for a short time, the DPSY function will receive iterative signals from the device. Such iterative signals can cause extra burden for the DPSY function; hence, event suppression can be required to reduce the additional burden created.

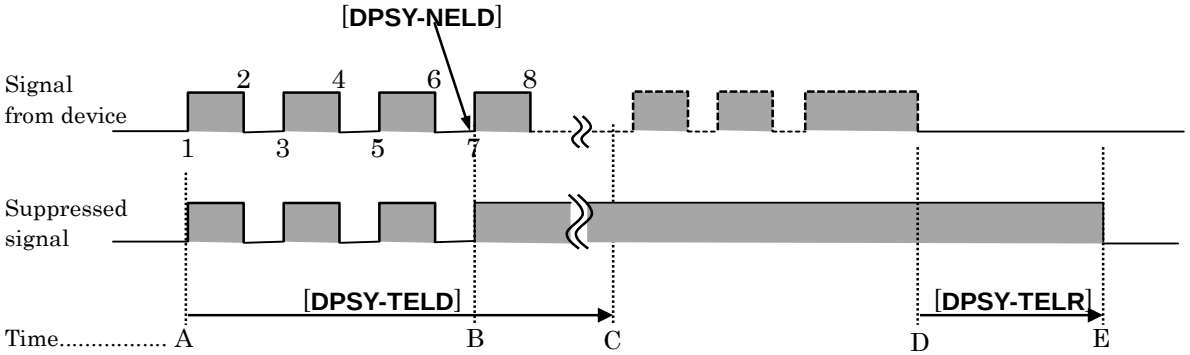


Figure 4.2-42 Iterative signals and signals suppressed

Figure 4.2-42 shows that the iterative signals received from the device have been suppressed by the event suppression function. The suppression commences on receipt of the seventh signal (at Time 'B'). This is because the function can count the iterative number of incoming signals. Detection commences at Time 'A', the setting [**DPSY-NELD**] is provided so that the suppression commences at Time B. The setting [**DPSY-TELD**] is pertains to the

operation of the detection function from Time 'A' (e.g., Time 'A' to Time 'C').

The event suppression ceases when the iterative signals stop. The user can adjust the point at which event suppression stops using the setting [**DPSY-TELR**]; as a result, no suppressed signal is output after the end of the iterative signals (e.g., Time 'D' to 'E').

To initiate event suppression the user should set **On** for scheme switch [**DPSY01-SPPEN**].

(ii) BO connection for "select command Open/Closing"

Figure 4.2-43 exemplifies the connection for the select command Open/Closing. Suppose that connection with the BOs is achieved by the PLC function using connection points "DPSY01_OSL_BO_FLG" and "DPSY01_FSL_BO_FLG"†; as a result, the "Select command Closing" and the "Select command Open" signals are issued at BO1 and BO2 respectively.

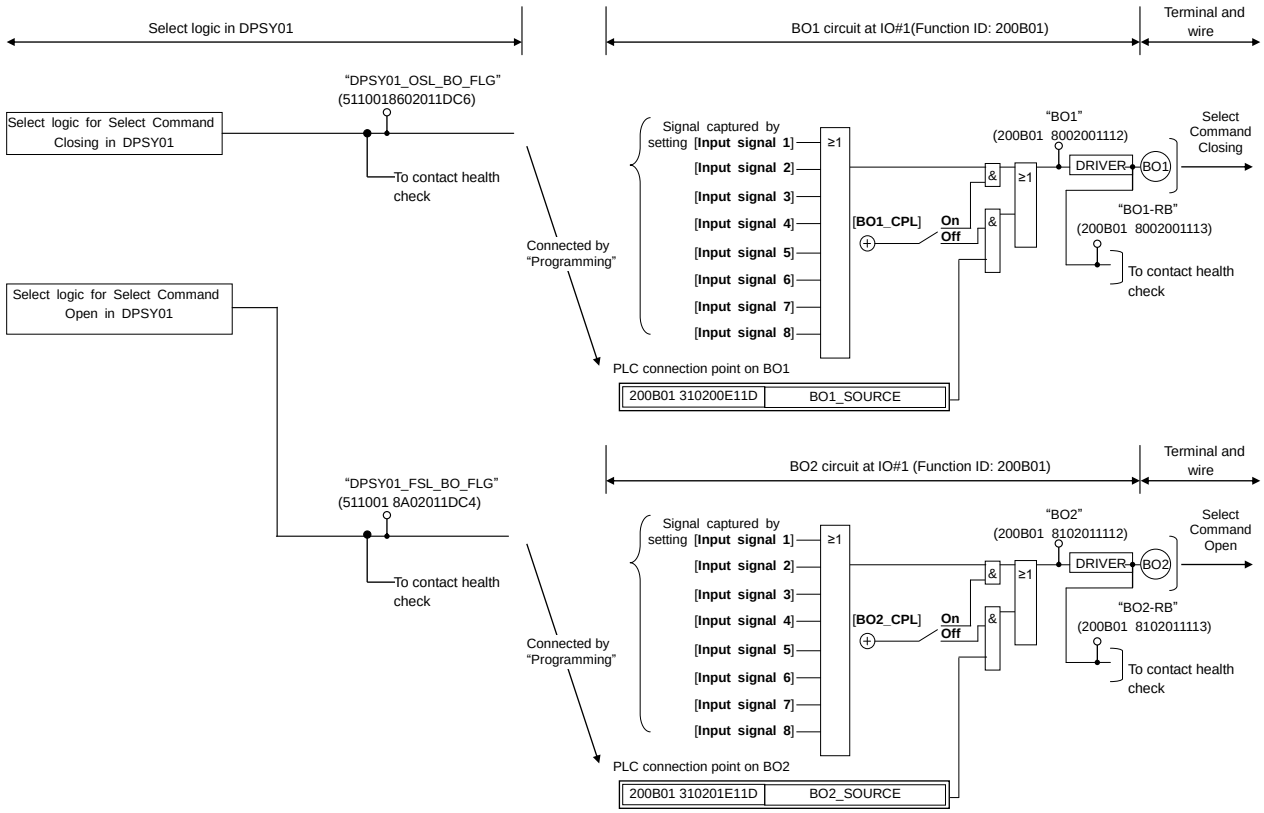


Figure 4.2-43 Example for select commands connection with BO1 & BO2 at IO#1

†Note:Table 4.2-10 shows the remaining signals with the excepting "DPSY01_OSL_BO_FLG" and "DPSY01_FSL_BO_FLG".

(iii) BO connection for "operate command Open/Closing"

Figure 4.2-44 exemplifies the connection for "Operate command Closing" or "Operate command Open". Suppose that connection with the BOs is achieved by the PLC function using connection

points “DPSY01_OEX_BO” and “DPSY01_FEX_BO”; as a result, the “Operate command Closing” and the “Operate command Open” signals are issued at BO3 and BO4 respectively.

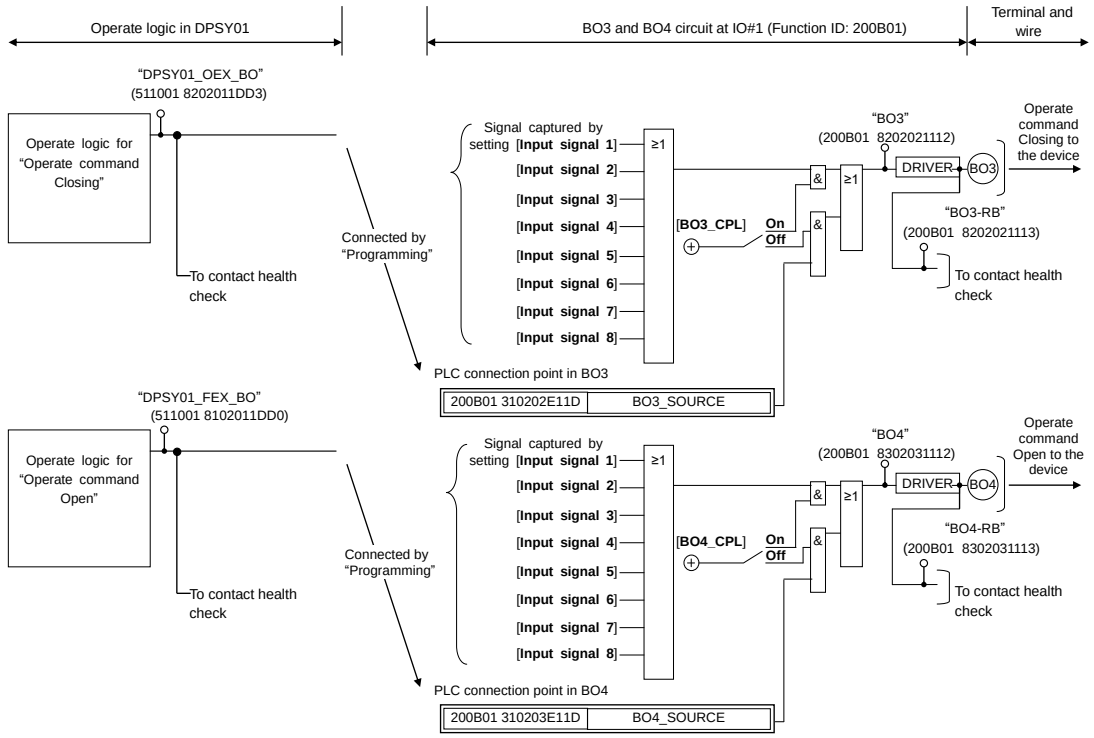


Figure 4.2-44 Example of operate commands connected with BO2 and BO3 at IO#1

†Note:Table 4.2-35 shows the remaining signals excepting “DPSY01_OEX_BO” and “DPSY01_FEX_BO”.

(iv) Contact health check

The DPSY01 function has a contact health check feature for the BO circuits; hence, the user is able to connect an output signal to the contact health check function when **Fixedlogic** is set for scheme switch [**DPSY01-LGXFEOT**]†. Consequently, the DPSY01 function can determine whether the signal has been successfully output from the BO. If a failure is reported, the DPSY01 function determines that the signal has not been output successfully to the BO; then, the Closing- or Open-command is canceled immediately and the DPSY01 function returns to the “Wait for a command” stage.

†Note:Table 4.2-37 shows settings for the health check feature in the DPSY02 function.

(iv)-1 Setting for “Select command Closing”

For example, the point “DPSY01_OSL_BO_FLG” is connected to the BO1 circuit for the issuing of the command; the user can connect point “BO1-RB” with the contact health check function using the setting [**DPSY01-OSLBORD**]. Do not key the point “DPSY01_OSL_BO_FLG”.

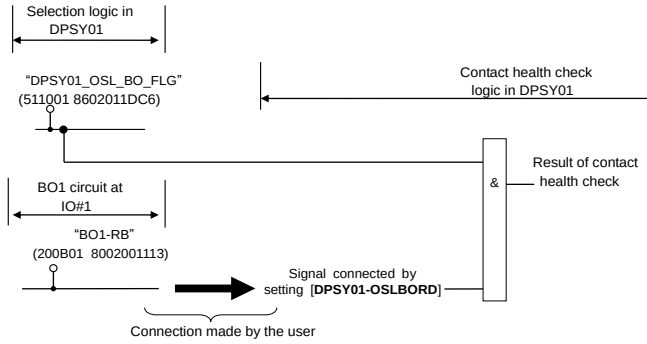


Figure 4.2-45 Example connection of “Select command Closing” for the health check feature

(iv)-2 Setting the “Select command Open”

Similar to “select command Closing”, the point “DPSY01_FSL_BO_FLG” is connected with the BO2 circuit; the user is required to key point “BO2-RB” for the setting [**DPSY01-FSLBORD**]. Do not key the point “DPSY01_FSL_BO_FLG”.

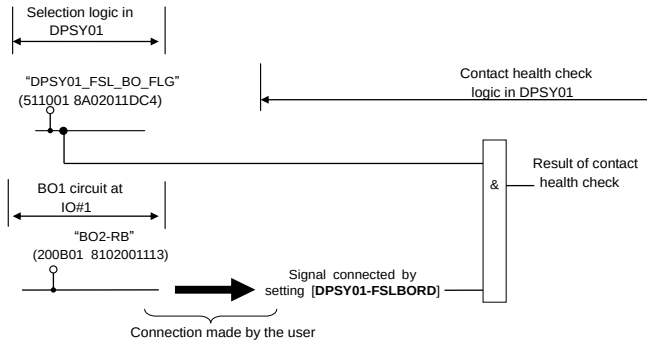


Figure 4.2-46 Example connection of “Select command Open” for the health check feature

(iv)-3 Setting for “Operate command Closing”

Similarly, the point “BO3-RB” must be applied for the setting [**DPSY01-OEXBORD**].

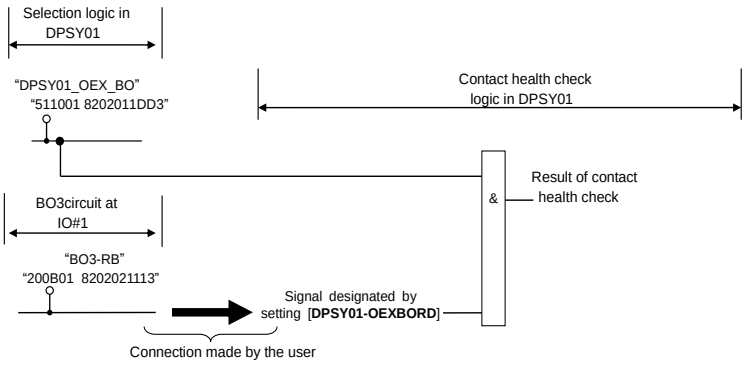


Figure 4.2-47 Example connection of "Operate command Closing" for the health check feature

(iv)-4 Setting for "Operate command Open"

Similarly, the point "BO4-RB" must be applied for the setting [**DPSY01-FEXBORD**].

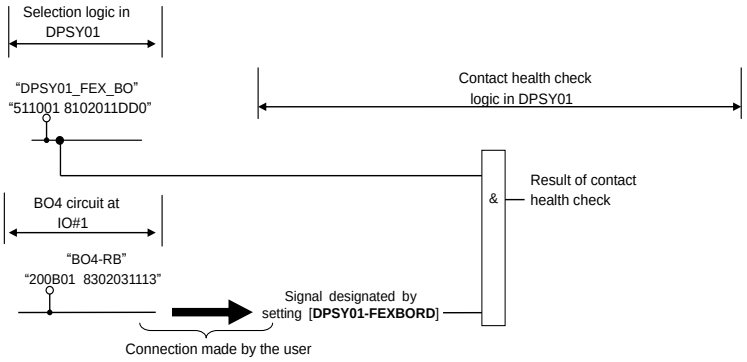


Figure 4.2-48 Example connection of "Operate command Open" for the health check feature

(iv)-5 Setting for the contact health check (normal setting, example)

Figure 4.2-49 shows a setting example for the 43SW scheme. Select and operate commands drive the BO1 to BO4 contacts. To check that the contact health check function is working correctly, the respective points of the BO-RBs should be connected as shown in Table 4.2-30, to demonstrate that the settings are physically matched with the BO contacts.

Table 4.2-30 Setting example for contact health check

Example #1	Contact health check settings for example #1	
"DPSY01_OSL_BO_FLG" is connected to "BO1" at IO#1	[DPSY01-OSLBORD] =" 200B018002001113"(BO1-RB)	OK
"DPSY01_FSL_BO_FLG" is connected to "BO2" at IO#1	[DPSY01-FSLBORD]=" 200B018102011113" (BO2-RB)	OK
"DPSY01_OEX_BO_CSF" is connected to "BO3" at IO#1	[DPSY01-OEXBORD]=" 200B018202021113" (BO3-RB)	OK
"DPSY01_FEX_BO_CSF" is connected to "BO4" at IO#1	[DPSY01-OEXBORD]=" 200B018302031113" (BO4-RB)	OK

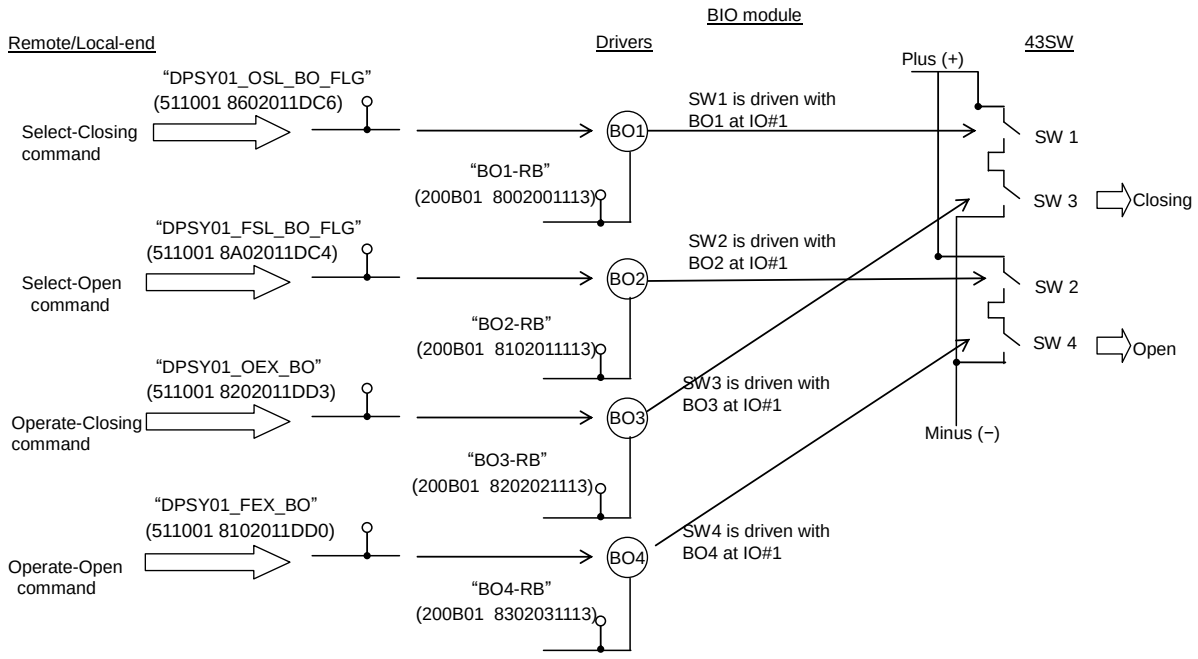


Figure 4.2-49 Contact health check setting and 43SW diagram for example #1

(iv)-6 Settings for erroneous contact health check (improper setting, example #2)

Figure 4.2-50 shows a setting example an improper setting of the 43SW scheme. The settings are implemented incorrectly as shown in Table 4.2-31, BO1-RB is not chosen, instead BO1 is actually chosen, which is incorrect. In this case, the setting [**DPSY01-OSLBORD**] is meaningless; hence, the issue of a select command is blocked.

Table 4.2-31 Erroneous setting example for contact health check

Example #2	Contact health check setting for example #2	
"DPSY01_OSL_BO_FLG" is connected to "BO1" Close SLOT1	[DPSY01-OSLBORD] =" 200B018002001112"(BO1)	NG
"DPSY01_FSL_BO_FLG" is connected to "BO2" Close SLOT1	[DPSY01-FSLBORD]=" 200B018102011113" (BO2-RB)	OK
"DPSY01_OEX_BO_CSF" is connected to "BO3" Close SLOT1	[DPSY01-OEXBORD]=" 200B018202021113" (BO3-RB)	OK
"DPSY01_FEX_BO_CSF" is connected to "BO4" Close SLOT1	[DPSY01-OEXBORD]=" 200B018302031113" (BO4-RB)	OK

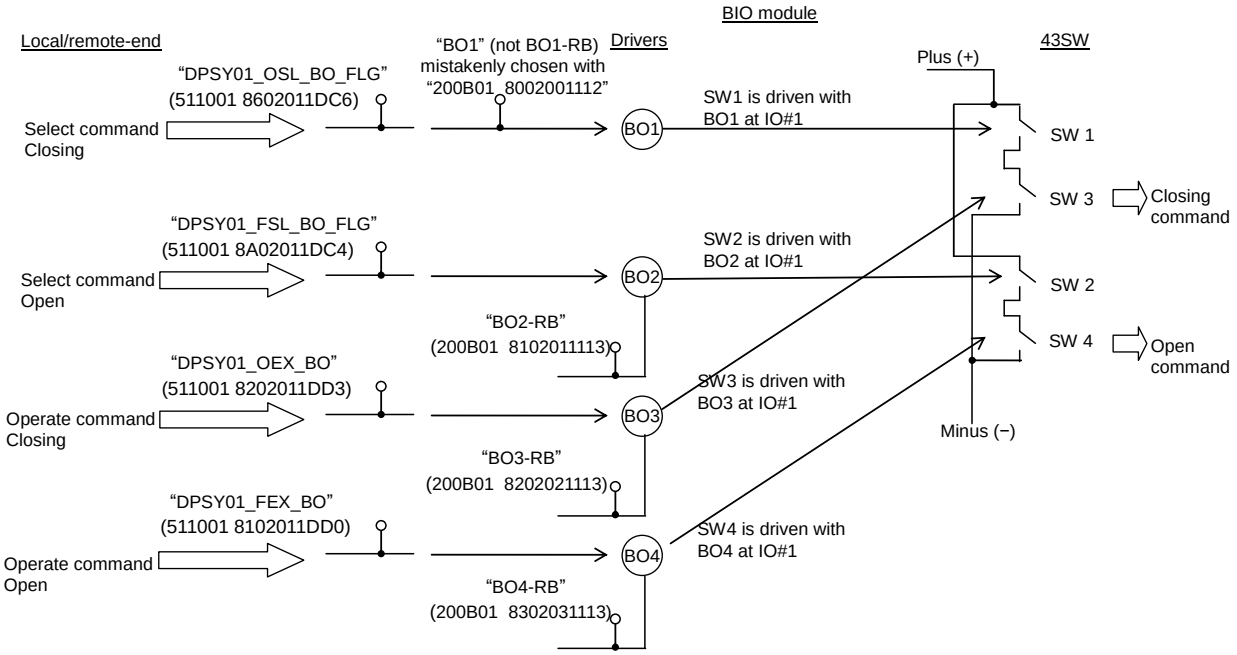


Figure 4.2-50 Contact health check setting and 43SW diagram for example #2

(iv)-7 Settings for extra contact health check (special setting, example #3)

Figure 4.2-51 shows an additional setting example for the 43SW scheme; one of the settings is made hypothetically. That is, the point "DPSY01_OSL_BO_FLG" is actually chosen for the setting [**DPSY01-OSLBORD**]; i.e. BO1-RB is not chosen for this selection. This special example can issue a select command, which is called "operated by internal select function". The user does not need to consider the use of a BO circuit for a select command, when there are no BO circuits available.

Table 4.2-32 Extra setting example for contact health check

Example #3		Setting for example #3	
"DPSY01_OSL_BO_FLG" is not connected to any BO	⇨	[DPSY01-OSLBORD] =" DPSY01_OSL_BO_FLG"	OK
"DPSY01_FSL_BO_FLG" is not connected to any BO	⇨	[DPSY01-FSLBORD]=" " DPSY01_OSL_BO_FLG"	OK
"DPSY01_OEX_BO_CSF" is connected to "BO3" at IO#1	⇨	[DPSY01-OEXBORD]=" 200B018202021113" (BO3-RB)	OK
"DPSY01_FEX_BO_CSF" is connected to "BO4" at IO#1	⇨	[DPSY01-OEXBORD]=" 200B018202031113" (BO4-RB)	OK

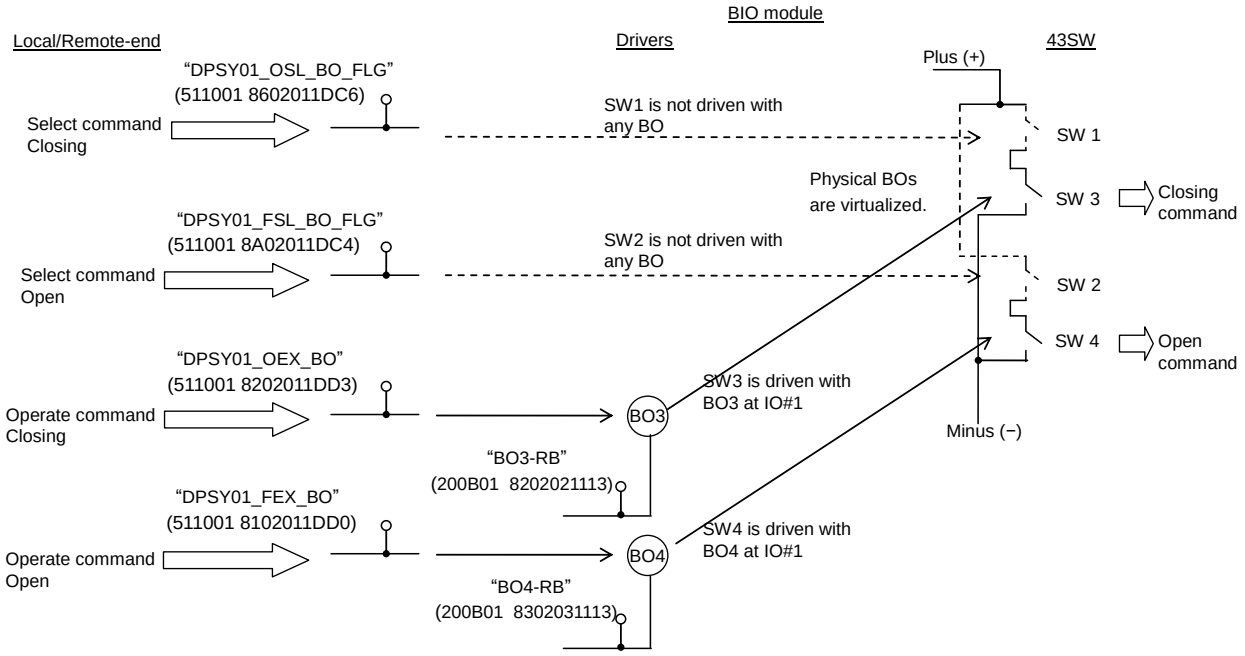


Figure 4.2-51 Contact health check setting and 43SW diagram for example #3

Table 4.2-33 PLC monitoring points (Output signal for event suppression function in DPSY)

Signal Number	Signal Name	Description
511001 3102011001	DPSY01_3PH_STATE	DPSY01 3ph_state
511001 3102021001	DPSY02_3PH_STATE	DPSY02 3ph_state
511001 8102011F5F	DPSY01_F_QLT_SPP	Event suppression detected (DPSY01)
511001 8102021F5F	DPSY02_F_QLT_SPP	Event suppression detected (DPSY02)

Table 4.2-34 PLC monitoring points (Output of select signal in DPSY)

Signal Number	Signal Name	Description
511001 8602011DC6	DPSY01_OSL_BO_FLG	DPSY01 select (CLOSE) command for Binary Output.
511001 8602021DC6	DPSY02_OSL_BO_FLG	DPSY02 select (CLOSE) command for Binary Output.
511001 8A02011DC4	DPSY01_FSL_BO_FLG	DPSY01 select (OPEN) command for Binary Output.
511001 8A02021DC4	DPSY02_FSL_BO_FLG	DPSY02 select (OPEN) command for Binary Output.

Table 4.2-35 PLC monitoring points (Output of operate signal in DPSY)

Signal Number	Signal Name	Description
511001 8202011DD3	DPSY01_OEX_BO	DPSY01 operate (CLOSE) command for Binary Output.
511001 8202021DD3	DPSY02_OEX_BO	DPSY02 operate (CLOSE) command for Binary Output.
511001 8102011DD0	DPSY01_FEX_BO	DPSY01 operate (OPEN) command for Binary Output.
511001 8102021DD0	DPSY02_FEX_BO	DPSY2 operate (OPEN) command for Binary Output.

(v) Setting names

Table 4.2-36 Setting for Binary input signals in DPSY

Setting Name	Description	Default	Setting item or value
DPSY01-CTREN	Activate control function (DPSY01)	On	Off / On
DPSY01-CTRAHMI	Activate local panel control(DPSY01)	SBO	DIR / SBO
DPSY01-EN	Activate monitoring function (DPSY01)	Close	Open / Close
DPSY01-DEVTYPE	Phase selector switch	3-pole	3-pole/1-pile/ switch
DPSY01-OPC	Activate monitoring function (DPSY01)	Close	Open / Close
DPSY01-CPC	Activate monitoring function (DPSY01)	Close	Open / Close
DPSY01A-NOPSG	BI position for DPSY01	*none	BI signal
DPSY01A-NCLSG	BI position for DPSY01	*none	BI signal
DPSY01B-NOPSG	BI position for DPSY01	*none	BI signal
DPSY01B-NCLSG	BI position for DPSY01	*none	BI signal
DPSY01C-NOPSG	BI position for DPSY01	*none	BI signal
DPSY01C-NCLSG	BI position for DPSY01	*none	BI signal
DPSY01-SPPEN	Activate event suppression for DPSY01	On	On / Off (Close/Open)
DPSY02-CTREN	Activate control function (DPSY02)	On	Off / On
DPSY02-CTRAHMI	Activate local panel control(DPSY02)	SBO	DIR / SBO
DPSY02-EN	Activate monitoring function (DPSY02)	Close	Open / Close
DPSY02-DEVTYPE	Phase selector switch	3-pole	3-pole/1-pile/ switch
DPSY02-OPC	Activate monitoring function (DPSY02)	Close	Open / Close
DPSY02-CPC	Activate monitoring function (DPSY02)	Close	Open / Close
DPSY02A-NOPSG	BI position for DPSY02	*none	BI signal
DPSY02A-NCLSG	BI position for DPSY02	*none	BI signal
DPSY02B-NOPSG	BI position for DPSY02	*none	BI signal
DPSY02B-NCLSG	BI position for DPSY02	*none	BI signal
DPSY02C-NOPSG	BI position for DPSY02	*none	BI signal
DPSY02C-NCLSG	BI position for DPSY02	*none	BI signal
DPSY02-SPPEN	Activate event suppression for DPSY02	On	On / Off (Close/Open)
DPSY-NELD	Number of change to lock status.	10	0~99
DPSY-TELD	Time to locking state(sliding window)	10[sec]	1~99[sec]
DPSY-TELR	Time to unlocking state(sliding window)	10[sec]	1~99[sec]

Table 4.2-37 Settings for health check function in DPSY

Setting Name	Description	Default	Setting item or value
DPSY01-OSLBORD	Select BO signal (BO*-RB) from signal list	*User-preferred	BO read-back signal
DPSY01-FSLBORD	Select BO signal (BO*-RB) from signal list	*User-preferred	BO read-back signal
DPSY01-OEXBORD	Select BO signal (BO*-RB) from signal list	*User-preferred	BO read-back signal
DPSY01-FEXBORD	Select BO signal (BO*-RB) from signal list	*User-preferred	BO read-back signal
DPSY02-OSLBORD	Select BO signal (BO*-RB) from signal list	*User-preferred	BO read-back signal
DPSY02-FSLBORD	Select BO signal (BO*-RB) from signal list	*User-preferred	BO read-back signal
DPSY02-OEXBORD	Select BO signal (BO*-RB) from signal list	*User-preferred	BO read-back signal
DPSY02-FEXBORD	Select BO signal (BO*-RB) from signal list	*User-preferred	BO read-back signal

4.2.7 Mapping for IEC 61850 communication

The user can operate the DPSY function over IEC 61850 communications† following mapping using GR-TIEMS. Note that the DPSY function is designed for the class of "Double Point Controller (DPC)" in the IEC 61850 standard for communication. The user should follow these steps, each of which is discussed below:

Step1: Editing Logical Node

Step2: Mapping output data

Step3: Mapping input data

(i) Editing Logical Node

The user will need to create a logical node (LN) for the DPSY01 function. Figure 4.2-52 exemplifies the editing of a LN; the LN "Common Switch controller (CSWI)" is chosen for the DPSY01 function. After the user has defined an object "DPC", the DPSY01 logical node can be saved with the name "CSWI" plus "LN Instance". Create a definition of object "DPC" in the DPSY01 logical node. Either the SBO mode or the DIR mode should be chosen in the editing for the LN.

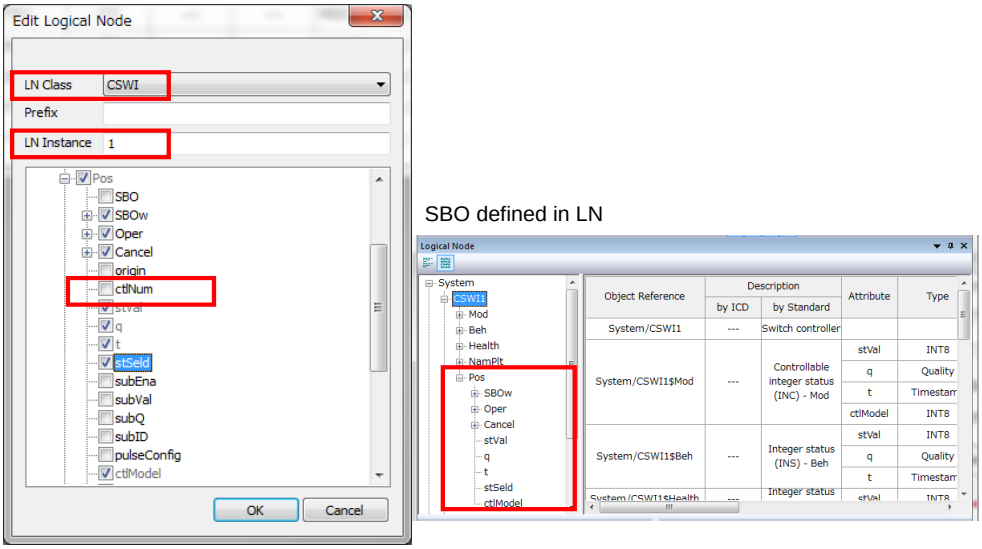
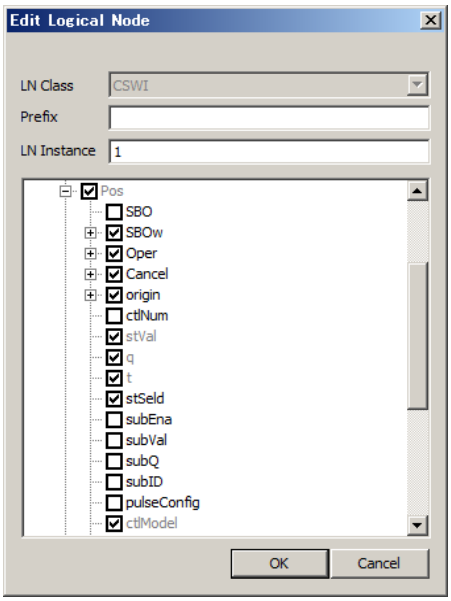


Figure 4.2-52 Defining "DPC" object in CSWI1 logic node

(i)-1 Defining SBO mode

Figure 4.2-53 exemplifies the DPSY01 logic node saved as "CSWI1". In the SBO mode, the user should select the following items for the "CSWI1$Pos" using GR-TIEMS:

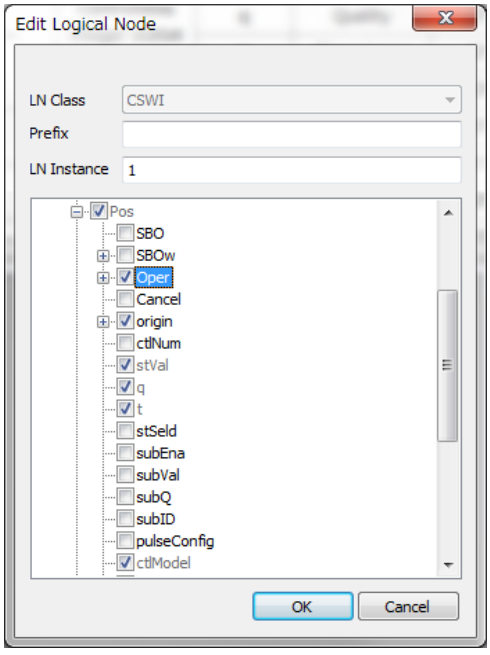


✓ SBOw
✓ Oper
✓ Cancel
✓ origin
✓ stSeld
✓ sboClass† (choice ”operate-once”)
✓ ctlmodel (choice ”SBOes or SBOns”)
†”sboClass” can be found by scrolling down.

Figure 4.2-53 LN editing screen for SBO mode

(i)-2 Defining DIR mode

Figure 4.2-54 exemplifies the SPOS logic node saved as “CSWI1”. In the DIR mode, the following three items should be selected using GR-TIEMS.



✓ Oper
✓ origin
✓ ctlmodel (choice ”DOes or DOns”)

Figure 4.2-54 LN editing screen for DIR mode

(ii) Mapping output data

The user should group the DPSY01 signals with regard to GOOSE and REPORT; the user should map them for IEC61850 communication using GR-TIEMS. Figure 4.2-55 illustrates how to map a signal; it indicates that the signals for the DPSY01 function are required to be mapped for IEC 61850 communications.

Table 4.2-38 Mapping signals for CSWI1 object

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/CSWI1Posorigin	orCat	orCategory	ST	511001 3102011008	DPSY01_3PH_ORCAT
Ctrl/CSWI1Posorigin	orIdent	Octet64	ST	511001 6A02011009	DPSY01_3PH_ORIDENT
Ctrl/CSWI1$Pos	stVal	Dbpos	ST	511001 3102011001	DPSY01_3PH_STATE
Ctrl/CSWI1$Pos	q	Quality	ST	511001 3102011005	DPSY01_3PH_QUALITY
Ctrl/CSWI1$Pos	t	Timestamp	ST	511001 9002011006	DPSY01_3PH_TIMESTAMP
Ctrl/CSWI1$Pos	stSeld	BOOLEAN	ST	511001 0002011D90	DPSY01_STD_RPT

Note: "Status (ST)" is defined in the function constraint (FC) of the IEC 61850.

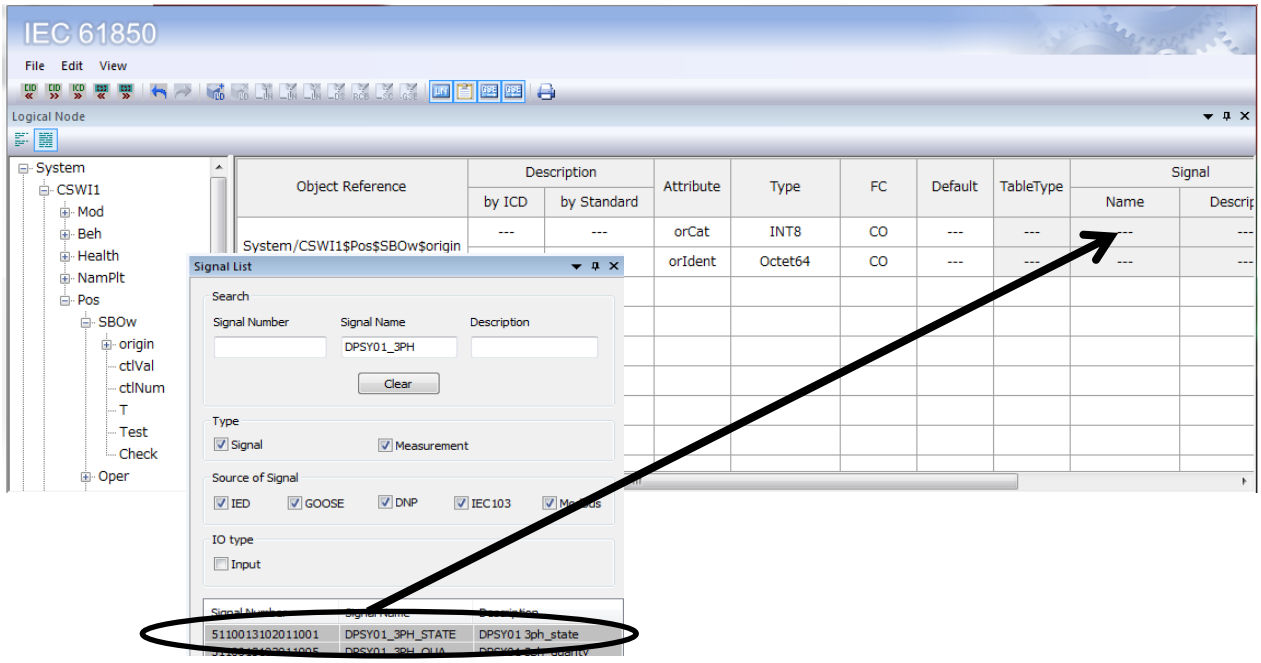


Figure 4.2-55 orCat attribute mapped into DPC object of CSWI1

(iii) Mapping input data

The DPSY01 function can receive three commands "select, operate and cancel." Thus, the user should map the input-point "DEV01_CONTROL_REQ" to the IEC 61850 configuration. Table 4.2-39 shows the input-point "DEV01_CONTROL_REQ" and the Object reference "Ctrl/CSWI1$Pos"; the user should map the input-point to the Object reference having attribute CO†.. Figure 4.2-56 shows how to map a signal.

†Note: The attribute is defined in the IEC 61850; "CO" stands for "Control" in the functional constraint (FC).

Table 4.2-39 Mapping signals required for DPC object for CSWI1

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/CSWI1PosSBOw	ctlVal	BOOLEAN	CO		

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/CSWI1PosSBOw	ctlNum	INT8U	CO	5110017002016D08	DEV01_CONTROL_REQ
Ctrl/CSWI1PosSBOw	T	Timestamp	CO		
Ctrl/CSWI1PosSBOw	Test	BOOLEAN	CO		
Ctrl/CSWI1PosSBOw	Check	Check	CO		
Ctrl/CSWI1PosSBOw$origin	orCat	orCategory	CO		
Ctrl/CSWI1PosSBOw$origin	orIdent	Octet64	CO		
Ctrl/CSWI1PosOper	ctlVal	BOOLEAN	CO		
Ctrl/CSWI1PosOper	ctlNum	INT8U	CO		
Ctrl/CSWI1PosOper	T	Timestamp	CO		
Ctrl/CSWI1PosOper	Test	BOOLEAN	CO		
Ctrl/CSWI1PosOper	Check	Check	CO		
Ctrl/CSWI1PosOper$origin	orCat	orCategory	CO		
Ctrl/CSWI1PosOper$origin	orIdent	Octet64	CO		
Ctrl/CSWI1PosCancel	ctlVal	BOOLEAN	CO		
Ctrl/CSWI1PosCancel	ctlNum	INT8U	CO		
Ctrl/CSWI1PosCancel	T	Timestamp	CO		
Ctrl/CSWI1PosCancel	Test	BOOLEAN	CO		
Ctrl/CSWI1PosCancel$origin	orCat	orCategory	CO		
Ctrl/CSWI1PosCancel$origin	orIdent	Octet64	CO		
Ctrl/CSWI1PosSBOw	ctlVal	BOOLEAN	CO		
Ctrl/CSWI1PosSBOw	ctlNum	INT8U	CO		

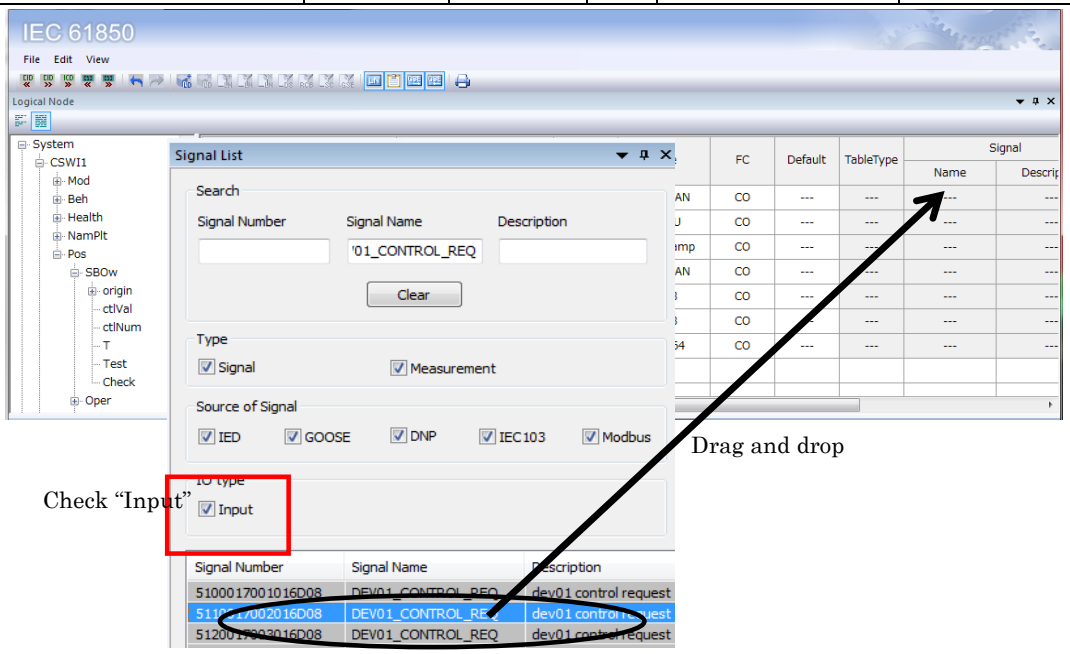


Figure 4.2-56 Input-point mapped for CSWI1

4.2.8 Setting

Common settings list for the DPSY(FunctionID:511001)

Setting items	Range	Units	Contents	Default setting value	Notes
DPSY-NELD	0-99	–	Number of Event lock detect time	10	
DPSY-TELD	1-99	s	Timer for detection of event lock	10	
DPSY-TELR	1-99	s	Timer for recovery from event lock	10	

DPSY01 Settings list (FunctionID:511001)

Setting items	Range	Units	Contents	Default setting value	Notes
DPSY01-EN	Off/On	–	DPSYSY_DEV1 Enable	Off	
DPSY01-DEVTYPE	1-Pole/3-Pole	–	Device Type	1-Pole	
DPSY01A-NOPSG		–	Normally Open Signal for a single-pole or phase A		
DPSY01A-NOPSGI	Off/On	–	Signal inverse or not inversed	Off	
DPSY01A-NCLSG		–	Normally Close Signal for a single-pole or phase A		
DPSY01A-NCLSGI	Off/On	–	Signal inverse or not inversed	Off	
DPSY01B-NOPSG		–	Normally Open Signal for phase B		
DPSY01B-NOPSGI	Off/On	–	Signal inverse or not inversed	Off	
DPSY01B-NCLSG		–	Normally Close Signal for phase B		
DPSY01B-NCLSGI	Off/On	–	Signal inverse or not	Off	
DPSY01C-NOPSG		–	Normally Open Signal of phase C		
DPSY01C-NOPSGI	Off/On	–	Signal inverse or not inversed	Off	
DPSY01C-NCLSG		–	Normally Close Signal for phase C		
DPSY01C-NCLSGI	Off/On	–	Signal inverse or not inversed	Off	
DPSY01-OPC	And/Or	–	Normally Open contact grouping	And	
DPSY01-CLC	And/Or	–	Normally Close contact grouping	Or	
DPSY01-SPPEN	Off/On	–	Automatic event suppression function	Off	
DPSY01-UDFEN	Off/On/CHKONLY	–	Undefined auxiliary -contact check function	Off	
DPSY01-UDFTIM	0.1-100.0	s	auxiliary-contact undefined check timer	30	
DPSY01-FLTEN	Off/On/CHKONLY	–	faulty pallet check function	Off	
DPSY01-FLTTIM	0.1-100.0	s	auxiliary-contact faulty check timer	30	
DPSY01-CTREN	Off/On	–	control mode (control enable)	Off	
DPSY01-SYNEN	APPLY/Bypass	–	Synchronism Check Apply or Bypass	APPLY	
DPSY01-CTRMENU	Off/On	–	control from MENU enable	Off	
DPSY01-CTRAHMI	DIR/SBO	–	control action(Direct or SBO)by HMI	SBO	
DPSY01-NSLBORD1		–	select binary output read data(DataID)1 for closed-direction command		
DPSY01-NSLBORD2		–	select binary output read data(Data ID)2 for closed-direction command		
DPSY01-FSLBORD		–	select binary output read data(Data ID) for open-direction select command		

DPSY01 Settings list (FunctionID:511001)

Setting items	Range	Units	Contents	Default setting value	Notes
DPSY01-OSLBORD		–	select binary output read data(Data ID) for closed-direction select command		
DPSY01-FEXBORD		–	execute binary output read data(Data ID) for open-direction execute command		
DPSY01-OEXBORD		–	execute binary output read data(Data ID) for closed-direction execute command		
DPSY01-LGCTRCON	FixedLogic/PLC	–	Change logic for control condition	FixedLogic	
DPSY01-LGSLFFCT	FixedLogic/PLC	–	Change logic for select fail factor	FixedLogic	
DPSY01-LGEXFFCT	FixedLogic/PLC	–	Change logic for execute command fail factor	FixedLogic	
DPSY01-LGFEXOT	FixedLogic/PLC	–	Change logic for open-direction execute output	FixedLogic	
DPSY01-LGOEXOT	FixedLogic/PLC	–	Change logic for closed-direction execute output	FixedLogic	
DPSY01-LGCNFFCT	FixedLogic/PLC	–	Change logic for cancel command fail factor	FixedLogic	
DPSY01-PLSM	Fix/Var	–	pulse mode	Fix	
DPSY01-CPW	0.1-50.0	s	control pulse width	1	
DPSY01-RST	1.0-100.0	s	response check timer	30	
DPSY01-CNTS	NA/C-On/C-Off/C-OnOff	–	count status	NA	
DPSY01-OPETMEN	Off/On	–	Operation Time Measurement enable	Off	
DPSY01-APBD	Process/Bay	–	status change origin	Process	
DPSY01-CTRDIR	Off/On	–	Capable control direction	On	

Note: The DPSY function is available for a 2nd Device. Hence, the DPSY setting table is provided for a 2nd device. We have omitted a 2nd table because this will be the same as the table for the 1st device with the exception of the device number.

4.2.9 Signal

◆ PLC connection points

DPSY(Function ID: 511001)

Element ID	Name	Description
830201EF56	DPSY01IN_TMP_25	PLC connection point connecting to PLC_BIT_529
820201ED50	DPSY01IN_TMP_28	PLC connection point connecting to PLC_BIT_517
800201EE53	DPSY01IN_TMP_29	PLC connection point connecting to PLC_BIT_530
810201EE54	DPSY01IN_TMP_30	PLC connection point connecting to PLC_BIT_531
800201EE61	DPSY01IN_TMP_31	PLC connection point connecting to PLC_BIT_532
810201EE62	DPSY01IN_TMP_32	PLC connection point connecting to PLC_BIT_533
800201EE55	DPSY01IN_TMP_33	PLC connection point connecting to PLC_BIT_534
800201EE56	DPSY01IN_TMP_34	PLC connection point connecting to PLC_BIT_535
810201EE57	DPSY01IN_TMP_35	PLC connection point connecting to PLC_BIT_536
820201EE5A	DPSY01IN_TMP_37	PLC connection point connecting to PLC_BIT_537
830201EE5B	DPSY01IN_TMP_38	PLC connection point connecting to PLC_BIT_538
800201EE65	DPSY01IN_TMP_40	PLC connection point connecting to PLC_BIT_539
810201EE66	DPSY01IN_TMP_41	PLC connection point connecting to PLC_BIT_540
800201EDDA	DPSY01IN_TMP_42	PLC connection point connecting to PLC_BIT_541
810201EDDB	DPSY01IN_TMP_43	PLC connection point connecting to PLC_BIT_542
820201EE5E	DPSY01IN_TMP_44	PLC connection point connecting to PLC_BIT_543
830201EE5F	DPSY01IN_TMP_45	PLC connection point connecting to PLC_BIT_544
800201EE69	DPSY01IN_TMP_46	PLC connection point connecting to PLC_BIT_545

◆ Common Signal monitoring points

DPSY(Function ID: 511001)

Element ID	Name	Description
8002001D5B	DPSY00_CH_SC_OWS	DPSY00 count change select command by OWS(HMI)
8002001D5C	DPSY00_CH_SC_RCC	DPSY00 count change select command by RCC
8002001D5D	DPSY00_CH_SC_RMT	DPSY00 count change select command by Remote
8002001F98	DPSY00_CH_SC_LCD	DPSY00 count change select command by LCD
8002001D5E	DPSY00_CH_EC_OWS	DPSY00 count change execute command by OWS(HMI)
8002001D5F	DPSY00_CH_EC_RCC	DPSY00 count change execute command by RCC
8002001D60	DPSY00_CH_EC_RMT	DPSY00 count change execute command by Remote
8002001F99	DPSY00_CH_EC_LCD	DPSY00 count change execute command by LCD

◆ Signal monitoring points in DPSY01

DPSY(Function ID: 511001)

Element ID	Name	Description
8002011DE0	DEV1PLCCTRLFAIL	DEV1PLCCTRLFAIL
8302011F49	DPSY01A_FLT_DET	DPSY01 Phase-A Faulty Detected
8302011F48	DPSY01A_FLT_STA	DPSY01 Phase-A Faulty Start
8202011F47	DPSY01A_UDF_DET	DPSY01 Phase-A Undefined Detected
8202011F46	DPSY01A_UDF_STA	DPSY01 Phase-A Undefined Start
8502011F4D	DPSY01B_FLT_DET	DPSY01 Phase-B Faulty Detected
8502011F4C	DPSY01B_FLT_STA	DPSY01 Phase-B Faulty Start
8402011F4B	DPSY01B_UDF_DET	DPSY01 Phase-B Undefined Detected
8402011F4A	DPSY01B_UDF_STA	DPSY01 Phase-B Undefined Start
8702011F51	DPSY01C_FLT_DET	DPSY01 Phase-C Faulty Detected
8702011F50	DPSY01C_FLT_STA	DPSY01 Phase-C Faulty Start
8602011F4F	DPSY01C_UDF_DET	DPSY01 Phase-C Undefined Detected
8602011F4E	DPSY01C_UDF_STA	DPSY01 Phase-C Undefined Start
8802011E9B	DPSY01_CC_ST_ERR	DPSY01 Mode disagreement (tested for a release command)
8102011F41	DPSY01_FLT_DET0	DPSY01 Faulty Detected

◆ Signal monitoring points in DPSY01

DPSY(Function ID: 511001)

Element ID	Name	Description
8102011F45	DPSY01_FLT_DET1	DPSY01 Faulty Detected (3 phase grouped data only)
8102011F44	DPSY01_FLT_STA	DPSY01 Faulty Start
8202011F60	DPSY01_F_BI_ERR	DPSY01 Inside of connection poor of binary input
8102011D03	DPSY01_ST_ON	DPSY01 Normal close state
8302011D02	DPSY01_ST_OFF	DPSY01 Normal open state
8302011E9C	DPSY01_CCF_FCT_CS	DPSY01 Release poor factor
8202011ED1	DPSY01_SYNEN	DPSY01 Synchronism Check Apply or Bypass
8002011F40	DPSY01_UDF_DET0	DPSY01 Undefined Detected
8002011F43	DPSY01_UDF_DET1	DPSY01 Undefined Detected (3 phase grouped data only)
8002011F42	DPSY01_UDF_STA	DPSY01 Undefined Start
8102011F5F	DPSY01_F_QLT_SPP	DPSY01 Under a lock of change of state
8702011E96	DPSY01_CC_FS	DPSY01 cancel fail signal
8602011E95	DPSY01_CC_SS	DPSY01 cancel success signal
8C02011F70	DPSY01_EX_CS04	DPSY01 close timer for under execution
8002011EA0	DPSY01_CTR_SGE	DPSY01 control logic stage(execute command check)
8002011E9E	DPSY01_CTR_SGC	DPSY01 control logic stage(select command check)
8002011E9F	DPSY01_CTR_SGS	DPSY01 control logic stage(selected)
8302011E9D	DPSY01_CTR_SGN	DPSY01 control logic stage(unselected)
8002011EA1	DPSY01_CTR_SGW	DPSY01 control logic stage(wait for change)
8802011F9D	DPSY01_SLF_FCT_F03CN	DPSY01 count change select fail factor signal by fixedlogic 03
8702011F9E	DPSY01_SLF_FCT_F04CN	DPSY01 count change select fail factor signal by fixedlogic 04
8A02011F88	DPSY01_SLD_CSCN	DPSY01 count change selected condition signal
8002011F87	DPSY01_TMP_72	DPSY01 count change selected condition signal check
8602011F8A	DPSY01_CNT_CS07	DPSY01 count change selected fail condition signal
8502011F89	DPSY01_SE_RCV_RMTCN	DPSY01 count change selected fail condition signal check
8902011F9B	DPSY01_CTR_SGUCN	DPSY01 count change selected signal
8302011F9C	DPSY01_SLF_FCT_F07CN	DPSY01 count change selected timer for a check
8A02011F9F	DPSY01_SLD_TMOCN	DPSY01 count change time out after selected
8902011FA0	DPSY01_EX_CMP_TMOCN	DPSY01 count change timeout after execute completion
8002011D58	DPSY01_EC_LCD	DPSY01 execute command by LCD
8002011D55	DPSY01_EC_OWS	DPSY01 execute command by OWS(HMI)
8002011D59	DPSY01_EC_PLC	DPSY01 execute command by PLC
8002011D56	DPSY01_EC_RCC	DPSY01 execute command by RCC
8002011D57	DPSY01_EC_RMT	DPSY01 execute command by Remote
8102011E9A	DPSY01_ECF_FCT_EIS	DPSY01 execute command fail factor signal except interlock/synchronism check
8002011F5B	DPSY01_EC_ST_ERR	DPSY01 execute command mode err
8002011E93	DPSY01_EX_CMP	DPSY01 execute complete signal
8602011E91	DPSY01_EX_FFL	DPSY01 execute fail signal by fixedlogic
8502011E8F	DPSY01_EX_SFL	DPSY01 execute success signal by fixedlogic
8102011E7B	DPSY01_SLF_CS	DPSY01 no direction select fail condition signal
8102011DD0	DPSY01_FEX_BO	DPSY01 open-direction execute binary output signal
8002011E81	DPSY01_FEC_OK_CS	DPSY01 open-direction execute command OK condition signal
8002011E7E	DPSY01_FEC_OK_CSF	DPSY01 open-direction execute command OK condition signal by fixedlogic
8202011E88	DPSY01_FEC_F_CS	DPSY01 open-direction execute command fail condition signal
8102011E85	DPSY01_FEC_F_CSF	DPSY01 open-direction execute command fail condition signal by fixedlogic
8A02011DC4	DPSY01_FSL_BO_FLG	DPSY01 open-direction select binary output signal
8202011DD3	DPSY01_OEX_BO	DPSY01 closed-direction execute binary output signal
8102011E82	DPSY01_OEC_OK_CS	DPSY01 closed -direction execute command OK condition signal
8002011E7F	DPSY01_OEC_OK_CSF	DPSY01 closed -direction execute command OK condition signal by fixedlogic
8302011E89	DPSY01_OEC_F_CS	DPSY01 closed -direction execute command fail condition signal
8102011E86	DPSY01_OEC_F_CSF	DPSY01 closed -direction execute command fail condition signal by fixedlogic
8B02011E48	DPSY01_OEC_RCV	DPSY01 closed -direction execute command received

◆ Signal monitoring points in DPSY01

DPSY(Function ID: 511001)

Element ID	Name	Description
8602011DC6	DPSY01_OSL_BO_FLG	DPSY01 closed -direction select binary output signal
8802011F73	DPSY01_OSL_CS41	DPSY01 closed -direction select condition signal 41
8902011F74	DPSY01_OSL_CS42	DPSY01 closed -direction select condition signal 42
8A02011F75	DPSY01_OSL_CS43	DPSY01 closed -direction select condition signal 43
8002011E45	DPSY01_OSE_RCV	DPSY01 closed -direction select or execute command received
8B02011F6F	DPSY01_EX_CS03	DPSY01 open timer for under execution
8002011F98	DPSY01_RE_EC_LCD	DPSY01 reset time execute command by LCD
8002011D7B	DPSY01_RE_EC_OWS	DPSY01 reset time execute command by OWS(HMI)
8002011D7C	DPSY01_RE_EC_RCC	DPSY01 reset time execute command by RCC
8002011D7D	DPSY01_RE_EC_RMT	DPSY01 reset time execute command by Remote
8002011F9A	DPSY01_RE_SC_LCD	DPSY01 reset time select command by LCD
8002011D78	DPSY01_RE_SC_OWS	DPSY01 reset time select command by OWS(HMI)
8002011D79	DPSY01_RE_SC_RCC	DPSY01 reset time select command by RCC
8002011D7A	DPSY01_RE_SC_RMT	DPSY01 reset time select command by Remote
8802011FA3	DPSY01_SLF_FCT_F03RS	DPSY01 reset time select fail factor signal by fixedlogic 03
8702011FA4	DPSY01_SLF_FCT_F04RS	DPSY01 reset time select fail factor signal by fixedlogic 04
8A02011F8C	DPSY01_SLD_CSRS	DPSY01 reset time selected condition signal
8002011F8B	DPSY01_TMP_73	DPSY01 reset time selected condition signal check
8602011F8E	DPSY01_RST_CS07	DPSY01 reset time selected fail condition signal
8502011F8D	DPSY01_SE_RCV_RMTRS	DPSY01 reset time selected fail condition signal check
8902011FA1	DPSY01_CTR_SGURS	DPSY01 reset time selected signal
8302011FA2	DPSY01_SLF_FCT_F07RS	DPSY01 reset time selected timer for a check
8A02011FA5	DPSY01_SLD_TMORS	DPSY01 reset time out after selected
8902011FA6	DPSY01_EX_CMP_TMORS	DPSY01 reset time timeout after execute completion
8A02011F6E	DPSY01_EX_CS02	DPSY01 response supervisory timer for close
8902011F6D	DPSY01_EX_CS01	DPSY01 response supervisory timer for open
8902011DC0	DPSY01_NSL_BO_FLG	DPSY01 select binary output signal
8502011F82	DPSY01_TMP_67	DPSY01 select BO close signal check
8702011F84	DPSY01_TMP_69	DPSY01 select BO close(interlock) signal check
8602011F83	DPSY01_TMP_68	DPSY01 select BO close(synchronism) signal check
8102011F7F	DPSY01_TMP_64	DPSY01 select BO open signal check
8202011F7C	DPSY01_TMP_61	DPSY01 select BO signal check
8002011D54	DPSY01_SC_LCD	DPSY01 select command by LCD
8002011D51	DPSY01_SC_OWS	DPSY01 select command by OWS(HMI)
8002011D52	DPSY01_SC_RCC	DPSY01 select command by RCC
8002011D53	DPSY01_SC_RMT	DPSY01 select command by Remote
8002011F5A	DPSY01_SC_ST_ERR	DPSY01 select command mode err
8602011F63	DPSY01_SLF_FCT_FLG03	DPSY01 select fail factor signal by fixedlogic 03
8702011F64	DPSY01_SLF_FCT_FLG04	DPSY01 select fail factor signal by fixedlogic 04
8502011F65	DPSY01_SLF_FCT_FLG05	DPSY01 select fail factor signal by fixedlogic 05
8702011E98	DPSY01_SLF_FCT_EIS	DPSY01 select fail factor signal except interlock/synchronism check
8502011F85	DPSY01_TMP_70	DPSY01 select receive closed signal check
8602011F86	DPSY01_TMP_71	DPSY01 select receive closed signal check answer
8502011F80	DPSY01_TMP_65	DPSY01 select receive open signal check
8A02011F81	DPSY01_FSL_CS19	DPSY01 select receive open signal check answer
8002011F7D	DPSY01_TMP_62	DPSY01 select receive signal check
8602011F7E	DPSY01_NSL_CS07	DPSY01 select receive signal check answer
8002011E7D	DPSY01_SLR_CS	DPSY01 select release condition signal
8002011E76	DPSY01_SLD_CS	DPSY01 selected condition signal
8002011F67	DPSY01_SLD_CS04	DPSY01 selected condition signal 04
8102011F68	DPSY01_SLD_CS05	DPSY01 selected condition signal 05
8202011F69	DPSY01_SLD_CS06	DPSY01 selected condition signal 06
8402011F76	DPSY01_OSL_CS44	DPSY01 selected condition signal 44

◆ Signal monitoring points in DPSY01

DPSY(Function ID: 511001)

Element ID	Name	Description
8502011F77	DPSY01_OSL_CS45	DPSY01 selected condition signal 45
8602011F78	DPSY01_OSL_CS46	DPSY01 selected condition signal 46
8B02011F79	DPSY01_CTR_SGU	DPSY01 selected signal
8802011F6C	DPSY01_SLF_FCT_FLG07	DPSY01 selected timer for a check
8E02011F5D	DPSY01_SLD_TMO	DPSY01 time out after selected
8F02011F5E	DPSY01_EX_CMP_TMO	DPSY01 timeout after execute completion
0002011D95	DPSY01_TMP_02	DPSY01 time reset selected signal(stSeld) for SAS
3102011D80	DPSY01_TMP_06	DPSY01 control event data (selected)
3102011D81	DPSY01_TMP_07	DPSY01 control event data (select fail)
3102011D82	DPSY01_TMP_08	DPSY01 control event data (select release)
3102011D83	DPSY01_TMP_09	DPSY01 control event data (execute output on)
3102011D84	DPSY01_TMP_10	DPSY01 control event data (execute command ng)
3102011D86	DPSY01_TMP_11	DPSY01 control event data (execute fail)
8202011F7C	DPSY01_TMP_61	DPSY01 select bo signal check
8002011F7D	DPSY01_TMP_62	DPSY01 select recive signal check
8102011F7F	DPSY01_TMP_64	DPSY01 select bo open signal check
8502011F80	DPSY01_TMP_65	DPSY01 select recive open signal check
8502011F82	DPSY01_TMP_67	DPSY01 select bo close signal check
8602011F83	DPSY01_TMP_68	DPSY01 select bo close(synchronism) signal check
8702011F84	DPSY01_TMP_69	DPSY01 select bo close(interlock) signal check
8502011F85	DPSY01_TMP_70	DPSY01 select recive cloase signal check
8602011F86	DPSY01_TMP_71	DPSY01 select recive cloase signal check answer
8002011F87	DPSY01_TMP_72	DPSY01 count change selected condition signal check
8002011F8B	DPSY01_TMP_73	DPSY01 reset time selected condition signal check

Note: In the table above, the user will only find Element IDs and their names for the 1st device, but a 2nd and other devices are also provided in the DPSY function. We have omitted the Element IDs and their names for the other devices to improve readability. Use the rule described below when the user wishes to obtain the Element IDs and their names for the other devices.

Rule: The same types of signal monitoring points are provided in every device; hence, the user can find the same ones for all of the other devices. For example, when the user wishes to find the "DPSY01_SC_OWS" point for the 2nd device, use the description of "DPSY02_SC_OWS" in place of "DPSY01_SC_OWS". The user can obtain the ID value of "DPSY02_SC_OWS" by using the following steps:

Step 1 Find the element ID for DPSY01_SC_OWS (i.e., "8002011D51").

Step 2 Identify the number at the fifth digit from the ID. (i.e., "1").

Step 3 Choose a new device number. (i.e. pick the number "2" for the 2nd device).

Step 4 Replace the number that occurs at the fifth digit with the new device number. (i.e., get new ID "8002021D51" of "DPSY02_SC_OWS") The ID is expressed in hexadecimal

notation. Thus, the user must change the device number from decimal notation to hexadecimal notation.

4.3 Software switch controller function (SOFTSW)

Eight single-position software-switches (S43-CBK, -ICB, -SCB, and -01 to -05) are provided in the IED memory as virtual switches; they are used to determine the operation of internal processes in the IED. Either the criteria "Enable (On)" or "Disable (Off)" may be applied for each software switch, S43. Three software switches, S43s (CBK, ICB, and SCB) have already been defined for special purposes; the three are controlled by command blocking (CBK), interlock bypassing (ICB), and synchronism bypass (SCB) functions. On the other hand, switches S43-01 to S43-05 are provided for general-purpose usage.

Note: The implementation of such features depends on the selection of hardware and the configuration of functions. Several IED models do not have its features. To determine whether its features are implemented in the IED, locate the IED ordering number; and check the order number at the "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 4.3-1 Comparative table in respective ordering numbers

Sec.	Feature	Ordering No. at "G&T"				
		10	11	13	19	22
–	Main features	NA	NA	NA	NA	✓
–	Number of functions	–	–	–	–	10

✓: Applicable NA: Not applicable

Figure 4.3-1 shows the eight switches and their controller functions. The statuses of the S43 switches are stored in the IED non-volatile memory; hence, the IED can retrieve their status while power is not being supplied to the IED.

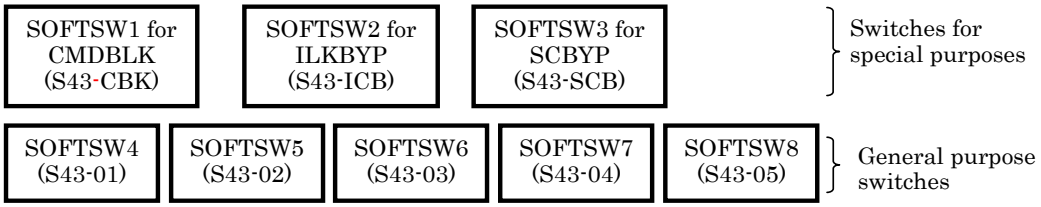


Figure 4.3-1 Software switches (S43s) and their controller

The SOFTSW function can control eight S43 software switches separately. To simplify the explanation provided below only the SOFTSW1 function is discussed. The features provided in the other SOFTSW2–8 switches are similar to the SOFTSW1 switch.

Tips: The user can set SOFTSW1 (S43-CBK), SOFTSW2 (S43-ICB) and SOFTSW3 (S43-SCB) without user programming. Jump to section 4.3.5 where we discuss how to map their signals for IEC61850 communication. When the user wishes to program the SOFTSW functions using the S43-01–S43-05 switches, the user is required to read from section 4.3.2 onwards.

4.3.1 SOFTSW controlling

(i) Command blocking (S43-CBK) provided by SOFTSW1

When the user wishes to avoid the control of devices by mistake during test and maintenance, the user can use the command blocking function so that mal-operation can be avoided. The execution of command blocking is available from the IED front panel. Additionally, the IEC 61850 standard provides command blocking (CmdBlk) for remote operation and the CBK function is defined at the logical node (LN) given in IEC 61850-7-1 (Edition 2.0). Thus, the IED can override all commands received when the command blocking function is engaged from the local-end and the remote-end. With regard to the command "CmdBlk" from the remote-end, the command is received at the input point "S4301_CONROL_REQ" of the SOFTSW1 function; the result of the SOFTSW1 function appears at output-point "S4301_STATE", as shown in Table 4.3-2. For SOFTSW1 operation, the user should set the scheme switch [**S43-CBKEN**] to **On**.

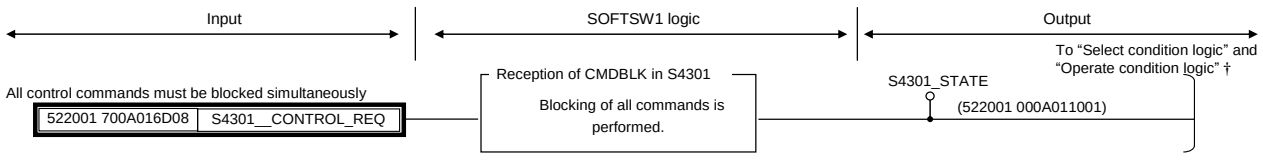


Figure 4.3-2 Logic "S43-CBK" and response "S4301_STATE"

†Note:The user is required to map a communication signal to the input-point. For

mapping, see section 4.3.5. The "S4301_STATE" signal is used in control applications so that control applications can determine their operational conditions. (See control and operation logic for the respective control applications.)

(ii) Interlock bypassing (S43-ICB) provided by SOFTSW2

When the user executes control applications from the IED front panel, the Interlock bypassing (ICB) function enables control applications to bypass their interlock conditions if required. When the ICB is engaged, all control processes, operated from the IED front panel, are able to bypass their interlock conditions. The user should note that operation of the ICB function is available for five minutes following its initiation. For operation of the ICB function, the user should set the scheme switch [**S43-ICBEN**] to **On**.

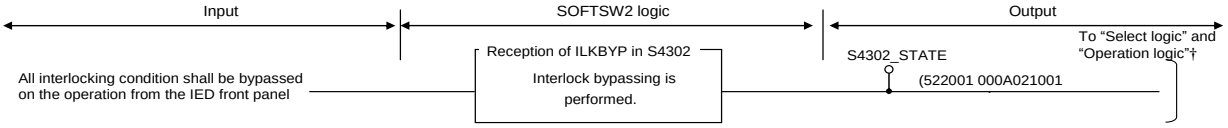


Figure 4.3-3 Logic "S43-ICB" and response "S4302_STATE"

†Note:The S4302_STATE is provided for the "Select logic" and "Operate logic" in the control applications.

(iii) Synchronism bypassing (S43-SCB) provided by SOFTSW3

Synchronism bypass (SCB) enables control applications to bypass synchronizing conditions if the user wishes control applications to bypass synchronizing conditions, if the user executes the control applications from the IED front panel. If the SCB is executed, all control processes, operated from the IED front panel, will bypass their respective synchronizing conditions. Note that the bypass operation is available for five minutes following initiation of the SCB function. For operation of the SCB function, the user should set the scheme switch [**S43-SCBEN**] to **On**.

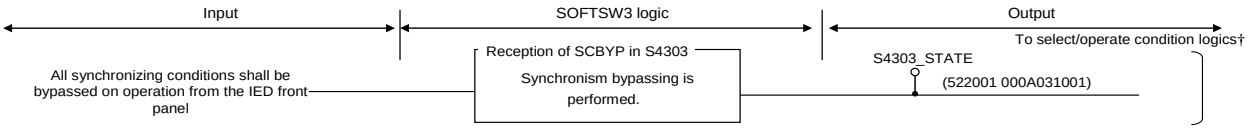


Figure 4.3-4 Logic "S43-SCB" and response "S4303_STATE"

†Note:The S4303_STATE is provided for the "Select logic" and "Operate logic" relating to the control applications including synchronism-check features.

(iv) S43-01 to S43-05 controlling provided by SOFTSW4 to SOFTSW8†

The SOFTSW4 to SOFTSW8 functions are provided for control of the S43-01 to S43-05 switches, as described previously. For example, Figure 4.3-5 shows the SOFTSW4 function controlling the S43-01 switch; control of the S43-01 switch is enabled when the user sets the scheme switch [**S4301-EN**]† to **On**. Likewise, the user is required to set **On** for scheme switches [**S4302-EN**] to [**S4305-EN**] with regard to the SOFTSW4–8 operations, respectively.

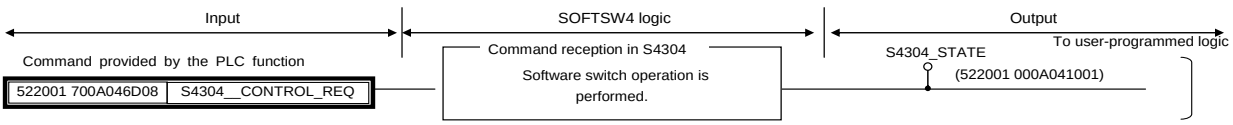


Figure 4.3-5 Logic "SOFTSW4" and response "S4304_STATE"

†Note:Although we are discussing the SOFTSW4 function, the name of the scheme switch in the figure above is represented by [**S4301-EN**]. The user should not confuse this scheme switch as being applied for the SOFTSW1 function.

(v) SOFTSW output-status

Table 4.3-2 shows the list of output signals of the SOFTSW functions.

Table 4.3-2 Output signals of SOFTSW function

Signal Number	Signal Name	Description
522001 000A011001	S4301_STATE	S43-CBK status (Off / Blocked)
522001 000A021001	S4302_STATE	S43-IBK switch status
522001 000A031001	S4303_STATE	S43-SCB switch status
522001 000A041001	S4304_STATE	S43-01 switch status
522001 000A051001	S4305_STATE	S43-02 switch status
522001 000A061001	S4306_STATE	S43-03 switch status
522001 000A071001	S4307_STATE	S43-04 switch status
522001 000A081001	S4308_STATE	S43-05 switch status

4.3.2 Control logics for SBO/DIR modes

For example, the user should set scheme switch [**S43-CBKEN**] to **On** when the SOFTSW1 function is required to be operated. Table 4.3-9 shows all scheme switches for the SOFTSW functions.

(i) Receiving "select command for ON operation" from the remote-end

(i)-1 Input point required mapping

Figure 4.3-6 shows the logic when a "Select command (Remote-ON-Control)" signal is applied to the SOFTSW1 function. The logic has an input-point "S4301_CONTROL_REQ" for the reception of the select command. That is, the input-point should be mapped for the IEC61850 communication. The input-point "S4301_CONTROL_REQ" is significant for the SOFTSW1 operation; hence, an operation failure in the IED is indicated if mapping is not performed correctly. Section 4.3.5 discusses how to map the information of the IEC61850 to the input-points.

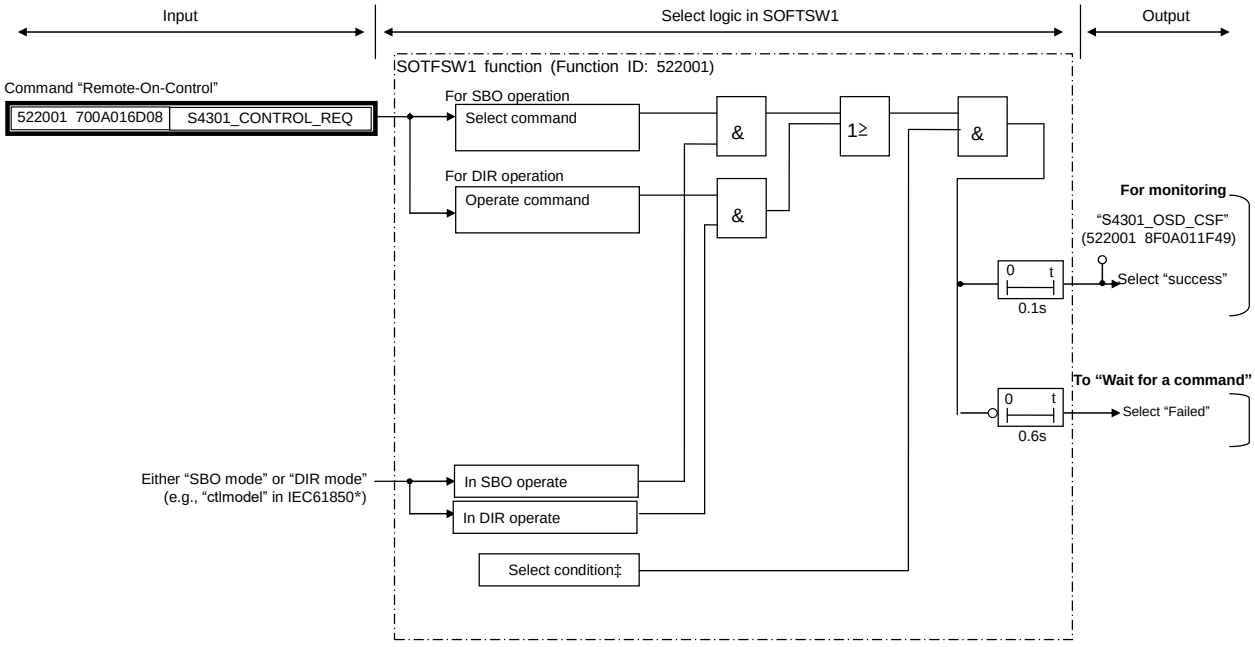


Figure 4.3-6 Select logic for 'ON' operation from remote end in SOFTSW1†

†Note: To identify the input and output points of the other SOFTSW logics, see Table 4.3-5 and Table 4.3-8.

‡Note:"Select condition" signal is provided from select condition scheme. For more information, see Figure 4.3-12.

*Note:The SOFTSW1 function can run on either the "SBO mode" or the "DIR mode". The user can use the signal "ctlmodel" in the IEC61850 communication.

(i)-2 Output signal for monitoring

The user can monitor a "Select success" signal at the output point "S4301_OSL_CSF", when the SOFTSW1 function determines that the received "Remote-ON-Control" signal is true. If

the SOFTSW1 function determines that the "Remote-ON-Control" is not true, the SOFTSW1 function returns to the "Wait for a command" stage.

(ii) Receiving "select command for OFF operation" from the remote end

(ii)-1 Input point required mapping

Figure 4.3-7 shows the logic when a "Select command (Remote-OFF-Control)" signal is applied at the SOFTSW1 function. The input-point "S4301_CONTROL_REQ" is used for the reception of the select command (Remote-OFF-Control).

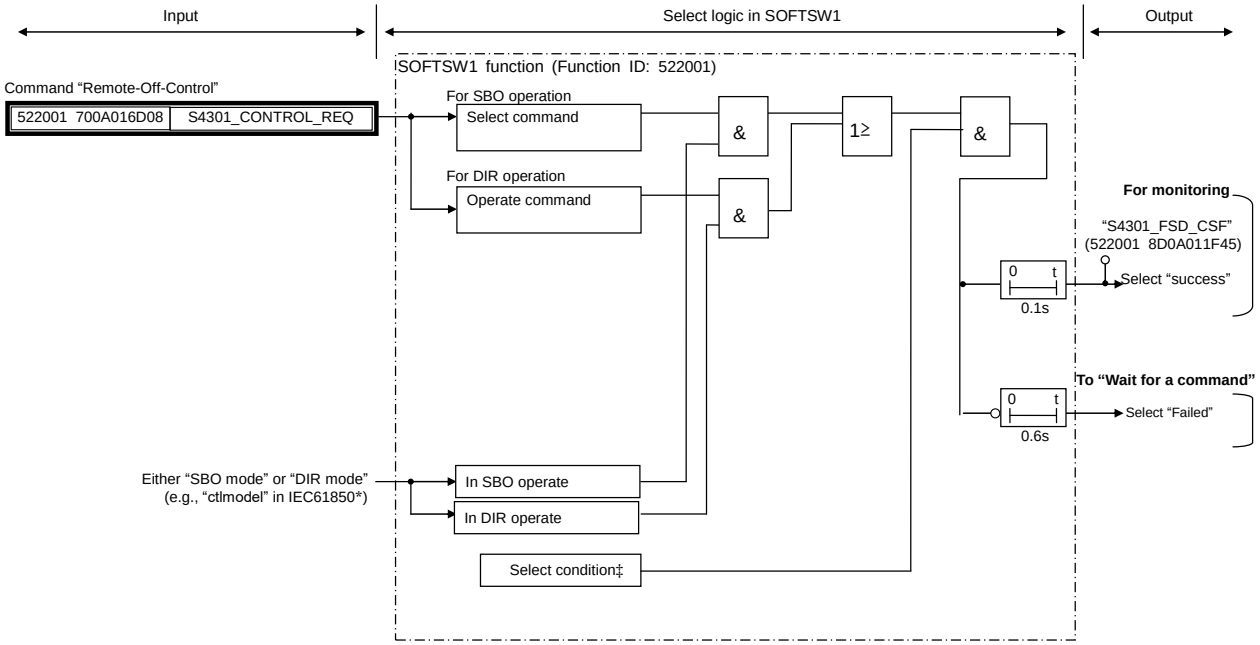


Figure 4.3-7 Select logic for 'OFF' operation from remote end in SOFTSW1†

†Note: To identify the input and output points of the other SOFTSW logics, see Table 4.3-5 and Table 4.3-8.

‡Note:"Select condition" signal is provided in Figure 4.3-12.

(ii)-2 Output signal for monitoring

The SOFTSW1 function, in Figure 4.3-7, can issue a "Select success" signal at output point "S4301_FSL_CSF" when the SOFTSW1 function determines that the input signal "Select command (Remote-OFF-Control)" is true. If the SOFTSW1 function determines that the "Remote-OFF-Control" is not true, the SOFTSW1 function returns to the "Wait for a command" stage.

(iii) Receiving "Selection command for ON operation" from the front panel

(iii)-1 Input signal

Figure 4.3-8 shows the logic when a "Select command (Local-ON-Control)" signal is applied to the SOFTSW1 function. The input signal is provided when "On" key is pressed on the IED

front panel; the input-point is not required to be mapped. Note that the user should set scheme switch [**S4301-CTRAHMI**] to **SBO** when the operation from the IED front panel is performed; chapter *User interface: Control sub-menu* discusses how to operate.

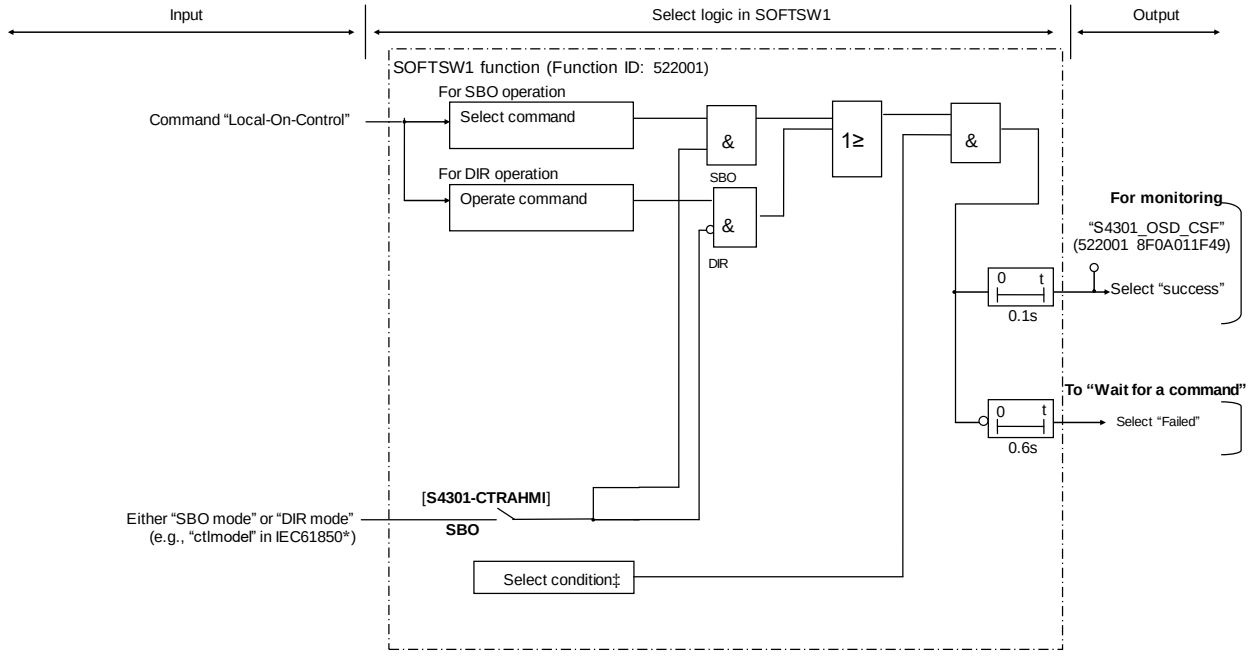


Figure 4.3-8 Select logic for 'ON' operation at the IED locally in SOFTSW1†

†Note: To identify the output points of the other SOFTSW logics, see Table 4.3-8.

‡Note:Signal "select condition" is provided. See Figure 4.3-12.

(iii)-2 Output signal for monitoring

When the state of "select condition" is true, the SOFTSW1 function can issue an output signal "Select success" at the output-point "S4301_OSD_CSF".

Note: The signal "S4301_OSD_CSF" is the same signal as shown in Figure 4.3-6. If the input signal "Local-ON-Control" is not true, the SOFTSW1 function returns to the "Wait for a command" stage.

(iv) Receiving "Select command for OFF operation" from the front panel

(iv)-1 Input signal

Figure 4.3-9 shows the logic when a "Select command (Local-OFF-Control)" signal is applied to the SOFTSW1 logic. The input signal is provided when the user presses "OFF" key on the IED front panel; the input-point is not required to be mapped.

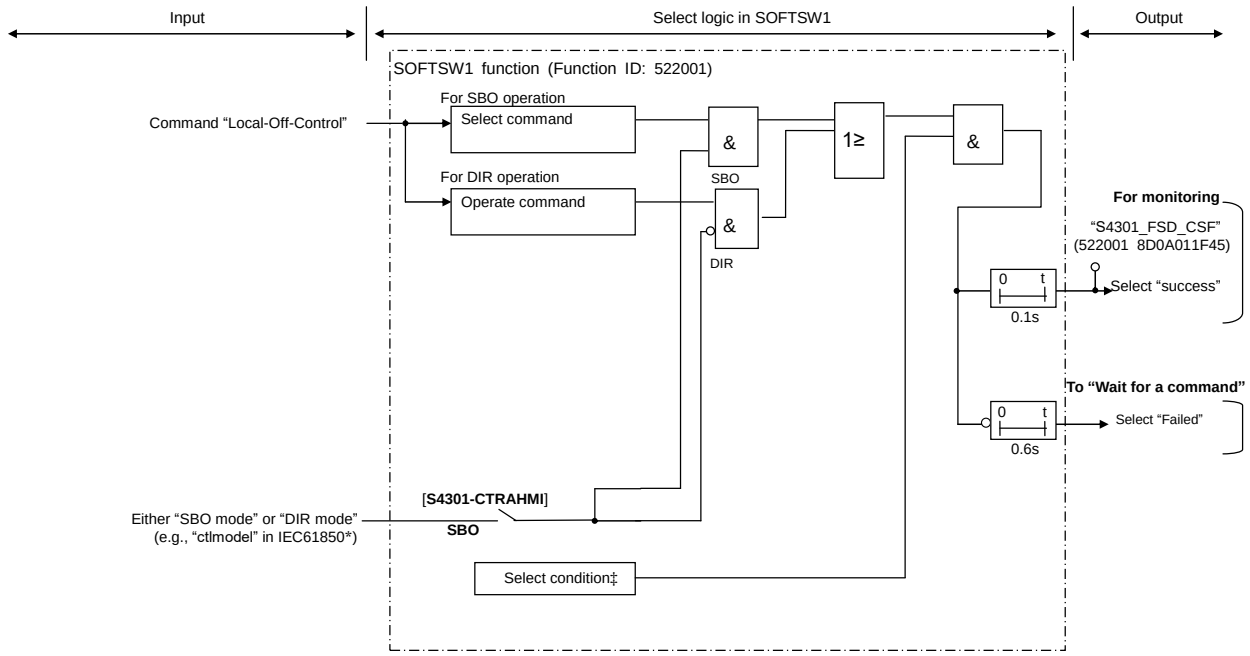


Figure 4.3-9 Select logic for 'OFF' operation at the IED locally in SOFTSW1†

†Note: Figure 4.3-9 is used for the discussion of SOFTSW1 logic. To identify the output points of the other SOFTSW logics, see Table 4.3-8.

‡Note:Signal "select condition" is provided. See Figure 4.3-12.

(iv)-2 Output signal for monitoring

When the state of "select condition" is true, the SOFTSW1 function can issue a "Select success" signal at the output-point "S4301_FSD_CSF".

Note: The "S4301_FSD_CSF" signal is the same as the signal shown in Figure 4.3-7. That is, this signal of the logic appears at the same PLC monitoring point. If the input signal "Local-OFF-Control" is not true, the SOFTSW1 function returns to the "Wait for a command" stage.

(v) Receiving "Select command for ON operation" using the PLC function

(v)-1 Input signal required to connect

Figure 4.3-10 shows that the select logic when a "Select command (PLC-ON-Control)" signal is applied to the SOFTSW1 logic. The input signal is generated using the user-programmed PLC logic; the user can connect the signal for the PLC connection point "PLC_BIT_1125".

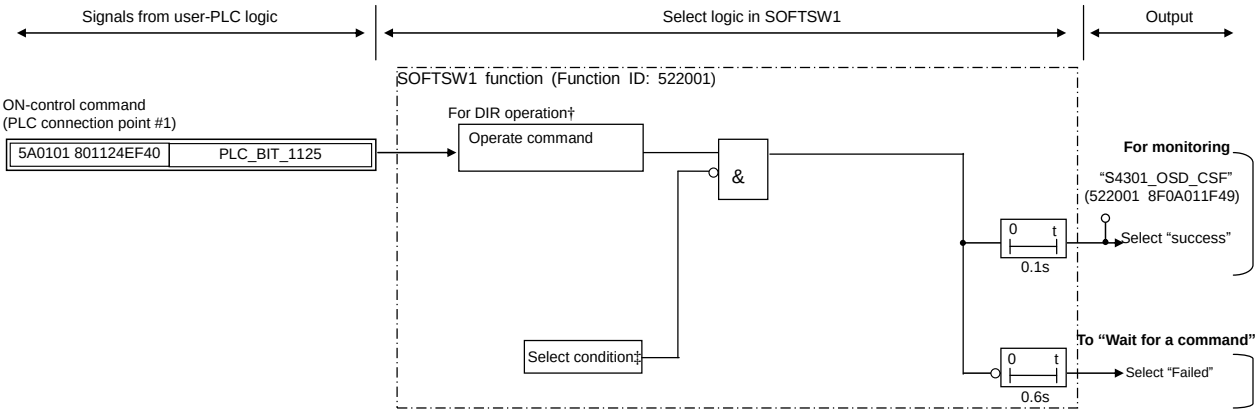


Figure 4.3-10 Select logic for ON operation by PLC in SOFTSW1††

†Note:Direct operation mode (DIR) is only available.

‡Note:"select condition" signal is provided. See Figure 4.3-12.

††Note: To identify the input and output points of the other SOFTSW logics, see Table 4.3-3 and Table 4.3-8.

(v)-2 Output signal for monitoring

The SOFTSW1 function shown in Figure 4.3-10, can issue a "Select success" signal at output-point "S4301_OSD_CSF".

Note: The signal "S4301_OSD_CSF" is the same as the signal shown in Figure 4.3-6.

(vi) Receiving "Select command for OFF operation" using PLC function

(vi)-1 Input signal required to connect

Figure 4.3-11 shows the SOFTSW1 logic for a "Select command (PLC-OFF-Control)" signal. The input signal is generated using the user-programmed PLC logic; the user can connect the signal for the PLC connection point "PLC_BIT_1124".

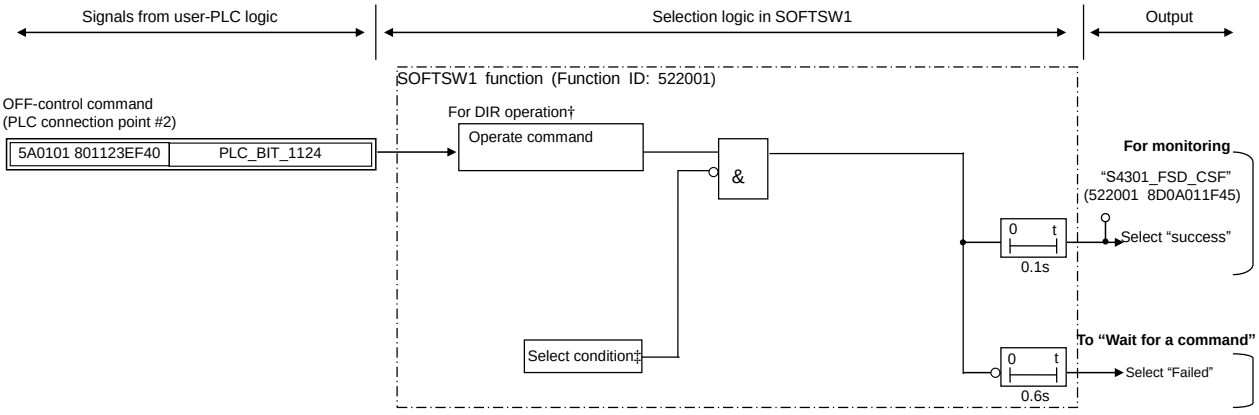


Figure 4.3-11 Select logic for OFF operation by PLC in SOFTSW1††

†Note:Direct operation mode (DIR) is available only.

‡Note:Signal "select condition" is provided. See Figure 4.3-12.

††Note: To identify the input and output points of the other SOFTSW logics, see Table 4.3-4 and Table 4.3-8.

(vi)-2 Output signal to monitoring

The SOFTSW1 function shown in Figure 4.3-11, can issue a "Select success" signal at the output point "S4301_FSD_CSF".

Note: The output point "S4301_FSD_CSF" is the same as the signal shown in Figure 4.3-7.

(vii) Select condition

Figure 4.3-12 shows the select condition logic of the SOFTSW1 function. The SOFTSW1 function can examine an operate-condition using "Command Blocking" signal[1].

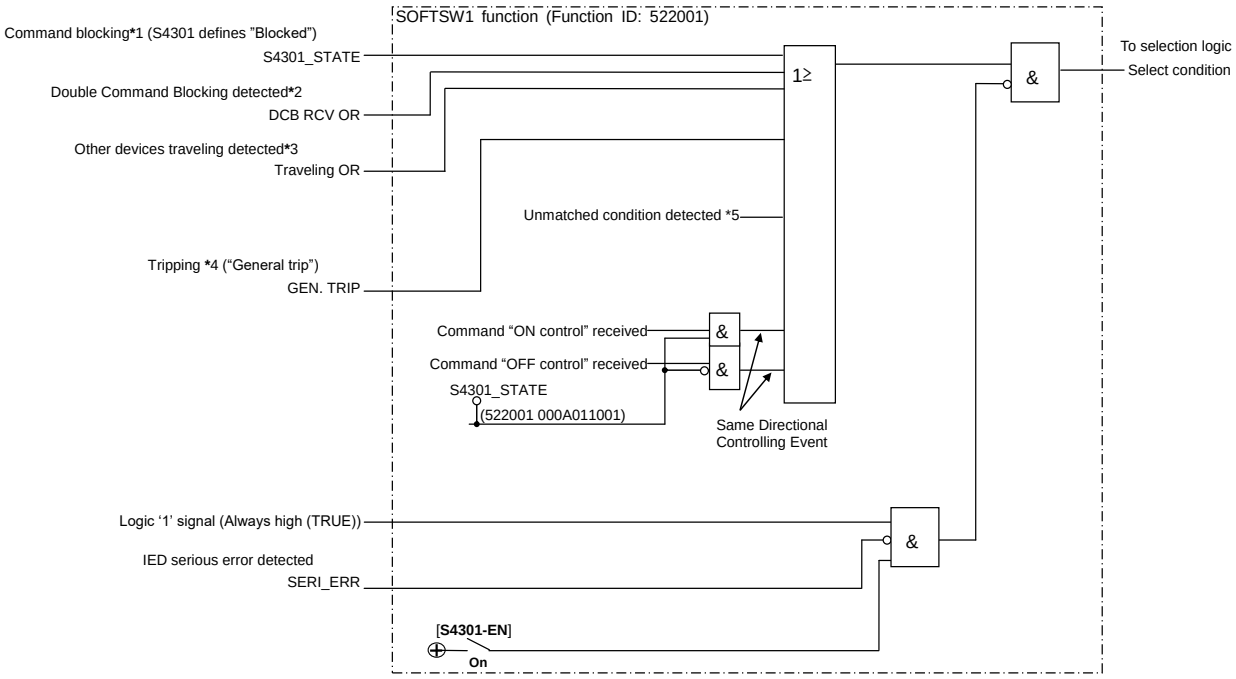


Figure 4.3-12 Select condition logic for 'ON/OFF' in SOFTSW1

[1]Note: "Command Blocking" disables any operation except its own; see the signal "S4301_STATE (Table 4.3-2)" as the state of "Command Blocking" in the SOFTSW function.

[2]Note: "Double Command Blocking (DCB_RCV_OR in Table 4.3-7)" is an operation philosophy. It can be used to protect a substation. The user can configure it using GR-TIEMS.

[3]Note: If the event "device-travelling (Traveling OR in Table 4.3-7)" is detected in the IED, it indicated that another operator is changing the status of a device. Thus, the IED should inhibit the operation of any device for the duration that the event is detected.

[4]Note: If tripping (GEN.TRIP in Table 4.3-7) is executed in the IED, any control operation is blocked upon the trip operation. Tripping can be introduced by the protection function if the IED has protection functions.

[5]Note: Criteria "unmatched conditions" are decided when "Test-bit status" in command is not identical to "IED test status".

(viii) Signal name and number

Note: The user should note the following descriptions shown in the column "M/O" for each table:

"O" indicates that the signal is provided for optional use.

"M" indicates that the user should map/set/configure the signal; otherwise, the user may experience an operational failure if the default settings are used.

"N/A" indicates that the user cannot change the state of the signal.

Table 4.3-3 PLC connection point #1 (Inputs point for 'On' control)

Signal Number	Signal Name	Description	M/O
5A0101 801124EF40	PLC_BIT_1125	PLC ON control for SOFTSW1 (S43-CBK)	O
5A0101 801126EF40	PLC_BIT_1127	PLC ON control for SOFTSW2 (S43-ICB)	O
5A0101 801128EF40	PLC_BIT_1129	PLC ON control for SOFTSW3 (S43-SCB)	O
5A0101 801130EF40	PLC_BIT_1131	PLC ON control for SOFTSW4 (S43-01)	O
5A0101 801132EF40	PLC_BIT_1133	PLC ON control for SOFTSW5 (S43-02)	O
5A0101 801134EF40	PLC_BIT_1135	PLC ON control for SOFTSW6 (S43-03)	O
5A0101 801136EF40	PLC_BIT_1137	PLC ON control for SOFTSW7 (S43-04)	O
5A0101 801138EF40	PLC_BIT_1139	PLC ON control for SOFTSW8 (S43-05)	O

Table 4.3-4 PLC connection point #2 (Input points for 'Off' control)

Signal Number	Signal Name	Description	M/O
5A0101 801123EF40	PLC_BIT_1124	PLC OFF control for SOFTSW1 (S43-CBK)	O
5A0101 801125EF40	PLC_BIT_1126	PLC OFF control for SOFTSW2 (S43-ICB)	O
5A0101 801127EF40	PLC_BIT_1128	PLC OFF control for SOFTSW3 (S43-SCB)	O
5A0101 801129EF40	PLC_BIT_1130	PLC OFF control for SOFTSW4 (S43-01)	O
5A0101 801131EF40	PLC_BIT_1132	PLC OFF control for SOFTSW5 (S43-02)	O
5A0101 801133EF40	PLC_BIT_1134	PLC OFF control for SOFTSW6 (S43-03)	O
5A0101 801135EF40	PLC_BIT_1136	PLC OFF control for SOFTSW7 (S43-04)	O
5A0101 801137EF40	PLC_BIT_1138	PLC OFF control for SOFTSW8 (S43-05)	O

Table 4.3-5 Mapping points for the command reception in SOFTSWx

Signal Number	Signal Name	Description	M/O
522001 700A016D08	S4301_CONTROL_REQ	Control command received in SOFTSW1 (S43-CBK)	M
522001 700A026D08	S4302_CONTROL_REQ	Control command received in SOFTSW2 (S43-ICB)	M
522001 700A036D08	S4303_CONTROL_REQ	Control command received in SOFTSW3 (S43-SCB)	M
522001 700A046D08	S4304_CONTROL_REQ	Control command received in SOFTSW4 (S43-01)	M
522001 700A056D08	S4305_CONTROL_REQ	Control command received in SOFTSW5 (S43-02)	M
522001 700A066D08	S4306_CONTROL_REQ	Control command received in SOFTSW6 (S43-03)	M
522001 700A076D08	S4307_CONTROL_REQ	Control command received in SOFTSW7 (S43-04)	M
522001 700A086D08	S4308_CONTROL_REQ	Control command received in SOFTSW8 (S43-05)	M

Table 4.3-6 Mapping points for the output signals of SOFTSWx

Signal Number	Signal Name	Description	M/O
522001 000A011D90	S4301_STSELD	Selection completed signal in SOFTSW1	M
522001 000A021D90	S4302_STSELD	Selection completed signal in SOFTSW2	M
522001 000A031D90	S4303_STSELD	Selection completed signal in SOFTSW3	M
522001 000A041D90	S4304_STSELD	Selection completed signal in SOFTSW4 (S43-01)	M
522001 000A051D90	S4305_STSELD	Selection completed signal in SOFTSW5 (S43-02)	M
522001 000A061D90	S4306_STSELD	Selection completed signal in SOFTSW6 (S43-03)	M
522001 000A071D90	S4307_STSELD	Selection completed signal in SOFTSW7 (S43-04)	M
522001 000A081D90	S4308_STSELD	Selection completed signal in SOFTSW8 (S43-05)	M

Table 4.3-7 Input signals for condition logic

Signal Number	Signal Name	Description	M/O
5A0001 0008001F41	DCB RCV OR	Double Command Blocking(DCB) is in progress.	N/A
5A0001 0008001F40	Traveling OR	Travelling events are detected.	N/A
4A0001 8300001B6F	GEN. TRIP	General trip	N/A
5A0001 3108003F40	SDCEN	(This is setting of CMNCTRL)	N/A
5A0101 3100001F43	SERI_ERR	Serious Error detected	N/A

Table 4.3-8 PLC monitoring points (ON and OFF selection completion)

Signal Number	Signal Name	Description
522001 8F0A011F49	S4301_OSD_CSF	On Selection completed in SOFTSW1 (S43-CBK)
522001 8F0A021F49	S4302_OSD_CSF	On Selection completed in SOFTSW2 (S43-ICB)
522001 8F0A031F49	S4303_OSD_CSF	On Selection completed in SOFTSW3 (S43-SCB)
522001 8F0A041F49	S4304_OSD_CSF	On Selection completed in SOFTSW4 (S43-01)
522001 8F0A051F49	S4305_OSD_CSF	On Selection completed in SOFTSW5 (S43-02)
522001 8F0A061F49	S4306_OSD_CSF	On Selection completed in SOFTSW6 (S43-03)
522001 8F0A071F49	S4307_OSD_CSF	On Selection completed in SOFTSW7 (S43-04)
522001 8F0A081F49	S4308_OSD_CSF	On Selection completed in SOFTSW8 (S43-05)
522001 8D0A011F45	S4301_FSD_CSF	Off Selection completed in SOFTSW1 (S43-CBK)
522001 8D0A021F45	S4302_FSD_CSF	Off Selection completed in SOFTSW2 (S43-ICB)
522001 8D0A031F45	S4303_FSD_CSF	Off Selection completed in SOFTSW3 (S43-SCB)
522001 8D0A041F45	S4304_FSD_CSF	Off Selection completed in SOFTSW4 (S43-01)
522001 8D0A051F45	S4305_FSD_CSF	Off Selection completed in SOFTSW5 (S43-02)
522001 8D0A061F45	S4306_FSD_CSF	Off Selection completed in SOFTSW6 (S43-03)
522001 8D0A071F45	S4307_FSD_CSF	Off Selection completed in SOFTSW7 (S43-04)
522001 8D0A081F45	S4308_FSD_CSF	Off Selection completed in SOFTSW8 (S43-05)

(ix) Setting names

Table 4.3-9 Setting of SOFTSWx control

Setting Name	Description	Default	Setting item or value
S43-CBKEN	Function activation in SOFTSW1 (S43-CBK)	On	Off / On
S43-ICBEN	Function activation in SOFTSW2 (S43-ICB)	On	Off / On
S43-SCBEN	Function activation in SOFTSW3 (S43-SCB)	On	Off / On
S4301-EN†	Function activation in SOFTSW4 (S43-01†)	On	Off / On
S4302-EN†	Function activation in SOFTSW5 (S43-02†)	On	Off / On
S4303-EN†	Function activation in SOFTSW6 (S43-03†)	On	Off / On
S4304-EN†	Function activation in SOFTSW7 (S43-04†)	On	Off / On
S4305-EN†	Function activation in SOFTSW8 (S43-05†)	On	Off / On
S43-CBKCTRAHMI	HMI activation in SOFTSW1 (S43-CBK)	On	Off / On

Setting Name	Description	Default	Setting item or value
S43-ICBCTRAHMI	HMI activation in SOFTSW2 (S43-ICB)	On	Off / On
S43-SCBCTRAHMI	HMI activation in SOFTSW3 (S43-SCB)	On	Off / On
S4301-CTRAHMI†	HMI activation in SOFTSW4 (S43-01†)	On	Off / On
S4302-CTRAHMI†	HMI activation in SOFTSW5 (S43-02†)	On	Off / On
S4303-CTRAHMI†	HMI activation in SOFTSW6 (S43-03†)	On	Off / On
S4304-CTRAHMI†	HMI activation in SOFTSW7 (S43-04†)	On	Off / On
S4305-CTRAHMI†	HMI activation in SOFTSW8 (S43-05†)	On	Off / On

†Note:There are inconsistency between the names of settings and switches, but the expression in Table 4.3-9 is true.

4.3.3 Cancel logic for SBO mode

In the SBO control mode, the reception of a cancel command is possible; when the cancel conditions are satisfied, accordingly, the function can discard the select command.

(i) Receiving "Cancel" from remote-end

Figure 4.3-13 shows the logic when a "Cancel command (Remote-Cancel)" signal is applied to the SOFTSW1 function. The input-point "S4301_CONTROL_REQ" is the same as the "Selection command (Remote-On-Control)" signal.

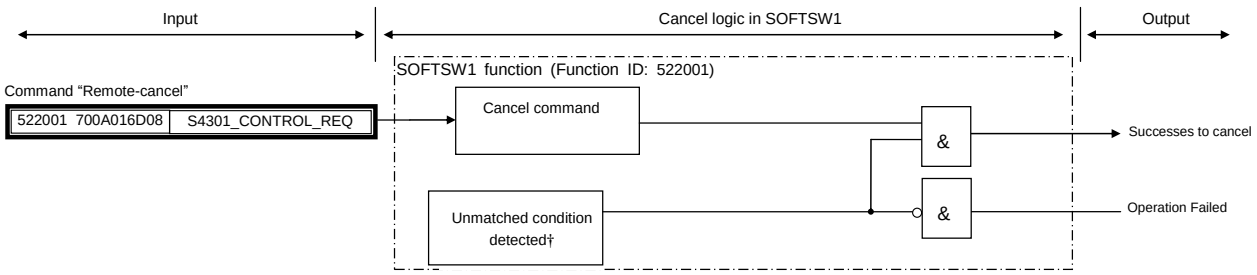


Figure 4.3-13 Cancel logic by the reception of the command from the remote end

†Note: The criteria "unmatched conditions" are determined when the "Test-bit status" in the 'cancel' command is not identical to the "IED test status".

(ii) Receiving "Cancel" from local-end

Figure 4.3-14 shows the logic when a "Cancel command (Local-cancel)" signal is applied to the SOFTSW1 function. The input signal is provided when the "Cancel" key is pressed on the IED front panel; the user is not required to map it. When the logic receives input "Local-cancel" signal, the logic is able to output a result signal, provided that the "unmatched condition detected" checking is satisfied.

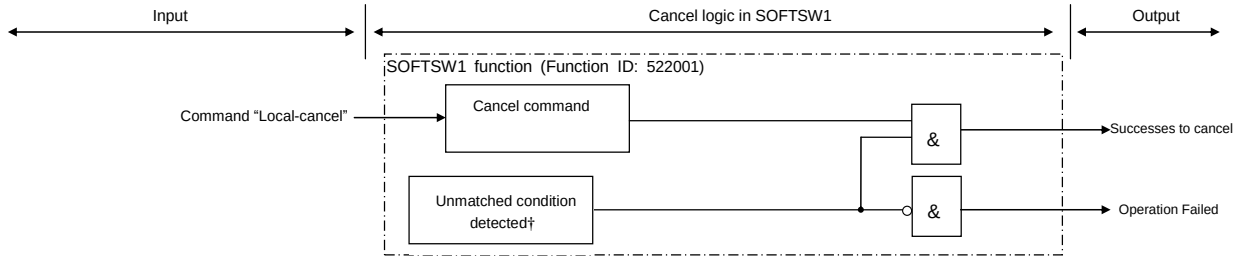


Figure 4.3-14 Cancel logic by the reception of the command at local end

†Note: The criteria "unmatched conditions" are determined when the "Test-bit status" in the 'cancel' command is not identical to the "IED test status".

4.3.4 Operate logic for SBO/DIR modes

The user should map the operation command to the operate logic. If the operation conditions are satisfied, the IED is able to change the state in the S4301 to S4308.

(i) Receiving "operate command On" from remote-end

Figure 4.3-15 shows the logic when an "Operate command (Remote-ON-Control)" signal is applied to the SOFTSW1 logic. The input-point "S4301_CONTROL_REQ" is used for the reception of the "Select command (Remote-On-Control)".

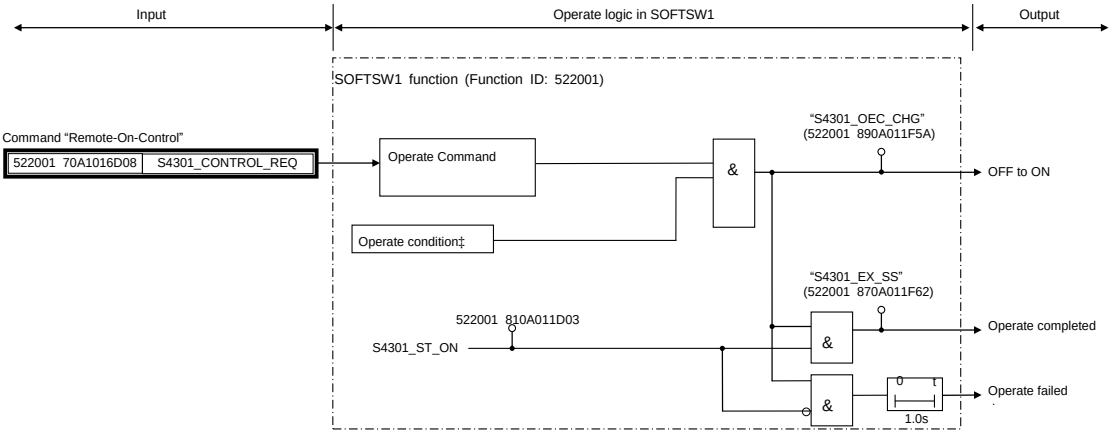


Figure 4.3-15 'ON' Operation logic by remote end in SOFTSW1†

†Note: To identify the input and output signal-points of the other SOFTSW logics, see Table 4.3-5, Table 4.3-7, Table 4.3-10, Table 4.3-13, and Table 4.3-14.

‡Note:"operate condition" signal is provided from operate condition scheme. For more information, see Figure 4.3-21.

(ii) Receiving "operate command Off" from remote-end

Figure 4.3-16 shows the logic when an "Operate command (Remote-Off-Control)" signal is applied to the SOFTSW1 logic. The input-point "S4301_CONTROL_REQ" is used for the reception of the signal "Operate command (Remote-Off-Control)".

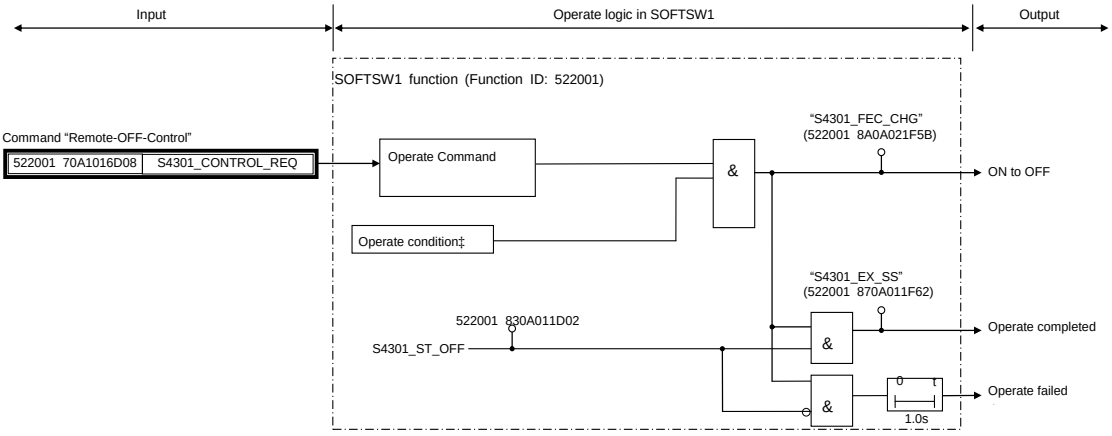


Figure 4.3-16 'OFF' Operation logic by remote end in SOFTSW1†

†Note: To identify the input and output signals of the other SOFTSW logics, see Table 4.3-5, Table 4.3-11, Table 4.3-12, and Table 4.3-13.

‡Note:"operate condition" signal is provided from operate condition scheme. For more information, see Figure 4.3-21.

(iii) Receiving "operate command On" from the local end

Figure 4.3-17 shows the logic when an "Operate command (Local-ON-Control)" signal is applied to the SOFTSW1 logic. The input signal is provided when "Execution of On" key is pressed on the IED front panel.

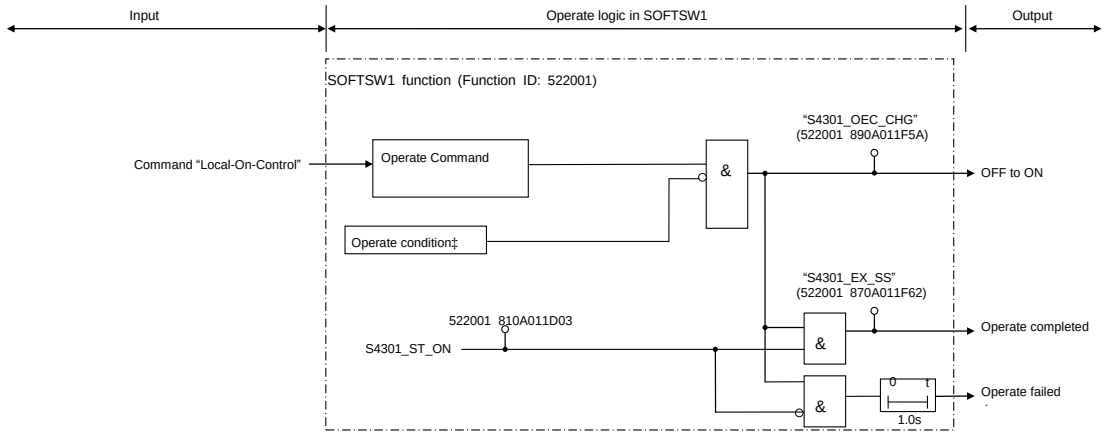


Figure 4.3-17 'ON' Operation logic at local in SOFTSW1†

†Note: To identify the input and output signal-points of the other SOFTSW logics, see Table 4.3-10, Table 4.3-12, and Table 4.3-14.

‡Note:"operate condition" signal is provided from operate condition scheme. For more information, see Figure 4.3-21.

(iv) Receiving "operate command Off" from the local end

Figure 4.3-18 shows the logic when an "Operation command (Local-OFF-Control)" signal is applied to the SOFTSW1 logic. The input signal is provided when "Execution for Off" key is pressed on the IED front panel.

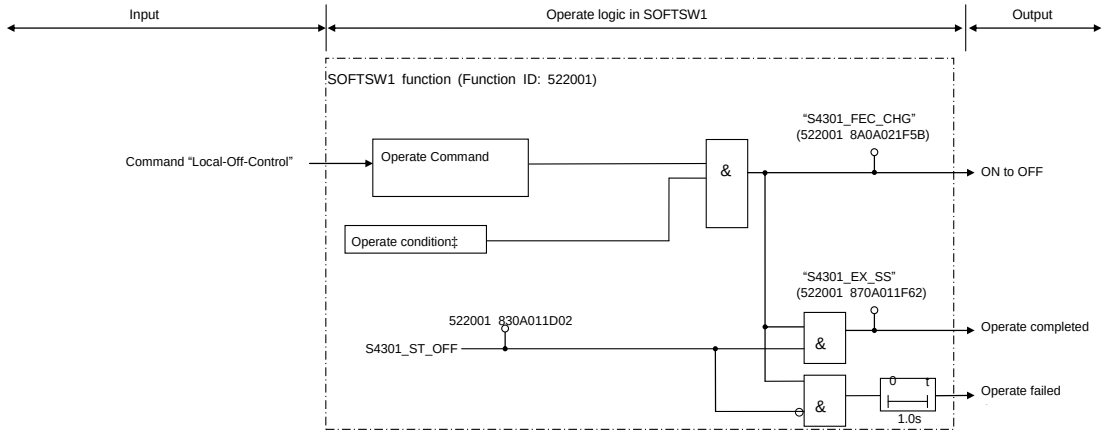


Figure 4.3-18 'OFF' Operation logic at local in SOFTSW1†

†Note: To identify the input and output signals of the other SOFTSW logics, see Table 4.3-11, Table 4.3-12, and Table 4.3-13.

‡Note: "operate condition" signal is provided from operate condition scheme. For more

information, see Figure 4.3-21.

(v) Receiving "operate command On" using PLC logic

Figure 4.3-19 shows the logic when an "Operate command (PLC-ON-Control)" signal is applied to the SOFTSW1 logic. The input signal is generated using the user-programmed PLC logic; the user can connect the signal for the PLC connection point "PLC_BIT_1125".

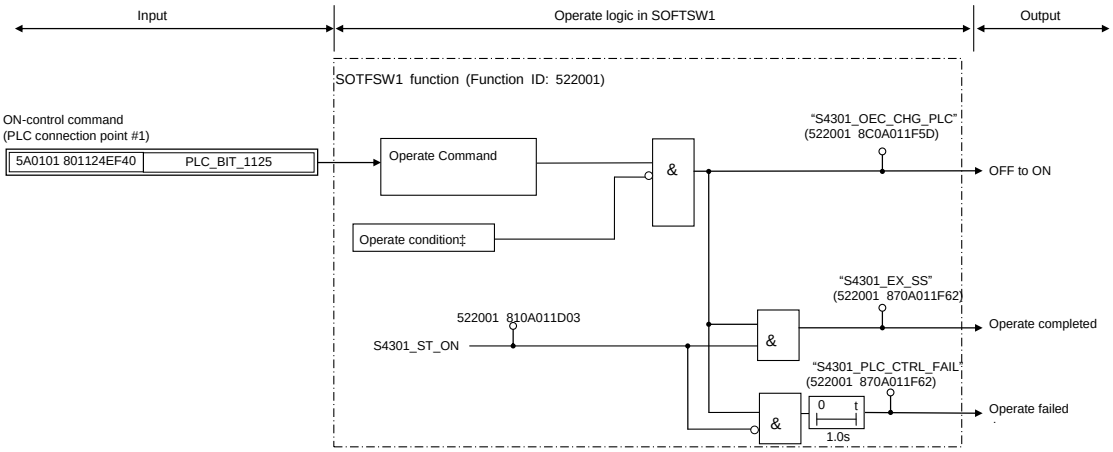


Figure 4.3-19 'ON' Operation logic using PLC logic†

†Note: To identify the input and output signal-points of the other SOFTSW logics, see Table 4.3-3, Table 4.3-12, Table 4.3-14, Table 4.3-15, and Table 4.3-16.

‡Note:"operate condition" signal is provided from operate condition scheme. For more information, see Figure 4.3-21.

(vi) Receiving "operate command Off" using PLC logic

Figure 4.3-20 shows the logic when an "Operation command (PLC-Off-Control)" signal is applied to the SOFTSW1 logic. The input signal is generated using the user-programmed PLC logic; the user can connect the signal for the PLC connection point "PLC_BIT_1124".

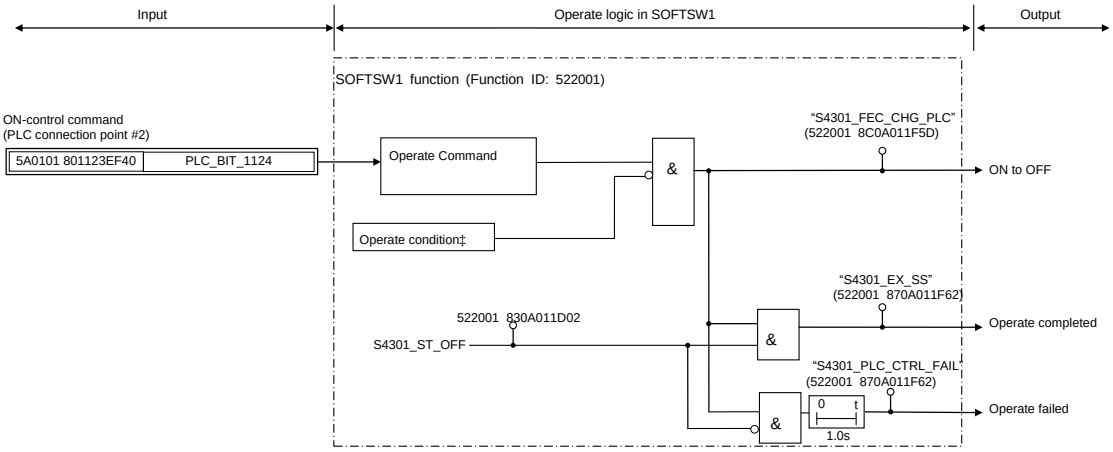


Figure 4.3-20 'Off' Operation logic using PLC logic†

†Note: To identify the input and output signal-points of the other SOFTSW logics, see Table 4.3-4, Table 4.3-12, Table 4.3-13, Table 4.3-15, and Table 4.3-17.

‡Note:"operate condition" signal is provided from operate condition scheme. For more information, see Figure 4.3-21.

(vii) Operate condition

Figure 4.3-21 shows the operate condition logic of the SOFTSW1 function. The SOFTSW1 function can examine an operate-condition using "Command Blocking" signal[1].

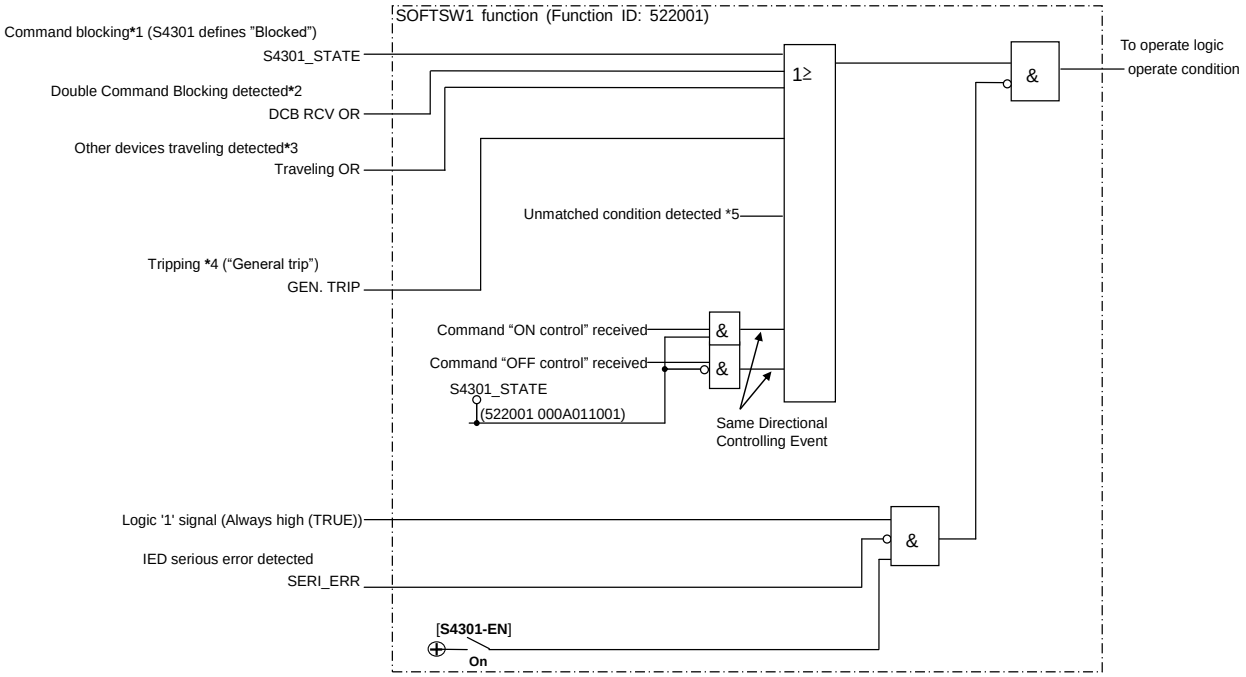


Figure 4.3-21 Operate condition logic for ON/OFF in SOFTSW1[*6]

[1]Note: "Command Blocking" disables any operation except for itself; See the signal "S4301_STATE (Table 4.3-2)" as the state of "Command Blocking" in the SOFTSW function.

[2]Note: "Double Command Blocking (DCB_RCV_OR in Table 4.3-7)" is an operation philosophy. It can be used to protect the substation. The user can configure it using GR-TIEMS.

[3]Note: Detection of event "device-travelling (Traveling OR in Table 4.3-7)" signifies that other operators are changing the status of one or more devices. Thus, device operation by the IED should be inhibited whilst the event is detected.

[4]Note: If an IED is in the process of issuing a trip (GEN.TRIP in Table 4.3-7) command, all control operation is blocked until the trip operation has been completed. Tripping can be introduced by the protection function if the IED has protection functions.

[5]Note: The criteria "unmatched conditions" is determined when the "Test-bit status" in a command is not identical to the "IED test status".

.

(viii) Signal name and number

Note: The user should note the meaning of the following abbreviations as shown in column "M/O" of each table:

"O" indicates that the signal is provided for the optional use.

"M" indicates that the user should map/set/configure the signal; otherwise, the user may experience an operational failure if the default settings is used.

"N/A" indicates that the user cannot change the state of the signal.

Table 4.3-10 Output signals on starting operation "Off to On"

Signal Number	Signal Name	Description
522001 890A011F5A	S4301_OEC_CHG	"Off to On" operation start in SOFTSW1 (S43-CBK)
522001 890A021F5A	S4302_OEC_CHG	"Off to On" operation start in SOFTSW2 (S43-ICB)
522001 890A031F5A	S4303_OEC_CHG	"Off to On" operation start in SOFTSW3 (S43-SCB)
522001 890A041F5A	S4304_OEC_CHG	"Off to On" operation start in SOFTSW4 (S43-01)
522001 890A051F5A	S4305_OEC_CHG	"Off to On" operation start in SOFTSW5 (S43-02)
522001 890A061F5A	S4306_OEC_CHG	"Off to On" operation start in SOFTSW6 (S43-03)
522001 890A071F5A	S4307_OEC_CHG	"Off to On" operation start in SOFTSW7 (S43-04)
522001 890A081F5A	S4308_OEC_CHG	"Off to On" operation start in SOFTSW8 (S43-05)

Table 4.3-11 Output signals on starting operation "On to Off"

Signal Number	Signal Name	Description
522001 8A0A011F5B	S4301_FEC_CHG	"On to Off" operation start in SOFTSW1 (S43-CBK)
522001 8A0A021F5B	S4302_FEC_CHG	"On to Off" operation start in SOFTSW2 (S43-ICB)
522001 8A0A031F5B	S4303_FEC_CHG	"On to Off" operation start in SOFTSW3 (S43-SCB)
522001 8A0A041F5B	S4304_FEC_CHG	"On to Off" operation start in SOFTSW4 (S43-01)
522001 8A0A051F5B	S4305_FEC_CHG	"On to Off" operation start in SOFTSW5 (S43-02)
522001 8A0A061F5B	S4306_FEC_CHG	"On to Off" operation start in SOFTSW6 (S43-03)
522001 8A0A071F5B	S4307_FEC_CHG	"On to Off" operation start in SOFTSW7 (S43-04)
522001 8A0A081F5B	S4308_FEC_CHG	"On to Off" operation start in SOFTSW8 (S43-05)

Table 4.3-12 Success signals of the operation

Signal Number	Signal Name	Description
522001 870A011F62	S4301_EX_SS	Operation succeeded in SOFTSW1 (S43-CBK)
522001 870A021F62	S4302_EX_SS	Operation succeeded in SOFTSW2 (S43-ICB)
522001 870A031F62	S4303_EX_SS	Operation succeeded in SOFTSW3 (S43-SCB)
522001 870A041F62	S4304_EX_SS	Operation succeeded in SOFTSW4 (S43-01)
522001 870A051F62	S4305_EX_SS	Operation succeeded in SOFTSW5 (S43-02)
522001 870A061F62	S4306_EX_SS	Operation succeeded in SOFTSW6 (S43-03)
522001 870A071F62	S4307_EX_SS	Operation succeeded in SOFTSW7 (S43-04)
522001 870A081F62	S4308_EX_SS	Operation succeeded in SOFTSW8 (S43-05)

Table 4.3-13 OFF status signals on the operation

Signal Number	Signal Name	Description
522001 830A011D02	S4301_ST_OFF	"Off" status of SOFTSW1 (S43-CBK)
522001 830A021D02	S4302_ST_OFF	"Off" status of SOFTSW2 (S43-ICB)
522001 830A031D02	S4303_ST_OFF	"Off" status of SOFTSW3 (S43-SCB)
522001 830A041D02	S4304_ST_OFF	"Off" status of SOFTSW4 (S43-01)
522001 830A051D02	S4305_ST_OFF	"Off" status of SOFTSW5 (S43-02)
522001 830A061D02	S4306_ST_OFF	"Off" status of SOFTSW6 (S43-03)

Signal Number	Signal Name	Description
522001 830A071D02	S4307_ST_OFF	"Off" status of SOFTSW7 (S43-04)
522001 830A081D02	S4308_ST_OFF	"Off" status of SOFTSW8 (S43-05)

Table 4.3-14 ON status signals on the operation

Signal Number	Signal Name	Description
522001 810A011D03	S4301_ST_ON	"On" status of SOFTSW1 (S43-CBK)
522001 810A021D03	S4302_ST_ON	"On" status of SOFTSW2 (S43-ICB)
522001 810A031D03	S4303_ST_ON	"On" status of SOFTSW3 (S43-SCB)
522001 810A041D03	S4304_ST_ON	"On" status of SOFTSW4 (S43-01)
522001 810A051D03	S4305_ST_ON	"On" status of SOFTSW5 (S43-02)
522001 810A061D03	S4306_ST_ON	"On" status of SOFTSW6 (S43-03)
522001 810A071D03	S4307_ST_ON	"On" status of SOFTSW7 (S43-04)
522001 810A081D03	S4308_ST_ON	"On" status of SOFTSW8 (S43-05)

Table 4.3-15 Failure signals generated by PLC control

Signal Number	Signal Name	Description
522001 800A011DE0	S4301_PLC_CTRL_FAIL	Control failure in SOFTSW1 (S43-CBK=CBK)
522001 800A021DE0	S4302_PLC_CTRL_FAIL	Control failure in SOFTSW2 (S43-ICB=ICB)
522001 800A031DE0	S4303_PLC_CTRL_FAIL	Control failure in SOFTSW3 (S43-SCB=SCB)
522001 800A041DE0	S4304_PLC_CTRL_FAIL	Control failure in SOFTSW4 (S43-01)
522001 800A051DE0	S4305_PLC_CTRL_FAIL	Control failure in SOFTSW5 (S43-02)
522001 800A061DE0	S4306_PLC_CTRL_FAIL	Control failure in SOFTSW6 (S43-03)
522001 800A071DE0	S4307_PLC_CTRL_FAIL	Control failure in SOFTSW7 (S43-04)
522001 800A081DE0	S4308_PLC_CTRL_FAIL	Control failure in SOFTSW8 (S43-05)

Table 4.3-16 Output signals on starting operation "Off to On" by PLC

Signal Number	Signal Name	Description
522001 8B0A011F5C	S4301_OEC_CHG_PLC	SOFTSW1 signal after KC_S43_SA022
522001 8B0A021F5C	S4302_OEC_CHG_PLC	SOFTSW2 signal after KC_S43_SA022
522001 8B0A031F5C	S4303_OEC_CHG_PLC	SOFTSW3 signal after KC_S43_SA022
522001 8B0A041F5C	S4304_OEC_CHG_PLC	SOFTSW4 signal after KC_S43_SA022
522001 8B0A051F6C	S4305_OEC_CHG_PLC	SOFTSW5 signal after KC_S43_SA022
522001 8B0A061F7C	S4306_OEC_CHG_PLC	SOFTSW6 signal after KC_S43_SA022
522001 8B0A071F8C	S4307_OEC_CHG_PLC	SOFTSW7 signal after KC_S43_SA022
522001 8B0A081F9C	S4308_OEC_CHG_PLC	SOFTSW8 signal after KC_S43_SA022

Table 4.3-17 Output signals on starting operation "On to Off" by PLC

Signal Number	Signal Name	Description
522001 8C0A011F5D	S4301_FEC_CHG_PLC	SOFTSW1 signal after KC_S43_SA023
522001 8C0A021F5D	S4302_FEC_CHG_PLC	SOFTSW2 signal after KC_S43_SA023
522001 8C0A031F5D	S4303_FEC_CHG_PLC	SOFTSW3 signal after KC_S43_SA023
522001 8C0A041F5D	S4304_FEC_CHG_PLC	SOFTSW4 signal after KC_S43_SA023
522001 8C0A051F5D	S4305_FEC_CHG_PLC	SOFTSW5 signal after KC_S43_SA023
522001 8C0A061F5D	S4306_FEC_CHG_PLC	SOFTSW6 signal after KC_S43_SA023
522001 8C0A071F5D	S4307_FEC_CHG_PLC	SOFTSW7 signal after KC_S43_SA023
522001 8C0A081F5D	S4308_FEC_CHG_PLC	SOFTSW8 signal after KC_S43_SA023

4.3.5 Mapping for IEC 61850 communication

The user can operate the SOFTSW1 function over IEC 61850 communications following mapping using GR-TIEMS. Note that the SOFTSW1 function is designed for the class of "Single Point Controller (SPC)" in the IEC 61850 standard for communication. The user should follow these steps, each of which is discussed below:

Step1: Editing Logical Node

Step2: Mapping output data

Step3: Mapping input data

(i) Editing Logical Node

The user will need to create a logical node (LN) for the SOFTSW1 function. Figure 4.3-22 exemplifies the editing of a LN; the LN "General Input/Output (GGIO)" is chosen for the SOFTSW1 function for IEC 61850 communication. After the user has defined an object "SPCSO", the SOFTSW1 logical node can be saved with the name "GGIO" plus "LN Instance". Create a definition of the object "SPCSO" in SOFTSW1 logical node. Either the SBO mode or the DIR mode can be chosen in the editing for the LN.

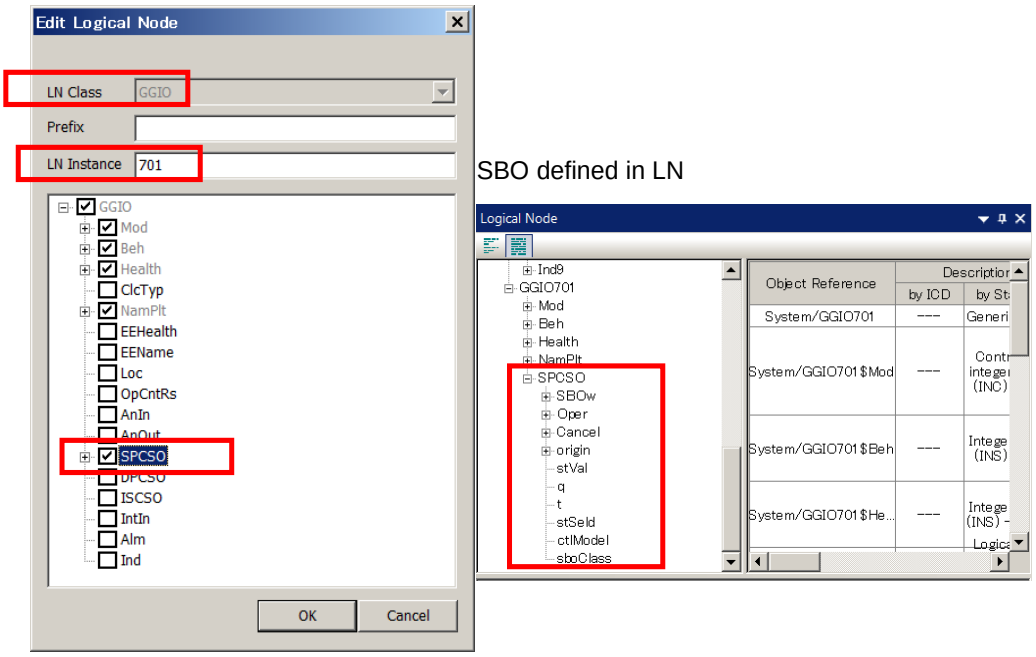
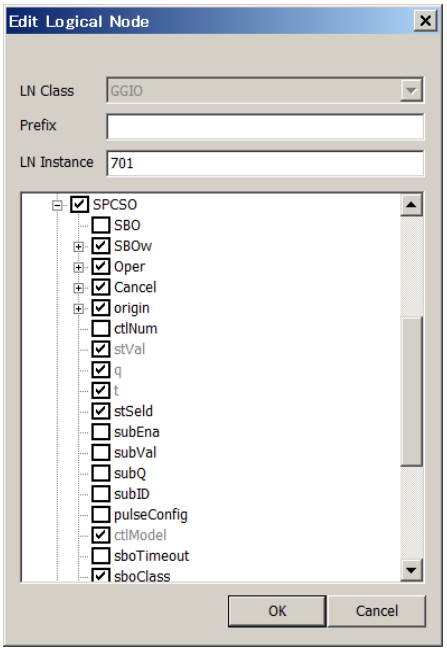


Figure 4.3-22 Defining "SPCSO" object in GGIO701 logic node

(i)-1 Defining SBO mode

Figure 4.3-23 exemplifies the settings in LN "GGIO701" when the SBO mode is required for the SOFTSW1 function. In the SBO control, the user should select the following items for the "GGIO701$SPCSO" using GR-TIEMS;

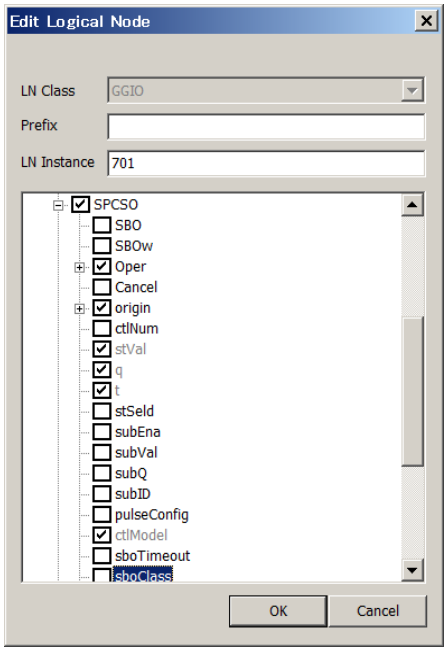


- ✓ SBOw
- ✓ Oper
- ✓ Cancel
- ✓ Origin
- ✓ stSeld
- ✓ sboClass (choice ”operate-once”)
- ✓ ctlmodel (choice ”SBOes or SBOns”)

Figure 4.3-23 LN editing screen for SBO mode (for example)

(i)-2 Defining DIR mode

Figure 4.3-24 exemplifies the settings in LN “GGIO701” when the DIR mode is required for the SOFTSW1 function. In the DIR mode, the following three items should be selected using GR-TIEMS:



- ✓ Oper
- ✓ origin
- ✓ ctlmodel (choice ”DOes or DOns”)

Figure 4.3-24 LN editing screen for DIR mode (for example)

(ii) Mapping output data

The user should group the SOFTSW1 (S4301) signals with regard to GOOSE and REPORT; the user should map them for IEC 61850 communication using GR-TIEMS.

Table 4.3-18 shows the required mapping signals in SOFTSW1 function to the IEC 61850 communications. Figure 4.3-25 shows how to map a signal.

Table 4.3-18 Mapping signals for SPCSO object.

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/GGIO701$SPCSO$origin	orCat	orCategory	ST	522001 310A011008	S4301_ORCAT
Ctrl/GGIO701$SPCSO$origin	orIdent	Octet64	ST	522001 6A0A011009	S4301_ORIDENT
Ctrl/GGIO701$SPCSO	stVal	INT32	ST	522001 000A011001	S4301_STATE
Ctrl/GGIO701$SPCSO	q	Quality	ST	522001 310A011005	S4301_QUALITY
Ctrl/GGIO701$SPCSO	t	Timestamp	ST	522001 900A011006	S4301_TIMESTAMP
Ctrl/GGIO701$SPCSO	stSeld	BOOLEAN	ST	522001 000A011D90	S4301_STSELD

Note: "Status (ST)" is defined in the function constraint (FC) of the IEC 61850 standard.

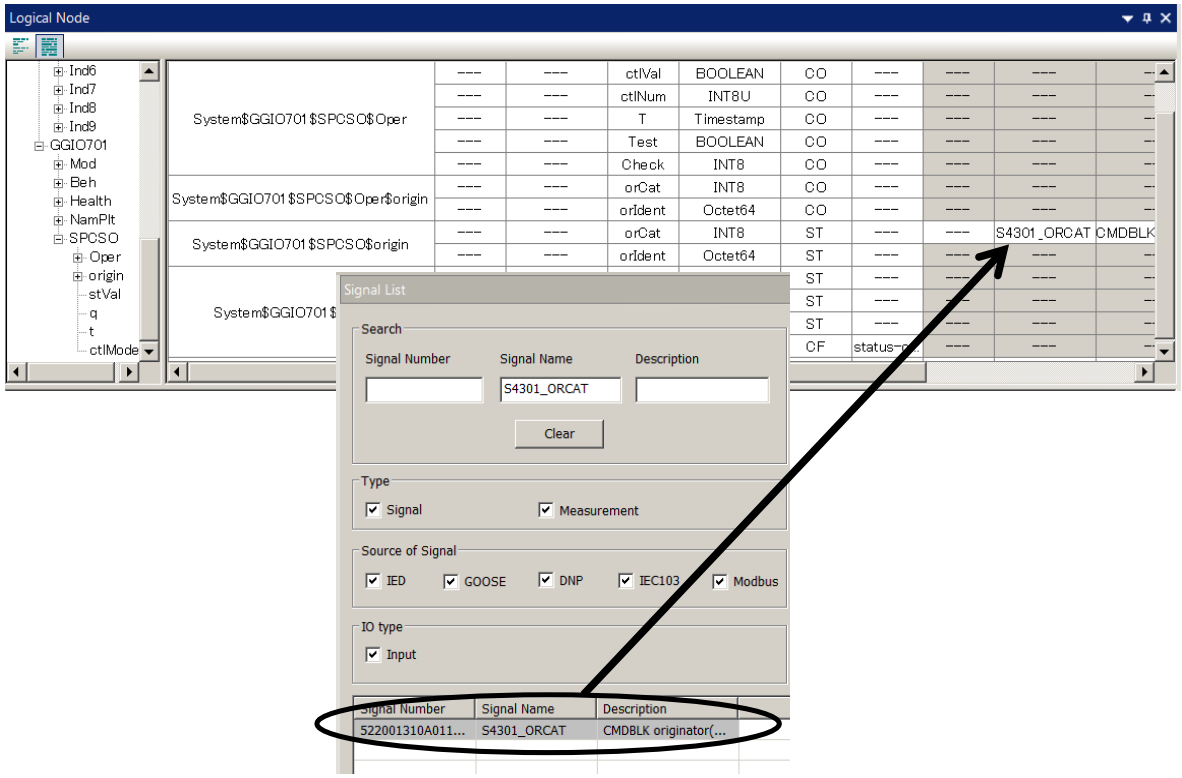


Figure 4.3-25 orCat attribute mapped into SPCSO object of GGIO701

(iii) Mapping input data

The SOFTSW1 function can receive three commands "select, operate, and cancel. Thus, the user should map the input-point "S4301_CONTROL_REQ". Table 4.3-19 shows the input-point "S4301_CONTROL_REQ" and the Object reference "Ctrl/GGIO701$SPCSO"; the user should map the Object reference having attributes CO and CF in FC† to the input-point. Figure 4.3-26 shows how to map a signal.

†Note: The attribute is defined in the IEC 61850 standard; "CO" stands for "Control" and "CF" stands for "Configuration" in the functional constraint (FC).

Table 4.3-19 Mapping signals required for SPCSO object in SOFTSW1 function

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/GGIO701$SPCSO$SBOw	ctlVal	BOOLEAN	CO	522001 700A016D08	S4301_CONTROL_REQ
Ctrl/GGIO701$SPCSO$SBOw	ctlNum	INT8U	CO		
Ctrl/GGIO701$SPCSO$SBOw	T	Timestamp	CO		
Ctrl/GGIO701$SPCSO$SBOw	Test	BOOLEAN	CO		
Ctrl/GGIO701$SPCSO$SBOw	Check	Check	CO		
Ctrl/GGIO701$SPCSO$SBOw$origin	orCat	orCategory	CO		
Ctrl/GGIO701$SPCSO$SBOw$origin	orIdent	Octet64	CO		
Ctrl/GGIO701$SPCSO$Oper	ctlVal	BOOLEAN	CO		
Ctrl/GGIO701$SPCSO$Oper	ctlNum	INT8U	CO		
Ctrl/GGIO701$SPCSO$Oper	T	Timestamp	CO		
Ctrl/GGIO701$SPCSO$Oper	Test	BOOLEAN	CO		
Ctrl/GGIO701$SPCSO$Oper	Check	Check	CO		
Ctrl/GGIO701$SPCSO$Oper$origin	orCat	orCategory	CO		
Ctrl/GGIO701$SPCSO$Oper$origin	orIdent	Octet64	CO		
Ctrl/GGIO701$SPCSO$Cancel	ctlVal	BOOLEAN	CO		
Ctrl/GGIO701$SPCSO$Cancel	ctlNum	INT8U	CO		
Ctrl/GGIO701$SPCSO$Cancel	T	Timestamp	CO		
Ctrl/GGIO701$SPCSO$Cancel	Test	BOOLEAN	CO		
Ctrl/GGIO701$SPCSO$Cancel$origin	orCat	orCategory	CO		
Ctrl/GGIO701$SPCSO$Cancel$origin	orIdent	Octet64	CO		
Ctrl/GGIO701$SPCSO	ctlModel	ctlModel	CF		
Ctrl/GGIO701$SPCSO	sboClass	sboClass	CF		

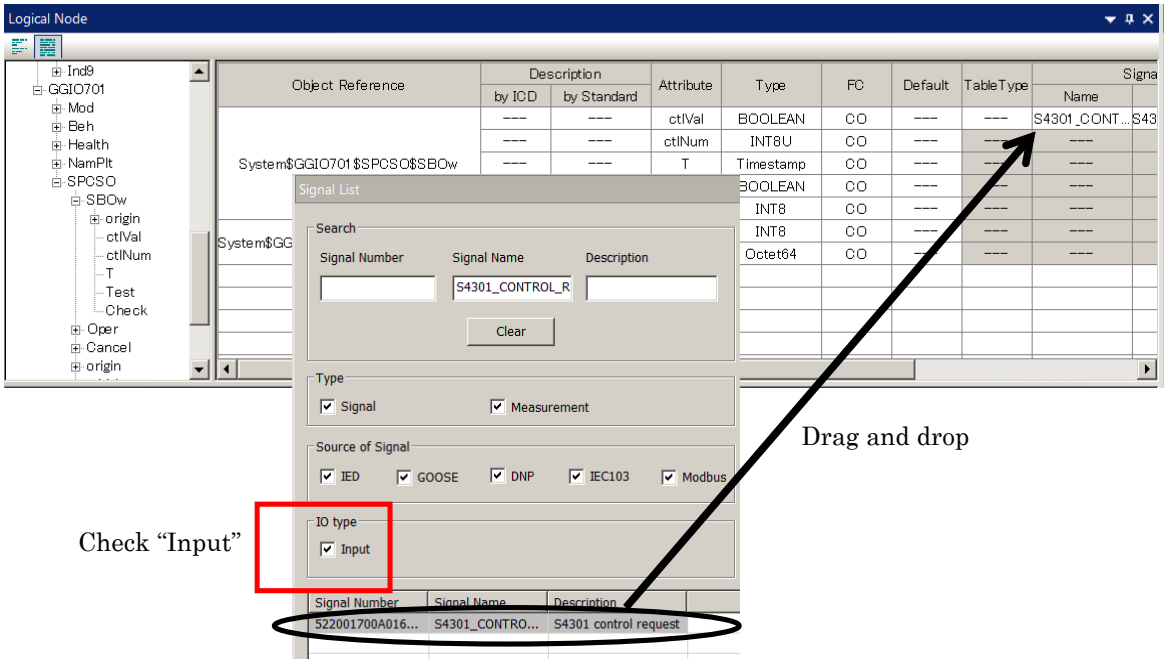


Figure 4.3-26 Input-point mapped for GGIO701

4.3.6 Setting

Settings list for the SOTFSW(FunctionID:522001)

Setting device			Range	Units	Contents	Default setting value	Notes
	CBK (S43-CBK)	S43-CBKEN	Off / On	-	Enabling control command block in SOFTSW1	Off	
		S43-CBKCTRMENU	Off / On	-	Enabling control menu in SOFTSW1	Off	
		S43-CBKCTRAHMI	DIR / SBO	-	Selection of control mode on the screen in SOTFSW1	DIR	
	ICB (S43-ICB)	S43-ICBEN	Off / On	-	Enabling interlock check bypass in SOFTSW2	Off	
		S43-ICBCTRMENU	Off / On	-	Enabling control menu in SOFTSW2	Off	
		S43-ICBCTRAHMI	DIR / SBO	-	Selection of control mode on the screen in SOTFSW2	DIR	
	SYNCBYP (S43-SCB)	S43-SCBEN	Off / On	-	Enabling synchronizing check bypass in SOTFSW3	Off	
		S43-SCBCTRMENU	Off / On	-	Enabling control menu in SOFTSW3	Off	
		S43-SCBCTRAHMI	DIR / SBO	-	Selection of control mode on the screen in SOTFSW3	DIR	
	Switch1 (S43-01)	S4301-EN	Off / On	-	Enabling the function in SOFTSW4	Off	
		S4301-CTRMENU	Off / On	-	Enabling control menu in SOTFSW4	Off	
		S4301-CTRAHMI	DIR / SBO	-	Selection of control mode on the screen in SOTFSW4	DIR	
	Switch2 (S43-02)	S4302-EN	Off / On	-	Enabling the function in SOFTSW5	Off	
		S4302-CTRMENU	Off / On	-	Enabling control menu in SOTFSW5	Off	
		S4302-CTRAHMI	DIR / SBO	-	Selection of control mode on the screen in SOTFSW5	DIR	
	Switch3 (S43-03)	S4303-EN	Off / On	-	Enabling the function in SOFTSW6	Off	
		S4303-CTRMENU	Off / On	-	Enabling control menu in SOTFSW6	Off	
		S4303-CTRAHMI	DIR / SBO	-	Selection of control mode on the screen in SOTFSW6	DIR	
	Switch4 (S43-04)	S4304-EN	Off / On	-	Enabling the function in SOFTSW7	Off	
		S4304-CTRMENU	Off / On	-	Enabling control menu in SOTFSW7	Off	
		S4304-CTRAHMI	DIR / SBO	-	Selection of control mode on the screen in SOTFSW7	DIR	
	Switch5 (S43-05)	S4305-EN	Off / On	-	Enabling the function in SOFTSW8	Off	
		S4305-CTRMENU	Off / On	-	Enabling control menu in SOTFSW8	Off	
		S4305-CTRAHMI	DIR / SBO	-	Selection of control mode on the screen in SOTFSW8	DIR	

4.3.7 Signal

◆ Connection points in PLC logic for S43-CBK

SOFTSW(Function ID:522001)

Element ID	Name	Description
860A01EDE0	S4301_CHG_TO_OFF	CBK change to off
850A01EDE1	S4301_CHG_TO_ON	CBK change to on
820A01ED50	S4301_CTRL_RIGHT	CBK control right from PLC

◆ Connection points in PLC logic for S43-ICB

SOFTSW(Function ID:522001)

Element ID	Name	Description
860A02EDE0	S4302_CHG_TO_OFF	ICB change to off
850A02EDE1	S4302_CHG_TO_ON	ICB change to on
820A02ED50	S4302_CTRL_RIGHT	ICB control right from PLC

◆ Connection points in PLC logic for S43-SCB

SOFTSW(Function ID:522001)

Element ID	Name	Description
860A03EDE0	S4303_CHG_TO_OFF	SCB change to off
850A03EDE1	S4303_CHG_TO_ON	SCB change to on
820A03ED50	S4303_CTRL_RIGHT	SCB control right from PLC

◆ Connection points in PLC logic for S43-01

SOFTSW(Function ID:522001)

Element ID	Name	Description
860A04EDE0	S4304_CHG_TO_OFF	S43-01 change to off
850A04EDE1	S4304_CHG_TO_ON	S43-01 change to on
820A04ED50	S4304_CTRL_RIGHT	S43-01 control right from PLC

◆ Connection points in PLC logic for S43-02

SOFTSW(Function ID:522001)

Element ID	Name	Description
860A05EDE0	S4305_CHG_TO_OFF	S43-02 change to off
850A05EDE1	S4305_CHG_TO_ON	S43-02 change to on
820A05ED50	S4305_CTRL_RIGHT	S43-02 control right from PLC

◆ Connection points in PLC logic for S43-03

SOFTSW(Function ID:522001)

Element ID	Name	Description
860A06EDE0	S4306_CHG_TO_OFF	S43-03 change to off
850A06EDE1	S4306_CHG_TO_ON	S43-03 change to on
820A06ED50	S4306_CTRL_RIGHT	S43-03 control right from PLC

◆ Connection points in PLC logic for S43-04

SOFTSW(Function ID:522001)

Element ID	Name	Description
860A07EDE0	S4307_CHG_TO_OFF	S43-04 change to off
850A07EDE1	S4307_CHG_TO_ON	S43-04 change to on
820A07ED50	S4307_CTRL_RIGHT	S43-04 control right from PLC

◆ Connection points in PLC logic for S43-05

SOFTSW(Function ID:522001)

Element ID	Name	Description
860A08EDE0	S4308_CHG_TO_OFF	S43-05 change to off
850A08EDE1	S4308_CHG_TO_ON	S43-05 change to on
820A08ED50	S4308_CTRL_RIGHT	S43-05 control right from PLC

◆ Signal monitoring points for S43-CBK

SOFTSW(Function ID:522001)

Element ID	Name	Description
8100011EC0	S4301_CBKEN	CBK control command block switch Enable
8500011E94	S4301_CC_EX	CBK cancel command execute
8700011E96	S4301_CC_FS	CBK cancel fail signal
8600011E95	S4301_CC_SS	CBK cancel success signal
8800011E9B	S4301_CC_ST_ERR	CBK cancel command mode error
8B00011EA2	S4301_CTR_SGU	CBK control logic stage(under selection)
8F00011E0B	S4301_DIR_RMT	CBK direct operate control setting received by remote
8C00011F45	S4301_EC_LCD	CBK execute command from LCD
8500011F44	S4301_EC_RMT	CBK execute command from REMOTE
8100011E85	S4301_ECF_FCT_EIS	CBK off direction execute command fail factor signal
8000011E8B	S4301_ECF_FCT_FLG	CBK execute command mode error
8000011E93	S4301_EX_CMP	CBK execute complete signal
8F00011F41	S4301_EX_CMP_TM0	CBK time limit over of execute complete
8800011E92	S4301_EX_FS	CBK execute fail signal
8700011E90	S4301_EX_SS	CBK execute success signal
8A00011F48	S4301_FEC_CHG	CBK off direction change signal
8000011E81	S4301_FEC_OK_CSF	CBK off direction execute success signal
8A00011E47	S4301_FEC_RCV	CBK off direction execute command received
8500011E24	S4301_FEC_RCV_LCD	CBK off direction execute command received from LCD
8300011E10	S4301_FEC_RCV_RMT	CBK off direction execute command received from remote
8400011E21	S4301_FSC_RCV_LCD	CBK off direction select command received from LCD
8000011E01	S4301_FSC_RCV_RMT	CBK off direction select command received from remote
8D00011E73	S4301_FSD_CSF	CBK off direction selected condition signal by fixedlogic
8200011E44	S4301_FSE_RCV	CBK off direction select and execute command received
8E00011E78	S4301_FSF_CSF	CBK off direction select fail condition signal by fixedlogic
8A00011E40	S4301_NSC_RCV	CBK no direction select command received
8100011E20	S4301_NSC_RCV_LCD	CBK no direction select command received from LCD
8000011E00	S4301_NSC_RCV_RMT	CBK no direction select command received from remote
8100011E86	S4301_OCF_FCT_EIS	CBK on direction execute command fail factor signal

◆ Signal monitoring points for S43-CBK

SOFTSW(Function ID:522001)

Element ID	Name	Description
8900011F47	S4301_OEC_CHG	CBK on direction change signal
8000011E82	S4301_OEC_OK_CSF	CBK on direction execute success signal
8B00011E48	S4301_OEC_RCV	CBK on direction execute command received
8100011E25	S4301_OEC_RCV_LCD	CBK on direction execute command received from LCD
8700011E12	S4301_OEC_RCV_RMT	CBK on direction execute command received from remote
8000011E22	S4301_OSC_RCV_LCD	CBK on direction select command received from LCD
8200011E03	S4301_OSC_RCV_RMT	CBK on direction select command received from remote
8F00011E74	S4301_OSD_CSF	CBK on direction selected condition signal by fixedlogic
8000011E45	S4301_OSE_RCV	CBK on direction select and execute command received
8F00011E79	S4301_OSF_CSF	CBK on direction select fail condition signal by fixedlogic
8F00011E0A	S4301_SBO_RMT	CBK select before operate control setting received by remote
8B00011F43	S4301_SC_LCD	CBK select command from LCD
8400011F42	S4301_SC_RMT	CBK select command from REMOTE
8000011E7B	S4301_SC_ST_ERR	CBK select command mode error
8000011E76	S4301_SLD_CS	CBK selected condition signal
8E00011F40	S4301_SLD_TM0	CBK time limit over of select complete
8100011E84	S4301_SLF_CS	CBK select fail condition signal
8700011E97	S4301_SLF_FCT_EIS	CBK select fail factor signal except check
8100011F46	S4301_SLR_CSF	CBK select cancel factor

◆ Signal monitoring points for S43-ICB

SOFTSW(Function ID:522001)

Element ID	Name	Description
8100021EC0	S4302_CBKEN	ICB control command block switch Enable
8500021E94	S4302_CC_EX	ICB cancel command execute
8700021E96	S4302_CC_FS	ICB cancel fail signal
8600021E95	S4302_CC_SS	ICB cancel success signal
8800021E9B	S4302_CC_ST_ERR	ICB cancel command mode error
8B00021EA2	S4302_CTR_SGU	ICB control logic stage(under selection)
8F00021E0B	S4302_DIR_RMT	ICB direct operate control setting received by remote
8C00021F45	S4302_EC_LCD	ICB execute command from LCD
8500021F44	S4302_EC_RMT	ICB execute command from REMOTE
8100021E85	S4302_ECF_FCT_EIS	ICB off direction execute command fail factor signal
8000021E8B	S4302_ECF_FCT_FLG	ICB execute command mode error
8000021E93	S4302_EX_CMP	ICB execute complete signal
8F00021F41	S4302_EX_CMP_TM0	ICB time limit over of execute complete
8800021E92	S4302_EX_FS	ICB execute fail signal
8700021E90	S4302_EX_SS	ICB execute success signal
8A00021F48	S4302_FEC_CHG	ICB off direction change signal
8000021E81	S4302_FEC_OK_CSF	ICB off direction execute success signal
8A00021E47	S4302_FEC_RCV	ICB off direction execute command received
8500021E24	S4302_FEC_RCV_LCD	ICB off direction execute command received from LCD
8300021E10	S4302_FEC_RCV_RMT	ICB off direction execute command received from remote
8400021E21	S4302_FSC_RCV_LCD	ICB off direction select command received from LCD
8000021E01	S4302_FSC_RCV_RMT	ICB off direction select command received from remote

◆ Signal monitoring points for S43-ICB

SOFTSW(Function ID:522001)

Element ID	Name	Description
8D00021E73	S4302_FSD_CSF	ICB off direction selected condition signal by fixedlogic
8200021E44	S4302_FSE_RCV	ICB off direction select and execute command received
8E00021E78	S4302_FSF_CSF	ICB off direction select fail condition signal by fixedlogic
8A00021E40	S4302_NSC_RCV	ICB no direction select command received
8100021E20	S4302_NSC_RCV_LCD	ICB no direction select command received from LCD
8000021E00	S4302_NSC_RCV_RMT	ICB no direction select command received from remote
8100021E86	S4302_OCF_FCT_EIS	ICB on direction execute command fail factor signal
8900021F47	S4302_OEC_CHG	ICB on direction change signal
8000021E82	S4302_OEC_OK_CSF	ICB on direction execute success signal
8B00021E48	S4302_OEC_RCV	ICB on direction execute command received
8100021E25	S4302_OEC_RCV_LCD	ICB on direction execute command received from LCD
8700021E12	S4302_OEC_RCV_RMT	ICB on direction execute command received from remote
8000021E22	S4302_OSC_RCV_LCD	ICB on direction select command received from LCD
8200021E03	S4302_OSC_RCV_RMT	ICB on direction select command received from remote
8F00021E74	S4302_OSD_CSF	ICB on direction selected condition signal by fixedlogic
8000021E45	S4302_OSE_RCV	ICB on direction select and execute command received
8F00021E79	S4302_OSF_CSF	ICB on direction select fail condition signal by fixedlogic
8F00021E0A	S4302_SBO_RMT	ICB select before operate control setting received by remote
8B00021F43	S4302_SC_LCD	ICB select command from LCD
8400021F42	S4302_SC_RMT	ICB select command from REMOTE
8000021E7B	S4302_SC_ST_ERR	ICB select command mode error
8000021E76	S4302_SLD_CS	ICB selected condition signal
8E00021F40	S4302_SLD_TM0	ICB time limit over of select complete
8100021E84	S4302_SLF_CS	ICB select fail condition signal
8700021E97	S4302_SLF_FCT_EIS	ICB select fail factor signal except check
8100021F46	S4302_SLR_CSF	ICB select cancel factor

◆ Signal monitoring points for S43-SCB

SOFTSW(Function ID:522001)

Element ID	Name	Description
8100031EC0	S4303_CBKEN	SCB control command block switch Enable
8500031E94	S4303_CC_EX	SCB cancel command execute
8700031E96	S4303_CC_FS	SCB cancel fail signal
8600031E95	S4303_CC_SS	SCB cancel success signal
8800031E9B	S4303_CC_ST_ERR	SCB cancel command mode error
8B00031EA2	S4303_CTR_SGU	SCB control logic stage(under selection)
8F00031E0B	S4303_DIR_RMT	SCB direct operate control setting received by remote
8C00031F45	S4303_EC_LCD	SCB execute command from LCD
8500031F44	S4303_EC_RMT	SCB execute command from REMOTE
8100031E85	S4303_ECF_FCT_EIS	SCB off direction execute command fail factor signal
8000031E8B	S4303_ECF_FCT_FLG	SCB execute command mode error
8000031E93	S4303_EX_CMP	SCB execute complete signal
8F00031F41	S4303_EX_CMP_TM0	SCB time limit over of execute complete
8800031E92	S4303_EX_FS	SCB execute fail signal
8700031E90	S4303_EX_SS	SCB execute success signal

◆ Signal monitoring points for S43-SCB

SOFTSW(Function ID:522001)

Element ID	Name	Description
8A00031F48	S4303_FEC_CHG	SCB off direction change signal
8000031E81	S4303_FEC_OK_CSF	SCB off direction execute success signal
8A00031E47	S4303_FEC_RCV	SCB off direction execute command received
8500031E24	S4303_FEC_RCV_LCD	SCB off direction execute command received from LCD
8300031E10	S4303_FEC_RCV_RMT	SCB off direction execute command received from remote
8400031E21	S4303_FSC_RCV_LCD	SCB off direction select command received from LCD
8000031E01	S4303_FSC_RCV_RMT	SCB off direction select command received from remote
8D00031E73	S4303_FSD_CSF	SCB off direction selected condition signal by fixedlogic
8200031E44	S4303_FSE_RCV	SCB off direction select and execute command received
8E00031E78	S4303_FSF_CSF	SCB off direction select fail condition signal by fixedlogic
8A00031E40	S4303_NSC_RCV	SCB no direction select command received
8100031E20	S4303_NSC_RCV_LCD	SCB no direction select command received from LCD
8000031E00	S4303_NSC_RCV_RMT	SCB no direction select command received from remote
8100031E86	S4303_OCF_FCT_EIS	SCB on direction execute command fail factor signal
8900031F47	S4303_OEC_CHG	SCB on direction change signal
8000031E82	S4303_OEC_OK_CSF	SCB on direction execute success signal
8B00031E48	S4303_OEC_RCV	SCB on direction execute command received
8100031E25	S4303_OEC_RCV_LCD	SCB on direction execute command received from LCD
8700031E12	S4303_OEC_RCV_RMT	SCB on direction execute command received from remote
8000031E22	S4303_OSC_RCV_LCD	SCB on direction select command received from LCD
8200031E03	S4303_OSC_RCV_RMT	SCB on direction select command received from remote
8F00031E74	S4303_OSD_CSF	SCB on direction selected condition signal by fixedlogic
8000031E45	S4303_OSE_RCV	SCB on direction select and execute command received
8F00031E79	S4303_OSF_CSF	SCB on direction select fail condition signal by fixedlogic
8F00031E0A	S4303_SBO_RMT	SCB select before operate control setting received by remote
8B00031F43	S4303_SC_LCD	SCB select command from LCD
8400031F42	S4303_SC_RMT	SCB select command from REMOTE
8000031E7B	S4303_SC_ST_ERR	SCB select command mode error
8000031E76	S4303_SLD_CS	SCB selected condition signal
8E00031F40	S4303_SLD_TM0	SCB time limit over of select complete
8100031E84	S4303_SLF_CS	SCB select fail condition signal
8700031E97	S4303_SLF_FCT_EIS	SCB select fail factor signal except check
8100031F46	S4303_SLR_CSF	SCB select cancel factor

◆ Signal monitoring points for S43-01

SOFTSW(Function ID:522001)

Element ID	Name	Description
8100041EC0	S4304_CBKEN	S43-01 control command block switch Enable
8500041E94	S4304_CC_EX	S43-01 cancel command execute
8700041E96	S4304_CC_FS	S43-01 cancel fail signal
8600041E95	S4304_CC_SS	S43-01 cancel success signal
8800041E9B	S4304_CC_ST_ERR	S43-01 cancel command mode error
8B00041EA2	S4304_CTR_SGU	S43-01 control logic stage(under selection)
8F00041E0B	S4304_DIR_RMT	S43-01 direct operate control setting received by remote
8C00041F45	S4304_EC_LCD	S43-01 execute command from LCD

◆ Signal monitoring points for S43-01

SOFTSW(Function ID:522001)

Element ID	Name	Description
8500041F44	S4304_EC_RMT	S43-01 execute command from REMOTE
8100041E85	S4304_ECF_FCT_EIS	S43-01 off direction execute command fail factor signal
8000041E8B	S4304_ECF_FCT_FLG	S43-01 execute command mode error
8000041E93	S4304_EX_CMP	S43-01 execute complete signal
8F00041F41	S4304_EX_CMP_TM0	S43-01 time limit over of execute complete
8800041E92	S4304_EX_FS	S43-01 execute fail signal
8700041E90	S4304_EX_SS	S43-01 execute success signal
8A00041F48	S4304_FEC_CHG	S43-01 off direction change signal
8000041E81	S4304_FEC_OK_CSF	S43-01 off direction execute success signal
8A00041E47	S4304_FEC_RCV	S43-01 off direction execute command received
8500041E24	S4304_FEC_RCV_LCD	S43-01 off direction execute command received from LCD
8300041E10	S4304_FEC_RCV_RMT	S43-01 off direction execute command received from remote
8400041E21	S4304_FSC_RCV_LCD	S43-01 off direction select command received from LCD
8000041E01	S4304_FSC_RCV_RMT	S43-01 off direction select command received from remote
8D00041E73	S4304_FSD_CSF	S43-01 off direction selected condition signal by fixedlogic
8200041E44	S4304_FSE_RCV	S43-01 off direction select and execute command received
8E00041E78	S4304_FSF_CSF	S43-01 off direction select fail condition signal by fixedlogic
8A00041E40	S4304_NSC_RCV	S43-01 no direction select command received
8100041E20	S4304_NSC_RCV_LCD	S43-01 no direction select command received from LCD
8000041E00	S4304_NSC_RCV_RMT	S43-01 no direction select command received from remote
8100041E86	S4304_OCF_FCT_EIS	S43-01 on direction execute command fail factor signal
8900041F47	S4304_OEC_CHG	S43-01 on direction change signal
8000041E82	S4304_OEC_OK_CSF	S43-01 on direction execute success signal
8B00041E48	S4304_OEC_RCV	S43-01 on direction execute command received
8100041E25	S4304_OEC_RCV_LCD	S43-01 on direction execute command received from LCD
8700041E12	S4304_OEC_RCV_RMT	S43-01 on direction execute command received from remote
8000041E22	S4304_OSC_RCV_LCD	S43-01 on direction select command received from LCD
8200041E03	S4304_OSC_RCV_RMT	S43-01 on direction select command received from remote
8F00041E74	S4304_OSD_CSF	S43-01 on direction selected condition signal by fixedlogic
8000041E45	S4304_OSE_RCV	S43-01 on direction select and execute command received
8F00041E79	S4304_OSF_CSF	S43-01 on direction select fail condition signal by fixedlogic
8F00041E0A	S4304_SBO_RMT	S43-01 select before operate control setting received by remote
8B00041F43	S4304_SC_LCD	S43-01 select command from LCD
8400041F42	S4304_SC_RMT	S43-01 select command from REMOTE
8000041E7B	S4304_SC_ST_ERR	S43-01 select command mode error
8000041E76	S4304_SLD_CS	S43-01 selected condition signal
8E00041F40	S4304_SLD_TM0	S43-01 time limit over of select complete
8100041E84	S4304_SLF_CS	S43-01 select fail condition signal
8700041E97	S4304_SLF_FCT_EIS	S43-01 select fail factor signal except check
8100041F46	S4304_SLR_CSF	S43-01 select cancel factor

◆ Signal monitoring points for S43-02

SOFTSW(Function ID:522001)

Element ID	Name	Description
8100051EC0	S4305_CBKEN	SOFT 43 switch2 control command block switch Enable

◆ Signal monitoring points for S43-02

SOFTSW(Function ID:522001)

Element ID	Name	Description
8500051E94	S4305_CC_EX	SOFT 43 switch2 cancel command execute
8700051E96	S4305_CC_FS	S43-02 cancel fail signal
8600051E95	S4305_CC_SS	S43-02 cancel success signal
8800051E9B	S4305_CC_ST_ERR	S43-02 cancel command mode error
8B00051EA2	S4305_CTR_SGU	S43-02 control logic stage(under selection)
8F00051E0B	S4305_DIR_RMT	S43-02 direct operate control setting received by remote
8C00051F45	S4305_EC_LCD	S43-02 execute command from LCD
8500051F44	S4305_EC_RMT	S43-02 execute command from REMOTE
8100051E85	S4305_ECF_FCT_EIS	S43-02 off direction execute command fail factor signal
8000051E8B	S4305_ECF_FCT_FLG	S43-02 execute command mode error
8000051E93	S4305_EX_CMP	S43-02 execute complete signal
8F00051F41	S4305_EX_CMP_TM0	S43-02 time limit over of execute complete
8800051E92	S4305_EX_FS	S43-02 execute fail signal
8700051E90	S4305_EX_SS	S43-02 execute success signal
8A00051F48	S4305_FEC_CHG	S43-02 off direction change signal
8000051E81	S4305_FEC_OK_CSF	S43-02 off direction execute success signal
8A00051E47	S4305_FEC_RCV	S43-02 off direction execute command received
8500051E24	S4305_FEC_RCV_LCD	S43-02 off direction execute command received from LCD
8300051E10	S4305_FEC_RCV_RMT	S43-02 off direction execute command received from remote
8400051E21	S4305_FSC_RCV_LCD	S43-02 off direction select command received from LCD
8000051E01	S4305_FSC_RCV_RMT	S43-02 off direction select command received from remote
8D00051E73	S4305_FSD_CSF	S43-02 off direction selected condition signal by fixedlogic
8200051E44	S4305_FSE_RCV	S43-02 off direction select and execute command received
8E00051E78	S4305_FSF_CSF	S43-02 off direction select fail condition signal by fixedlogic
8A00051E40	S4305_NSC_RCV	S43-02 no direction select command received
8100051E20	S4305_NSC_RCV_LCD	S43-02 no direction select command received from LCD
8000051E00	S4305_NSC_RCV_RMT	S43-02 no direction select command received from remote
8100051E86	S4305_OCF_FCT_EIS	S43-02 on direction execute command fail factor signal
8900051F47	S4305_OEC_CHG	S43-02 on direction change signal
8000051E82	S4305_OEC_OK_CSF	S43-02 on direction execute success signal
8B00051E48	S4305_OEC_RCV	S43-02 on direction execute command received
8100051E25	S4305_OEC_RCV_LCD	S43-02 on direction execute command received from LCD
8700051E12	S4305_OEC_RCV_RMT	S43-02 on direction execute command received from remote
8000051E22	S4305_OSC_RCV_LCD	S43-02 on direction select command received from LCD
8200051E03	S4305_OSC_RCV_RMT	S43-02 on direction select command received from remote
8F00051E74	S4305_OSD_CSF	S43-02 on direction selected condition signal by fixedlogic
8000051E45	S4305_OSE_RCV	S43-02 on direction select and execute command received
8F00051E79	S4305_OSF_CSF	S43-02 on direction select fail condition signal by fixedlogic
8F00051E0A	S4305_SBO_RMT	S43-02 select before operate control setting received by remote
8B00051F43	S4305_SC_LCD	S43-02 select command from LCD
8400051F42	S4305_SC_RMT	S43-02 select command from REMOTE
8000051E7B	S4305_SC_ST_ERR	S43-02 select command mode error
8000051E76	S4305_SLD_CS	S43-02 selected condition signal
8E00051F40	S4305_SLD_TM0	S43-02 time limit over of select complete
8100051E84	S4305_SLF_CS	S43-02 select fail condition signal

◆ Signal monitoring points for S43-02

SOFTSW(Function ID:522001)

Element ID	Name	Description
8700051E97	S4305_SLF_FCT_EIS	S43-02 select fail factor signal except check
8100051F46	S4305_SLR_CSF	S43-02 select cancel factor

◆ Signal monitoring points for S43-03

SOFTSW(Function ID:522001)

Element ID	Name	Description
8100061EC0	S4306_CBKEN	S43-03 control command block switch Enable
8500061E94	S4306_CC_EX	S43-03 cancel command execute
8700061E96	S4306_CC_FS	S43-03 cancel fail signal
8600061E95	S4306_CC_SS	S43-03 cancel success signal
8800061E9B	S4306_CC_ST_ERR	S43-03 cancel command mode error
8B00061EA2	S4306_CTR_SGU	S43-03 control logic stage(under selection)
8F00061E0B	S4306_DIR_RMT	S43-03 direct operate control setting received by remote
8C00061F45	S4306_EC_LCD	S43-03 execute command from LCD
8500061F44	S4306_EC_RMT	S43-03 execute command from REMOTE
8100061E85	S4306_ECF_FCT_EIS	S43-03 off direction execute command fail factor signal
8000061E8B	S4306_ECF_FCT_FLG	S43-03 execute command mode error
8000061E93	S4306_EX_CMP	S43-03 execute complete signal
8F00061F41	S4306_EX_CMP_TM0	S43-03 time limit over of execute complete
8800061E92	S4306_EX_FS	S43-03 execute fail signal
8700061E90	S4306_EX_SS	S43-03 execute success signal
8A00061F48	S4306_FEC_CHG	S43-03 off direction change signal
8000061E81	S4306_FEC_OK_CSF	S43-03 off direction execute success signal
8A00061E47	S4306_FEC_RCV	S43-03 off direction execute command received
8500061E24	S4306_FEC_RCV_LCD	S43-03 off direction execute command received from LCD
8300061E10	S4306_FEC_RCV_RMT	S43-03 off direction execute command received from remote
8400061E21	S4306_FSC_RCV_LCD	S43-03 off direction select command received from LCD
8000061E01	S4306_FSC_RCV_RMT	S43-03 off direction select command received from remote
8D00061E73	S4306_FSD_CSF	S43-03 off direction selected condition signal by fixedlogic
8200061E44	S4306_FSE_RCV	S43-03 off direction select and execute command received
8E00061E78	S4306_FSF_CSF	S43-03 off direction select fail condition signal by fixedlogic
8A00061E40	S4306_NSC_RCV	S43-03 no direction select command received
8100061E20	S4306_NSC_RCV_LCD	S43-03 no direction select command received from LCD
8000061E00	S4306_NSC_RCV_RMT	S43-03 no direction select command received from remote
8100061E86	S4306_OCF_FCT_EIS	S43-03 on direction execute command fail factor signal
8900061F47	S4306_OEC_CHG	S43-03 on direction change signal
8000061E82	S4306_OEC_OK_CSF	S43-03 on direction execute success signal
8B00061E48	S4306_OEC_RCV	S43-03 on direction execute command received
8100061E25	S4306_OEC_RCV_LCD	S43-03 on direction execute command received from LCD
8700061E12	S4306_OEC_RCV_RMT	S43-03 on direction execute command received from remote
8000061E22	S4306_OSC_RCV_LCD	S43-03 on direction select command received from LCD
8200061E03	S4306_OSC_RCV_RMT	S43-03 on direction select command received from remote
8F00061E74	S4306_OSD_CSF	S43-03 on direction selected condition signal by fixedlogic
8000061E45	S4306_OSE_RCV	S43-03 on direction select and execute command received
8F00061E79	S4306_OSF_CSF	S43-03 on direction select fail condition signal by fixedlogic

◆ Signal monitoring points for S43-03

SOFTSW(Function ID:522001)

Element ID	Name	Description
8F00061E0A	S4306_SBO_RMT	S43-03 select before operate control setting received by remote
8B00061F43	S4306_SC_LCD	S43-03 select command from LCD
8400061F42	S4306_SC_RMT	S43-03 select command from REMOTE
8000061E7B	S4306_SC_ST_ERR	S43-03 select command mode error
8000061E76	S4306_SLD_CS	S43-03 selected condition signal
8E00061F40	S4306_SLD_TM0	S43-03 time limit over of select complete
8100061E84	S4306_SLF_CS	S43-03 select fail condition signal
8700061E97	S4306_SLF_FCT_EIS	S43-03 select fail factor signal except check
8100061F46	S4306_SLR_CSF	S43-03 select cancel factor

◆ Signal monitoring points for S43-04

SOFTSW(Function ID:522001)

Element ID	Name	Description
8100071EC0	S4307_CBKEN	S43-04 control command block switch Enable
8500071E94	S4307_CC_EX	S43-04 cancel command execute
8700071E96	S4307_CC_FS	S43-04 cancel fail signal
8600071E95	S4307_CC_SS	S43-04 cancel success signal
8800071E9B	S4307_CC_ST_ERR	S43-04 cancel command mode error
8B00071EA2	S4307_CTR_SGU	S43-04 control logic stage(under selection)
8F00071E0B	S4307_DIR_RMT	S43-04 direct operate control setting received by remote
8C00071F45	S4307_EC_LCD	S43-04 execute command from LCD
8500071F44	S4307_EC_RMT	S43-04 execute command from REMOTE
8100071E85	S4307_ECF_FCT_EIS	S43-04 off direction execute command fail factor signal
8000071E8B	S4307_ECF_FCT_FLG	S43-04 execute command mode error
8000071E93	S4307_EX_CMP	S43-04 execute complete signal
8F00071F41	S4307_EX_CMP_TM0	S43-04 time limit over of execute complete
8800071E92	S4307_EX_FS	S43-04 execute fail signal
8700071E90	S4307_EX_SS	S43-04 execute success signal
8A00071F48	S4307_FEC_CHG	S43-04 off direction change signal
8000071E81	S4307_FEC_OK_CSF	S43-04 off direction execute success signal
8A00071E47	S4307_FEC_RCV	S43-04 off direction execute command received
8500071E24	S4307_FEC_RCV_LCD	S43-04 off direction execute command received from LCD
8300071E10	S4307_FEC_RCV_RMT	S43-04 off direction execute command received from remote
8400071E21	S4307_FSC_RCV_LCD	S43-04 off direction select command received from LCD
8000071E01	S4307_FSC_RCV_RMT	S43-04 off direction select command received from remote
8D00071E73	S4307_FSD_CSF	S43-04 off direction selected condition signal by fixedlogic
8200071E44	S4307_FSE_RCV	S43-04 off direction select and execute command received
8E00071E78	S4307_FSF_CSF	S43-04 off direction select fail condition signal by fixedlogic
8A00071E40	S4307_NSC_RCV	S43-04 no direction select command received
8100071E20	S4307_NSC_RCV_LCD	S43-04 no direction select command received from LCD
8000071E00	S4307_NSC_RCV_RMT	S43-04 no direction select command received from remote
8100071E86	S4307_OCF_FCT_EIS	S43-04 on direction execute command fail factor signal
8900071F47	S4307_OEC_CHG	S43-04 on direction change signal
8000071E82	S4307_OEC_OK_CSF	S43-04 on direction execute success signal
8B00071E48	S4307_OEC_RCV	S43-04 on direction execute command received

◆ Signal monitoring points for S43-04

SOFTSW(Function ID:522001)

Element ID	Name	Description
8100071E25	S4307_OEC_RCV_LCD	S43-04 on direction execute command received from LCD
8700071E12	S4307_OEC_RCV_RMT	S43-04 on direction execute command received from remote
8000071E22	S4307_OSC_RCV_LCD	S43-04 on direction select command received from LCD
8200071E03	S4307_OSC_RCV_RMT	S43-04 on direction select command received from remote
8F00071E74	S4307_OSD_CSF	S43-04 on direction selected condition signal by fixedlogic
8000071E45	S4307_OSE_RCV	S43-04 on direction select and execute command received
8F00071E79	S4307_OSF_CSF	S43-04 on direction select fail condition signal by fixedlogic
8F00071E0A	S4307_SBO_RMT	S43-04 select before operate control setting received by remote
8B00071F43	S4307_SC_LCD	S43-04 select command from LCD
8400071F42	S4307_SC_RMT	S43-04 select command from REMOTE
8000071E7B	S4307_SC_ST_ERR	S43-04 select command mode error
8000071E76	S4307_SLD_CS	S43-04 selected condition signal
8E00071F40	S4307_SLD_TM0	S43-04 time limit over of select complete
8100071E84	S4307_SLF_CS	S43-04 select fail condition signal
8700071E97	S4307_SLF_FCT_EIS	S43-04 select fail factor signal except check
8100071F46	S4307_SLR_CSF	S43-04 select cancel factor

◆ Signal monitoring points for S43-05

SOFTSW(Function ID:522001)

Element ID	Name	Description
8100081EC0	S4308_CBKEN	S43-05 control command block switch Enable
8500081E94	S4308_CC_EX	S43-05 cancel command execute
8700081E96	S4308_CC_FS	S43-05 cancel fail signal
8600081E95	S4308_CC_SS	S43-05 cancel success signal
8800081E9B	S4308_CC_ST_ERR	S43-05 cancel command mode error
8B00081EA2	S4308_CTR_SGU	S43-05 control logic stage(under selection)
8F00081E0B	S4308_DIR_RMT	S43-05 direct operate control setting received by remote
8C00081F45	S4308_EC_LCD	S43-05 execute command from LCD
8500081F44	S4308_EC_RMT	S43-05 execute command from REMOTE
8100081E85	S4308_ECF_FCT_EIS	S43-05 off direction execute command fail factor signal
8000081E8B	S4308_ECF_FCT_FLG	S43-05 execute command mode error
8000081E93	S4308_EX_CMP	S43-05 execute complete signal
8F00081F41	S4308_EX_CMP_TM0	S43-05 time limit over of execute complete
8800081E92	S4308_EX_FS	S43-05 execute fail signal
8700081E90	S4308_EX_SS	S43-05 execute success signal
8A00081F48	S4308_FEC_CHG	S43-05 off direction change signal
8000081E81	S4308_FEC_OK_CSF	S43-05 off direction execute success signal
8A00081E47	S4308_FEC_RCV	S43-05 off direction execute command received
8500081E24	S4308_FEC_RCV_LCD	S43-05 off direction execute command received from LCD
8300081E10	S4308_FEC_RCV_RMT	S43-05 off direction execute command received from remote
8400081E21	S4308_FSC_RCV_LCD	S43-05 off direction select command received from LCD
8000081E01	S4308_FSC_RCV_RMT	S43-05 off direction select command received from remote
8D00081E73	S4308_FSD_CSF	S43-05 off direction selected condition signal by fixedlogic
8200081E44	S4308_FSE_RCV	S43-05 off direction select and execute command received
8E00081E78	S4308_FSF_CSF	S43-05 off direction select fail condition signal by fixedlogic

◆ Signal monitoring points for S43-05

SOFTSW(Function ID:522001)

Element ID	Name	Description
8A00081E40	S4308_NSC_RCV	S43-05 no direction select command received
8100081E20	S4308_NSC_RCV_LCD	S43-05 no direction select command received from LCD
8000081E00	S4308_NSC_RCV_RMT	S43-05 no direction select command received from remote
8100081E86	S4308_OCF_FCT_EIS	S43-05 on direction execute command fail factor signal
8900081F47	S4308_OEC_CHG	S43-05 on direction change signal
8000081E82	S4308_OEC_OK_CSF	S43-05 on direction execute success signal
8B00081E48	S4308_OEC_RCV	S43-05 on direction execute command received
8100081E25	S4308_OEC_RCV_LCD	S43-05 on direction execute command received from LCD
8700081E12	S4308_OEC_RCV_RMT	S43-05 on direction execute command received from remote
8000081E22	S4308_OSC_RCV_LCD	S43-05 on direction select command received from LCD
8200081E03	S4308_OSC_RCV_RMT	S43-05 on direction select command received from remote
8F00081E74	S4308_OSD_CSF	S43-05 on direction selected condition signal by fixedlogic
8000081E45	S4308_OSE_RCV	S43-05 on direction select and execute command received
8F00081E79	S4308_OSF_CSF	S43-05 on direction select fail condition signal by fixedlogic
8F00081E0A	S4308_SBO_RMT	S43-05 select before operate control setting received by remote
8B00081F43	S4308_SC_LCD	S43-05 select command from LCD
8400081F42	S4308_SC_RMT	S43-05 select command from REMOTE
8000081E7B	S4308_SC_ST_ERR	S43-05 select command mode error
8000081E76	S4308_SLD_CS	S43-05 selected condition signal
8E00081F40	S4308_SLD_TM0	S43-05 time limit over of select complete
8100081E84	S4308_SLF_CS	S43-05 select fail condition signal
8700081E97	S4308_SLF_FCT_EIS	S43-05 select fail factor signal except check
8100081F46	S4308_SLR_CSF	S43-05 select cancel factor

4.4 Operation time reset function (OPTIMRSTCTRL)

As shown in Figure 4.4-1, all operation-times measured by the DPOS, DPSY, and TPOS functions† can be cleared when the operation time reset controller (OPTR) function issues a reset command "OPTR01_RST_CMD". That is, within the respective functions the measured time intervals (OT1 and the others‡) are entirely cleared upon occurrence of the reset command.

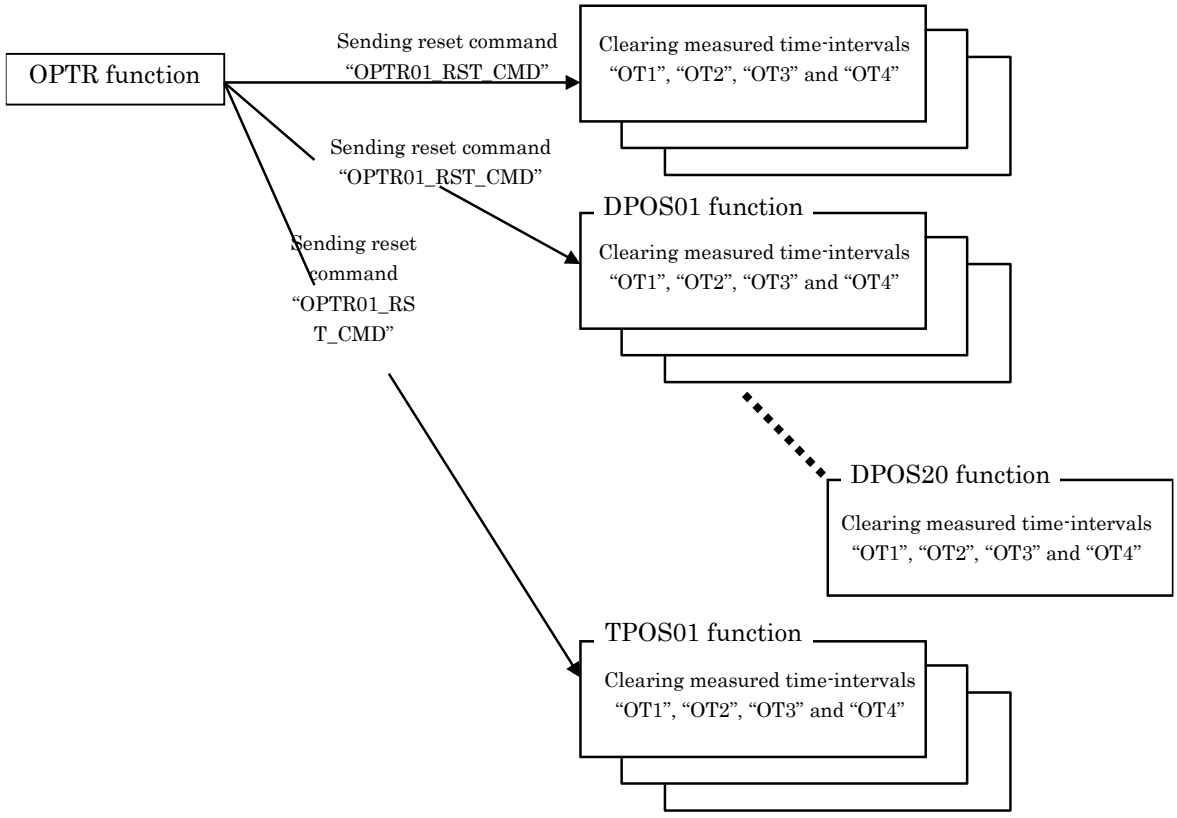


Figure 4.4-1 Reception of a reset command

†Note: For more information with regard to measurement, refer to the section "Measurement of operation intervals" for the respective DPOS, DPSY, and TPOS functions. The user should note that all interval OTs specific to a particular function are cleared by the OPTR reset command.

‡Note: The measurements in the DPOS and the DPSY functions are grouped into four intervals in each respective device. Measurement is possible by sensing the device events. The measured intervals are accumulated; they are grouped into four intervals (OT1–OT4), which the user can monitor from the IED screen. Figure 4.4-2 and Figure 4.4-3 exemplify the four intervals upon occurrence of On (Closing)-control event and Off (Open)-control event, provided that the DPOS function operates.

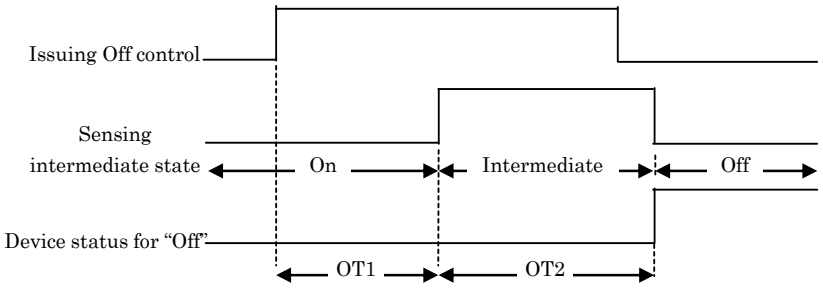


Figure 4.4-2 Two intervals (OT1 and OT2) for Off-control event

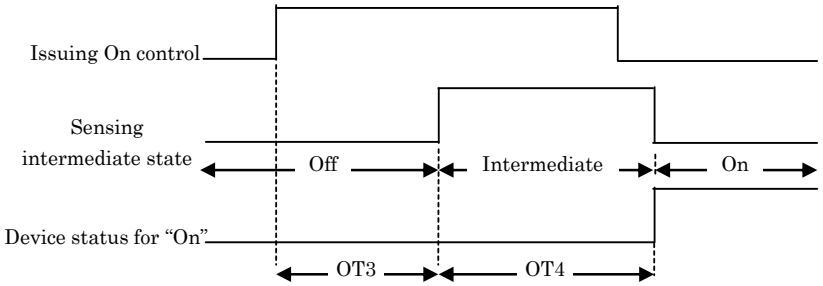


Figure 4.4-3 Two intervals (OT3 and OT4) for On-control event

Tips: If the user wishes to implement the OPTR function quickly, go to section 4.4.4, which discusses how to map signal-points for the IEC 61850 communication.

Note: The implementation of such features depends on the selection of hardware and the configuration of functions. Several IED models do not have its features. To determine whether its features are implemented in the IED, locate the IED ordering number; and check the order number at the "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 4.4-1 Comparative table in respective ordering numbers

Sec.	Feature	Ordering No. at "G&T"				
		10	11	13	19	22
–	Main features	NA	NA	NA	NA	✓
–	Number of functions	–	–	–	–	10

✓: Applicable NA: Not applicable

4.4.1 Select logic for SBO/DIR modes

The user should set the scheme switch [**OPTR01-EN**] to **On** prior to the OPTR operation. Figure 4.4-4 shows select logic in the OPTR function.

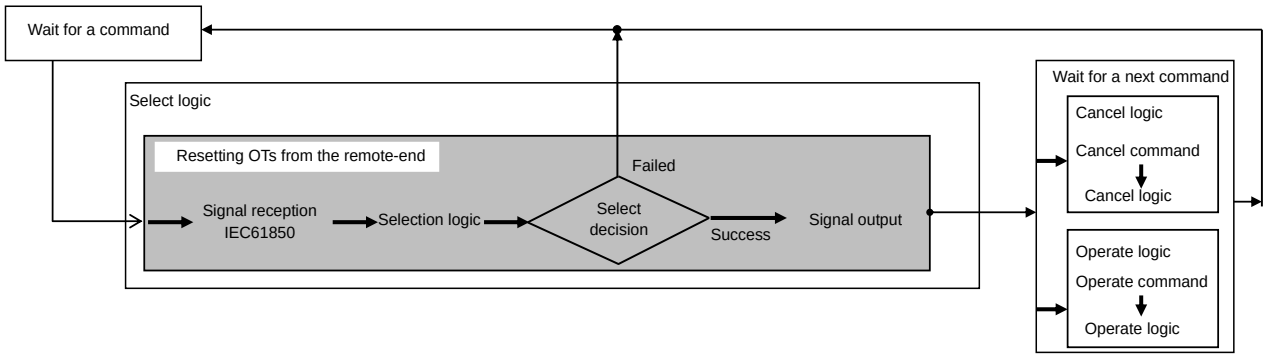


Figure 4.4-4 Outline of select command for resetting

(i) Input point required mapping

Figure 4.4-5 shows the select logic when a "Select command (Reset)" signal enters the OPTR function. The logic has the input-point "OPTR01_CONTROL_REQ" for the reception. That is, the input-point should be mapped for the IEC61850 communication. The function encounters an operation failure if mapping is not performed correctly. We discuss how to map the input-points for the IEC61850 communication in section 4.4.4.

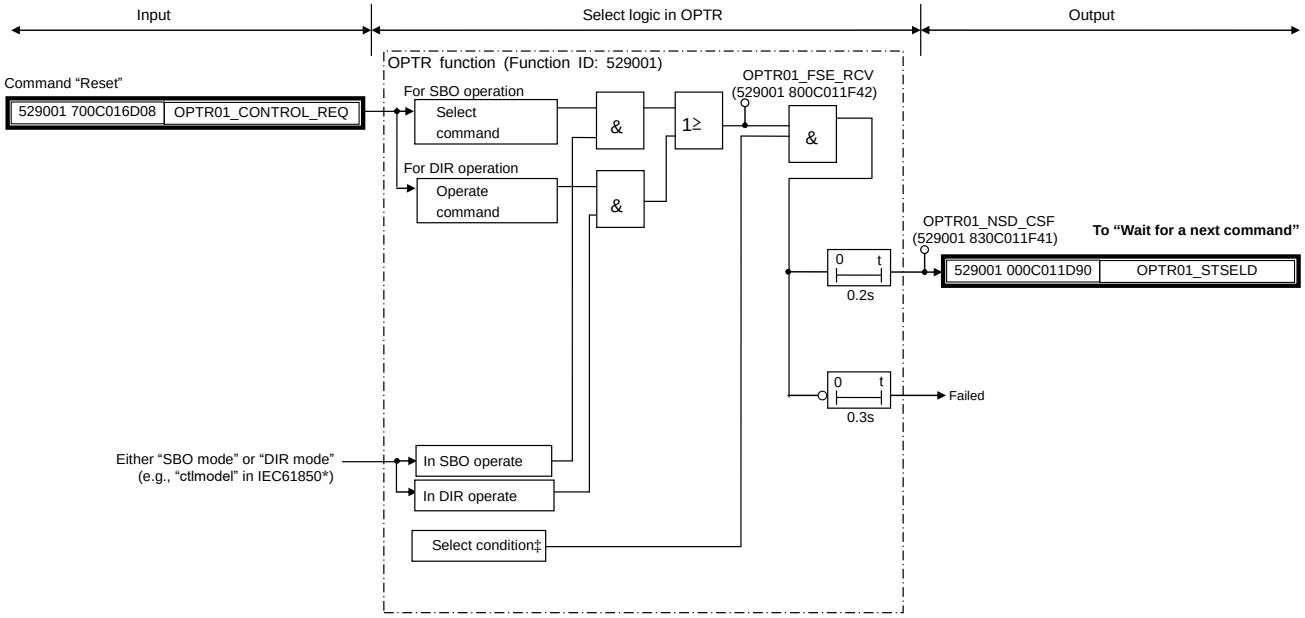


Figure 4.4-5 Select logic for resetting intervals OT1 to OT4

‡Note: A "select condition" signal is provided from the select condition scheme. For more information, see Figure 4.4-6.

*Note: The OPTR function can run on either "the SBO mode" or "the DIR mode" using a signal "ctlmodel" when the communication is carried out in the IEC61850; thus, mapping is required for the IEC61850 communication.

(ii) Output signal required to map

The OPTR function can issue a "Select success" signal at the output point "OPTR01_NSD_CSF", when the OPTR function can decide that the input signal "Select command (Reset)" is true. If the OPTR function decides that the "Select command (Reset)" is not true, the OPTR function returns to the "Wait for a command" stage.

(iii) Select condition

Figure 4.4-6 shows the select condition logic in the OPTR function.

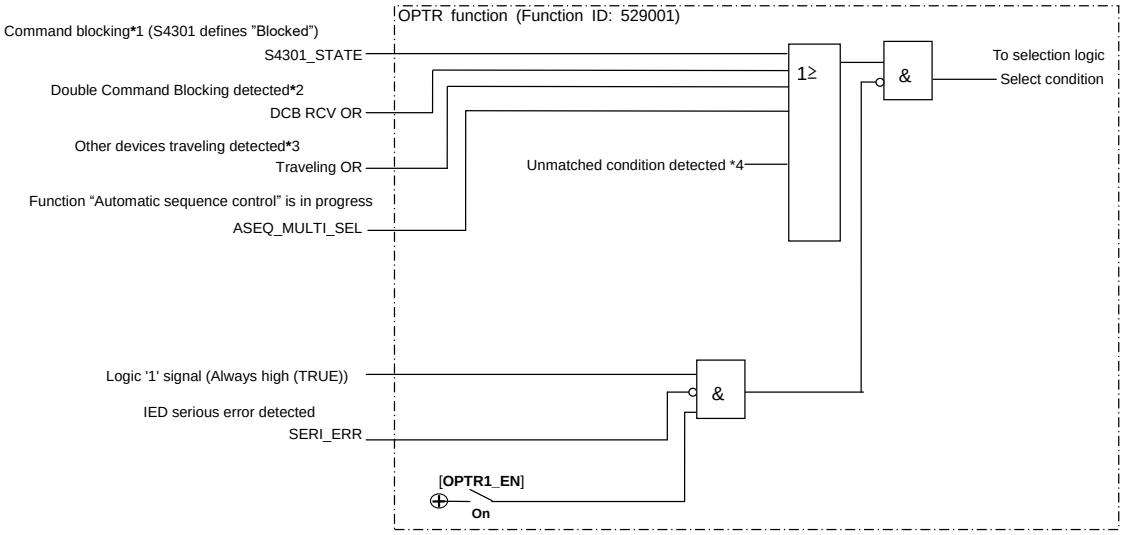


Figure 4.4-6 Select condition logic in the OPTR function*6

*1Note: The "command blocking" disables any operation except for itself: the "command blocking" is stated with "S4301" in a software controller (SOFTSW). The IEC61850 defines the "command blocking" as "CmdBlk". For more information on S4301, see Chapter *Control and monitoring application: Software switch control function*. See the signal "S4301_STATE" of Table 4.4-2.

*2Note: "Double Command Blocking (DCB)" is operation philosophy in the common control function (CMNCTRL). It can be used to protect the substation. The user should program it using the GR-TIEMS. The DCB operating signal is denoted as "DCB RCV_OR in Table 4.4-2. For more information, see Chapter *General control function: Common controls*.

*3Note: If events "device-travelling" are detected in the CMNCTRL function, we can see that some statuses of the devices are being changed by other operators. Thus, the IED should stop any operation while the events are being detected. The detecting signal is denoted by "Traveling OR" in Table 4.4-2.

*4Note: Criteria "unmatched conditions" are decided when "Test-bit status" in a command is not identical to "IED test status".

.

Table 4.4-2 Input signal for condition logic

Signal Number	Signal Name	Description	M/O
522001 000A011001	S4301_STATE	Command Blocking status (Off / Blocked)	N/A
5A0001 0008001F41	DCB RCV OR	Double Command Blocking(DCB) is in progress.	N/A
5A0001 0008001F40	Traveling OR	Travelling events are detected.	N/A
5A0101 3100001F43	SERI_ERR	Serious Error detected	N/A

Table 4.4-3 Setting of the OPTR function

Setting Name	Description	Default	Setting item or value
OPTR01_EN	Enabling the OPTR function	On	Off / On

4.4.2 Cancel logic in SBO mode

In the SBO control mode the reception of the cancel command is possible when the cancel conditions are satisfied. Accordingly, the function can discard the select command; finally, the operation returns to the initial stage (i.e., "Wait for a command".)

(i) Receiving "Cancel" from the remote-end

Figure 4.4-7 outlines the reception of the cancel command from the remote end.

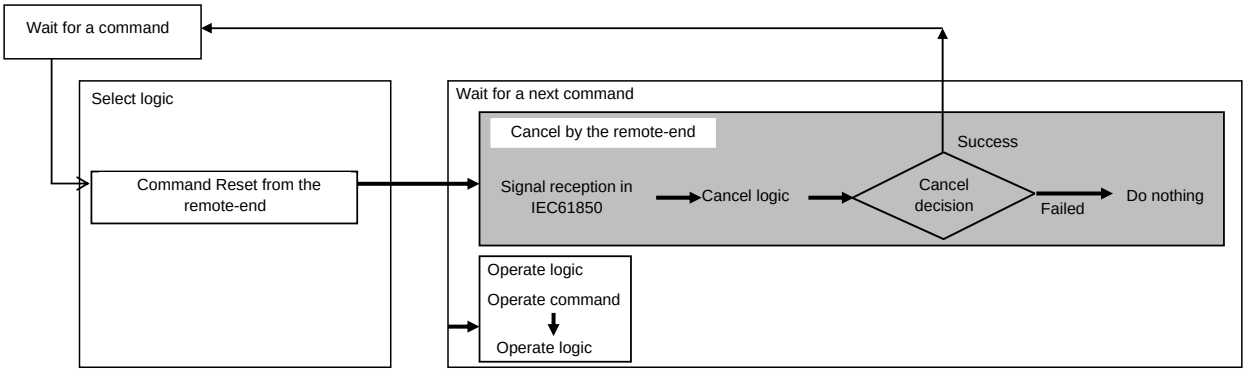


Figure 4.4-7 Outline of cancel command from the remote-end

(ii) Input point required mapping

Figure 4.4-8 shows the cancel logic when a "Cancel command (Remote-Cancel)" signal enters the OPTR function. The input-point "OPTR01_CONTROL_REQ" is the same point of the Figure 4.4-5.

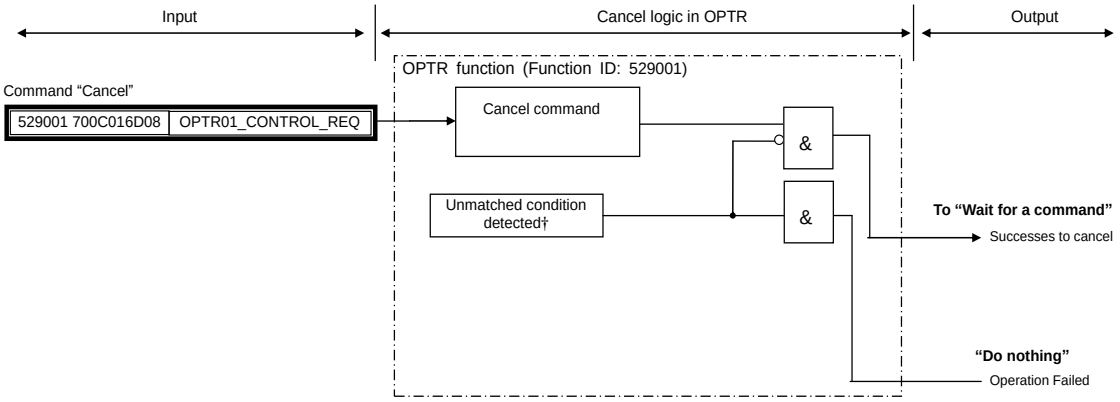


Figure 4.4-8 Cancel from the remote-end

†Note:The criteria "unmatched conditions" are determined when "Test-bit status" in a command is not identical to "IED test status".

4.4.3 Operate logic for SBO/DIR modes

After the completion of the operation of the select logic, the operate logic enters to clear all interval OTs.

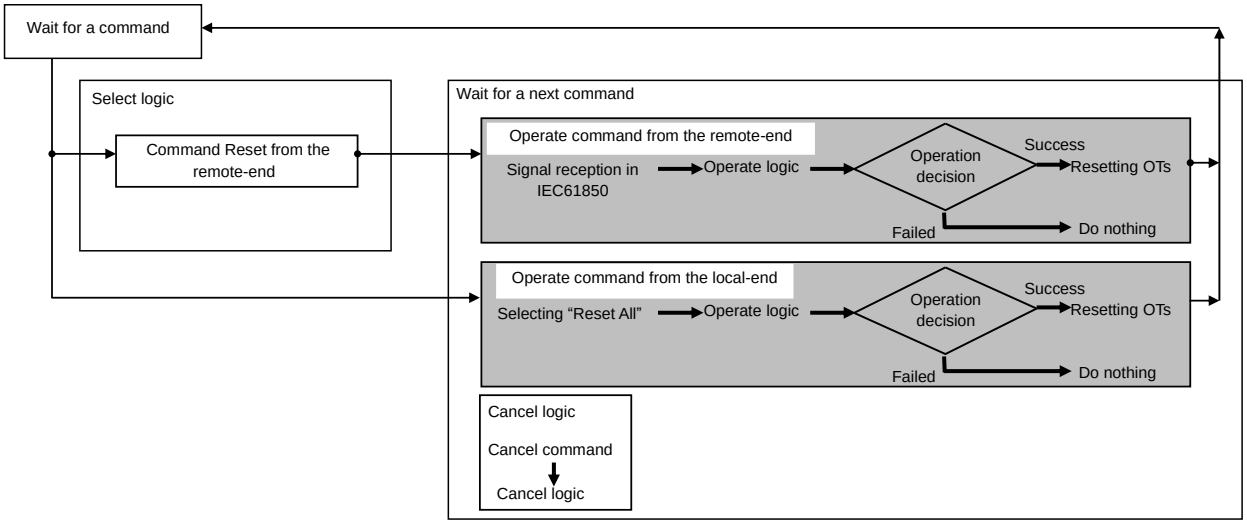


Figure 4.4-9 Outline of operate command for resetting intervals OT1 to OT4

(i) Input signal required mapping

Figure 4.4-10 shows the operate logic when an "Operation command (Reset)" signal enters the OPTR function. The input-point "OPTR_CONTROL_REQ" is used for the reception of the "Operation command (Reset)" signal, which is the same point of the select logic.

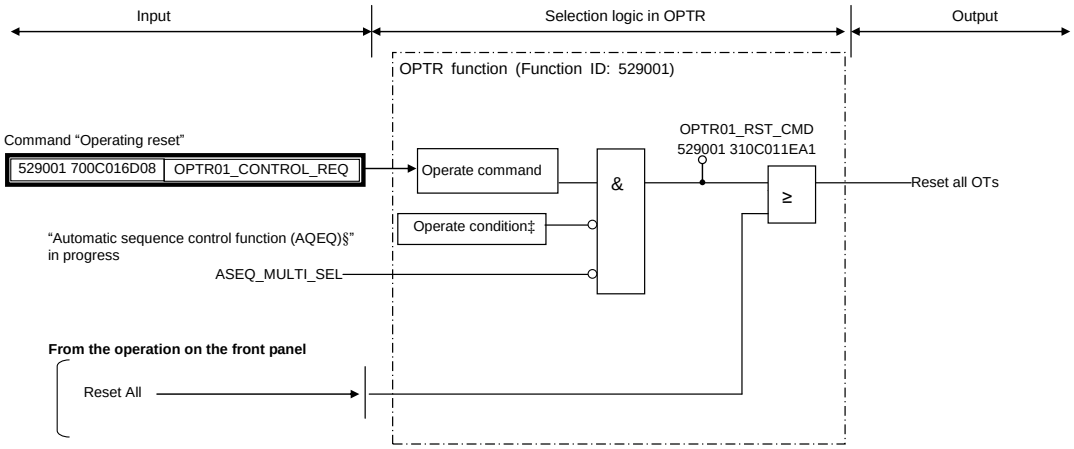


Figure 4.4-10 Operate logic for resetting intervals OT1 to OT4

(ii) Output signal required to map

The operate logic issues a "OPRT_RST_CMD" signal to clear all intervals OT1 to OT4. The signal "OTS_RST_CMD" can be transferred to the remote-end, when mapping the signal is carried out in the IEC61850 communication. (See section 4.4.4)

(iii) Operate condition

Figure 4.4-11 shows the operate condition logic of the OPTR function, which is used to examine a reset-condition in the OPRT function.

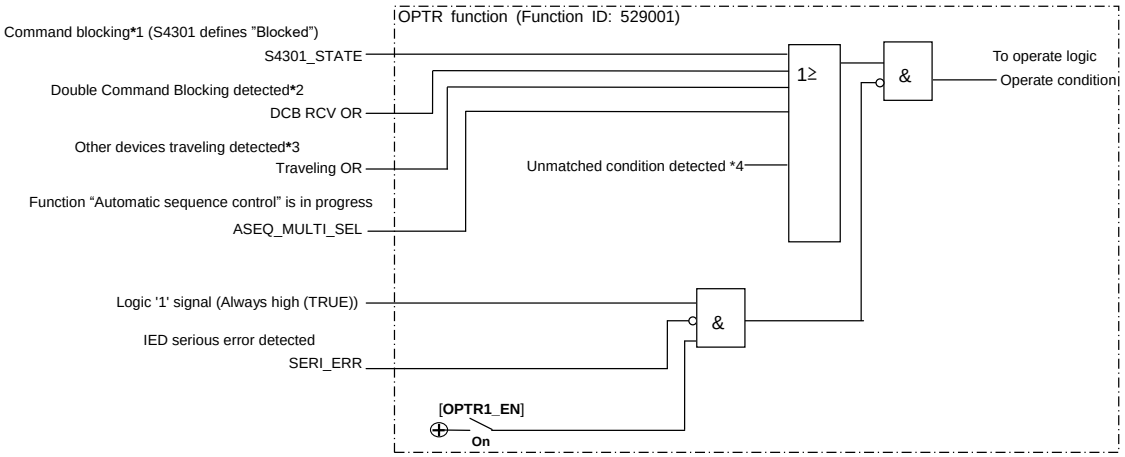


Figure 4.4-11 Operate condition logic in OPTR

*1to4Note: The signals and settings of the Figure 4.4-11 are same as the ones of the Figure 4.4-6.

4.4.4 Mapping for IEC61850 communication

The user can operate the OPTR function over the IEC61850 communication after the mapping using the GR-TIEMS. Note that the OPTR function is designed for “Single Point Controller (SPC) class” in the IEC61850 communication. The user should follow steps:

Step1: Editing Logical Node

Step2: Mapping output data

Step3: Mapping input data

(i) Editing Logical Node

The user should make a logical node (LN) for the OPTR function. Figure 4.4-12 exemplifies LN editing; the LN “General Input / Output (GGIO)” is chosen for the OPTR function. After the user defining an object “SPCSO”, the OPTR logical node can be saved with the name “GIGO” plus “LN Instance”. Make a definition of the object “SPCSO” in the OPTR logical node. “Either the SBO mode or the DIR mode can be chosen in the LN editing.

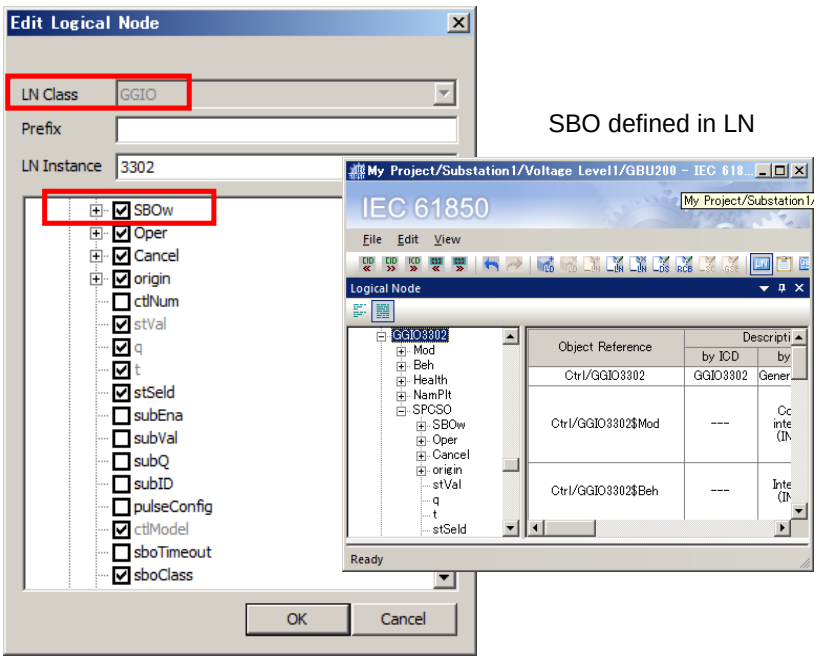
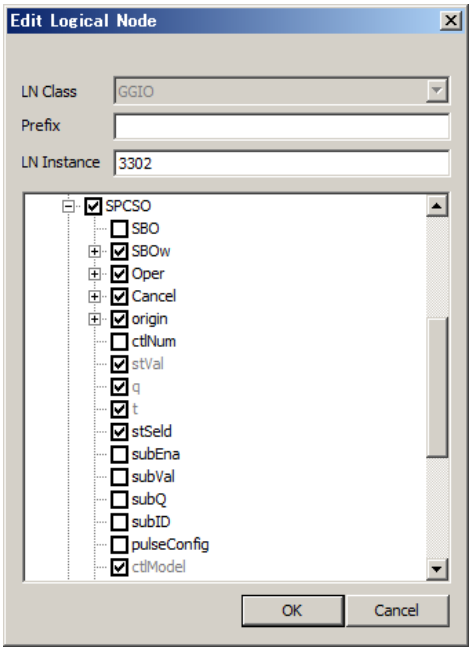


Figure 4.4-12 Defining “SPCSO” object in GIGO3302 logic node

(i)-1 Defining SBO mode

Figure 4.4-13 exemplifies the OPTR logic node saved as “GGIO3302”. In the SBO mode, the user should select the following items for the “GGIO3302$SCPSO” using the GR-TIEMS:



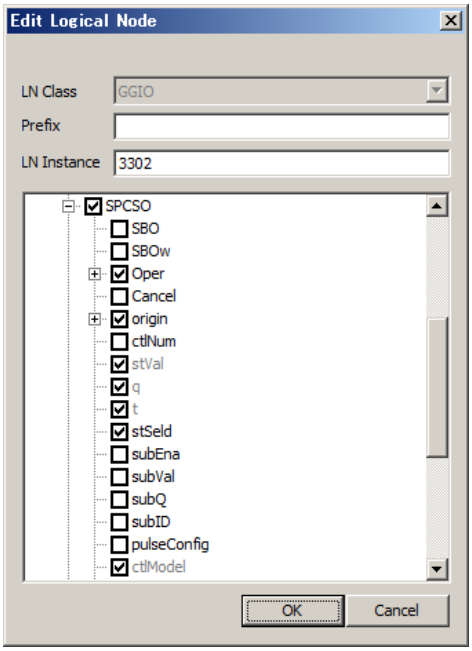
- ✓ SBOw
- ✓ Oper
- ✓ Cancel
- ✓ Origin
- ✓ stSeld
- ✓ sboClass† (choice ”operate-once”)
- ✓ ctlmodel (choice ”SBOes or SBOns”)

†”sboClass” can be found by scrolling down.

Figure 4.4-13 LN editing for SBO (for example)

(i)-2 Defining DIR mode

Figure 4.4-14 exemplifies the OPTR logic node saved as GGIO3302. In the DIR mode, the following three items should be selected using the GR-TIEMS:



- ✓ Oper
- ✓ origin
- ✓ ctlmodel (choice ”DOes or DOns”)

Figure 4.4-14 LN editing for DIR mode (for example)

(ii) Mapping output data

The user should group the OPTR signals with regard to GOOSE and REPORT; the user should map them for the IEC61850 communication using the GR-TIEMS. Figure 4.4-15 shows how to map a signal; it shows that the signals of the OPTR function are required to map for the IEC61850 communication.

Table 4.4-4 Mapping signals for SPC object

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/GGIO3302$SPCSO1$origin	orCat	orCategory	ST	529001 200C011008	OPTR01_ORCAT
Ctrl/GGIO3302$SPCSO1$origin	orIdent	Octet64	ST	529001 310C01170A	OPTR01_ORIDENT
Ctrl/GGIO3302$SPCSO1	stVal	BOOLEAN	ST	529001 310C011EA1	OPT_RST_CMD
Ctrl/GGIO3302$SPCSO1	Q	Quality	ST	301001 3110041005	Qual_Val
Ctrl/GGIO3302$SPCSO1	T	Timestamp	ST	200301 9010001006	SYS_TIME
Ctrl/GGIO3302$SPCSO1	stSeld	BOOLEAN	ST	529001 000C011D90	OPTR01_STSELD

Note: "Status (ST)" is defined in the function constraint (FC) of the IEC 61850 standard.

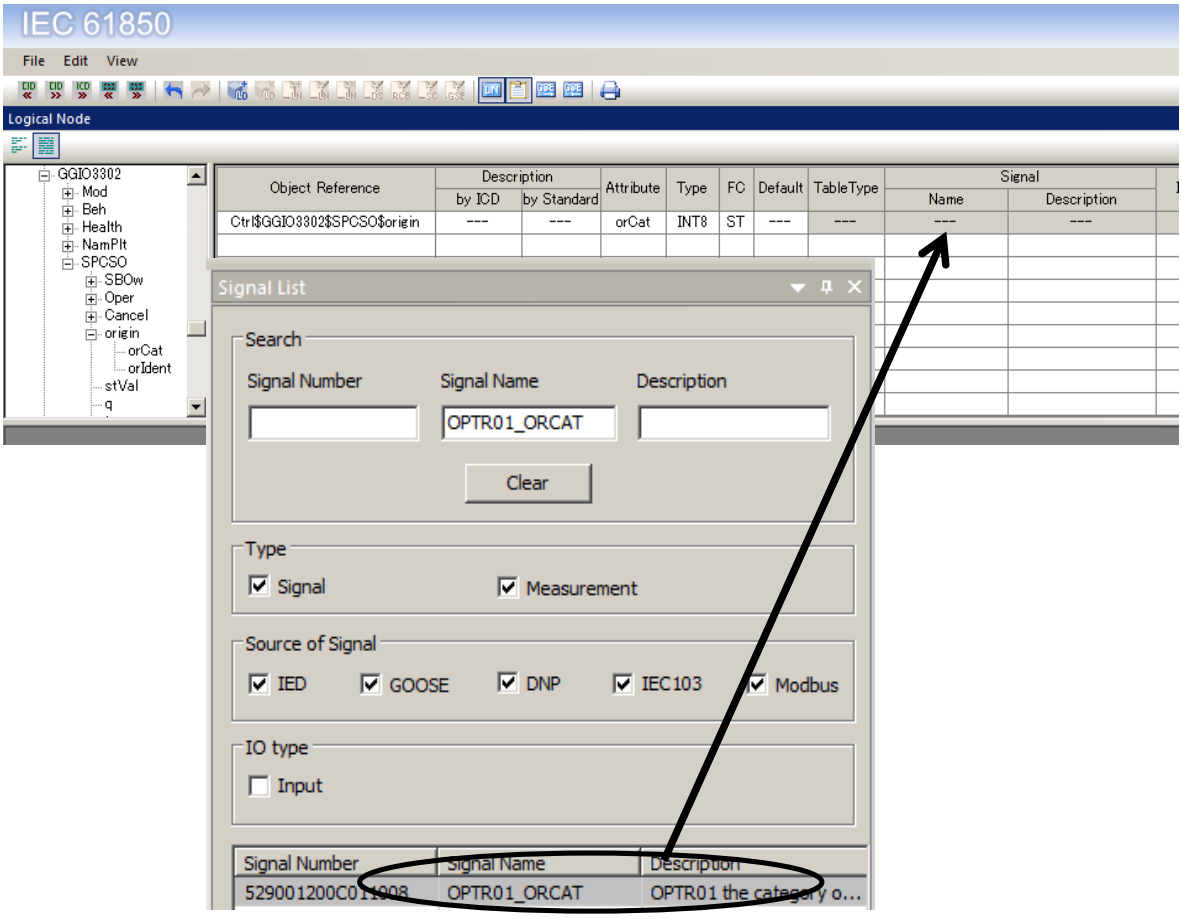


Figure 4.4-15 orCat attribute mapped into SPCSO object of GGIO3302

(iii) Mapping input data

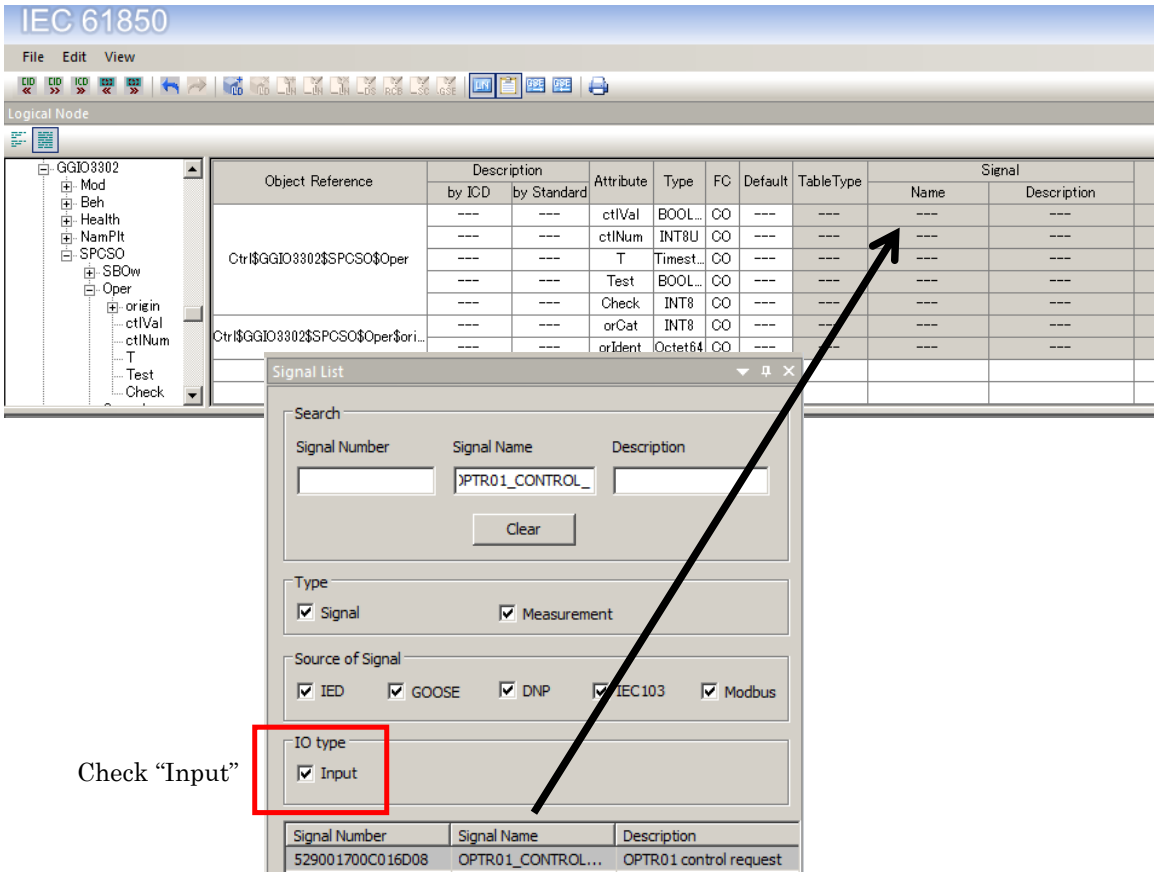
The OPTR function can receive three commands "select, operate, and cancel". Thus, the user should map the input-point "OPTR01_CONTROL_REQ". Table 4.4-5 shows the input-point "OPTR01_CONTROL_REQ" and the Object reference "Ctrl/GGIO3302$SCPSO"; the user should

map the input-point to the Object references having attributes CO and CF†. Figure 4.4-16 shows how to map a signal.

†Note: The attribute is defined in the IEC 61850; "CO" stands for "Control" and "CF" stands for "Configuration" in the functional constraint (FC).

Table 4.4-5 Mapping signals required for SPCSO object of GGIO3302

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/GGIO3302$SPCSO1$Oper	ctlVal	BOOLEAN	CO	529001 700C016D08	OPTR01_CONTROL_REQ
Ctrl/GGIO3302$SPCSO1$Oper	ctlNum	INT8U	CO		
Ctrl/GGIO3302$SPCSO1$Oper	T	Timestamp	CO		
Ctrl/GGIO3302$SPCSO1$Oper	Test	BOOLEAN	CO		
Ctrl/GGIO3302$SPCSO1$Oper	Check	Check	CO		
Ctrl/GGIO3302$SPCSO1$Oper$origin	orCat	orCategory	CO		
Ctrl/GGIO3302$SPCSO1$Oper$origin	orIdent	Octet64	CO		
Ctrl/GGIO3302$SPCSO1	ctlModel	ctlModel	CF		
Ctrl/GGIO3302$SPCSO1	sboClass	sboClass	CF		



Check "Input"

Figure 4.4-16 Input-point mapped for GGIO3302

4.4.5 Setting

Setting list of OPTR (Function ID: 529001)

Setting device		Range	Units	Contents	Default setting value	Notes
	OPTR01-EN	Off / On	-	OPTR01 Reset Control Enable	Off	

4.4.6 Signal

◆ Signal monitoring point

OPTR (Function ID: 529001)

Element ID	Name	Description
820C01ED50	OPTR01_CTRL_RIGHT	OPTR01 control right from PLC

◆ Connection point in PLC logic

OPTR (Function ID: 529001)

Element ID	Name	Description
800C011D53	OPTR01_SC	OPTR01 select command
800C011D57	OPTR01_EC	OPTR01 execute command
800C011D51	OPTR01_SC_OWS	OPTR01 select command by OWS(HMI)
800C011D52	OPTR01_SC_RCC	OPTR01 select command by RCC
800C011D55	OPTR01_EC_OWS	OPTR01 execute command by OWS(HMI)
800C011D56	OPTR01_EC_RCC	OPTR01 execute command by RCC
820C011F40	OPTR01_TMP1	OPTR01 signal before KC_OPTR_SA001
830C011F41	OPTR01_NSD_CSF	OPTR01 signal after KC_OPTR_SA001
800C011F42	OPTR01_FSE_RCV	OPTR01 signal before LC_OPTR_SA002
860C011F43	OPTR01_TMP2	OPTR01 signal after KC_OPTR_SA002
8B0C011F44	OPTR01_CTR_SGU	OPTR01 signal before KC_OPTR_SC001
860C011F45	OPTR01_TMP3	OPTR01 signal after KC_OPTR_SC001
860C011F46	OPTR01_SLF_FCT_FLG1	OPTR01 signal before MCTOPTR_SC001
8E0C011F47	OPTR01_SLD_TM0	OPTR01 signal after MCTOPTR_SC001
870C011F48	OPTR01_SLF_FCT_FLG2	OPTR01 signal before MCTOPTR_SC002
8F0C011F49	OPTR01_EX_CMP_TM0	OPTR01 signal after MCTOPTR_SC002

4.5 Total time measurement function (TOTALTIM)

The total time measurement function (TOTALTIM) measures the time of the On state using a signal which is selected with the logic programmed by the PLC function. The TOTALTIM function increments the time for which the signal is in the "ON" state and stores it as a cumulative time. The TOTALTIM function can monitor up to 12 signals simultaneously. This function also has correction processes.

Note: The implementation of such features depends on the selection of hardware and the configuration of functions. Several IED models do not have its features. To determine whether its features are implemented in the IED, locate the IED ordering number; and check the order number at the "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 4.5-1 Comparative table in respective ordering numbers

Sec.	Feature		Ordering No. at "G&T"			
		10	11	13	19	22
–	Main features	NA	NA	NA	NA	✓
–	Number of functions	–	–	–	–	10

✓: Applicable NA: Not applicable

4.5.1 Operation feature

(i) Time accumulation process

Figure 4.5-1 outlines the time accumulation process within the TOTALTIM function. The TOTALTIM function accumulates the time for which the state of the operating signal is in the "ON" status every second. The accumulation process continues until the maximum accumulated time reaches 10,000 days (almost 27 years).

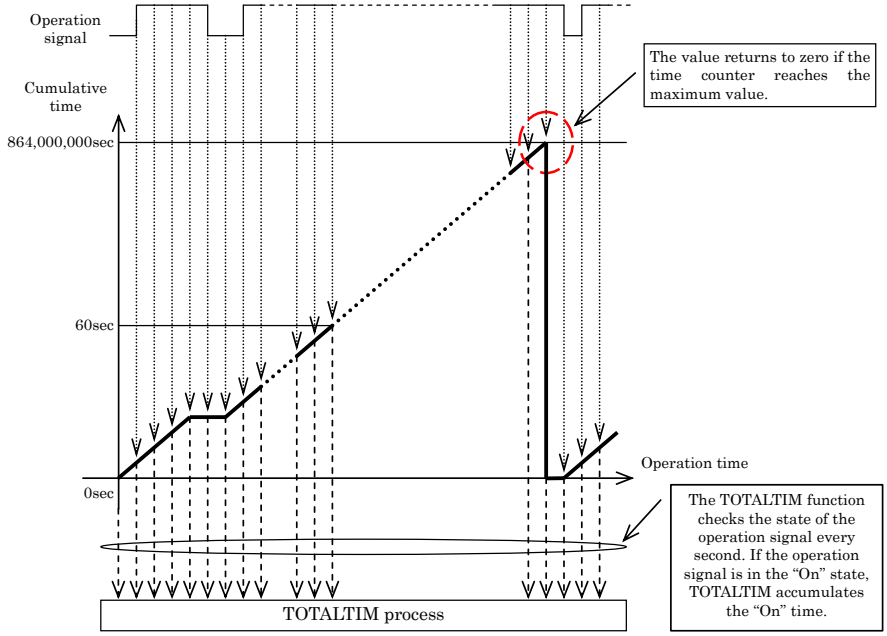


Figure 4.5-1 Cumulative time process

(ii) Acquisition of operation signal

The user should connect the binary input circuit (BI) to the TOTALTIM function.

Figure 4.5-2 illustrates that 12 signals can be accommodated from external devices using BIs. For example, when binary input circuit BI1 receives operating signal1, provided signal-monitoring point "BI1" is applied for the acquisition of the signal, the user can make the logic to connect "BI1" with TT01 of the TOTALTIM function using the PLC function.

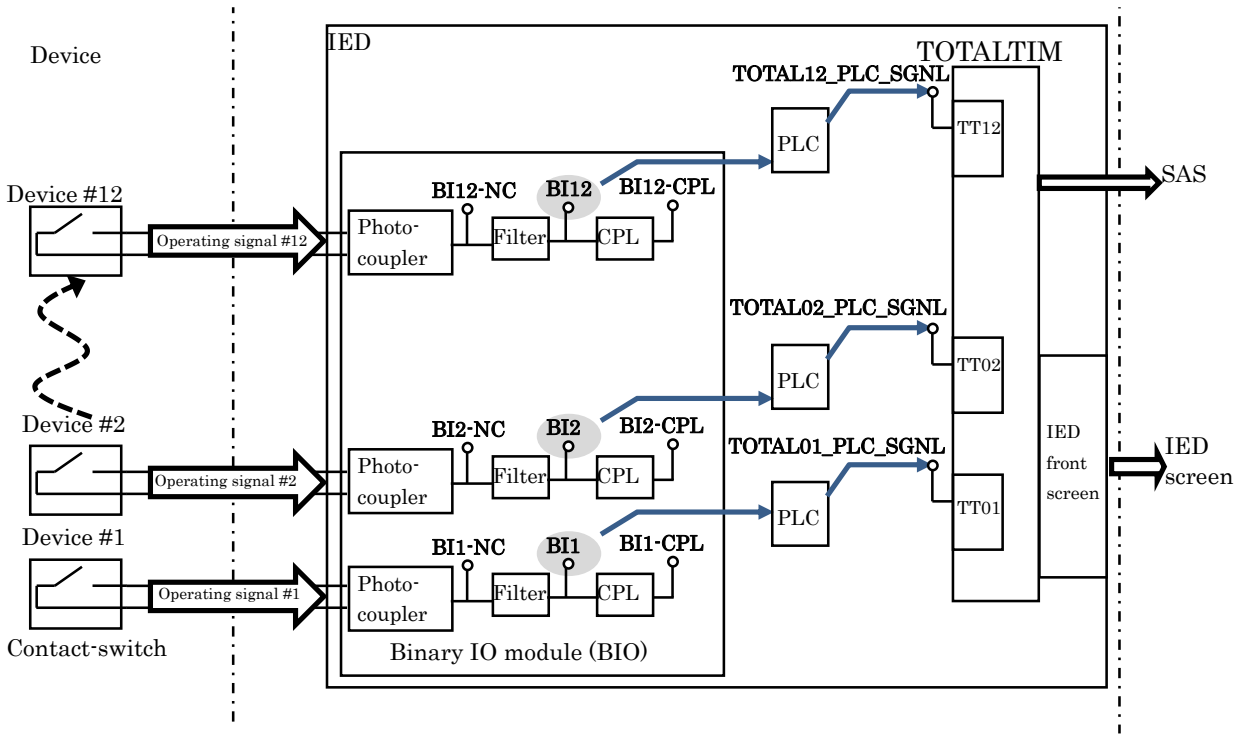


Figure 4.5-2 Acquisition of operation signals

(iii) Setting for the report (Dead band)

For sending data for the network, the TOTALTIM function will get a new accumulated data every cycle that is defined with the setting [**TTIM*-SDB**]. For example, if the user wishes to report the operation time about the device #1, the user should set '1' to the setting [**TTIM01-SDB**], provided the report cycle is required every one second.

Table 4.5-2 Setting for data revision

Scheme switch	Set	Comment
TTIM01-SDB	1 to 720sec	Data revision period for operating signal 1
TTIM02-SDB	1 to 720sec	Data revision period for operating signal 2
(omitted)	(omitted)	(omitted)
TTIM12-SDB	1 to 720sec	Data revision period for operating signal 12

(iv) Data correction

In the TOTALTIM function the user can correct the accumulation time using either IED front panel operation or GR-TIEMS operation (For IED screen operation, see Chapter *User interface*. For GR-TIEMS operation, see Chapter *Engineering tool*)

4.5.2 Preparation for operation

The TOTALTIM function is enabled when the user sets [**TTIM*-EN**] **On**.

Table 4.5-3 TOTALTIM operation

Scheme switch	Set	Comment
TTIM01-EN	On / Off	Operation enable for operating signal #1
TTIM02-EN	On / Off	Operation enable for operating signal #2
(omitted)	(omitted)	(omitted)
TTIM12-EN	On / Off	Operation enable for operating signal #12

4.5.3 Mapping for IEC 61850 communication

The user can operate the TTIM01 function using IEC 61850 communications after first mapping the function using GR-TIEMS. The user should proceed as follows

Step1: Editing Logical Node

Step2: Mapping output data

Step3: Mapping input data

(i) Editing Logical Node

The user must make a logical node (LN) for the TTIM01 function. Figure 4.5-3 exemplifies LN editing; LN "GGIO1301" is selected for the TTIM01 function for IEC 61850 communication. After the user has defined an object "ISCSO1", the TTIM01 logical node can be saved with the name "GGIO1301". Define the object "ISCSO1" in the TTIM01 logical node. Either the SBO mode or the DIR mode can be chosen when editing the LN.

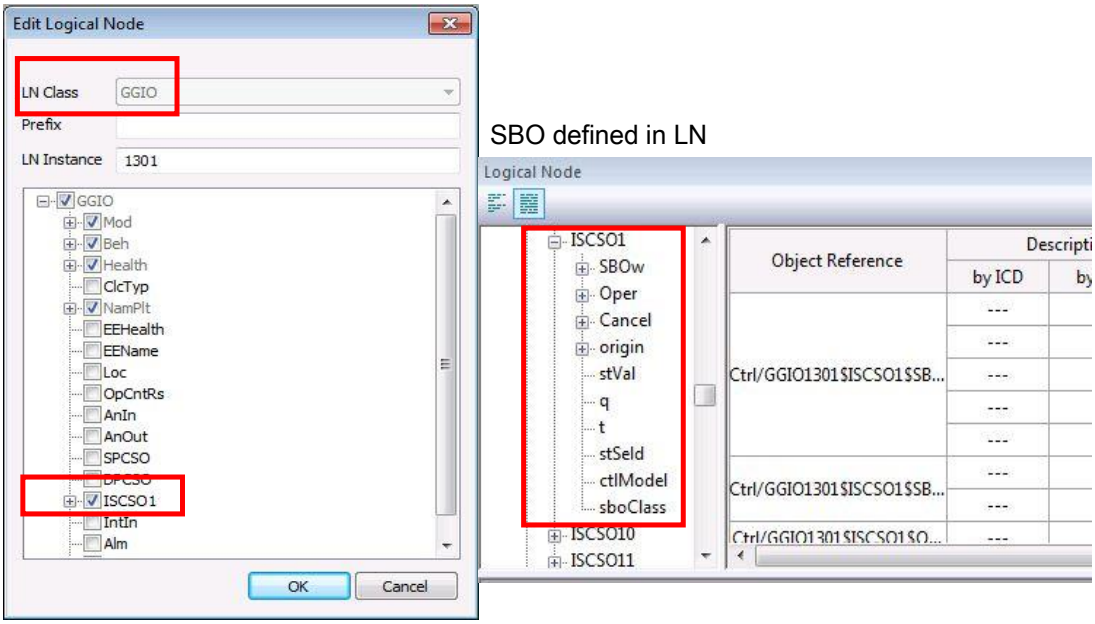
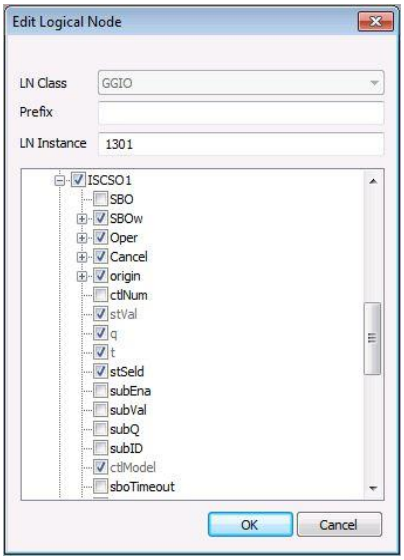


Figure 4.5-3 Defining "ISCSO1" object in GGIO1301 logic node

(i)-1 Defining SBO mode

Figure 4.5-4 exemplifies the settings in LN "GGIO1301" when the SBO mode is required for the TTIM01 function. For SBO control, the user should select the following items for the "GGIO1301$ISCSO1" using GR-TIEMS;



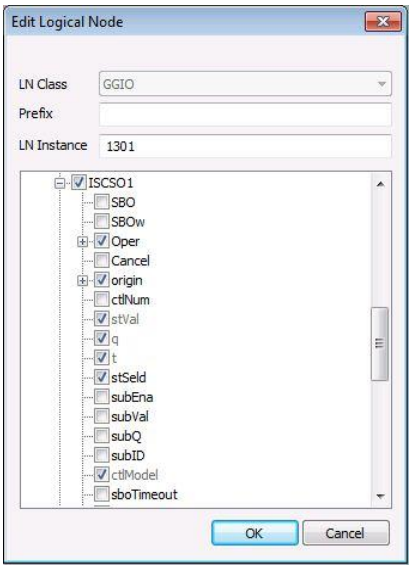
- ✓ SBOw
- ✓ Oper
- ✓ Cancel
- ✓ Origin
- ✓ stSeld
- ✓ sboClass† (choice ”operate-once”)
- ✓ ctlmodel (choice ”SBOes or SBOns”)

†”sboClass” can be found by scrolling down.

Figure 4.5-4 LN editing screen for SBO mode (for example)

(i)-2 Defining DIR mode

Figure 4.5-5 exemplifies the settings in LN “GGIO1301” when the DIR mode is required for the TTIM01 function. In the DIR mode, the following three items should be selected using GR-TIEMS:



- ✓ Oper
- ✓ origin
- ✓ ctlmodel (choice ”DOes or DOns”)

Figure 4.5-5 LN editing screen for DIR mode (for example)

(ii) Mapping output data

The user should group the TTIM01 signals with regard to GOOSE and REPORT; the user should map them for IEC 61850 communication using GR-TIEMS.

Table 4.5-4 shows the mapping signals within the TTIM01 function required for IEC 61850 communication. Figure 4.5-6 shows how to map a signal.

Table 4.5-4 Mapping signals for ISCSO1 object.

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/GGIO1301$ISCSO1$origin	orCat	orCategory	ST	5410013015011D23	TTIM01_TIM_ORCAT
Ctrl/GGIO1301$ISCSO1$origin	orIdent	Octet64	ST	5410016A15011FA7	TTIM01_TIM_ORIDENT
Ctrl/GGIO1301$ISCSO1	stVal	INT32	ST	5410013215011D20	TTIM01_TIM_SEC_VAL
Ctrl/GGIO1301$ISCSO1	q	Quality	ST	5410013115011D21	TTIM01_TIM_QLT
Ctrl/GGIO1301$ISCSO1	t	Timestamp	ST	5410019015011D22	TTIM01_TIM_TIM
Ctrl/GGIO1301$ISCSO1	stSeld	BOOLEAN	ST	5410010015011D91	TTIM01_TMP_01
Ctrl/GGIO1301$AnIn1$mag	f	FLOAT32	MX	5410013215011D20	TTIM01_TIM_SEC_VAL
Ctrl/GGIO1301$AnIn1	q	Quality	MX	5410013115011D21	TTIM01_TIM_QLT
Ctrl/GGIO1301$AnIn1	t	Timestamp	MX	5410019015011D22	TTIM01_TIM_TIM

Note: "Status (ST)" and "Measurement (MX)" are defined in the function constraint (FC) of the IEC 61850 standard.

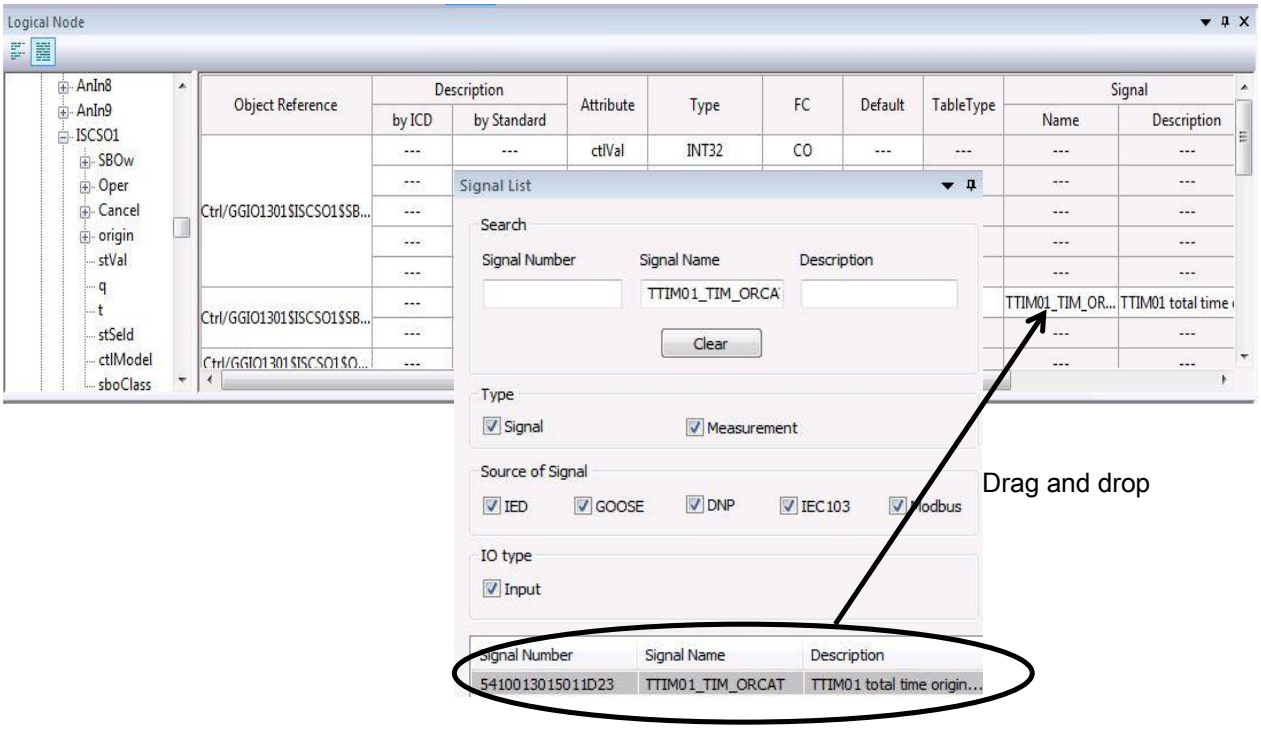


Figure 4.5-6 orCat attribute mapped into ISCSO1 object of GGIO1301

(iii) Mapping input data

The TTIM01 function can receive three commands "select, operate, and cancel. Thus, the user will need to map the input-point "TOTAL01_CMM_REQ". Table 4.5-5 shows the input-point "TOTAL01_CMM_REQ" and the Object reference "Ctrl/GGIO1301$ISCSO1$"; the user should map the input-point to the Object reference having attributes CO and CF in FC†. Figure 4.5-7 shows how to map a signal.

†Note: The attribute is defined in the IEC 61850 standard; "CO" stands for "Control" and "CF" stands for "Configuration" in the functional constraint (FC).

Table 4.5-5 Mapping signals required for GGIO1301 object in TTIM01 function

Object_reference	Attribute	Type	FC	Signal Number	Signal Name
Ctrl/GGIO1301$ISCSO1$SBOw	ctlVal	INT32	CO	5410017015016D08	TOTAL01_CMM_REQ
Ctrl/GGIO1301$ISCSO1$SBOw	ctlNum	INT8U	CO		
Ctrl/GGIO1301$ISCSO1$SBOw	T	Timestamp	CO		
Ctrl/GGIO1301$ISCSO1$SBOw	Test	BOOLEAN	CO		
Ctrl/GGIO1301$ISCSO1$SBOw	Check	Check	CO		
Ctrl/GGIO1301$ISCSO1$SBOw$origin	orCat	orCategory	CO		
Ctrl/GGIO1301$ISCSO1$SBOw$origin	orIdent	Octet64	CO		
Ctrl/GGIO1301$ISCSO1$Oper	ctlVal	INT32	CO		
Ctrl/GGIO1301$ISCSO1$Oper	ctlNum	INT8U	CO		
Ctrl/GGIO1301$ISCSO1$Oper	T	Timestamp	CO		
Ctrl/GGIO1301$ISCSO1$Oper	Test	BOOLEAN	CO		
Ctrl/GGIO1301$ISCSO1$Oper	Check	Check	CO		
Ctrl/GGIO1301$ISCSO1$Oper$origin	orCat	orCategory	CO		
Ctrl/GGIO1301$ISCSO1$Oper$origin	orIdent	Octet64	CO		
Ctrl/GGIO1301$ISCSO1$Cancel	ctlVal	INT32	CO		
Ctrl/GGIO1301$ISCSO1$Cancel	ctlNum	INT8U	CO		
Ctrl/GGIO1301$ISCSO1$Cancel	T	Timestamp	CO		
Ctrl/GGIO1301$ISCSO1$Cancel	Test	BOOLEAN	CO		
Ctrl/GGIO1301$ISCSO1$Cancel$origin	orCat	orCategory	CO		
Ctrl/GGIO1301$ISCSO1$Cancel$origin	orIdent	Octet64	CO		
Ctrl/GGIO1301$ISCSO1	ctlModel	ctlModel	CF		
Ctrl/GGIO1301$ISCSO1	sboClass	sboClass	CF		

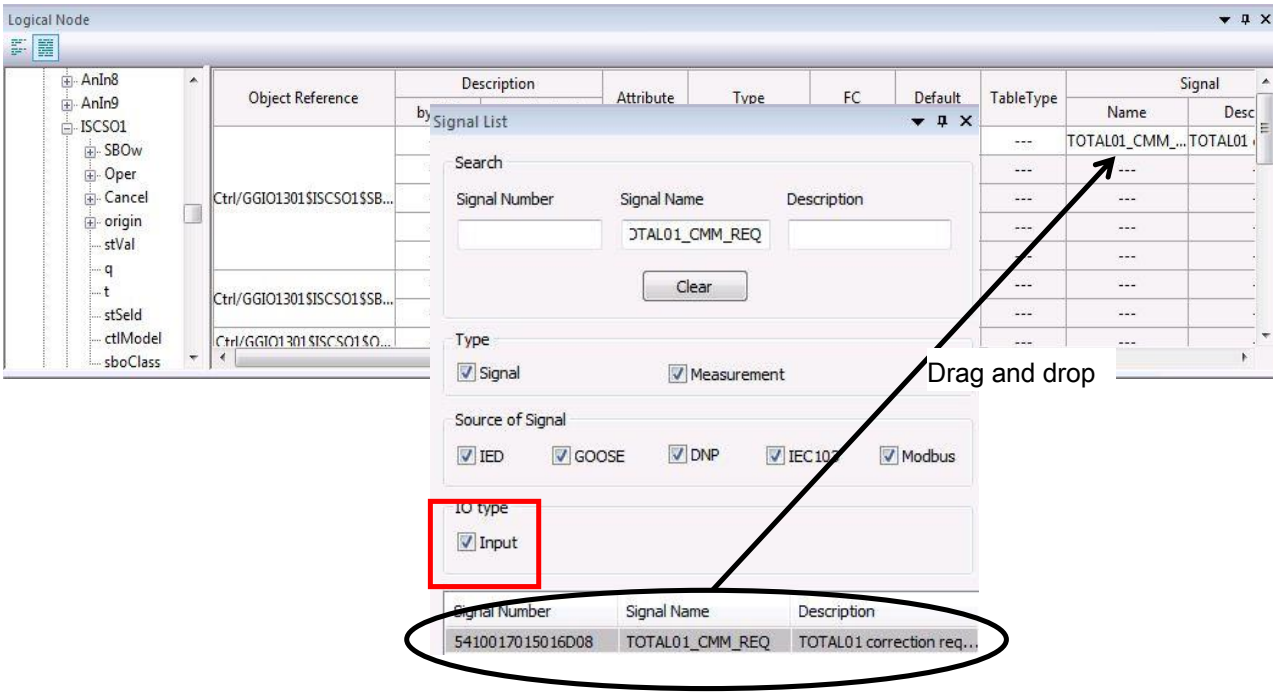


Figure 4.5-7 Input-point mapped for GGIO1301

4.5.4 Setting

Setting list for TOTALTIM（Function ID: 541001)

Setting device			Range	Units	Contents	Default setting value	Notes
	TT1	TTIM01-EN	Off / On	-	TotalTimer1 Enable	Off	
		TTIM01-SDB	1-720	min	TotalTimer1 Sending Dead Band	0	
	TT2	TTIM02-EN	Off / On	-	TotalTimer2 Enable	Off	
		TTIM02-SDB	1-720	min	TotalTimer2 Sending Dead Band	0	
	TT3	TTIM03-EN	Off / On	-	TotalTimer3 Enable	Off	
		TTIM03-SDB	1-720	min	TotalTimer3 Sending Dead Band	0	
	TT4	TTIM04-EN	Off / On	-	TotalTimer4 Enable	Off	
		TTIM04-SDB	1-720	min	TotalTimer4 Sending Dead Band	0	
	TT5	TTIM05-EN	Off / On	-	TotalTimer5 Enable	Off	
		TTIM05-SDB	1-720	min	TotalTimer5 Sending Dead Band	0	
	TT6	TTIM06-EN	Off / On	-	TotalTimer6 Enable	Off	
		TTIM06-SDB	1-720	min	TotalTimer6 Sending Dead Band	0	
	TT7	TTIM07-EN	Off / On	-	TotalTimer7 Enable	Off	
		TTIM07-SDB	1-720	min	TotalTimer7 Sending Dead Band	0	
	TT8	TTIM08-EN	Off / On	-	TotalTimer8 Enable	Off	
		TTIM08-SDB	1-720	min	TotalTimer8 Sending Dead Band	0	
	TT9	TTIM09-EN	Off / On	-	TotalTimer9 Enable	Off	
		TTIM09-SDB	1-720	min	TotalTimer9 Sending Dead Band	0	
	TT10	TTIM10-EN	Off / On	-	TotalTimer10 Enable	Off	
		TTIM10-SDB	1-720	min	TotalTimer10 Sending Dead Band	0	
	TT11	TTIM11-EN	Off / On	-	TotalTimer11 Enable	Off	
		TTIM11-SDB	1-720	min	TotalTimer11 Sending Dead Band	0	
	TT12	TTIM12-EN	Off / On	-	TotalTimer12 Enable	Off	
		TTIM12-SDB	1-720	min	TotalTimer12 Sending Dead Band	0	

4.5.5 Signal

◆ Signal monitoring points

TOTALTIM(Function ID: 541001)

Element ID	Name	Description
8015001D51	TTIM00_CH_SC_OWS	TTIM00 total time change select command by OWS(HMI)
8015001D52	TTIM00_CH_SC_RCC	TTIM00 total time change select command by RCC
8015001D53	TTIM00_CH_SC_RMT	TTIM00 total time change select command by Remote
8015001D54	TTIM00_CH_SC_LCD	TTIM00 total time change select command by LCD
8015001D55	TTIM00_CH_EC_OWS	TTIM00 total time change execute command by OWS(HMI)
8015001D56	TTIM00_CH_EC_RCC	TTIM00 total time change execute command by RCC
8015001D57	TTIM00_CH_EC_RMT	TTIM00 total time change execute command by Remote
8015001D58	TTIM00_CH_EC_LCD	TTIM00 total time change execute command by LCD
8915011EA2	TTIM01_CTR_SGU	TTIM01 control logic stage(under selection)
8A15011E76	TTIM01_SLD_CS	TTIM01 selected condition signal
8B15011E7B	TTIM01_SLF_CS	TTIM01 select fail condition signal
8215011E84	TTIM01_EC_OK_CS	TTIM01 execute command OK condition signal
8315011E8B	TTIM01_EC_F_CN	TTIM01 execute command fail condition signal
8415011E95	TTIM01_CC_SS	TTIM01 cancel success signal
8915021EA2	TTIM02_CTR_SGU	TTIM02 control logic stage(under selection)
8A15021E76	TTIM02_SLD_CS	TTIM02 selected condition signal
8B15021E7B	TTIM02_SLF_CS	TTIM02 select fail condition signal
8215021E84	TTIM02_EC_OK_CS	TTIM02 execute command OK condition signal
8315021E8B	TTIM02_EC_F_CS	TTIM02 execute command fail condition signal
8415021E95	TTIM02_CC_SS	TTIM02 cancel success signal
8915031EA2	TTIM03_CTR_SGU	TTIM03 control logic stage(under selection)
8A15031E76	TTIM03_SLD_CS	TTIM03 selected condition signal
8B15031E7B	TTIM03_SLF_CS	TTIM03 select fail condition signal
8215031E84	TTIM03_EC_OK_CS	TTIM03 execute command OK condition signal
8315031E8B	TTIM03_EC_F_CS	TTIM03 execute command fail condition signal
8415031E95	TTIM03_CC_SS	TTIM03 cancel success signal
8915041EA2	TTIM04_CTR_SGU	TTIM04 control logic stage(under selection)
8A15041E76	TTIM04_SLD_CS	TTIM04 selected condition signal
8B15041E7B	TTIM04_SLF_CS	TTIM04 select fail condition signal
8215041E84	TTIM04_EC_OK_CS	TTIM04 execute command OK condition signal
8315041E8B	TTIM04_EC_F_CS	TTIM04 execute command fail condition signal
8415041E95	TTIM04_CC_SS	TTIM04 cancel success signal
8915051EA2	TTIM05_CTR_SGU	TTIM05 control logic stage(under selection)
8A15051E76	TTIM05_SLD_CS	TTIM05 selected condition signal
8B15051E7B	TTIM05_SLF_CS	TTIM05 select fail condition signal
8215051E84	TTIM05_EC_OK_CS	TTIM05 execute command OK condition signal
8315051E8B	TTIM05_EC_F_CS	TTIM05 execute command fail condition signal
8415051E95	TTIM05_CC_SS	TTIM05 cancel success signal
8915061EA2	TTIM06_CTR_SGU	TTIM06 control logic stage(under selection)
8A15061E76	TTIM06_SLD_CS	TTIM06 selected condition signal
8B15061E7B	TTIM06_SLF_CS	TTIM06 select fail condition signal
8215061E84	TTIM06_EC_OK_CS	TTIM06 execute command OK condition signal
8315061E8B	TTIM06_EC_F_CS	TTIM06 execute command fail condition signal

◆ Signal monitoring points

TOTALTIM(Function ID: 541001)

Element ID	Name	Description
8415061E95	TTIM06_CC_SS	TTIM06 cancel success signal
8915071EA2	TTIM07_CTR_SGU	TTIM07 control logic stage(under selection)
8A15071E76	TTIM07_SLD_CS	TTIM07 selected condition signal
8B15071E7B	TTIM07_SLF_CS	TTIM07 select fail condition signal
8215071E84	TTIM07_EC_OK_CS	TTIM07 execute command OK condition signal
8315071E8B	TTIM07_EC_F_CS	TTIM07 execute command fail condition signal
8415071E95	TTIM07_CC_SS	TTIM07 cancel success signal
8915081EA2	TTIM08_CTR_SGU	TTIM08 control logic stage(under selection)
8A15081E76	TTIM08_SLD_CS	TTIM08 selected condition signal
8B15081E7B	TTIM08_SLF_CS	TTIM08 select fail condition signal
8215081E84	TTIM08_EC_OK_CS	TTIM08 execute command OK condition signal
8315081E8B	TTIM08_EC_F_CS	TTIM08 execute command fail condition signal
8415081E95	TTIM08_CC_SS	TTIM08 cancel success signal
8915091EA2	TTIM09_CTR_SGU	TTIM09 control logic stage(under selection)
8A15091E76	TTIM09_SLD_CS	TTIM09 selected condition signal
8B15091E7B	TTIM09_SLF_CS	TTIM09 select fail condition signal
8215091E84	TTIM09_EC_OK_CS	TTIM09 execute command OK condition signal
8315091E8B	TTIM09_EC_F_CS	TTIM09 execute command fail condition signal
8415091E95	TTIM09_CC_SS	TTIM09 cancel success signal
89150A1EA2	TTIM10_CTR_SGU	TTIM10 control logic stage(under selection)
8A150A1E76	TTIM10_SLD_CS	TTIM10 selected condition signal
8B150A1E7B	TTIM10_SLF_CS	TTIM10 select fail condition signal
82150A1E84	TTIM10_EC_OK_CS	TTIM10 execute command OK condition signal
83150A1E8B	TTIM10_EC_F_CS	TTIM10 execute command fail condition signal
84150A1E95	TTIM10_CC_SS	TTIM10 cancel success signal
89150B1EA2	TTIM11_CTR_SGU	TTIM11 control logic stage(under selection)
8A150B1E76	TTIM11_SLD_CS	TTIM11 selected condition signal
8B150B1E7B	TTIM11_SLF_CS	TTIM11 select fail condition signal
82150B1E84	TTIM11_EC_OK_CS	TTIM11 execute command OK condition signal
83150B1E8B	TTIM11_EC_F_CS	TTIM11 execute command fail condition signal
84150B1E95	TTIM11_CC_SS	TTIM11 cancel success signal
89150C1EA2	TTIM12_CTR_SGU	TTIM12 control logic stage(under selection)
8A150C1E76	TTIM12_SLD_CS	TTIM12 selected condition signal
8B150C1E7B	TTIM12_SLF_CS	TTIM12 select fail condition signal
82150C1E84	TTIM12_EC_OK_CS	TTIM12 execute command OK condition signal
83150C1E8B	TTIM12_EC_F_CS	TTIM12 execute command fail condition signal
84150C1E95	TTIM12_CC_SS	TTIM12 cancel success signal

◆ Connection points in PLC logic

TOTALTIM(Function ID: 541001)

Element ID	Name	Description
801500ED5	TOTAL00IN_TMP_51	TOTAL00IN_TMP_51
801501EDE0	TOTAL01_PLC_SGNL	TOTAL01 plc signal
801502EDE0	TOTAL02_PLC_SGNL	TOTAL02 plc signal

◆ Connection points in PLC logic

TOTALTIM(Function ID: 541001)

Element ID	Name	Description
801503EDE0	TOTAL03_PLC_SGNL	TOTAL03 plc signal
801504EDE0	TOTAL04_PLC_SGNL	TOTAL04 plc signal
801505EDE0	TOTAL05_PLC_SGNL	TOTAL05 plc signal
801506EDE0	TOTAL06_PLC_SGNL	TOTAL06 plc signal
801507EDE0	TOTAL07_PLC_SGNL	TOTAL07 plc signal
801508EDE0	TOTAL08_PLC_SGNL	TOTAL08 plc signal
801509EDE0	TOTAL09_PLC_SGNL	TOTAL09 plc signal
80150EDE0	TOTAL10_PLC_SGNL	TOTAL10 plc signal
80150BEDE0	TOTAL11_PLC_SGNL	TOTAL11 plc signal
80150CEDE0	TOTAL12_PLC_SGNL	TOTAL12 plc signal

4.6 Synchronizing check for different network (SYNDIF)

The Synchronizing check function (SYNCHK) is provided for checking for the presence of voltage or the voltage/frequency-variance when connection between two parts of a network is required. The SYNCHK function is of benefit where the "Double position controller with synchronizing-check (DPSY†)" function is used for connection between two parts of a network. This is because operation of the DPSY function to close the circuit breaker is inhibited until the SYNCHK function gives permission. The SYNCHK function is made up of two group functions (SYNCHK01 and SYNCHK02‡). The group function consists of two logic elements: the former part is to check for the voltage-presence (or absence) on an incoming line and a running line; the latter part is to check the synchronizing condition between two energized lines.

Note: The implementation of such features depends on the selection of hardware and the configuration of functions. Several IED models do not have its features. To determine whether its features are implemented in the IED, locate the IED ordering number; and check the order number at the "G&T position" referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 4.6-1 Comparative table in respective ordering numbers

Sec.	Feature	Ordering No. at "G&T"				
		10	11	13	19	22
–	Main features	NA	NA	NA	NA	✓
–	Number of functions	–	–	–	–	2

✓: Applicable NA: Not applicable

The SYNCHK_RY function consists of several over-voltage and under-voltage and synchronizing relays (OV, UV, and SyncRys) integrated within the synchronization check feature (SYNCHK). The SYNCHK function issues permissive signals to the DPSY functions; hence, ensuring that the DPSY functions are only able to close the CB when the required conditions for closure have been satisfied.

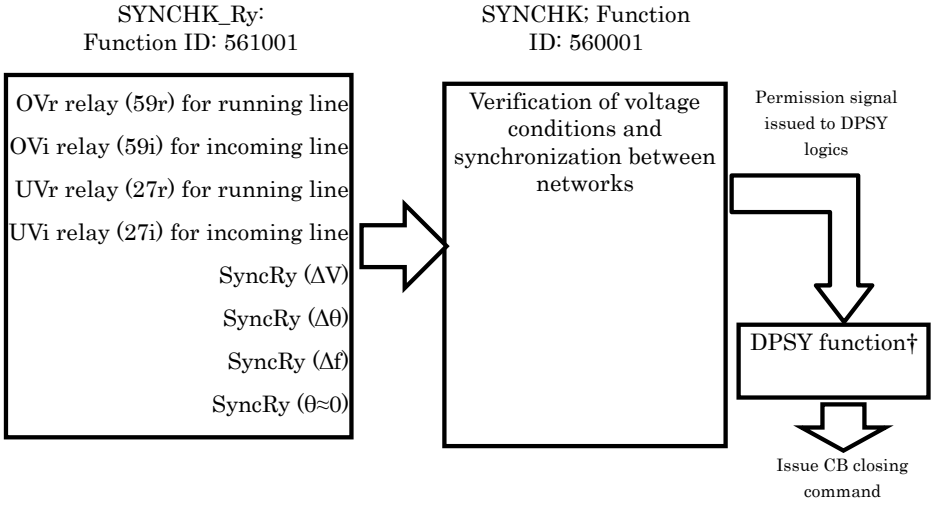


Figure Outline of SYNCHK function

†Note:The DPSY function is discussed separately. See Chapter *Control and monitoring application: Double position controller with synchronizing-check*.

‡Note:To simplify the description, only the SYNCHK1 (SYNCHK_Ry1) function is discussed; however, the same description is applicable to the SYNCHK2 (SYNCHK_Ry2) function. The user should read the expression for SYNCHK1 as SYNCHK2 unless a special explanation or instruction has been provided (e.g., the user can reason by analogy that the feature in the OVr2 relay is identical to the OVr1 relay).

4.6.1 Relays to check line-outage

The voltage condition for either line being out of service or being in service is verified using OV and UV relays in the SYNCHK_Ry1 function.

Table 4.6-2 Settings in SYNCHK_Ry1

Setting Name	Description	Default	Range
OVR1	Checking Live-Running Voltage	51V	10 to 150 V
UVR1	Checking Dead-Running Voltage	13V	10 to 150 V
OVI1	Checking Live-Incoming Voltage	51V	10 to 150 V
UVI1	Checking Dead-Incoming Voltage	13V	10 to 150 V

(i) Overvoltage-relay elements (OVr1, OVi1)

Two overvoltage-relay elements (OVr1 and OVi1) are provided to determine the voltage presence between running and incoming lines. In Figure 4.6-1 the hatched area depicts the

operating area of OV characteristic. The OVr1 element is used to check for the presence of voltage on the running-line; similarly, the OVi1 element is used to check for the presence of voltage on the incoming-line. The user can set pick-up thresholds using the settings [**OVR1**] and [**OVI1**].

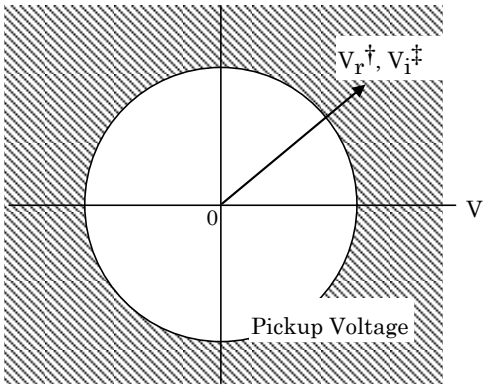


Figure 4.6-1 Characteristics of OVr1 and OVi1

(ii) Undervoltage-relay elements (UVr1, UVi1)

Two undervoltage-relay elements (UVr1 and UVi1) are provided to determine the absence of voltage on the running and incoming lines. In Figure 4.6-2 the hatched area depicts the operating area of the UV characteristic. The UVr1 element is used to check for the absence of voltage on the running-line; similarly, the UVi1 element is used to check for the absence of voltage on the incoming-line. The user can set drop-off thresholds using the settings [**UVR1**] and [**UVI1**].

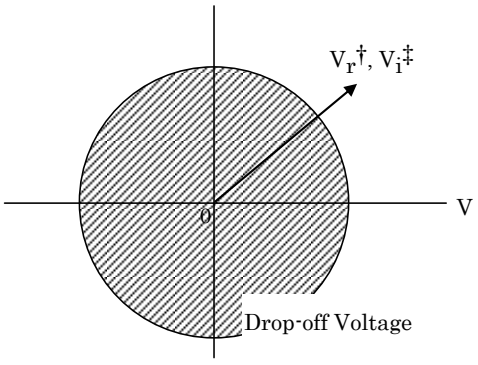


Figure 4.6-2 Characteristics of UVr1 and UVi1

†Note: Settings [**OVR1**] and [**UVR1**] are applied for the measurement of voltage on the running line (Vr).

‡Note: Settings [**OVI1**] and [**UVI1**] are applied for the measurement of voltage on the incoming line (Vi).

4.6.2 Synchronization check relays

Figure 4.6-3 shows the variance of voltages, phase-angles and frequencies for Vr and Vi.

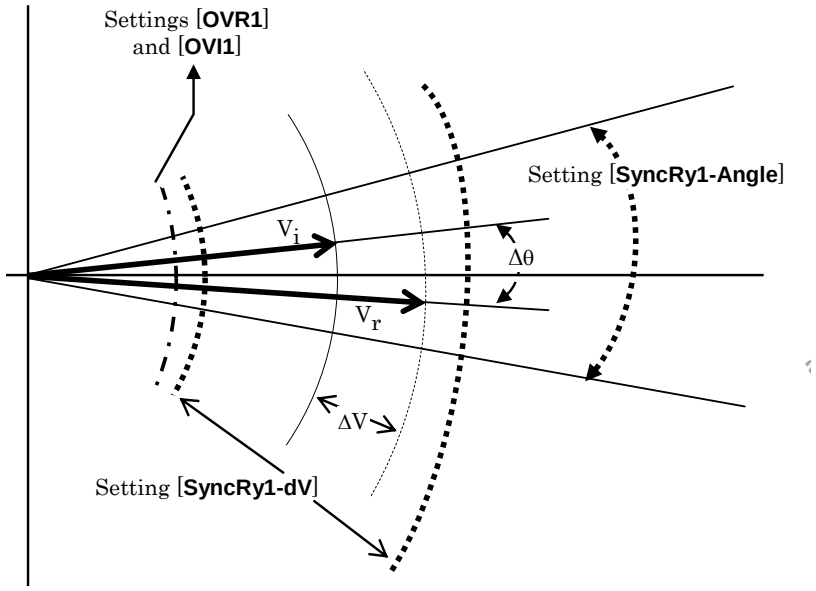


Figure 4.6-3 Permissible ranges for connections between synchronous networks

The provision of a signal for CB closure between two networks may be required subject to the variance of the two voltages, phase-angles and frequencies being small. Therefore, the SYNCHK function continuously monitors the Δθ, ΔV and Δf; subsequently the SYNCHK function issues an operate-permission signal to the DPSY function when the variance is less than the permissible range. For this purpose, synchronism-relays (SyncRy1-dV, SyncRy1-df, SyncRy1-dθ) are provided; the user can set them in accordance with their specific requirements.

Figure 4.6-4 shows the angle-variance between Vi and Vr; the increment or decrement of the angle-variance (Δθ) is shown based upon the running voltage Vr.

When connection between asynchronous networks is required, the split-synchronism-check elements (SyncRy-θ=0 and SyncRy-θless) are used so that the connection will be performed when the angle-variance Δθ is small.

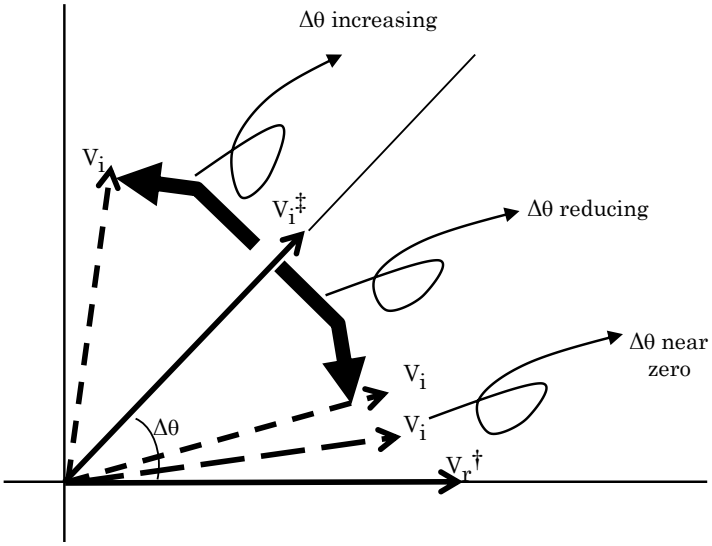


Figure 4.6-4 Permissible ranges for connections between asynchronous networks

†Note: Vr is the voltage on a running line.

‡Note: Vi is the voltage on an incoming line.

Table 4.6-3 Settings in SYNCHK_Ry1

Setting Name	Description	Default	Setting item or value
SyncRy1-Angle	Checking angle variance	30 degrees	0 to 75 degrees
SyncRy1-dV	Checking voltage variance	150V	0 to 150 V
SyncRy1-df	Checking frequency variance	1Hz	0.01 to 2 Hz
SyncRy1-TCB	Advance time for SYNCHK01	–	Seconds
SYNC01_TSYN	Sync check timer for loop system	10s	0.00 to 100.00 s

(i) Synchronism-relays (SyncRy1-dV, SyncRy1-df, SyncRy1-dθ)

Synchronism-relays, SyncRy1-dV, SyncRy1-df, and SyncRy1-dθ are provided; the setting ranges for these relays are shown in Table 4.6-3.

(i)-1 Voltage-variance (ΔV) (see Figure 4.6-3)

The voltage-variance between Vr and Vi ($|V_r - V_i|$) is measured by the voltage-variance relay-element having a setting [**SyncRy1-dV**]. If equation (4.6-3) is satisfied together with the conditions stipulated in equations (4.6-2) and (4.6-3), the SyncRy1-dV relay determines that the voltage-variance is inside the permissible range.

$$V_r \geq \text{Setting [OVR1]} \quad (4.6\text{-}1)$$

$$V_i \geq \text{Setting [OVI1]} \quad (4.6\text{-}2)$$

$$|V_r - V_i| \leq \text{Setting [SyncRy1-dV]} \quad (4.6\text{-}3)$$

(i)-2 Phase-angle variance (Δθ) (see Figure 4.6-4)

The phase-angle variance of Vr and Vi (Δθ) is measured by the phase-angle variance-relay having the setting [**SyncRy1-Angle**]. If the following equations are satisfied, the SyncRy1-Angle relay determines that the phase-angle variance is inside the permissible range.

$$V_r \times V_i \cos\Delta\theta > 0 \qquad (4.6\text{-}4)$$

$$V_r \times V_i \sin(\text{setting}[\textbf{SyncRy1-Angle}]) \geq V_r \times V_i \sin\Delta\theta \qquad (4.6\text{-}5)$$

(i)-3 Frequency-variance (Δf)

The frequency-variance of Vr and Vi (Δf) is measured by the frequency-variance relay having the setting [**SyncRy1-df**]. If the following equations are satisfied, the SyncRy1-df relay determines that the frequency-variance is inside the permissible range.

$$\Delta f = |f_{Vi} - f_{Vr}| \leq \text{setting } [\textbf{SyncRy1-df}] \qquad (4.6\text{-}6)$$

where,

f_{Vr}	Frequency of Vr
f_{Vi}	Frequency of Vi
Δf	Frequency-variance between Vr and Vi

(i)-4 Tips

The SYNCHK relay could detect the frequency-variance between the Vr and the Vi, although the SYNCHK relay does not have the setting [**SyncRy1-df**]. To detect the frequency-variance with the absent of the [**SyncRy1-df**], set both the settings [**SyncR1-Angle**] and [**SYNC01_TSYN**]; then, the frequency-variance (i.e., detected maximum slip cycle) is given with Equation:

$$\Delta f > \frac{\text{Setting } [\textbf{SyncR1-Angle}]}{180° \times \text{Setting } [\textbf{SYNC01_TSYN}]} \qquad (4.6\text{-}7)$$

where,

Δf= cycle-slip in Hertz

(ii) Split-synchronism-check element (SyncRy1-θ=0, SyncRy1-θless)

With regard to the connection of asynchronous networks, it is necessary to use the technique of split synchronism to avoid the occurrence of cycle-slip on the system. The technique consists of three parts: (1) calculation of the synchronization point (SyncRy1-θ=0), (2) check for slip cycle (SyncRy1-θless), and (3) advance time for issuing the closure command.

(ii)-1 Calculation of synchronization point

Issuing a closure command for the CB is appropriate when the variance of Vr and Vi is small. Hence, the timing of when it should be issued is calculated in the SyncRy1-θ=0 element so that the prediction of coincident timing between the running, (Vr) and the incoming, (Vi) voltages can be introduced. Figure 4.6-5(c) shows the coincident point (zero point).

(ii)-2 Check for slip cycle

Checking the decrease in Δθ is a suitable means for controlling the issue of a closure command to a CB at the requisite timing. The SyncRy1-θless element calculates the for reducing Δθ; it assists in the computation of the SyncRy1-θ=0 element.

(ii)-3 Advance time

The user shall consider the actual device operation time. For an asynchronous network, the issue of the CB closure command should be initiated such that it is coordinated with the actual closing. Figure 4.6-5 shows the advancing time; it is introduced with setting [**SyncRy1-TCB**], closing time (Tcb) and compensation time:

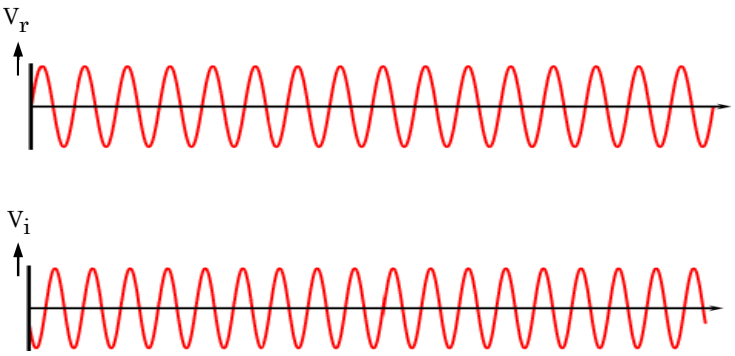
$$\text{Setting}[\textbf{SyncRy1-TCB}] = \alpha + T_{CB} + \beta \qquad (4.6\text{-}8)$$

where,

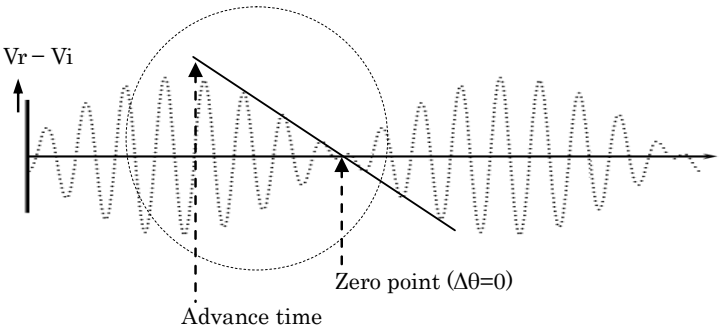
α: Operation time of the element

ß: Compensation (i.e., tolerance) time

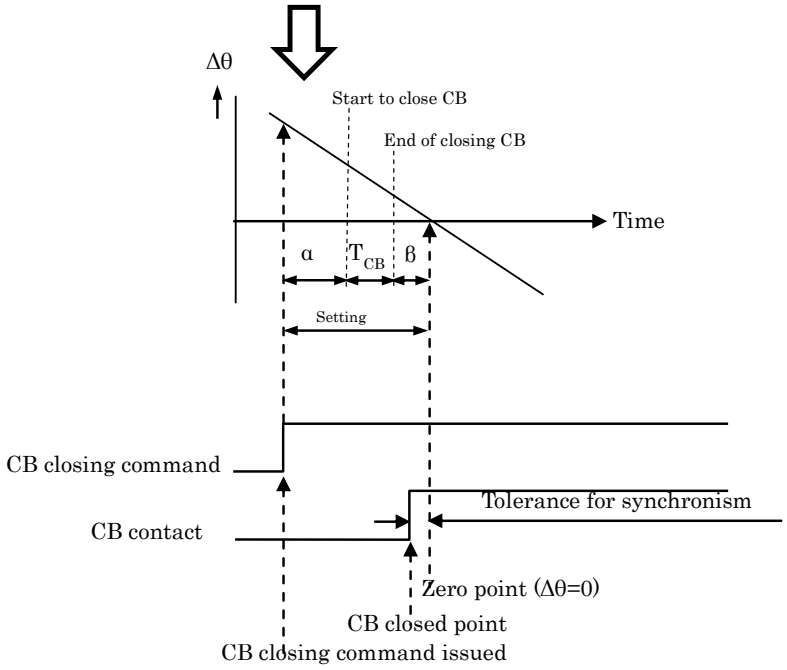
Tcb: Closing time of CB



(b) Incoming voltage (V_i)



(c) Beat wave provided by $V_r + V_i$



(d) Advance time and CB closing command

Figure 4.6-5 Advance time to close CB for an asynchronous system

4.6.3 Line-outage check

(i) Voltage conditions

In the SYNCHK function the OVr, OVi, UVr, and UVi elements are used to verify the line-condition. For example, when the user wishes to connect an incoming-line (i.e., transmission line) with the running-line (i.e., a busbar), the voltage conditions on either lines may be examined prior to connection. Alternatively, the absence of voltage on both lines may be required before connection. In order to provide this functionality, the SYNCHK function has four check zones to test for the line being either in-service or out-of-service; the four zones are illustrated in Figure 4.6-6.

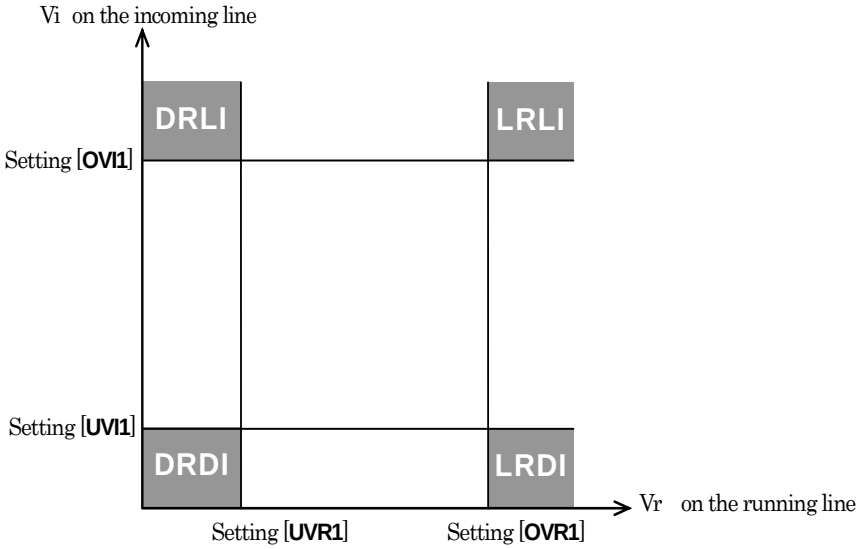


Figure 4.6-6 Four voltage conditions examined in SYNCHK_Ry1

For example, "DRLI" zone covers the case when the running-line is out-of-service (DR) and the incoming-line is in-service (LI). Table 4.6-4 exemplifies the areas in accordance with the voltage conditions.

Table 4.6-4 Four voltage conditions and zones

Voltage condition	1	2	3	4
Area	DⓇLⒾ	LⓇLⒾ	DⓇDⒾ	LⓇDⒾ
Ⓡunning line (Vr)	(Dead)	(Live)	(Dead)	(Live)
Ⓘncoming line (Vi)	(Live)	(Live)	(Dead)	(Dead)

Figure 4.6-7 and Figure 4.6-8 show the voltage-presence (or voltage-absence) check logic used in the SYNCHK_Ry1 and Ry2 functions.

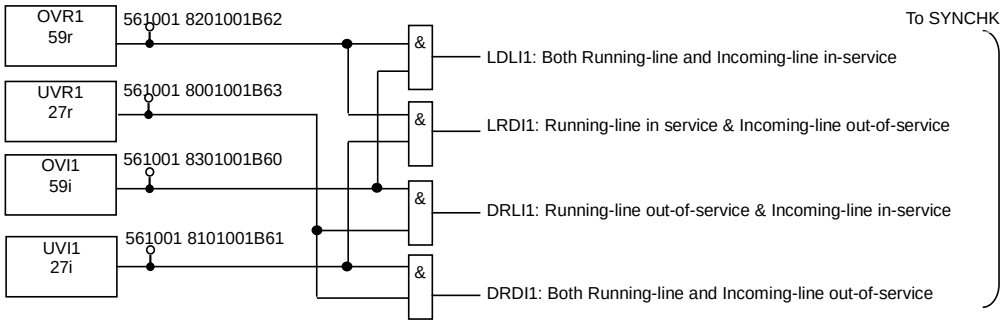


Figure 4.6-7 Line-outage check logic in SYNCHK_Ry1

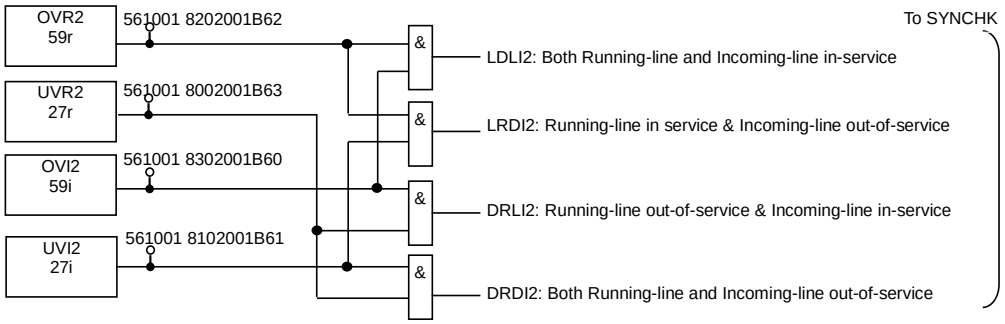


Figure 4.6-8 Line-outage check logic in SYNCHK_Ry2

Table 4.6-5 Voltage condition settings in SYNCHK1

Setting Name	Description	Default	Setting item or value
SYNC01_TLRDIDRLI	Voltage check timer (LRDI, DRLI)	5s	0.00 to 5.00s
SYNC01_TDRDI	Voltage check timer (DRDI)	5s	0.00 to 5.00s
SYNC01_LRDIEN	CB close enable for LRDI	On	Off/On
SYNC01_DRLIEN	CB close enable for DRLI	On	Off/On
SYNC01_DRDIEN	CB close enable for DRDI	On	Off/On

(ii) Check logic and settings

Figure 4.6-9 shows the SYNCHK1 logic. When the DPSY01 function confirms the reception of a selection-command, the DPSY01 function issues a "DPSY01_OSE_RCV" signal to the SYNCHK1 function. Then the SYNCHK1 function commences with the check for the voltage condition by introducing the results of the SYNCHK_Ry function. As described previously, four voltage conditions are considered, the user should select the voltage-conditions required by the application. The SYNCHK1 logic provides two permissive signals: "SYNC01_SLD_VCS" signal and "SYNC01_SYN_CLC" signal.

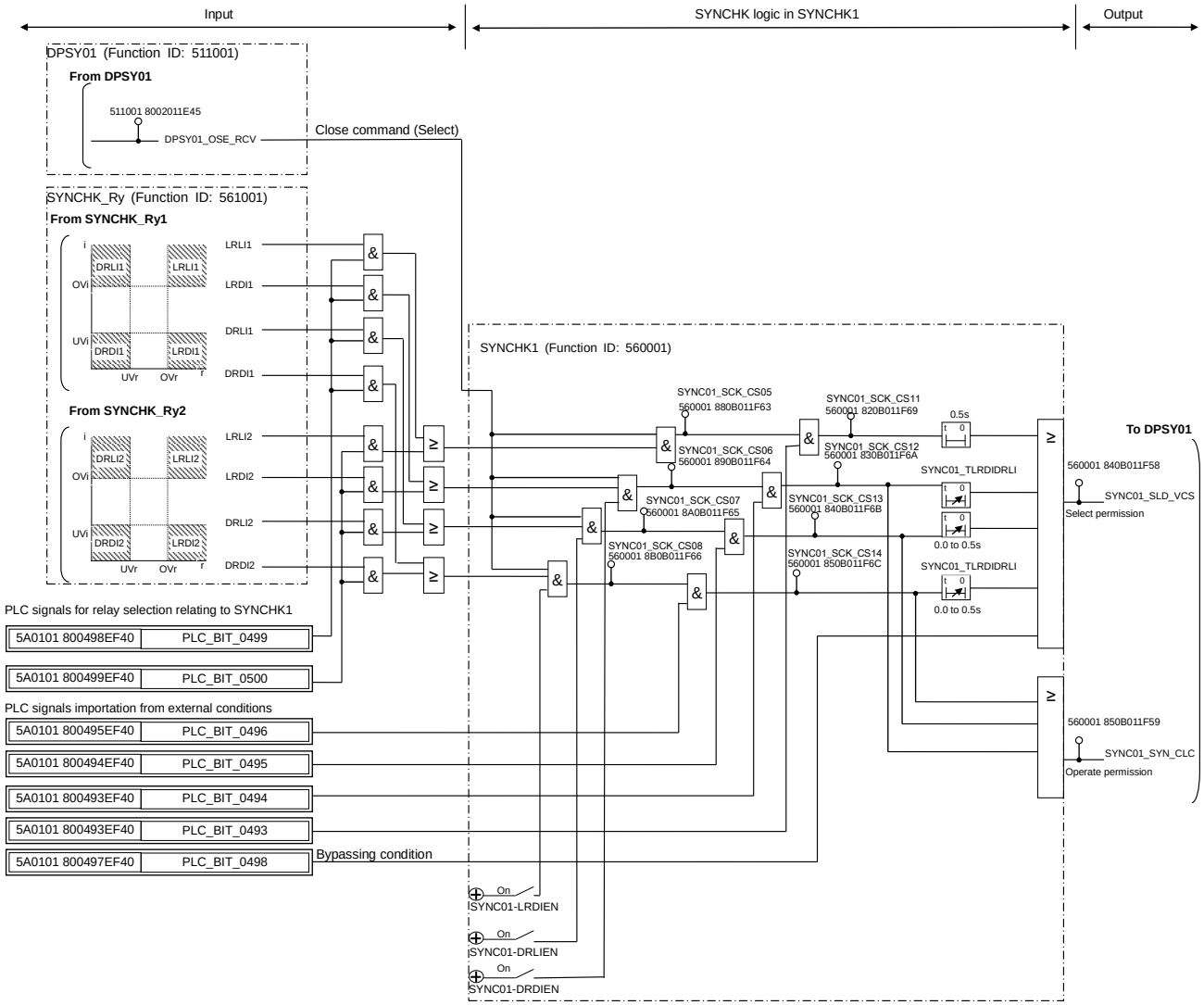


Figure 4.6-9 Voltage-condition check logic in SYNCHK1

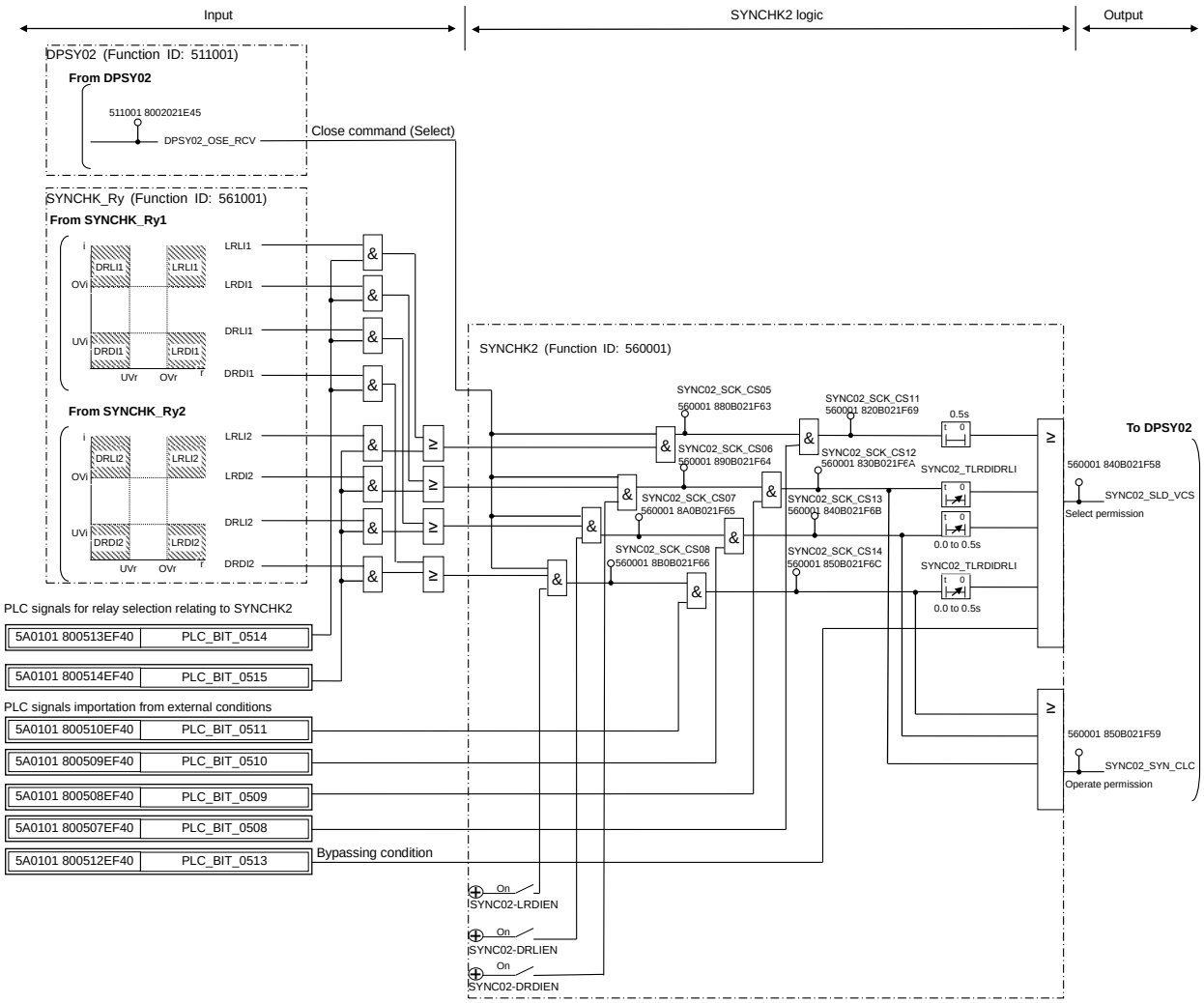


Figure 4.6-10 Voltage-condition check logic in SYNCHK2

(ii)-1 Permission signal "SYNC01_SLD_VCS"†

The "SYNC01_SLD_VCS" signal is transferred to the DPSY01 select-logic. For example, suppose the DPSY01 function is given permission to operate when any voltage-condition is satisfied, then the user should set **On** for the scheme switches [**SYNCHK01-LRDIEN**], [**SYNCHK01-DRLIEN**], and [**SYNCHK01-DRDIEN**].

For example, if the DPSY01 function is required to operate when the voltage condition "LRDI" is confirmed (Table 4.6-4.(4)), just set **On** for the scheme switch [**SYNCHK01-LRDIEN**].

User programmable pick-up delay timers are available for the conditions "LRDI" and "DRLI" (Table 4.6-4.(1 and 4)); hence the user can set a desired value for the setting [**SYNC01_TLRDIDRLI**]; similarly, a desired value can be applied for the setting [**SYNC01_TDRDI**] for the condition "DRDI" (Table 4.6-4.(3)).

†Note: This signal is required for CB closing in the select logic. For more information, see separate section *DPSY: Control logics*.

(ii)-2 Permission signal "SYNC01_SYN_CLC"‡

The "SYNC01_SYN_CLC" signal is input to the DPSY01 operate-closing-logic as a permissive signal. The DPSY01 function is allowed to operate when any voltage-conditions except "LRLI" is satisfied in the DPSY01 operation.

‡Note: This signal is required only for CB closing in the operate-closing logic. For more information, see separate section *DPSY: Operate logics*.

(iii) Adding other voltage-conditions using PLC signals

The user can add a user-preferred condition to the logic signal using PLC connection points. In the SYNCHK1 logic, points "PLC_BIT_0493 to PLC_BIT_0495" are provided†. Similarly, points "PLC_BIT_0508 to PLC_BIT_0511" are provided in the SYNCHK2 function.

†Note: For more information on PLC programing, see chapter *PLC function*, separately.

(iv) Relay selection using PLC signals

Either SYNCHK_Ry1 or SYNCHK_Ry2 function can be chosen for SYNCHK1 operation. On this account, points "PLC_BIT_0499" and "PLC_BIT_0500" are provided and the user can choose either for use in conjunction with SYNCHK1 operation; similarly, "PLC_BIT_0514" and "PLC_BIT_0515" are provided for SYNCHK2 operation. The purpose of the choice is discussed in section 4.6.5.

4.6.4 Synchronization check

The user should set **On** for scheme switch [**SYNC01-SYNCHK1EN**] when synchronization check is required.

(i) Synchronization conditions

The synchronizing relays are used to check the respective conditions of the incoming-line and the running-line. For example, the ΔV, Δθ, and Δf variances of Vi and Vr may be examined when the SYNCHK function is used in a synchronous network. Conversely, the Δθ reducing-degree feature can be applied for asynchronous networks; the SYNCHK function can use signals 'Δθ1≈0' and 'Δθ1_less' in order to decide whether the difference-angle is reducing. Thus, the SYNCHK function is required to have two sets of check logic covering both (1) synchronous conditions and (2) asynchronous conditions.

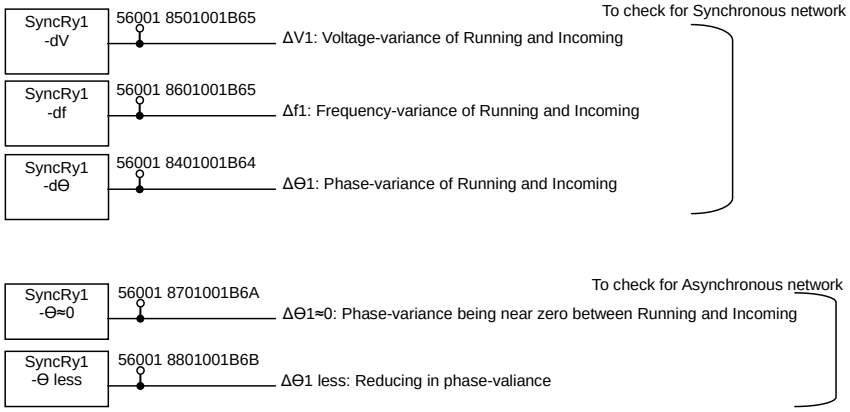


Figure 4.6-11 Synchronization check relays in SYNCHK_Ry1

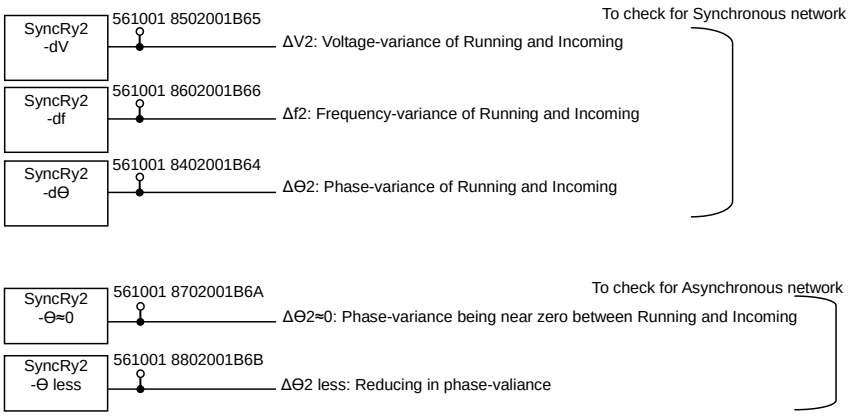


Figure 4.6-12 Synchronization check relays in SYNCHK_Ry2

Figure 4.6-13 shows the synchronization check logic in the SYNCHK1 function. The user should note that the logic has been separated for (1) the synchronous condition and (2) the asynchronous condition; the synchronization check logic is initiated when the "DPSY01_OEC_RCV" signal is received, which is identical to an operate-command in the On-direction.

Table 4.6-6 Synchronization settings in SYNCHK1

Setting Name	Description	Default	Setting item or value
SYNC01_SYNCHK1EN	SYNCHK1 synchronization checking enable	Off	On / Off
SYNC01_TSYN	Synchronism check timer for synchronous system	10s	0.00–100.00s
SYNC01_TSYN2	Timer to give up the synchronization	60s	30.0–1800.0s
SYNC01_Split_EN	SYNCHK1 async. checking enable	Off	Off/On
SYNC01_SYNCTEST	Test in SYNCHK1 synchronism check	Off	Off/On

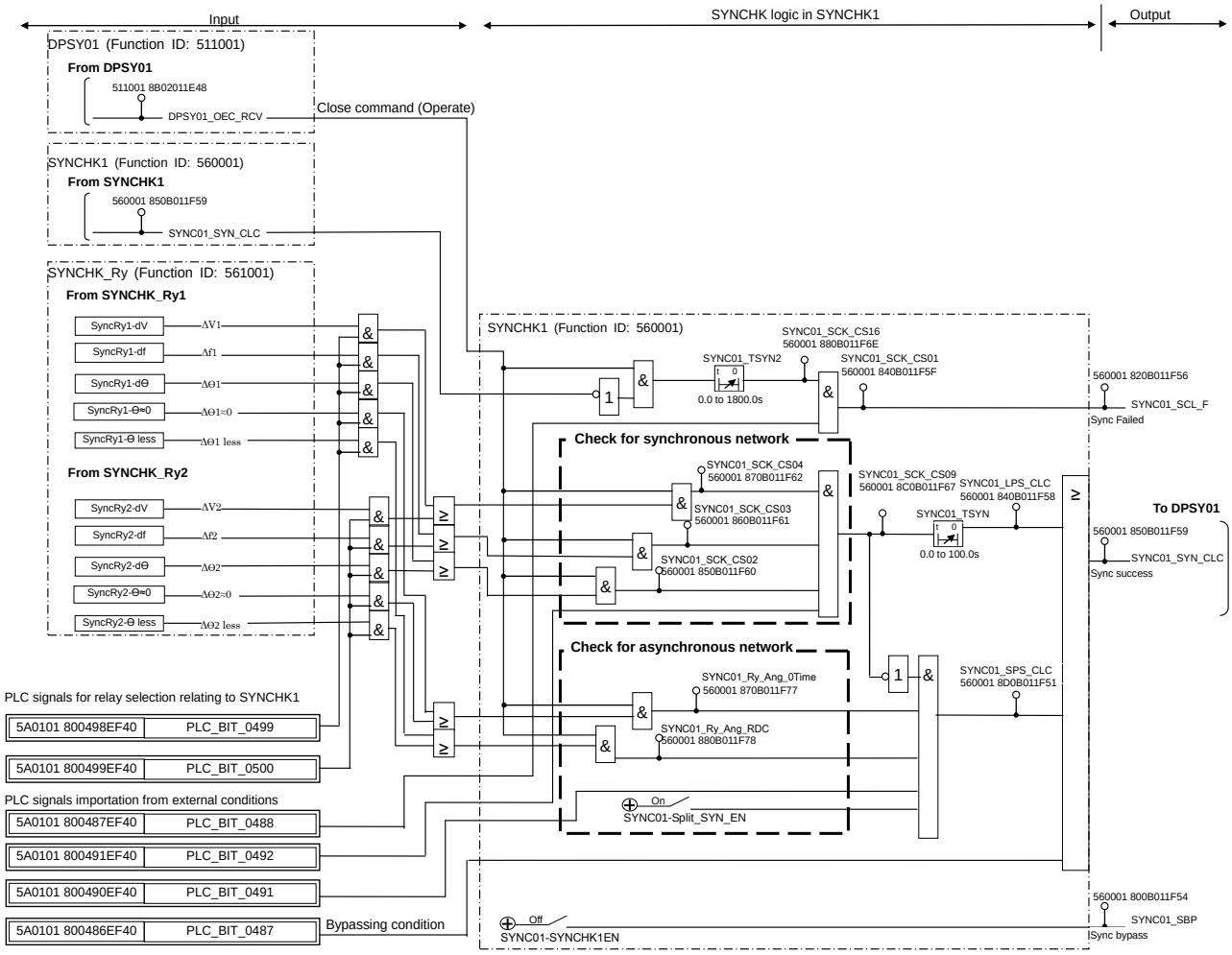


Figure 4.6-13 Synchronization check logic in SYNCHK1

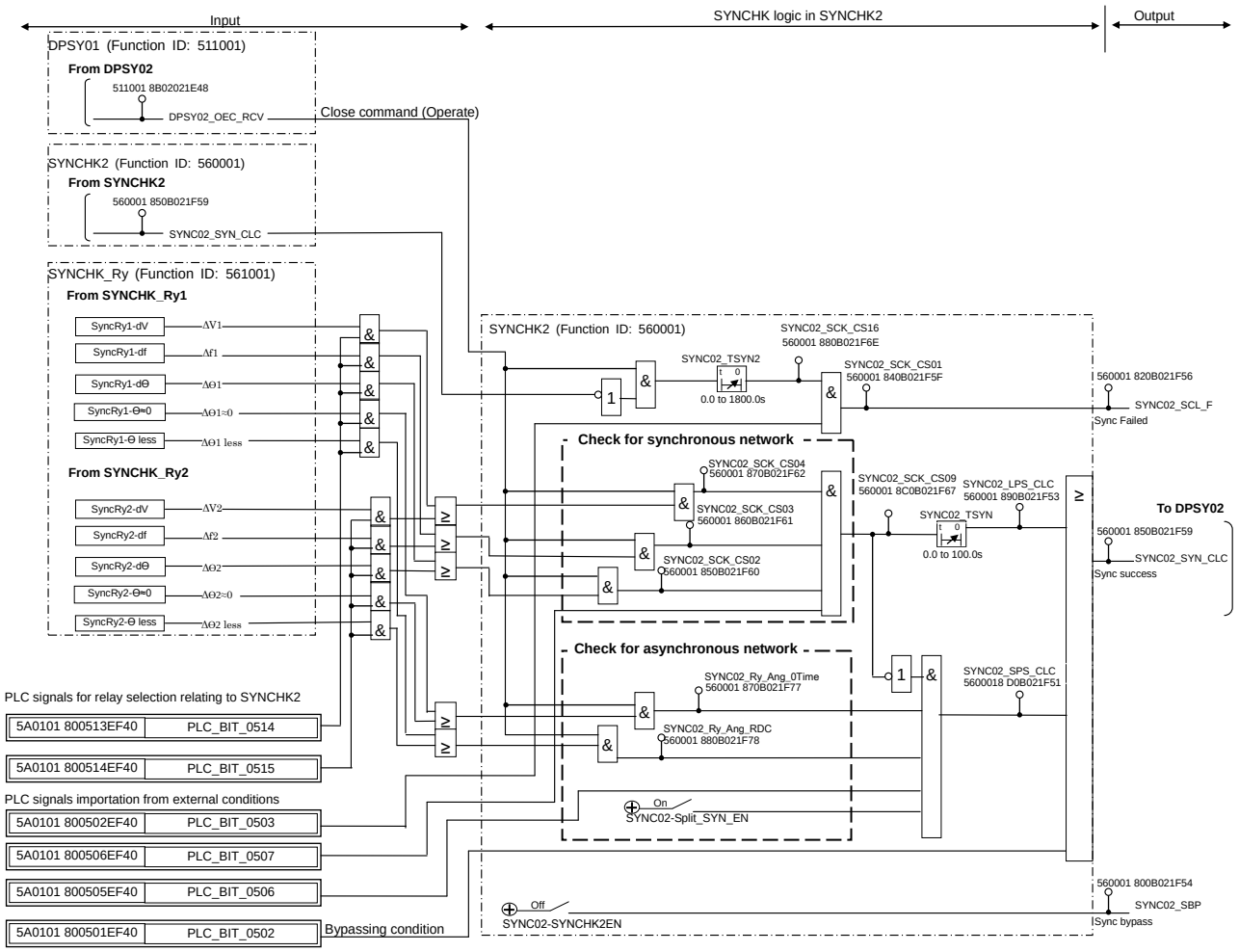


Figure 4.6-14 Synchronization check logic in SYNCHK2

(ii) Check logic and settings for synchronous network

As shown in Figure 4.6-13, the ΔV, Δθ, and Δf signals are required to check the synchronous condition; the three signals are input to the logic. The sync-success signal "SYNC01_SYN_CLC" is provided after the operation of the delay timer "SYNC01_TSYN". The user can regulate the timer using the setting [**SYNC01_TSYN**].

(iii) Check logic and settings for asynchronous network

In Figure 4.6-13, the 'Δθ1≈0' and 'Δθ1_less' signals are used to check the synchronization condition when the user sets **On** for scheme switch [**SYNC01-Split_SYN_EN**]; subsequently sequentially the sync-success signal "SYNC01_SYN_CLC" is issued for the DPSY01 function.

(iv) Bypassing synchronization check

If the user wishes to remove the synchronization check, set **Off** for the scheme switch [**SYNC01-SYNCHK1EN**]. The DPSY01 function can operate with the absence of the sync-success signal "SYNC01_SYN_CLC".

(v) Unsuccessful synchronization check

If the injected signal "DPSY01_OEC_RCV" persists for longer than a pre-determined time, the check logic determines that synchronization has not occurred; hence, the check logic can issue a failure signal for the DPSY01 function. Consequently, the DPSY01 function abandons the attempt to close the CB due to the failure in the synchronization process. The user can set the time using the setting [**SYNC01_TSYN2**].

(vi) Adding other sync-conditions using PLC signals

When required, a user-preferred sync-condition can be added to the SYNCHK function using the PLC connection points. For the SYNCHK1 logic, points "PLC_BIT_0488", "0492", and "0491" are provided. Similar points are also provided in the SYNCHK2 function.

(vii) Relay selection using PLC signals

As described in 4.6.3(iv), either the SYNCHK_Ry1 or SYNCHK_Ry2 function can be chosen for check synchronization in addition to checking the voltage condition. For the purpose of the choice provided, see section 4.6.5.

(viii) Synchronization logic test

When required, a hypothetical sync-success signal can be issued for testing, the user can set **On** for the scheme switch [**SYNC01_SYNCTEST**]. Note that **Off** should be set for the scheme switch after testing.

4.6.5 Relay selection for checking synchronization

Figure 4.6-15 exemplifies a bus-bar arrangement used as an example for check synchronization. In this example, the SYNCHK_Ry1 relays require the voltage signals† V3, V4, and V1. This is because DS1 and DS3 are closed, but DS2 is open; the selection of SYNCHK_Ry1 is initiated by the reception of the "SYNCHK_Ry1_selection" signal. The "SYNCHK_Ry1_selection" and "SYNCHK_Ry2_selection" signals are generated by logic programmed by the user; hence, here the signal "SYNCHK_Ry1_selection" is connected with the PLC connection point "PLC_BIT_0499"‡.

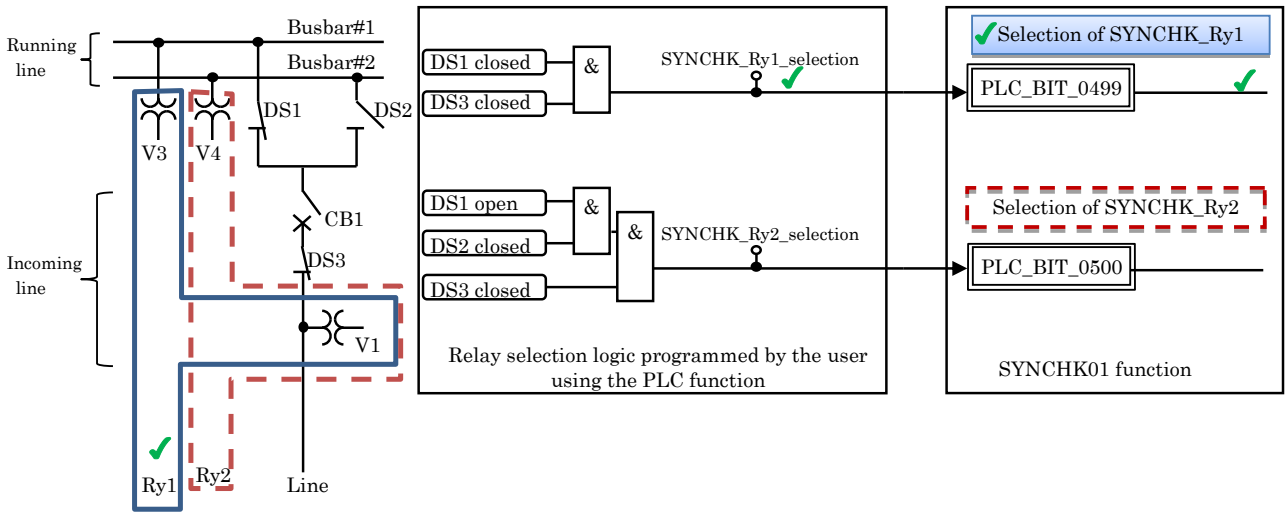


Figure 4.6-15 Relay-selection-signal provided by DPSY function (an example)

†Note: The relationship between the injected voltage-signals and the SYNCHK_Ry function is discussed in section 4.6.6.

‡Note: The user should also connect the "SYNCHK_Ry2_selection" signal with the PLC connection point "PLC_BIT_0500". Users should note that Figure 4.6-15 is provided for explanation/information; the user is required to program relay-selection logic using the PLC function that responds dynamically to configuration changes that occur as a consequence of CB and DS operations.

In Figure 4.6-15 , two signals are used for relay selection, but the user should note that the selection-signals are provided in accordance with the actual line and bus-bar arrangement. Figure 4.6-16 shows the overall logic used for the selection. The user can program the selection-signals using the PLC function.

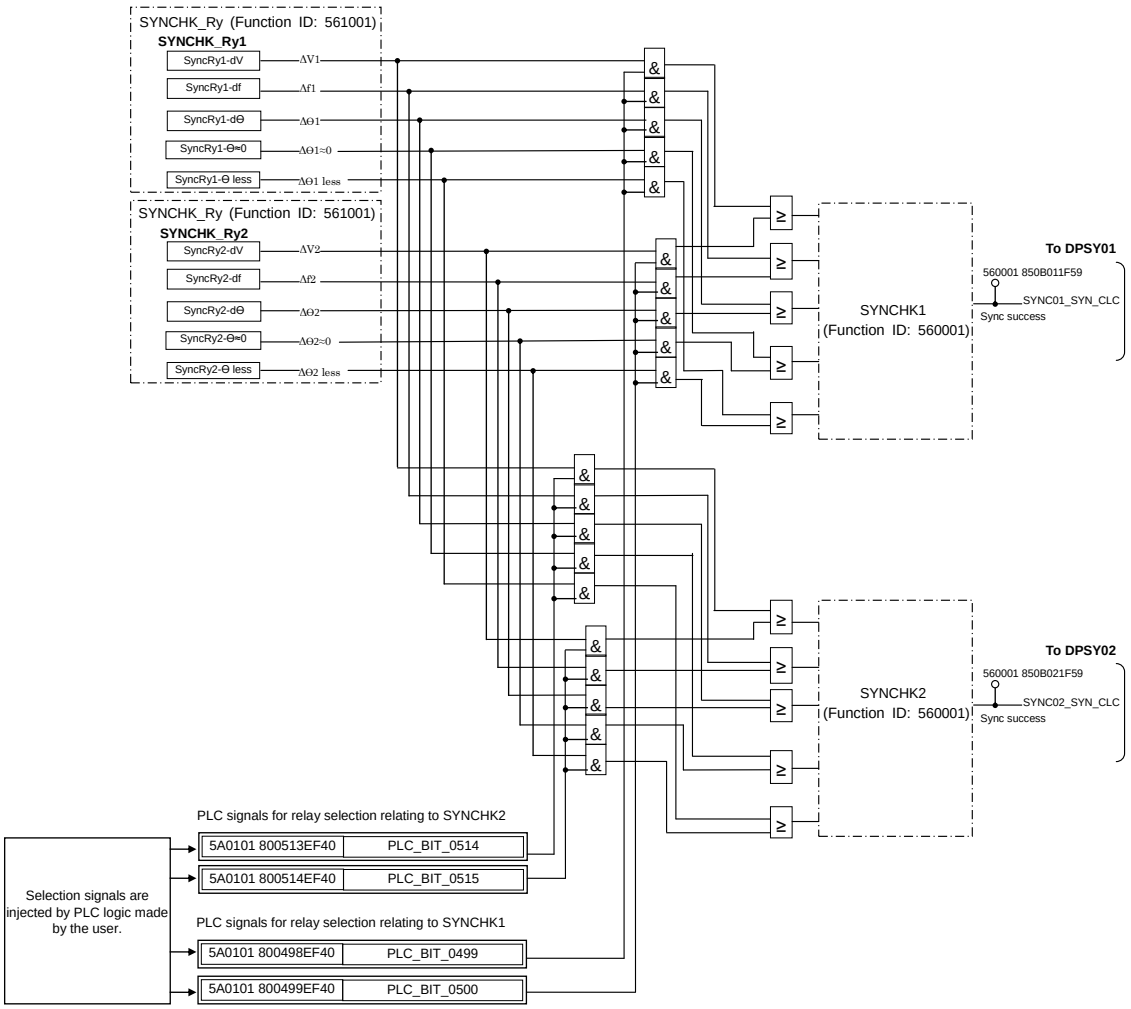


Figure 4.6-16 Relay selection made using PLC signals

Table 4.6-7 PLC connection point (Relay selection)

Signal Number	Signal Name	Description	M/O
5A0101 800498EF40	PLC_BIT_0499	SYNCHK1 use SYNCHK_RY1	M
5A0101 800499EF40	PLC_BIT_0500	SYNCHK1 use SYNCHK_RY2	M
5A0101 800513EF40	PLC_BIT_0514	SYNCHK2 use SYNCHK_RY1	M
5A0101 800514EF40	PLC_BIT_0515	SYNCHK2 use SYNCHK_RY2	M

4.6.6 Voltage selection for line arrangement

As shown in Figure 4.6-15, input-voltage signals are required in response to the line and busbar arrangement. Incidentally, the input-voltage signals supplied by the VTs are applied to the IED via the transformer module (VCT†); hence, the input-voltage signal should correspond with the required relay-element. On this account, settings are provided in the SYNCHK_Ry function.

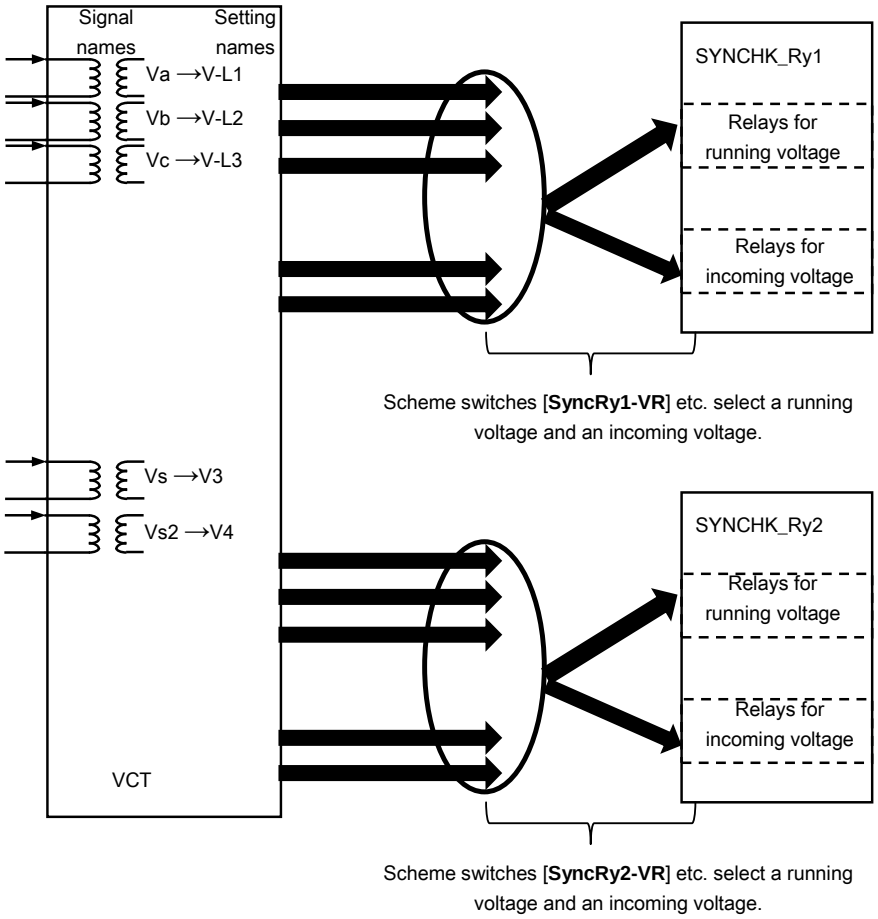


Figure 4.6-17 Voltage signals selected using scheme switches

†Note: For the actual terminal arrangement and signals injected, see chapter *Technical description: Transformer module for AC analog input.*

Figure 4.6-17 illustrates that the signals injected are distributed using scheme switches: [**SyncRy1-VR**], [**SyncRy1-VI**], [**SyncRy1-VR**], and [**SyncRy1-VI**]. Examples below show how to apply a voltage signal for the required relay-element.

(i) Setting example

Figure 4.6-18 depicts an example of a busbar arrangement and S43P logic programmed by the user. In this case, only the SYNCHK_Ry1 function is used; therefore, the user need only select the signal provided by the S43P logic for the SYNCHK_Ry1 function.

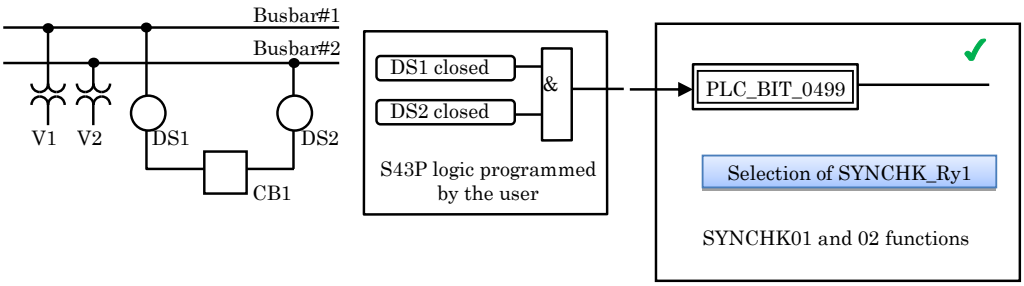


Figure 4.6-18 Bus-bar arrangement and PLC setting

Voltage selection should be considered in accordance with the arrangement of VTs. Voltages V1 and V2 represent the running voltage (V_R) and the incoming voltage (V_I), respectively. Consequently, **V-L1** and **V2-L1** are set for the scheme switches [**SyncRy1-VR**] and [**SyncRy1-VI**], respectively. Table 4.6-8 shows the setting example for this arrangement.

Table 4.6-8 Setting example

Setting Name	Description	Default	Setting item or value
SyncRy1-VR	Selection of running voltage	V-L1	Either of V-L1 / V-L2 / V-L3
SyncRy1-VI	Selection of incoming voltage	V2-L1	Either of V2-L1 / V2-L2 / V2-L3
SyncRy2-VR	Selection of running voltage	N.A	N.A
SyncRy2-VI	Selection of incoming voltage	N.A	N.A

4.6.7 Setting

Main settings for SYNCHK (Function ID: 560001)

Setting item		Range	Units	Contents	Default setting value	Notes
SYNCHK1	SYNC01_SYNCHK1EN	On / Off	–	SYNC DEV1 synchronism check mode enable	Off	
	SYNC01_TLRDIDRLI	0.00–5.00	s	V check timer(Live Running & Dead Incoming Dead Running & Live Incoming)	5.00	
	SYNC01_TDRDI	0.00–5.00	s	V check timer (Dead Running & Dead Incoming)	5.00	
	SYNC01_TSYN	0.00–100.00	s	synchronism check timer (Loop)	10.00	
	SYNC01_TSYN2	30.0–1800.0	s	Synchronism check time up	60	
	SYNC01_Split_EN	Off/On	–	SYNC DEV1 split synchronism check mode enable	Off	
	SYNC01_LRDIEN	Off/On	–	SYNC DEV1 Live Running & Dead Incoming close mode enable	On	
	SYNC01_DRLIEN	Off/On	–	SYNC DEV1 Dead Runing & Live Incoming close mode enable	On	
	SYNC01_DRDIEN	Off/On	–	SYNC DEV1 Dead Running & Dead Incoming close mode enable	On	
	SYNC01_SYNCTEST	Off/On	–	SYNC DEV1 synchronism check test mode	Off	
SYNCHK2	SYNC02_SYNCHK2EN	On / Off	–	SYNC DEV2 synchronism check mode enable	Off	
	SYNC02_TLRDIDRLI	0.00–5.00	s	V check timer (Live Running & Dead Incoming Dead Running & Live Incoming)	5.00	
	SYNC02_TDRDI	0.00–5.00	s	V check timer (Dead Run. & Dead Incoming)	5.00	
	SYNC02_TSYN	0.00–100.00	s	synchronism check timer(Loop)	10.00	
	SYNC02_TSYN2	30.0–1800.0	s	Synchronism check time up	60	
	SYNC02_Split_EN	Off/On	–	SYNC DEV2 split synchronism check mode enable	Off	
	SYNC02_LRDIEN	Off/On	–	SYNC DEV2 Live Running & Dead Incoming close mode enable	On	
	SYNC02_DRLIEN	Off/On	–	SYNC DEV2 Dead Running & Live Incoming close mode enable	On	
	SYNC02_DRDIEN	Off/On	–	SYNC DEV2 Dead Running. & Dead Incoming close mode enable	On	
	SYNC02_SYNCTEST	Off/On	–	SYNC DEV2 synchronism check test mode	Off	

Relay settings for SYNCHK (Function ID: 561001)

Setting item		Range	Units	Contents	Default setting value	Notes
Ry1	SyncRy1-VR	V-L1/V-L2/V-L3/V-L12/V-L23/V-L31/V2-L1/V2-L2/V2-L3/V2-L12/V2-L23/V2-L31/V3/V4		Running Voltage		
	SyncRy1-VI	V-L1/V-L2/V-L3/V-L12/V-L23/V-L31/V2-L1/V2-L2/V2-L3/V2-L12/V2-L23/V2-L31/V3/V4		Incoming Voltage	V-L1	
	OVR1	10-150	V	Voltage for checking Live-Running Voltage	51	
	UVR1	10-150	V	Voltage for checking Dead-Running Voltage	13	
	OVI1	10-150	V	Voltage for checking Live-Incoming Voltage	51	
	UVI1	10-150	V	Voltage for checking Dead-Incoming Voltage	13	
	SyncRy1-Angle	0-75	degrees	Angle valiance for checking SyncRy1	30	
	SyncRy1-dV	0-150	V	Voltage valiance for checking SyncRy1	150	
	SyncRy1-df	0.01-2.00	Hz	Frequency valiance for checking SyncRy1	1.00	
	SyncRy1-TCB		s	CB Operate timer for SyncRy1		
Ry2	SyncRy2-VR	V-L1/V-L2/V-L3/V-L12/V-L23/V-L31/V2-L1/V2-L2/V2-L3/V2-L12/V2-L23/V2-L31/V3/V4		Running Voltage		
	SyncRy2-VI	V-L1/V-L2/V-L3/V-L12/V-L23/V-L31/V2-L1/V2-L2/V2-L3/V2-L12/V2-L23/V2-L31/V3/V4		Incoming Voltage	V-L1	
	OVR2	10-150	V	Voltage for checking Live-Running Voltage	51	
	UVR2	10-150	V	Voltage for checking Dead-Running Voltage	13	
	OVI2	10-150	V	Voltage for checking Live-Incoming Voltage	51	
	UVI2	10-150	V	Voltage for checking Dead-Incoming Voltage	13	
	SyncRy2-Angle	0-75	degrees	Angle valiance for checking SyncRy2	30	
	SyncRy2-dV	0-150	V	Voltage valiance for checking SyncRy2	150	
	SyncRy2-df	0.01-2.00	Hz	Frequency valiance for checking SyncRy2	1.00	
	SyncRy2-TCB		s	CB Operate timer for SyncRy2		

4.6.8 Signal

◆ Signal monitoring points

SYNCHK (Function ID: 560001)

Element ID	Name	Description
8D0B011F51	SYNC01_SPS_CLC	SYNC DEV1 split synchronism close command
860B011F52	SYNC01_SLF_VCS	SYNC DEV1 select fail voltage condition signal
890B011F53	SYNC01_LPS_CLC	SYNC DEV1 loop synchronism close command
800B011F54	SYNC01_SBP	SYNC DEV1 synchronism bypass
810B011F55	SYNC01_SCK_STA	SYNC DEV1 synchronism check start command
820B011F56	SYNC01_SCL_F	SYNC DEV1 synchronism closed fail
830B011F57	SYNC01_SCD_CS	SYNC DEV1 synchronism checked condition signal
840B011F58	SYNC01_SLD_VCS	SYNC DEV1 selected voltage condition signal
850B011F59	SYNC01_SYN_CLC	SYNC DEV1 synchronism close command
860B011F5A	SYNC01_LLV_CS	SYNC DEV1 84Vr & 84Vi condition signal
870B011F5B	SYNC01_DLV_CS	SYNC DEV1 27Vr & 84Vi condition signal
880B011F5C	SYNC01_DDV_CS	SYNC DEV1 27Vr & 27Vi condition signal
890B011F5D	SYNC01_LDV_CS	SYNC DEV1 84Vr & 27Vi condition signal
840B011F5F	SYNC01_SCK_CS01	SYNC DEV1 synchronism check condition signal 01
850B011F60	SYNC01_SCK_CS02	SYNC DEV1 synchronism check condition signal 02
860B011F61	SYNC01_SCK_CS03	SYNC DEV1 synchronism check condition signal 03
870B011F62	SYNC01_SCK_CS04	SYNC DEV1 synchronism check condition signal 04
880B011F63	SYNC01_SCK_CS05	SYNC DEV1 synchronism check condition signal 05
890B011F64	SYNC01_SCK_CS06	SYNC DEV1 synchronism check condition signal 06
8A0B011F65	SYNC01_SCK_CS07	SYNC DEV1 synchronism check condition signal 07
8B0B011F66	SYNC01_SCK_CS08	SYNC DEV1 synchronism check condition signal 08
8C0B011F67	SYNC01_SCK_CS09	SYNC DEV1 synchronism check condition signal 09
8E0B011F68	SYNC01_SCK_CS10	SYNC DEV1 synchronism check condition signal 10
820B011F69	SYNC01_SCK_CS11	SYNC DEV1 synchronism check condition signal 11
830B011F6A	SYNC01_SCK_CS12	SYNC DEV1 synchronism check condition signal 12
840B011F6B	SYNC01_SCK_CS13	SYNC DEV1 synchronism check condition signal 13
850B011F6C	SYNC01_SCK_CS14	SYNC DEV1 synchronism check condition signal 14
870B011F6D	SYNC01_SCK_CS15	SYNC DEV1 synchronism check condition signal 15
880B011F6E	SYNC01_SCK_CS16	SYNC DEV1 synchronism check condition signal 16
8A0B011F6F	SYNC01_SCK_CS17	SYNC DEV1 synchronism check condition signal 17
8B0B011F70	SYNC01_SCK_CS18	SYNC DEV1 synchronism check condition signal 18
8C0B011F71	SYNC01_SCK_CS19	SYNC DEV1 synchronism check condition signal 19
8D0B011F72	SYNC01_SCK_CS20	SYNC DEV1 synchronism check condition signal 20
8A0B011F73	SYNC01_SCK_CS21	SYNC DEV1 synchronism check condition signal 21
8B0B011F74	SYNC01_SCK_CS22	SYNC DEV1 synchronism check condition signal 22
8C0B011F75	SYNC01_SCK_CS23	SYNC DEV1 synchronism check condition signal 23
8D0B011F76	SYNC01_SCK_CS24	SYNC DEV1 synchronism check condition signal 24
810B011F85	SYNC01_SCK_CS25	SYNC DEV1 synchronism check condition signal 25
820B011F86	SYNC01_SCK_CS26	SYNC DEV1 synchronism check condition signal 26
870B011F77	SYNC01_Ry_Ang_0Time	SYNC DEV1 Relay Output(Ang 0Time)
880B011F78	SYNC01_Ry_Ang_RDC	SYNC DEV1 Relay Output(Ang RDC)
800B011F80	SYNC01_SS_VCS_PLC	SYNC DEV1 successful voltage condition signal from PLC
800B011F81	SYNC01_RY1_USE_STS	SYNC DEV1 Relay Module1 use status from PLC

◆ Signal monitoring points

SYNCHK (Function ID: 560001)

Element ID	Name	Description
800B011F82	SYNC01_RY2_USE_STS	SYNC DEV1 Relay Module2 use status received from PLC
8D0B021F51	SYNC02_SPS_CLC	SYNC DEV2 split synchronism close command
860B021F52	SYNC02_SLF_VCS	SYNC DEV2 select fail voltage condition signal
890B021F53	SYNC02_LPS_CLC	SYNC DEV2 loop synchronism close command
800B021F54	SYNC02_SBP	SYNC DEV2 synchronism bypass
810B021F55	SYNC02_SCK_STA	SYNC DEV2 synchronism check start command
820B021F56	SYNC02_SCL_F	SYNC DEV2 synchronism closed fail
830B021F57	SYNC02_SCD_CS	SYNC DEV2 synchronism checked condition signal
840B021F58	SYNC02_SLD_VCS	SYNC DEV2 selected voltage condition signal
850B021F59	SYNC02_SYN_CLC	SYNC DEV2 synchronism close command
860B021F5A	SYNC02_LLV_CS	SYNC DEV2 84Vr & 84Vi condition signal
870B021F5B	SYNC02_DLV_CS	SYNC DEV2 27Vr & 84Vi condition signal
880B021F5C	SYNC02_DDV_CS	SYNC DEV2 27Vr & 27Vi condition signal
890B021F5D	SYNC02_LDV_CS	SYNC DEV2 84Vr & 27Vi condition signal
840B021F5F	SYNC02_SCK_CS01	SYNC DEV2 synchronism check condition signal 01
850B021F60	SYNC02_SCK_CS02	SYNC DEV2 synchronism check condition signal 02
860B021F61	SYNC02_SCK_CS03	SYNC DEV2 synchronism check condition signal 03
870B021F62	SYNC02_SCK_CS04	SYNC DEV2 synchronism check condition signal 04
880B021F63	SYNC02_SCK_CS05	SYNC DEV2 synchronism check condition signal 05
890B021F64	SYNC02_SCK_CS06	SYNC DEV2 synchronism check condition signal 06
8A0B021F65	SYNC02_SCK_CS07	SYNC DEV2 synchronism check condition signal 07
8B0B021F66	SYNC02_SCK_CS08	SYNC DEV2 synchronism check condition signal 08
8C0B021F67	SYNC02_SCK_CS09	SYNC DEV2 synchronism check condition signal 09
8E0B021F68	SYNC02_SCK_CS10	SYNC DEV2 synchronism check condition signal 10
820B021F69	SYNC02_SCK_CS11	SYNC DEV2 synchronism check condition signal 11
830B021F6A	SYNC02_SCK_CS12	SYNC DEV2 synchronism check condition signal 12
840B021F6B	SYNC02_SCK_CS13	SYNC DEV2 synchronism check condition signal 13
850B021F6C	SYNC02_SCK_CS14	SYNC DEV2 synchronism check condition signal 14
870B021F6D	SYNC02_SCK_CS15	SYNC DEV2 synchronism check condition signal 15
880B021F6E	SYNC02_SCK_CS16	SYNC DEV2 synchronism check condition signal 16
8A0B021F6F	SYNC02_SCK_CS17	SYNC DEV2 synchronism check condition signal 17
8B0B021F70	SYNC02_SCK_CS18	SYNC DEV2 synchronism check condition signal 18
8C0B021F71	SYNC02_SCK_CS19	SYNC DEV2 synchronism check condition signal 19
8D0B021F72	SYNC02_SCK_CS20	SYNC DEV2 synchronism check condition signal 20
8A0B021F73	SYNC02_SCK_CS21	SYNC DEV2 synchronism check condition signal 21
8B0B021F74	SYNC02_SCK_CS22	SYNC DEV2 synchronism check condition signal 22
8C0B021F75	SYNC02_SCK_CS23	SYNC DEV2 synchronism check condition signal 23
8D0B021F76	SYNC02_SCK_CS24	SYNC DEV2 synchronism check condition signal 24
810B021F85	SYNC02_SCK_CS25	SYNC DEV2 synchronism check condition signal 25
820B021F86	SYNC02_SCK_CS26	SYNC DEV2 synchronism check condition signal 26
870B021F77	SYNC02_Ry_Ang_0Time	SYNC DEV2 Relay Output(Ang 0Time)
880B021F78	SYNC02_Ry_Ang_RDC	SYNC DEV2 Relay Output(Ang RDC)
800B021F80	SYNC02_SS_VCS_PLC	SYNC DEV2 successful voltage condition signal from PLC
800B021F81	SYNC02_RY1_USE_STS	SYNC DEV2 Relay Module1 use status from PLC

◆ Signal monitoring points

SYNCHK (Function ID: 560001)

Element ID	Name	Description
800B021F82	SYNC02_RY2_USE_STS	SYNC DEV2 Relay Module2 use status from PLC

◆ Connection points in PLC logic

SYNCHK (Function ID: 560001)

Element ID	Name	Description
800B012E45	SYNC01_OSC	SYNC DEV1 on direction select command
810B012E48	SYNC01_OEC	SYNC DEV1 on direction execute command
820B012E9D	SYNC01_SLR_NO_SLD	SYNC DEV1 select release (no selected)
8B0B012EA2	SYNC01_SLD	SYNC DEV1 selected
850B012E93	SYNC01_CEC	SYNC DEV1 control execute completed
800B01EDE0	SYNC01_SBP_ECP	SYNC DEV1 synchronism bypass enable condition signal from PLC
800B01EDE1	SYNC01_SBP_SSP	SYNC DEV1 synchronism bypass success condition signal from PLC
800B01EDE2	SYNC01_SCL_F_ECP	SYNC DEV1 synchronism close fail condition signal from PLC
800B01EDE3	SYNC01_SCL_SSP	SYNC DEV1 synchronism close success condition signal from PLC
800B01EDE4	SYNC01_SCL_CSP	SYNC DEV1 synchronism close condition signal from PLC
800B01EDE5	SYNC01_SPS_CL_ECP	SYNC DEV1 split SYNC. close enable condition signal from PLC
800B01EDE6	SYNC01_LPS_CL_ECP	SYNC DEV1 loop synchronism close enable condition signal from PLC
800B01EDE7	SYNC01_LLV_CL_ECP	SYNC DEV1 84Vr & 84Vi close enable condition signal from PLC
800B01EDE8	SYNC01_LDV_CL_ECP	SYNC DEV1 84Vr & 27Vi close enable condition signal from PLC
800B01EDE9	SYNC01_DLV_CL_ECP	SYNC DEV1 27Vr & 84Vi close enable condition signal from PLC
800B01EDEA	SYNC01_DDV_CL_ECP	SYNC DEV1 27Vr & 27Vi close enable condition signal from PLC
800B01EDEB	SYNC01_SBK_CSP	SYNC DEV1 synchronism block condition signal from PLC
800B01EDEC	SYNC01_SS_VCS_PLC	SYNC DEV1 successful voltage condition signal from PLC
800B01EDED	SYNC01_RY1_USE_STS	SYNC DEV1 Relay Module1 use status from PLC
800B01EDEE	SYNC01_RY2_USE_STS	SYNC DEV1 Relay Module2 use status from PLC
800B022E45	SYNC02_OSC	SYNC DEV2 on direction select command
810B022E48	SYNC02_OEC	SYNC DEV2 on direction execute command
820B022E9D	SYNC02_SLR_NO_SLD	SYNC DEV2 select release (no selected)
8B0B022EA2	SYNC02_SLD	SYNC DEV2 selected
850B022E93	SYNC02_CEC	SYNC DEV2 control execute completed
800B02EDE0	SYNC02_SBP_ECP	SYNC DEV2 synchronism bypath enable condition signal from PLC
800B02EDE1	SYNC02_SBP_SSP	SYNC DEV2 synchronism bypath success condition signal from PLC
800B02EDE2	SYNC02_SCL_F_ECP	SYNC DEV2 synchronism close fail condition signal from PLC
800B02EDE3	SYNC02_SCL_SSP	SYNC DEV2 synchronism close success condition signal from PLC
800B02EDE4	SYNC02_SCL_CSP	SYNC DEV2 synchronism close condition signal from PLC
800B02EDE5	SYNC02_SPS_CL_ECP	SYNC DEV2 split SYNC. close enable condition signal from PLC
800B02EDE6	SYNC02_LPS_CL_ECP	SYNC DEV2 loop synchronism close enable condition signal from PLC
800B02EDE7	SYNC02_LLV_CL_ECP	SYNC DEV2 84Vr & 84Vi close enable condition signal from PLC
800B02EDE8	SYNC02_LDV_CL_ECP	SYNC DEV2 84Vr & 27Vi close enable condition signal from PLC
800B02EDE9	SYNC02_DLV_CL_ECP	SYNC DEV2 27Vr & 84Vi close enable condition signal from PLC
800B02EDEA	SYNC02_DDV_CL_ECP	SYNC DEV2 27Vr & 27Vi close enable condition signal from PLC
800B02EDEB	SYNC02_SBK_CSP	SYNC DEV2 synchronism block condition signal from PLC
800B02EDEC	SYNC02_SS_VCS_PLC	SYNC DEV2 successful voltage condition signal from PLC
800B02EDED	SYNC02_RY1_USE_STS	SYNC DEV2 Relay Module1 use status from PLC

◆ Connection points in PLC logic

SYNCHK (Function ID: 560001)

Element ID	Name	Description
800B02EDEE	SYNC02_RY2_USE_STS	SYNC DEV2 Relay Module2 use status from PLC

◆ Connection point in PLC logic

SYNCHK_Ry (Function ID: 561001)

Element ID	Name	Description
8000012A60	SYNC01_SCK_STA	SYNC DEV1 synchronism check start command
8000012A61	SYNC01_RY1_USE_STS	SYNC DEV1 Relay Module1 use status from PLC
8000012A62	SYNC01_RY2_USE_STS	SYNC DEV1 Relay Module2 use status from PLC
8000022A60	SYNC02_SCK_STA	SYNC DEV2 synchronism check start command
8000022A61	SYNC02_RY1_USE_STS	SYNC DEV2 Relay Module1 use status from PLC
8000022A62	SYNC02_RY2_USE_STS	SYNC DEV2 Relay Module2 use status from PLC

5 Technical Description

The IED hardware consists of a case, modules, and a human machine interface (HMI). For instance, Figure 5-1 shows the structure of the GR-series IED which is mounted in 3/4×19" rack. The user can find that the IED consists of a transformer module (VCT), a signal processing and communication module (CPU), binary input and output modules (BI, BI, and BIO, and a power supply module (PWS), which can be mounted in an order from left to right. The IED case, which is designed for rack mount as shown in Figure 5-1, has two flanges attached on the IED sides. Figure 5-2 shows hardware block diagram. The module structure depends on the GR-series models, IED cases, and the customer specification. Therefore, the user should check and confirm the actual modules with the ordering number in advance.

(The description of IED case helps to understand the IED structure and its functions. Based on slot reference, terminal block, slot reference, GR-Series selects different cases. VCT, CPU, BI, BO and BIO modules, PWS and HMI are described sequentially in this chapter. The user is required to understand information provided in this chapter when wiring between the IED and external devices and setting of the IED are performed. Hence, the user is required to read this chapter thoroughly.)

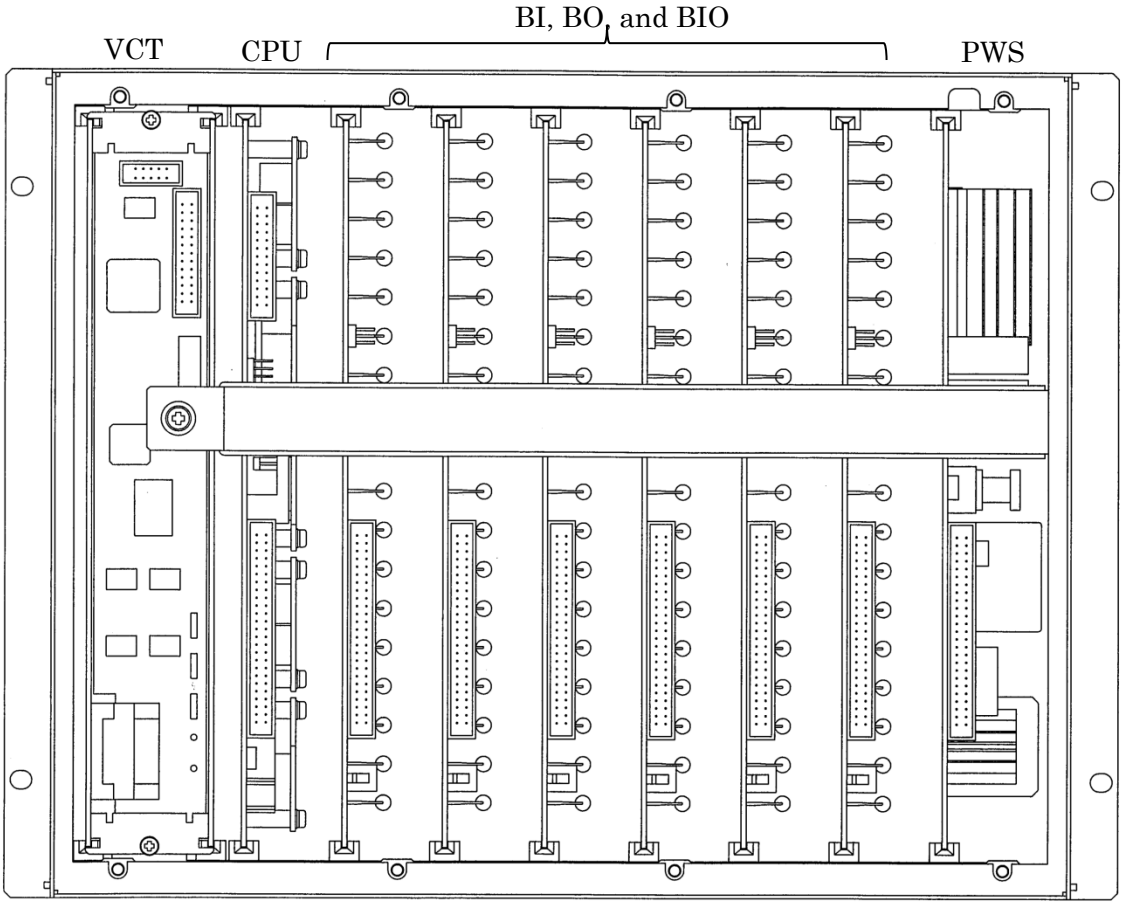


Figure 5-1 Modules in 3/4 19" rack's chassis (Front view, removed the front panel)

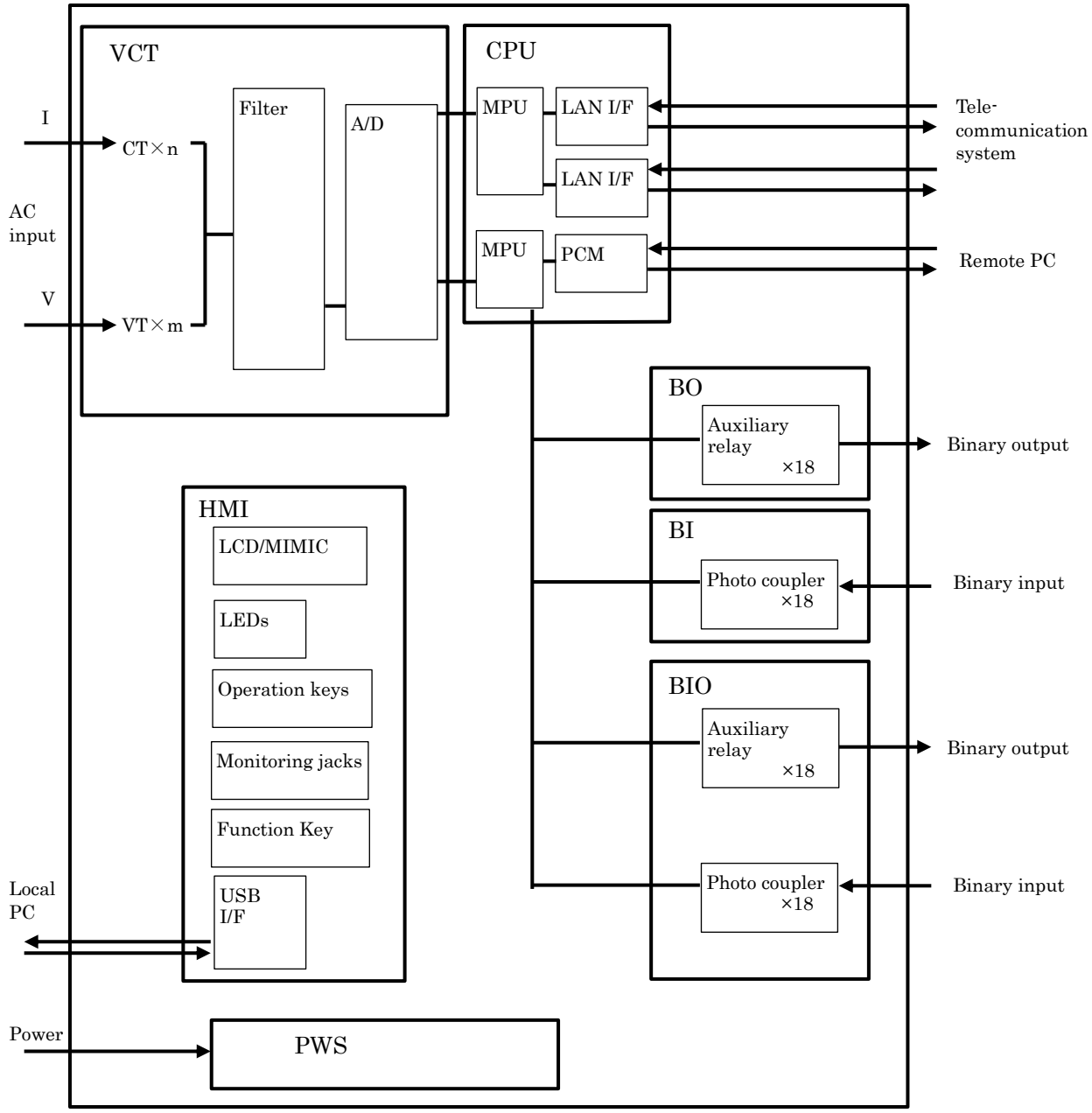


Figure 5-2 Hardware Block Diagram (for example)

5.1 IED case and module slot

5.1.1 1/1 Case

Figure 5.1-1 shows diagrams of the IED case structure for 1/1 size: (a) IED internal structure seen from the front, (b) Terminal block arrangement seen from the rear, and (c) schematic diagram.

(i) Viewing from the front side (Figure 5.1-1.a)

Thirteen slots are provided for mounting modules. The transformer module (VCT), the signal processing and communication module (CPU), and the power supply module (PWS) are mounted at predefined locations in the case. The binary IO modules (BI, BO, and BIO) are placed in slots (IO#1 to IO#8), these slot locations are determined before factory shipment. For detailed information on slot locations, module types and their connections for all IEDs, see external connection figures. (See Appendix: Typical external connection).

(ii) Viewing from the rear side (Figure 5.1-1.b)

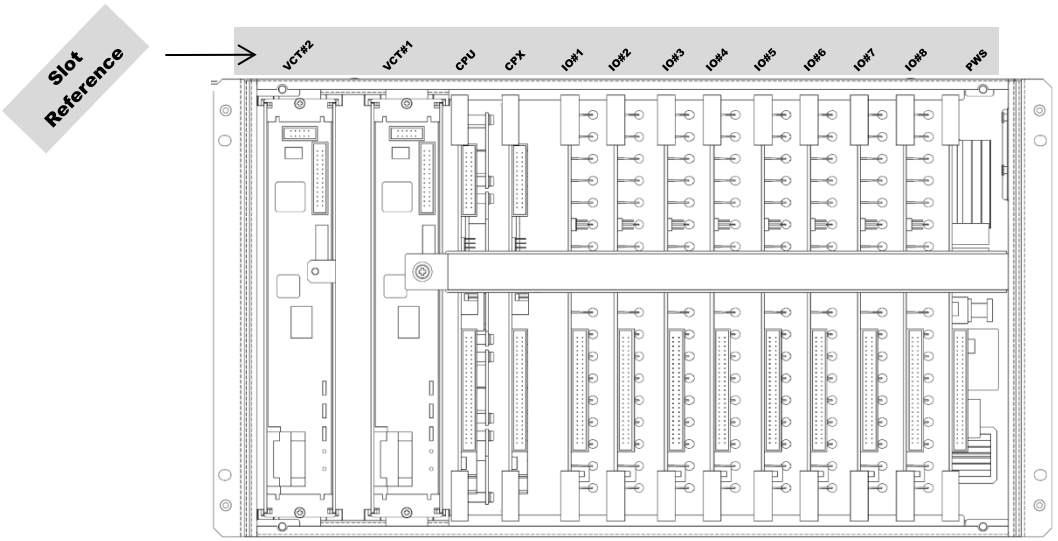
The group of terminal blocks for the 1/1 case viewed from the rear is shown. With respect to BI, BO, and BIO, the terminal blocks are designed with both upper and lower terminals and are labeled with alpha-numeric reference "T1", "T2" and so on. Note that both the upper and lower terminals are provided in the form of a single terminal block for respective BIs, BOs, or BIOs. The terminal screw numbers for each terminal block relate to the individual circuits and the user should check the configuration for each circuit. (For details, see section 5.4 or later). Each slot is identified by its alpha-numeric reference (or slot reference) on the IED case. For example, the user can identify that slot "IO#1" is linked with alpha-numeric reference "T1".

For PWS, note that the terminal blocks are placed on the left hand side. The user can also find alpha-numeric reference "T9" for PWS. The PWS circuits and relevant terminals are discussed later. (For details, see section 5.5 or later)

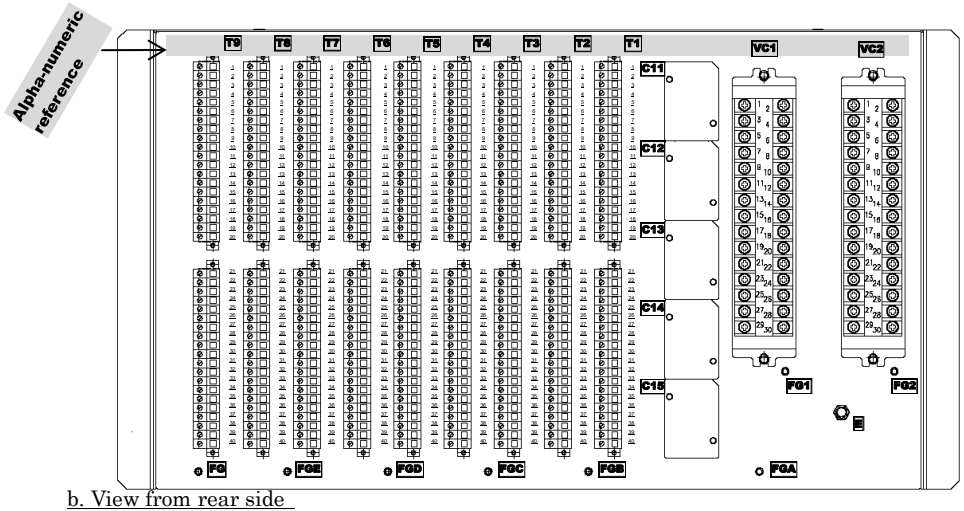
The communication modules, which are between the VCT slot and BIO slot, are labeled "C11" to "C15". These communication modules are used for LAN, IEC61850 communication, and external devices.

(iii) Schematic figure (Figure 5.1-1.c)

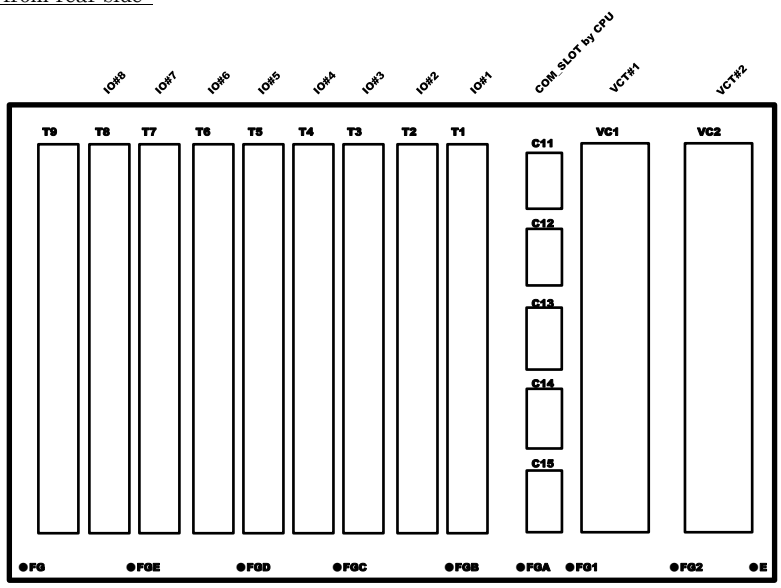
The slots and terminal blocks in the IED are shown. Using this figure, the user can find the location of VCT, BIO, and PWS. This figure is useful when the user sets binary IO modules using the setting tables. (For setting of binary IO modules, see section 5.4)



a. View from front side



b. View from rear side

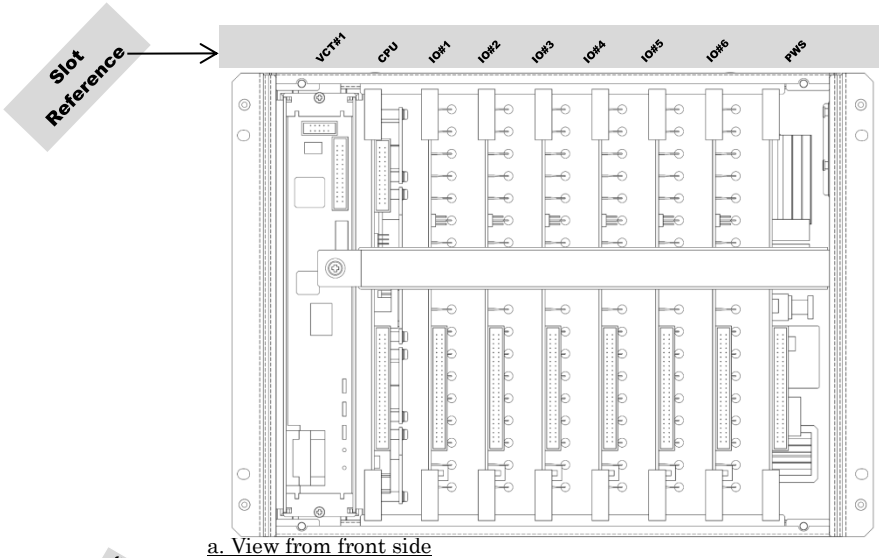


c. Schematic diagram

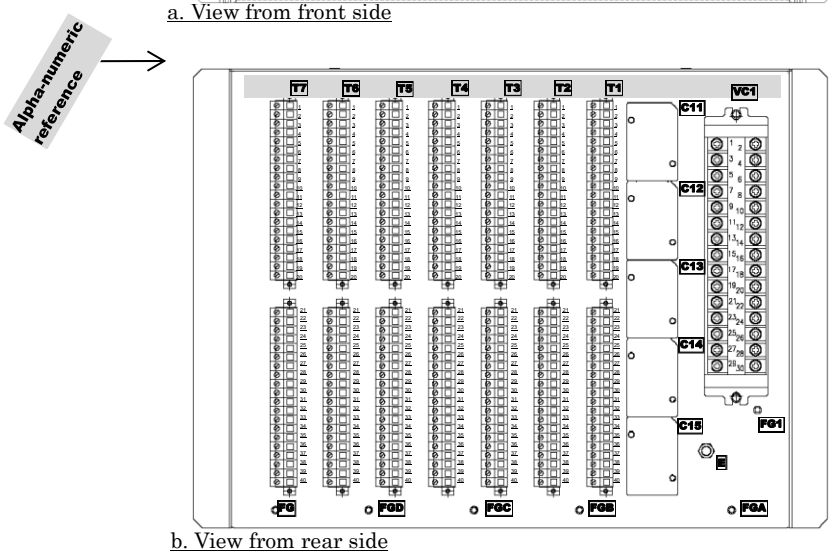
Figure 5.1-1 Slots and terminal blocks in 1/1 case for Compression-type terminal

5.1.2 3/4 case

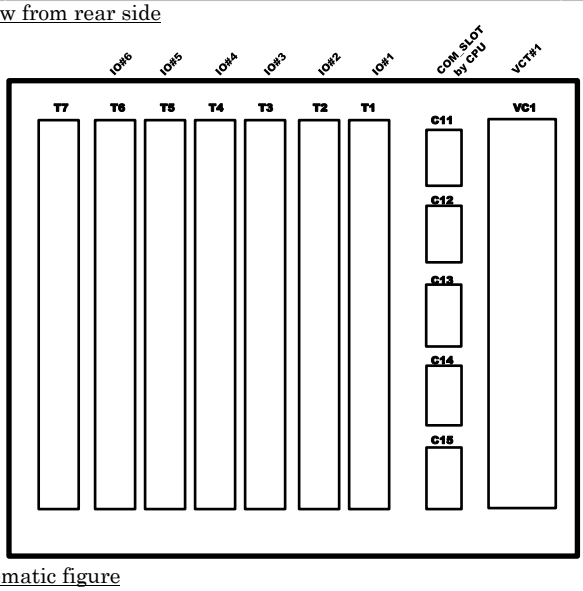
Figure 5.1-2 shows diagrams of the IED case structure for 3/4 size: (a) IED internal structure seen from the front, (b) Terminal block arrangement seen from the rear, and (c) schematic diagram. For PWS, note that the terminal blocks are placed on the left hand side. The user can also find alpha-numeric reference "T7" for PWS.



a. View from front side



b. View from rear side



c. Schematic figure

Figure 5.1-2 Slots and terminal blocks in 3/4 case for Compression-type terminal

5.1.3 1/2 case

Figure 5.1-3 shows diagrams of the IED case structure for 1/2 size: (a) IED internal structure seen from the front, (b) Terminal block arrangement seen from the rear, and (c) schematic diagram. For PWS, note that the terminal blocks are placed on the left hand side. The user can also find alpha-numeric reference "T4" for PWS.

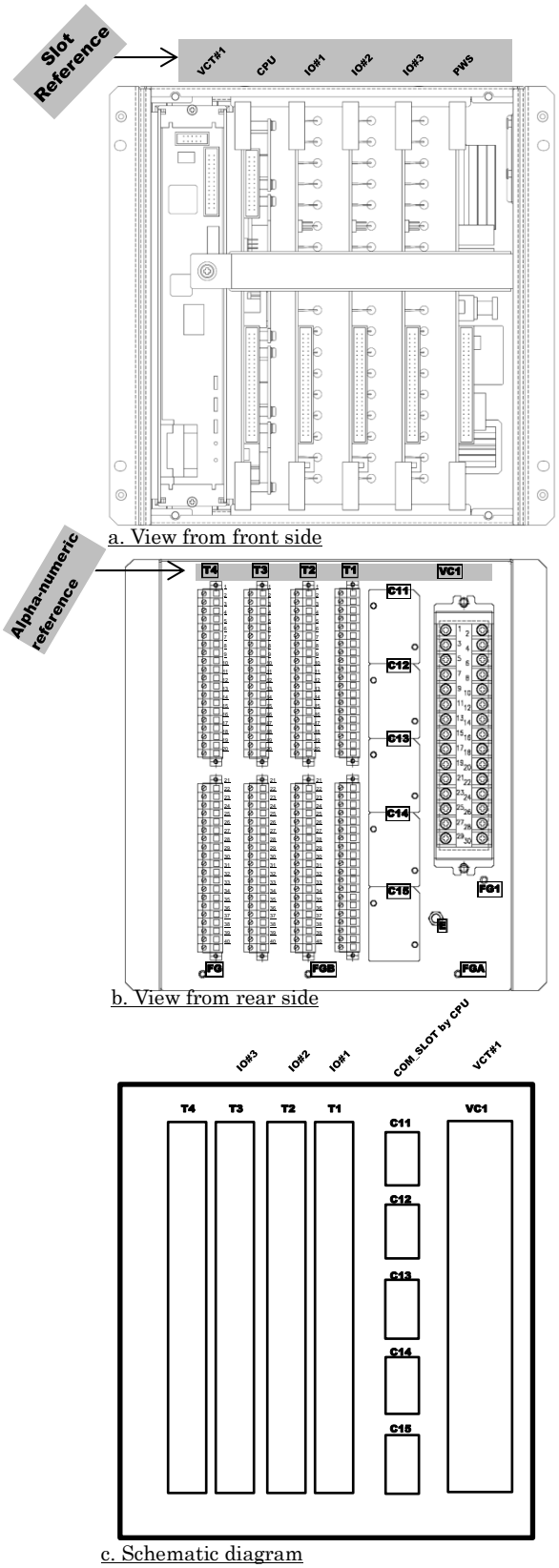


Figure 5.1-3 Slots and terminal blocks in 1/2 case for Compression-type terminal

5.2 Transformer module for AC analog input (VCT)

The transformer module (VCT) of the IED is used to acquire the power system quantities. A safety feature is available such that all of the VCT current inputs are shorted when a VCT module is removed from the IED case. Note also that all of the voltage inputs are disconnected. However, the user should make short circuit all AC current inputs and disconnect all AC voltage inputs.

Note; The user should understand that the rating current is fixed once the ordering is done.

Note: We represent respective input signals at the "AC analog input (VCT)" as "Channel numbers (Ch*)" when settings as to the ratio and others are required. The figure below shows the operation screen for the AC analog input, which we shall discuss later. The term "AI#1" in the below figure represents the VC alpha-numeric references discussed in the preceding section.

The blow figures exemplify the ratio settings for respective channels on the VCT. For more information about the operation of LCD screen, see chapter *User interface*. The user can also set them using GR-TIMES (see chapter *Engineering tool*).

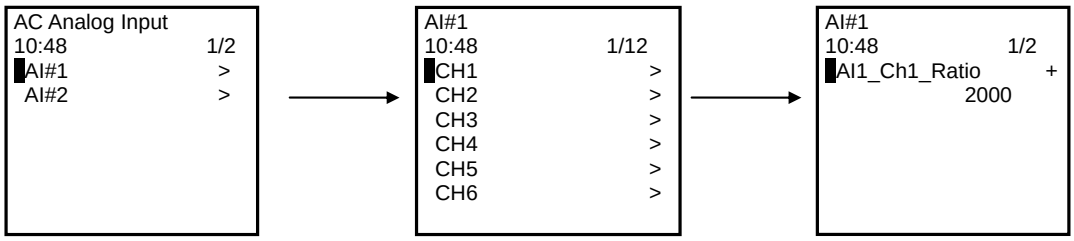


Figure 5.2-1 Ratio setting sample of AC analog input for VCT

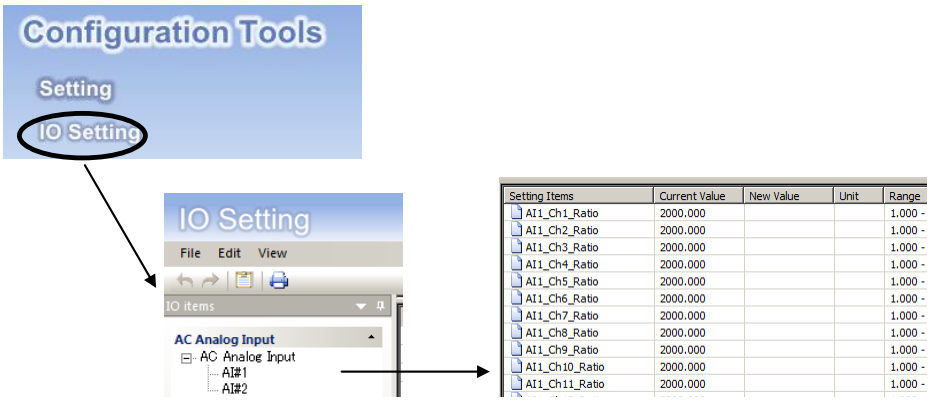
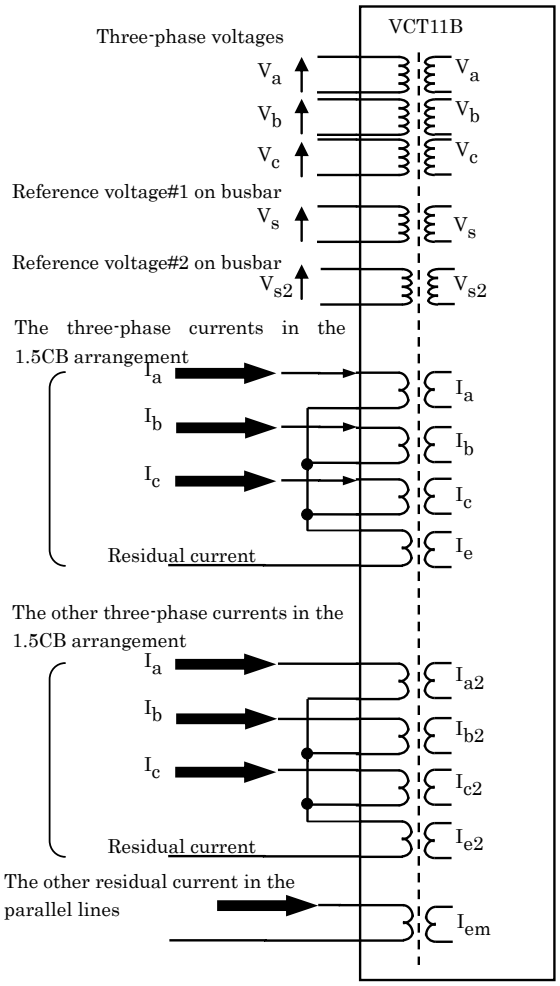


Figure 5.2-2 Setting sample of AC analog input (GR-TIEMS)

5.2.1 VCT11B

VCT11B is designed for 1.5 circuit breaker arrangement (1.5CB), as shown in Figure 5.2-3. VCT11B is available for 1/2 case and larger.



Terminal Screw Number		Input signal(3)	Type of input	Jumper position (2)	AC analog input channel(1)
1	2	V_a	Voltage	NA	Ch1
3	4	V_b	Voltage	NA	Ch2
5	6	V_c	Voltage	NA	Ch3
7	8	V_s(4)	Voltage	NA	Ch4
9	10	V_{s2}(4)	Voltage	NA	Ch5
11	12	I_a	Current	W6	Ch6
13	14	I_b	Current	W7	Ch7
15	16	I_c	Current	W8	Ch8
17	18	I_e	Current	W13	Ch9
19	20	I_{a2}	Current	W9	Ch10
21	22	I_{b2}	Current	W10	Ch11
23	24	I_{c2}	Current	W11	Ch12
25	26	I_{e2}	Current	W14	Ch13
27	28	I_{em}	Current	W12	Ch14

Figure 5.2-3 Transformer module (VCT11B)

(1)Note: The channel number about the AC analog input is used to represent the terminal location when the user sets the ratio about the CT or the VT. We shall discuss later in section *Setting VCT ratio.*

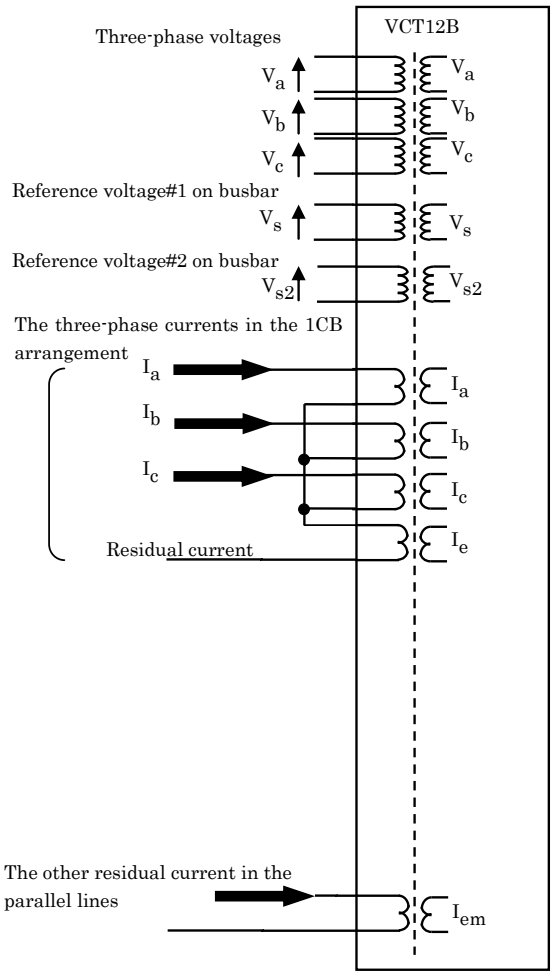
(2)Note: Inserting a jumper on the board is carried out to operate for 5A rated current. We shall discuss the rated current in later section *Check of rated current*.

(3)Note: For the destination of input signals, see Appendix: *Matrix between VCT terminals and relay applications*.

(4)Note: Reference voltage is used in the Voltage check (VCHK) function; see Chapter *Relay applications*.

5.2.2 VCT12B

VCT12B is designed for a single circuit breaker arrangement (1CB), as shown in Figure 5.2-4. VCT12B is available for 1/2 case and larger. When the VCT12B is used in 1.5CB arrangement, the user should have the Paralleling connected CTs (i.e., summation) at VCT12B.



Terminal Screw Number		Input signal(3)	Type of input	Jumper position (2)	AC analog input channel(1)
1	2	V_a	Voltage	NA	Ch1
3	4	V_b	Voltage	NA	Ch2
5	6	V_c	Voltage	NA	Ch3
7	8	V_s(4)	Voltage	NA	Ch4
9	10	V_{s2}(4)	Voltage	NA	Ch5
11	12	I_a	Current	W6	Ch6
13	14	I_b	Current	W7	Ch7
15	16	I_c	Current	W8	Ch8
17	18	I_e	Current	W13	Ch9
19	20	–	–	–	–
21	22	–	–	–	–
23	24	–	–	–	–
25	26	–	–	–	–
27	28	I_{em}	Current	W12	Ch14

Figure 5.2-4 Transformer module (VCT12B)

(1)Note: The cannel number about the AC analog input is used to represent the terminal location when the user sets the ratio about the CT or the VT. We shall discuss later in section *Setting VCT ratio.*

(2)Note: Inserting a jumper on the board is carried out to operate for 5A rated current. We shall discuss the rated current in later section *Check of rated current*.

(3)Note: For the destination of input signals, see Appendix: *Matrix between VCT terminals and relay applications*.

(4)Note: Reference voltage is used in the Voltage check (VCHK) function; see Chapter *Relay applications*.

5.2.3 Constitution of VCT

Figure 5.2-5 shows a VCT terminal block together with its schematic diagram (VC1); the same terminal screw numbers are shown on the terminal block and schematic diagram. The user should note that the last terminal screw (No. 30) and FG terminal are connected with a short-wire by default.

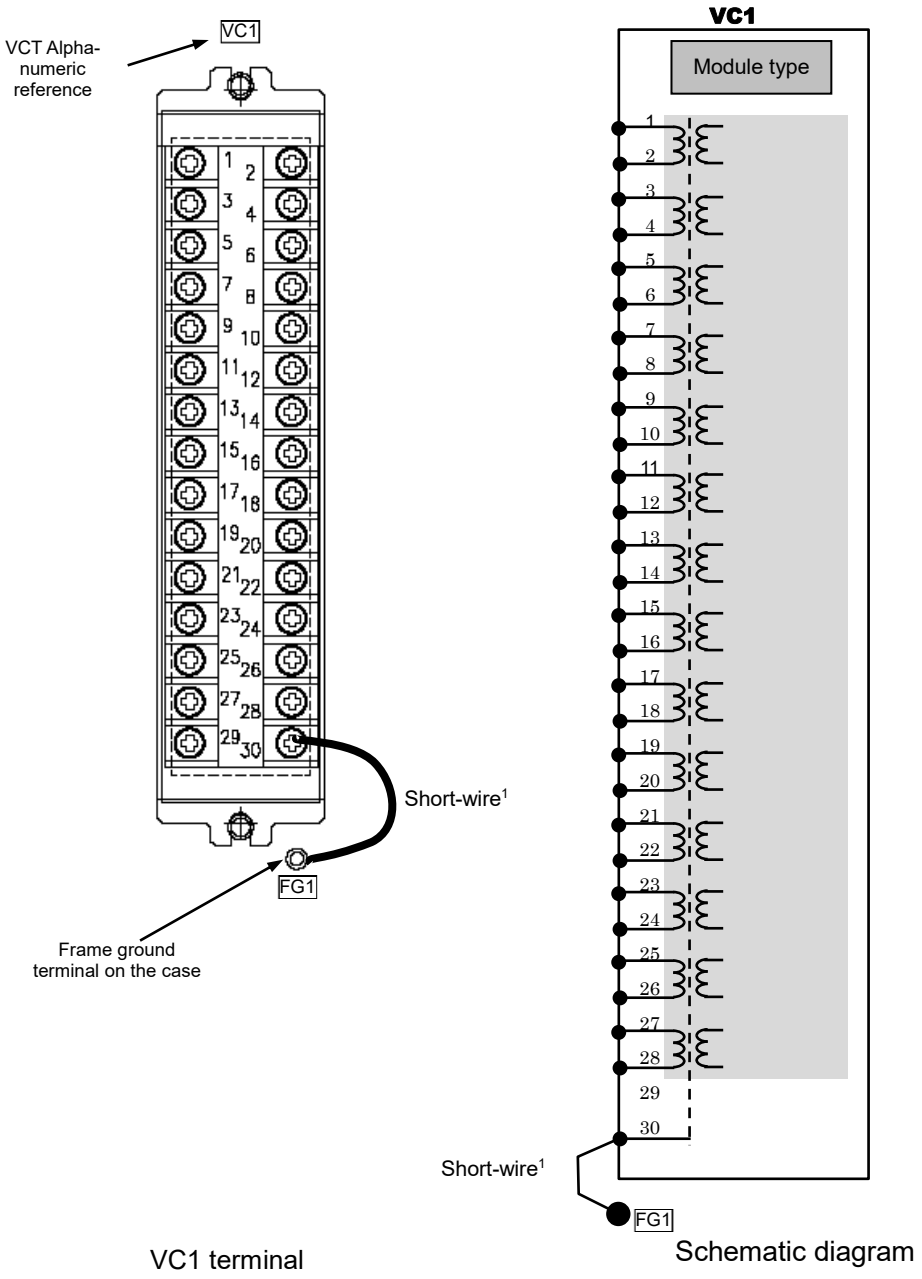


Figure 5.2-5 VC1 terminals (Rear view)

[1]Note: The connection between terminal screw 30 and FG is made with a short-wire by the manufacturer.

[2]Note: The figure is drawn for general instruction with regard to the VCT. Thus, the number of the VTs and CTs in the VCT depends on the selection of the VCT type.

5.2.4 Setting VCT ratio

As input sources are transformed with various VTs and CTs in the power system, the user shall set each VT or CT ratio at each VCT terminal.

(i) Setting a ratio for the VT

When the VT quantity applied at the VCT terminal, a ratio of the primary voltage to the secondary voltage should be set. A voltage is applied at the first terminal (Ch1) at VC1 alpha-numeric reference, the user should set the ratio for the setting [**AI1_Ch1_Ratio**]. For example, the user is requires to set a value '3636' for the [**AI1_Ch1_Ratio**] when the primary is 400kV and the secondary is 110V (i.e., 400kV/110V=3636). The channel position on the VCT is discussed in the preceding section *VCT*.

(ii) Setting a ratio for the CT

When the CT quantity flows into the VCT terminal, a ratio of the primary current to the secondary current should be set. For example, the user is required to set a value '4000' for the [**AI1_Ch1_Ratio**] when the primary is 4000A and the secondary is 1A (i.e., 4000/1=4000).

(iii) Setting list

Setting of AC analog input(Function ID: 200201)

Setting item			Range	Units	Contents	Default setting value	Notes
	VC1 alpha-numeric reference	AI1_Ch1_Ratio	1.000 to 20,000.000	–	For AC analog input ch#1 at VCT#1	1.000	
		AI1_Ch2_Ratio	1.000 to 20,000.000	–	For AC analog input ch#2 at VCT#1	1.000	
		AI1_Ch3_Ratio	1.000 to 20,000.000	–	For AC analog input ch#3 at VCT#1	1.000	
		AI1_Ch4_Ratio	1.000 to 20,000.000	–	For AC analog input ch#4 at VCT#1	1.000	
		AI1_Ch5_Ratio	1.000 to 20,000.000	–	For AC analog input ch#5 at VCT#1	1.000	
		AI1_Ch6_Ratio	1.000 to 20,000.000	–	For AC analog input ch#6 at VCT#1	1.000	
		AI1_Ch7_Ratio	1.000 to 20,000.000	–	For AC analog input ch#7 at VCT#1	1.000	
		AI1_Ch8_Ratio	1.000 to 20,000.000	–	For AC analog input ch#8 at VCT#1	1.000	
		AI1_Ch9_Ratio	1.000 to 20,000.000	–	For AC analog input ch#9 at VCT#1	1.000	
		AI1_Ch10_Ratio	1.000 to 20,000.000	–	For AC analog input ch#10 at VCT#1	1.000	
		AI1_Ch11_Ratio	1.000 to 20,000.000	–	For AC analog input ch#11 at VCT#1	1.000	
		AI1_Ch12_Ratio	1.000 to 20,000.000	–	For AC analog input ch#12 at VCT#1	1.000	
		AI1_Ch13_Ratio	1.000 to 20,000.000	–	For AC analog input ch#13 at VCT#1	1.000	
		AI1_Ch14_Ratio	1.000 to 20,000.000	–	For AC analog input ch#14 at VCT#1	1.000	

†Note: For more information, see Chapter *User interface: AC analog input.*

‡Note: The number of AC analog input channels depends on the configuration of the VCT type and the VCT slot. Thereby, the user has to set the value of the VCT ratio corresponding to a specific auxiliary VT/CT.

5.2.5 Check of rated current

On the VCT, the rated current is fixed by the manufacturer according to the hardware configuration. The set value is not allowed to change by the user; hence, the user should be in touch with the sales representative once changing the rated current is required. We just discuss here the means for checking the rated current set by the manufacture at each input channel.

(i) Hardware definition by jumper insertion

Each of the auxiliary CTs has a Jumper; either rated-1-ampere (1A) or rated-5-ampere (5A) is defined using the Jumpers. The user can examine the rated current by following the steps below with reference to Figure 5.2-6:

Step1: Open the IED front panel.

Step2: Check the receptacle at respective jumpers.

The Jumpers positons are represented with the marks "W1" to "W14", which are printed on the circuit board of the VCT. The user can find the "W*" marks correspond to the AC analog input channel numbers in the preceding section.

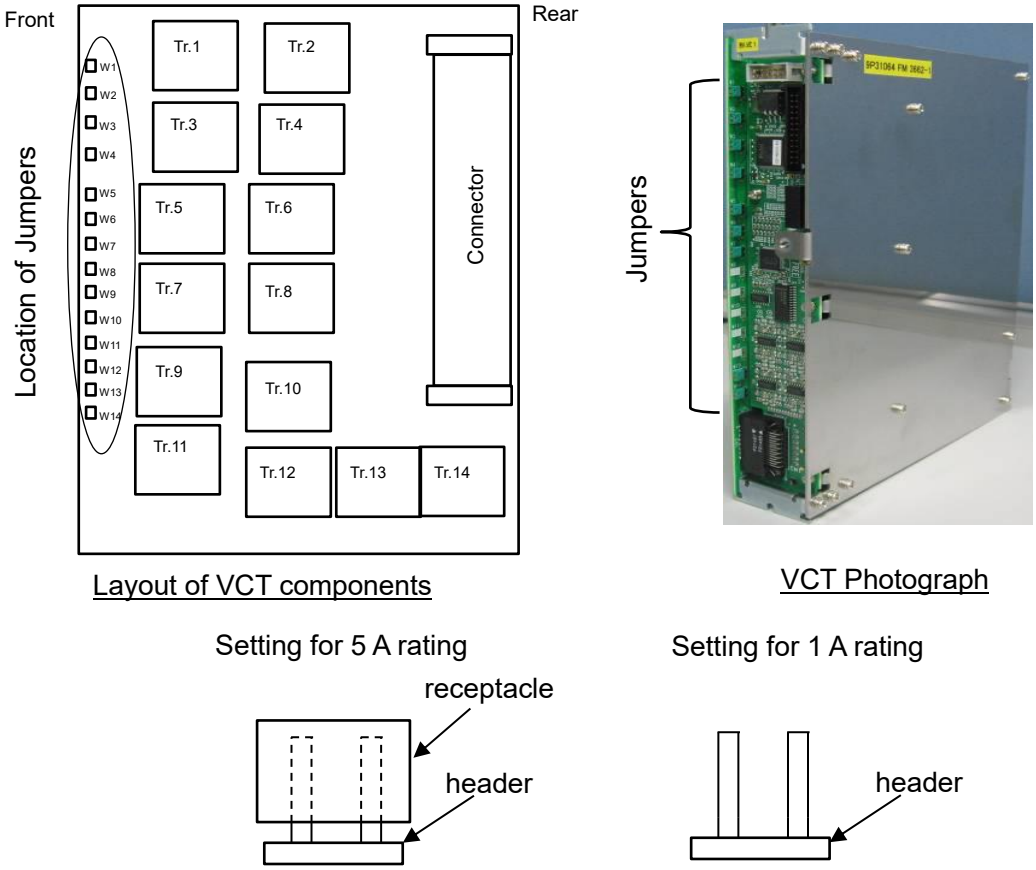


Figure 5.2-6 Jumpers and their locations

(ii) Software definition

The table below shows the software definitions for each AC analog input channel. As a rule, the rated current is defined once the customer has done the ordering: hence, term "**DEP**" is set for all settings [**AI1_Ch*_Rating**]. The term "**DEP**" represents a pre-configured rated current set by the manufacturer; the pre-configured rated current is identical to the AC rating determined at the customer's ordering.

Setting of AC analog input(Function ID: 200201)

Setting item			Range		Units	Contents	Default setting value		Notes
			1A rating	5A rating			1A rating	5A rating	
	VC1 alpha-numeric reference	AI1_Ch1_Rating	DEP / 1A / 5A		–	For AC analog input ch#1 at VCT#1	DEP		
		AI1_Ch2_Rating	DEP / 1A / 5A		–	For AC analog input ch#2 at VCT#1	DEP		
		AI1_Ch3_Rating	DEP / 1A / 5A		–	For AC analog input ch#3 at VCT#1	DEP		
		AI1_Ch4_Rating	DEP / 1A / 5A		–	For AC analog input ch#4 at VCT#1	DEP		
		AI1_Ch5_Rating	DEP / 1A / 5A		–	For AC analog input ch#5 at VCT#1	DEP		
		AI1_Ch6_Rating	DEP / 1A / 5A		–	For AC analog input ch#6 at VCT#1	DEP		
		AI1_Ch7_Rating	DEP / 1A / 5A		–	For AC analog input ch#7 at VCT#1	DEP		
		AI1_Ch8_Rating	DEP / 1A / 5A		–	For AC analog input ch#8 at VCT#1	DEP		
		AI1_Ch9_Rating	DEP / 1A / 5A		–	For AC analog input ch#9 at VCT#1	DEP		
		AI1_Ch10_Rating	DEP / 1A / 5A		–	For AC analog input ch#10 at VCT#1	DEP		
		AI1_Ch11_Rating	DEP / 1A / 5A		–	For AC analog input ch#11 at VCT#1	DEP		
		AI1_Ch12_Rating	DEP / 1A / 5A		–	For AC analog input ch#12 at VCT#1	DEP		
		AI1_Ch13_Rating	DEP / 1A / 5A		–	For AC analog input ch#13 at VCT#1	DEP		
		AI1_Ch14_Rating	DEP / 1A / 5A		–	For AC analog input ch#14 at VCT#1	DEP		

†Note: Number of auxiliary CTs depends on the configuration of the VCT type and the VCT slot. For more information, see Chapter *User interface: AC analog input.*

5.3 Signal processing and communication module (CPU)

A signal-processing including communication module (CPU) consists of a main circuit board for processing (CPU1) and 'piggyback' circuit boards for communication modules (COM#1 to COM#5). The piggyback circuit boards are provided so that the IED can have the communication with the network, time synchronization servers and others. The piggyback circuit boards are mounted on the CPU1.

Other signal-processing modules (CPM1 and CPX1) are provided to augment the CPU performance. The CPUs configuration depends on respective models; the arrangement of the CPU1, CPM1, and CPX1 varies in the respective models. Figure 5.3-1 exemplifies the full implementation for the CPU.

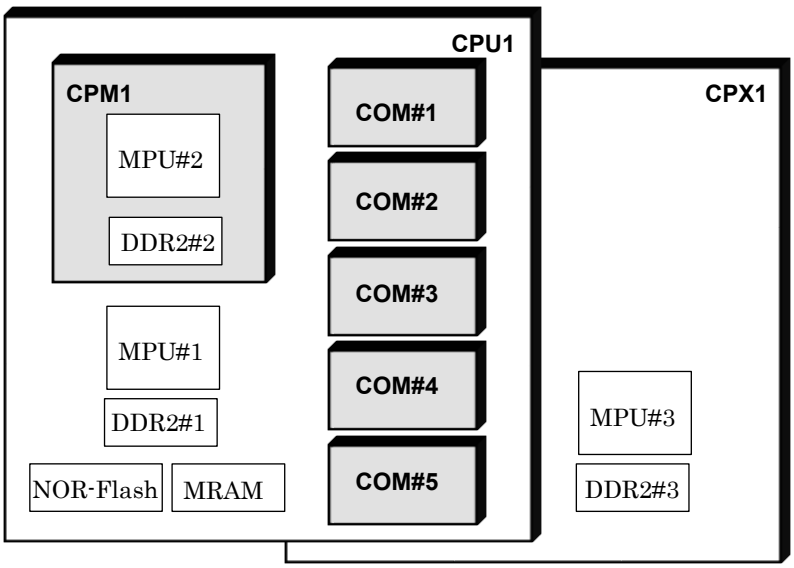


Figure 5.3-1 CPU and communication modules for the processing

Note: The implementation of the above may vary according to circumstances.

5.3.1 Processing module

Assuring the performance of protection and control functions can be obtained with some MPUs. The numbers of MPUs are chosen based on the performance. Memory on the CPU1 consists of MRAM, and NOR-Flash. The NOR-Flash is used to store setting data and recording data, whereas the MRAM is used to store several counter values. Both are of non-volatile memory so that the stored data will be not be erased if the power is cut off. Table 5.3-1 summarizes the memory type.

The relaying practices, which are validated by several IO modules, are operated through the signal processing. The diagram of their processing is illustrated in Figure 5.3-2.

Table 5.3-1 memory on CPU

Memory Type	Memory	Purpose of use
Volatile	DDR2	CPU working area
Non-volatile	NOR-Flash	Storage of setting data and recording data
Non-volatile	MRAM	Storage of counter values

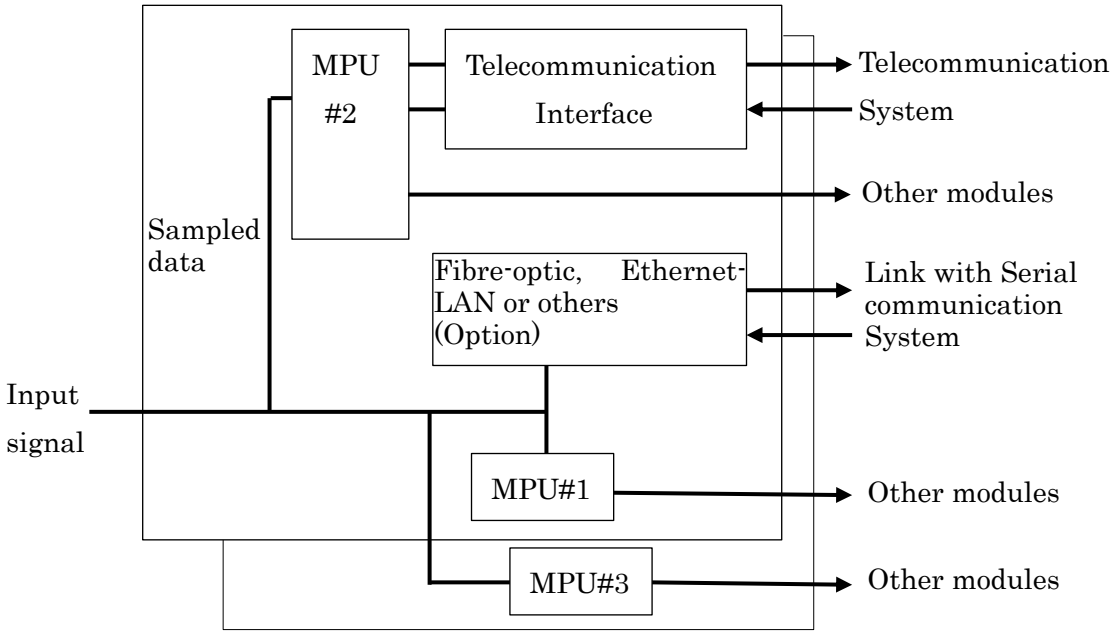
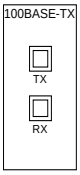
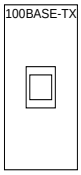
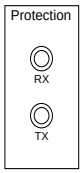
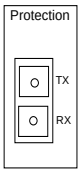


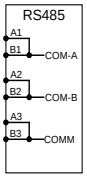
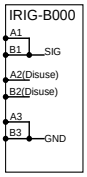
Figure 5.3-2 Diagram of processing

5.3.2 Communication modules

For communication, piggyback-circuit-modules are provided and these are mounted on CPU1, as shown in Table 5.3-2. These specifications are tabulated and their symbols are also shown in Table 5.3-2. The arrangement of these modules depends on the IED models. Thus, it is required to refer external connection figures in order to examine which modules are used and where they are located. The external connection figures are shown separately. (See *Appendix: Typical External connection*)

Table 5.3-2 Communication modules

I/F	100BASE-FX	100BASE-TX	Protection signaling	Protection signaling
Connector	SC type	RJ45 type	ST type	LC type (Duplex)
Medium	Fiber optic	Twist pair	Fiber optic(GI)	Fiber optic(SM/DSF)
Usage	Substation automation system and others	Substation automation system and others	Tele-protection (2km class)	Tele-Protection (30km / 80 km class)
Symbol				

I/F	RS485	IRIG-B000
Connector	PCB connector	PCB connector
Medium	Shielded twist pair	Shielded twist pair
Usage	Setting and monitoring for the IED	Time synchronization
Symbol		

1. 100BASE-TX module (RJ-45 plug)

A twisted-pair cable is required for the LAN connection. The 100BASE-TX module is used for the GR-TIEMS operation or the communication for remote end. Use a shielded twisted pair cable so that electric magnetic compatibility is satisfied.

2. 100Base-FX module (SC plug)

A fiber optic cable is required for the connection. 100Base-FX module is used for the LAN communication.

3. Protection signalling module (GI-ST plug or SM/DSF-LC plug)

The protection signalling communication module is to communicate with the remote IED for relay applications. A fiber optical cable classified in the GI optical fiber is mainly used in short haul communication (shorter than 2km). In medium haul, an optical fiber in SM is required. In long haul, an optical fiber in DSF is required.

4. RS485 module

RS485 module has a PCB connector. The module should be connected with a shielded-twisted-pair cable; it is used for communication in the IEC60870-5-103, Modbus, and DNP. The terminal arrangement and references are shown below. The cable sheath should be connected with the frame ground (FG) in the IED case. For the use of the a shielded-twisted-pair cable, the user should note that the total length should be less than 1200 meter (0.75 miles); the terminal resistor (150 ohms) should be connected when any connector is not connected. The settings of the RS485 module are provided for the first module (#1) and the second module (#2), respectively, as shown the table below. For setting the parameters, see Chapter *Communication protocol: RS485 communication*.

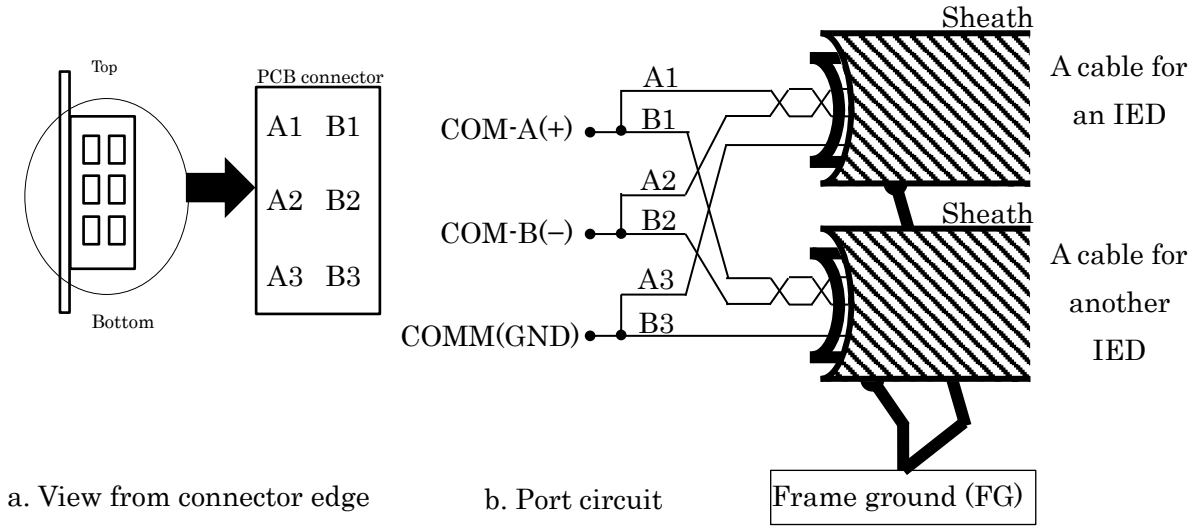


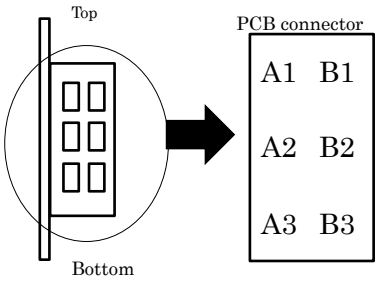
Figure 5.3-3 RS485 connector and circuit

Setting of RS485 (Function ID: 232201)

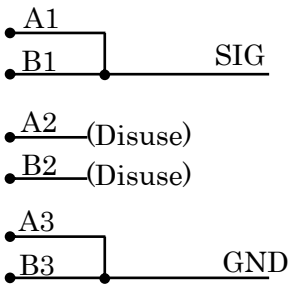
Setting item		Range	Units	Contents	Default setting value	Notes
Module #1	RS485_1_BRATE_SW	9.6 / 19.2 / 38.4 /57.6 / 115.2	kbps	Transmission speed	19.2	
	RS485_1_PAR_SW	NONE / ODD /EVEN	–	Parity check code	NONE	
Module #2	RS485_2_BRATE_SW	9.6 / 19.2 / 38.4 /57.6 / 115.2	kbps	Transmission speed	19.2	
	RS485_2_PAR_SW	NONE / ODD /EVEN	–	Parity check code	NONE	

5. IRIG-B000 module

IRIG-B000 module is used to receive the digital signal generated with an external clock; the signal is in conformity to serial IRIG-B000 format. Note that the IRIG-B000 module is able to receive digital signal (TTL) only (i.e., the reception of AM signal is not applicable). This module is isolated using a photo coupler; the user should note A2 and B2 connectors are not used. The peak value of IRIG-B000 signal should be greater than 3.5 volts; the IRIG-B000 module has the input register (about 3k ohm). Thus, the terminal register can be required when the IRIG-B000 signal is delivered for several devices; the value of the terminal register depends on the number of deliveries and the performance of the external clocks. For setting of time synchronization, see Chapter *Technical Description: Clock function*.



a. View from connector edge



b. Port circuit

5.3.3 Location of communication modules

As described earlier, the user should examine the type of communication module and the location where the module is placed. Therefore, the user is required to understand the reference, when the user examines the connection figures. (See *Appendix: Typical external connection*)

For example, Figure 5.3-4 shows LAN modules (100BASE-FX) and Protection signaling module (ST) are placed at locations C11 to C14. Blank panel is placed at location C15. The user can find the corresponded communication modules placed in the IED on the right side

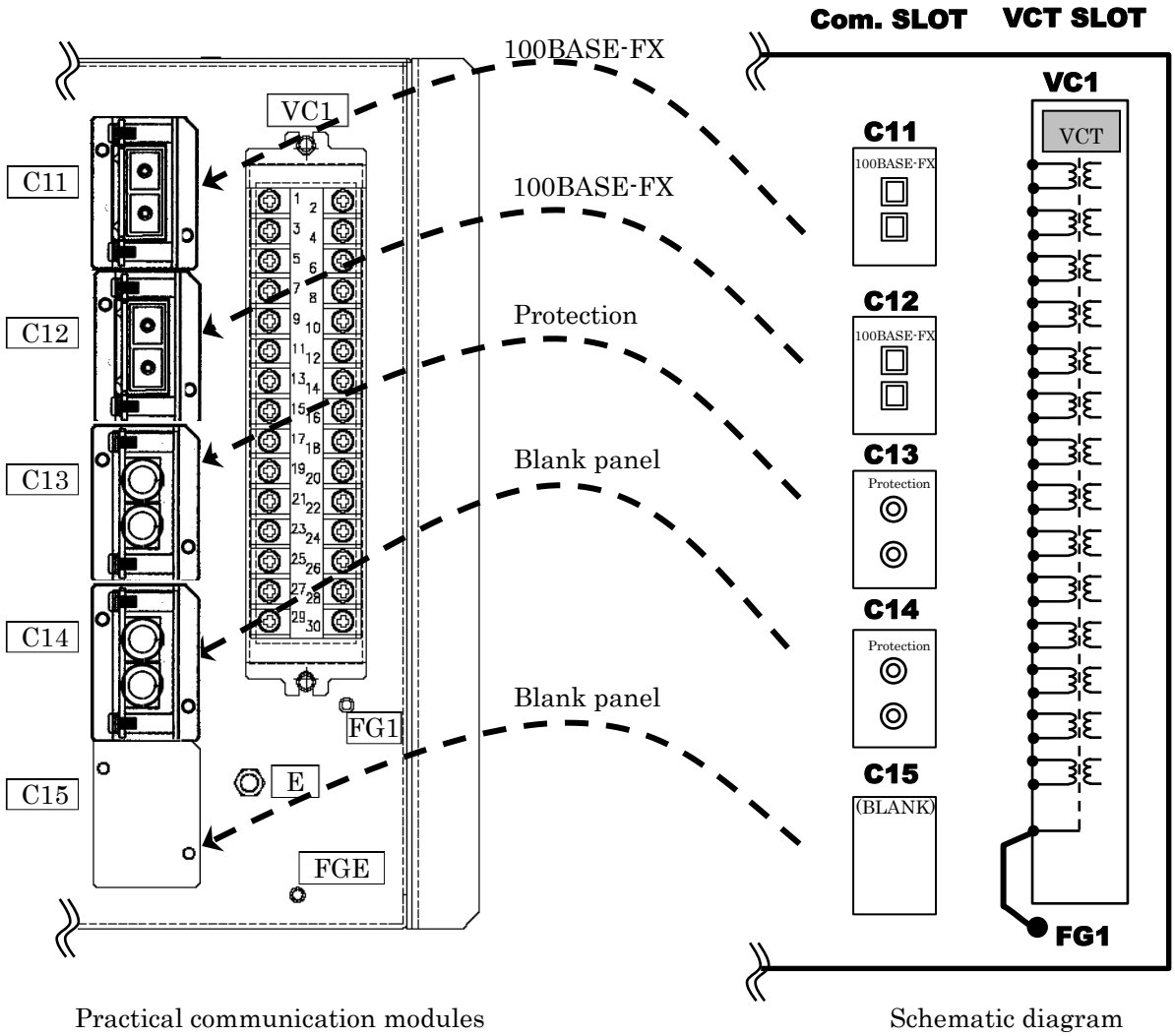


Figure 5.3-4 Communication modules structure (an example)

5.4 Binary IO module (BI, BO, and BIO)

Binary IO modules are provided in the IED to signal a command for external devices. Binary IO modules are also used to receive status information. Binary IO modules are connected to external devices with signal wires using terminal blocks on the rear of the IED. There are standard type and variable type in Binary IO modules as shown in Table 5.4-1.

Table 5.4-1 Number of input and output circuits[1]

#	Module name[3]	Module Type[4]	Number of input circuits	Number of output circuits[2]				
				Fast operating	Semi-fast operating	Hybrid	Auxiliary (Normal)	Form C
1	BI1A	Standard	18	0	0	0	0	0
2	BI2A	Variable	12	0	0	0	0	0
3	BI3A	Standard	32	0	0	0	0	0
4	BO1A	Standard	0	0	6	0	12	0
5	BO2A	Standard	0	0	0	16	0	0
6	BIO1A	Standard	7	0	6	0	3	1
7	BIO2A	Standard	12	0	3	0	1	1
8	BIO3A	Standard	8	6	0	0	1	1
9	BIO4A	Variable	6	0	0	6	1	1

[1]Note: One of two voltages is applied for the binary IO modules: 48Vdc (24 to 60) and 220Vdc (110 to 250). The DC voltage supplied to the IED determines the voltage type selection; hence, a combination of different voltage types is not possible.

[2]Note: For the structure and the number of binary IO modules, see section 5.4.5.

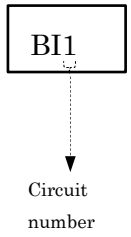
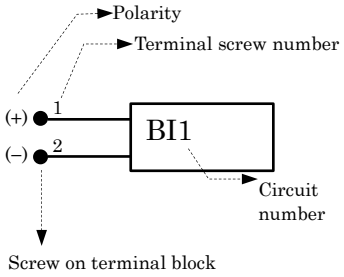
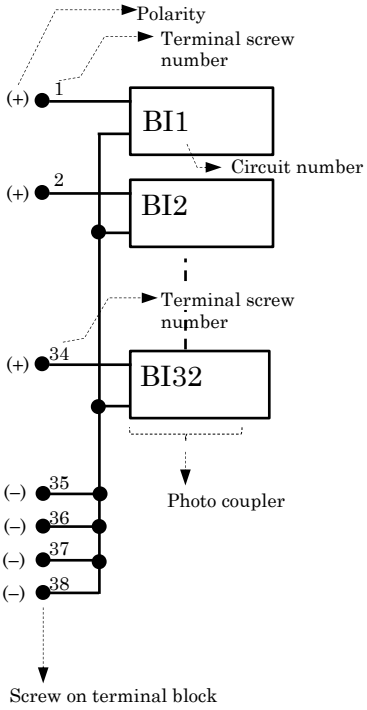
[3]Note: For details of the output circuits, see Table 5.4-6.

[4]Note: For the binary input circuits in the standard type, the user can choice either a high voltage or a low voltage with regard to the input threshold. For the ones of the variable type, the user itself can set a threshold value with regard to input voltage using settings.

5.4.1 Binary input feature

Binary input circuits have common programmable logic (CPL). Each circuit is independent, but the circuits in the BI3A module are not independent, as shown in Table 5.4-2.

Table 5.4-2 Input circuits and features associated with binary IO module

<table>
<tr><th></th><th>Module type</th><th>Input features</th><th>Example sign</th><th>Symbols</th></tr>
<tr><td>1</td><td>BI1A</td><td>- Isolated using photo coupler
-Polarity dependent
-Independent circuit</td><td rowspan="7"> 
</td><td rowspan="2"> 
</td></tr>
<tr><td>2</td><td>BI2A</td><td>-Isolated using photo coupler
-Polarity dependent
- Independent circuit
-Variable threshold</td></tr>
<tr><td>3</td><td>BI3A</td><td>-Isolated using photo coupler
-Polarity dependent
-Sharing common connections</td><td> 
</td></tr>
<tr><td>4</td><td>BIO1A</td><td rowspan="3">Same as BI1A</td><td rowspan="3">Same as BI1A and BI2A</td></tr>
<tr><td>5</td><td>BIO2A</td></tr>
<tr><td>6</td><td>BIO3A</td></tr>
<tr><td>7</td><td>BIO4A</td><td>Same as BI2A</td></tr>
</table>

The user can find the connector of binary IO modules, the terminal number and arrangement of the binary input circuits in section 5.4.5.

5.4.2 Binary input circuit

The binary input circuit has a threshold for the input voltage and the user can regulate the threshold using scheme switches and settings. Additionally, the binary input circuit has a function in response to chattering signals produced by bouncing contacts, a programmable logic for retarding and inverting the signal, and the user can set the respective features with settings. Table 5.4-3 shows the respective settings and ranges in the standard type. Table 5.4-4 shows the ones in the variable types.

Table 5.4-3 Setting items for binary input circuits in the standard type

Setting item[1]		Range	Units	Contents	Default
Common	THRES_Lvl	Low/High	–	Threshold level for input voltage	Low
	CMP_NUM	4 to 9	–	Number of times in the filter	4
BI1	BI1_CPL	Off/On	–	Switch of programmable operation in BI1	Off
	On Delay Timer	0.000 to 300.000	s	Value in the on-delay timer	0.000
	Off Delay Timer	0.000 to 300.000	s	Value in the off-delay timer	0.000
	INVERSE-SW	Normal / Inverse	–	Inversion operation of BI1 signal	Normal
BI2	BI2_CPL	Off/On	–	Switch of programmable operation in BI2	Off
	On Delay Timer	0.000 to 300.000	s	Value in the on-delay timer	0.000
	Off Delay Timer	0.000 to 300.000	s	Value in the off-delay timer	0.000
	INVERSE-SW	Normal / Inverse	–	Inversion operation of BI2 signal	Normal
BI3	BI3_CPL	Off/On	–	Switch of programmable operation in BI3	Off
	On Delay Timer	0.000 to 300.000	s	Value in the on-delay timer	0.000
	Off Delay Timer	0.000 to 300.000	s	Value in the off-delay timer	0.000
	INVERSE-SW	Normal / Inverse	–	Inversion operation of BI3 signal	Normal
.....	.....	.....		.....	.....
BI*n*[2]	BI*n*_CPL	Off/On	–	Switch of programmable operation in BI*n*	Off
	On Delay Timer	0.000 to 300.000	s	Value in the on-delay timer	0.000
	Off Delay Timer	0.000 to 300.000	s	Value in the off-delay timer	0.000
	INVERSE-SW	Normal / Inverse	–	Inversion operation of BIn signal	Normal

[1]Note: Setting items are provided in each slot; see Figure 5.4-4. Also, see section 5.4.6 (i).

[2]Note: BI*n*_CPL and other settings are provided for all binary input circuits. For example, the user can configure 18 CPLs in BI1A.

[3]Note: Each setting item above is required to set at every IO_slots.

Table 5.4-4 Setting items for binary input circuits in the variable type (i.e., BI2A and BIO4A)

Setting devices		Range	Unit	Contents	Default
Common	BI1-3_PICKUP	18 to 222	V	Guaranteed-minimum-pick-ups at BI1, BI2, and BI3	77
	BI4-6_PICKUP	18 to 222	V	Guaranteed-minimum-pick-ups at BI4, BI5, and BI6	77
	BI7-9_PICKUP	18 to 222	V	Guaranteed-minimum-pick-ups at BI7 to BI9[4]	77
	BI10-12_PICKUP	18 to 222	V	Guaranteed-minimum-pick-ups at BI10 to BI*n*[4]	77
	CMP_NUM	4 to 9	–	Number of times in the filter	4
BI1	BI1_CPL	Off/On	–	Switch for programmable operation in BI1	Off
	On Delay Timer	0.000 to 300.000	s	Value in the on-delay timer	0.000
	Off Delay Timer	0.000 to 300.000	s	Value in the off-delay timer	0.000
	INVERSE-SW	Normal / Inverse	–	Inversion operation of BI1 signal	Normal
BI2	BI2_CPL	Off/On	–	Switch for programmable operation in BI 2	Off
	On Delay Timer	0.000 to 300.000	s	Value in the on-delay timer	0.000
	Off Delay Timer	0.000 to 300.000	s	Value in the off-delay timer	0.000
	INVERSE-SW	Normal / Inverse	–	Inversion operation of BI2 signal	Normal
BI3	BI3_CPL	Off/On	–	Switch for programmable operation in BI 3	Off
	On Delay Timer	0.000 to 300.000	s	Value in the on-delay timer	0.000
	Off Delay Timer	0.000 to 300.000	s	Value in the off-delay timer	0.000
	INVERSE-SW	Normal / Inverse	–	Inversion operation of BI3 signal	Normal
.....	.....	.....		.....	.....
BI*n*[4]	BI*n*_CPL	Off/On	–	Switch for programmable operation in BI *n*	Off
	On Delay Timer	0.000 to 300.000	s	Value in the on-delay timer	0.000
	Off Delay Timer	0.000 to 300.000	s	Value in the off-delay timer	0.000
	INVERSE-SW	Normal / Inverse	–	Inversion operation of BIn signal	Normal

[4]Note: BI*n*_CPL and other settings are provided for all binary input circuits. For example, the user can set for 12 CPLs in BI2A and for 6 CPLs in BIO4A.

As an example, Figure 5.4-1 shows the binary input circuit of BI1A in order to help understand the settings. BI1A consists of 18 binary input circuits and each circuit has three settings:

Setting threshold level

Comparison feature for contact chatter

CPL switches ("Delayed pick-up and delayed drop-off signal" and "Logic level inversion"), used as basis of input signal characteristics.

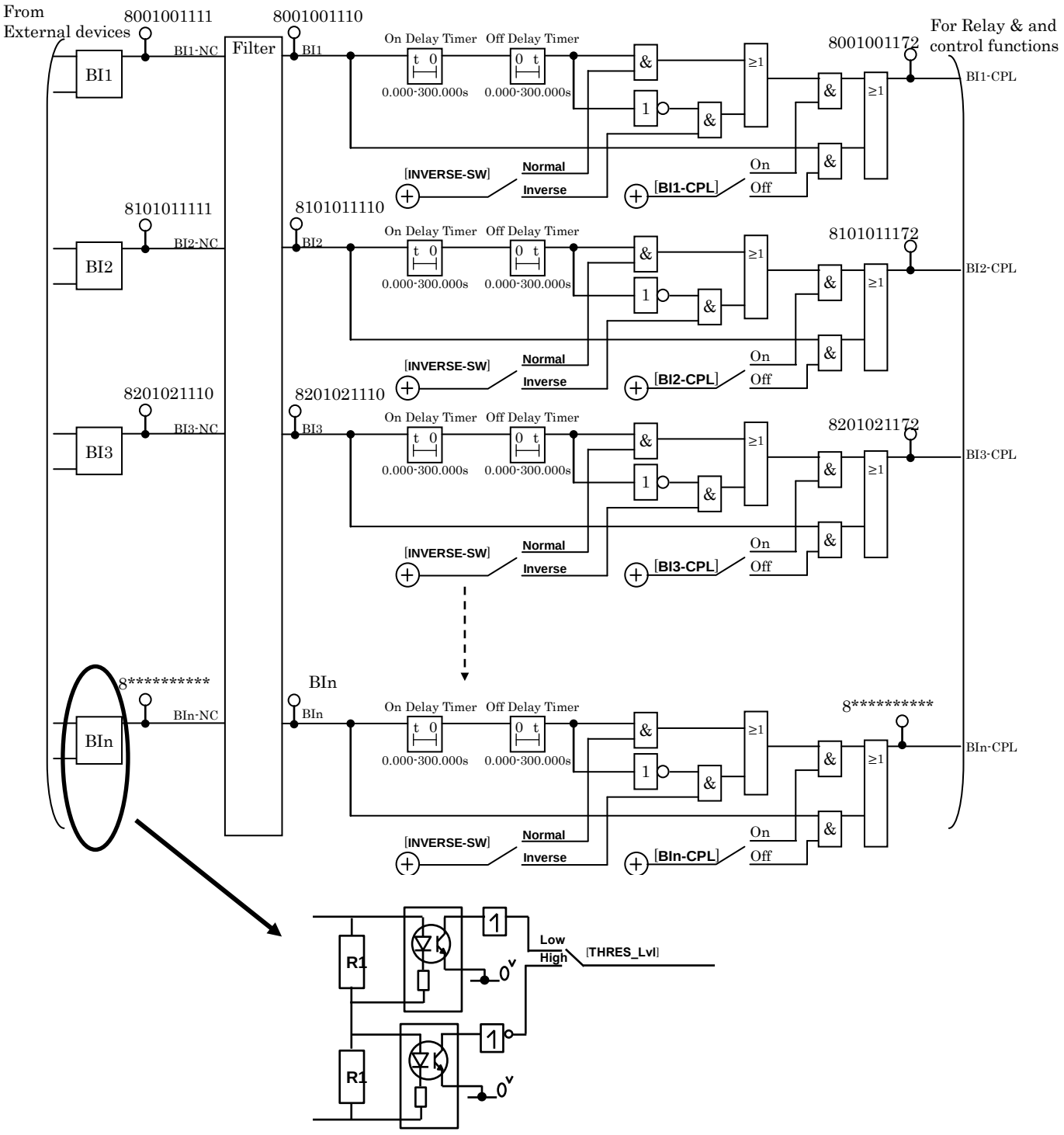


Figure 5.4-1 Common programmable logic for BI1A

Respective element IDs (i.e., 8001001172 and others) designate respective signal monitoring points of the binary input circuits (i.e., BI1-CPL and others). Thus, the user can handle the signals on the binary input circuit using element ID together with function ID. When we assume that BI1A module is at IO#1 slot in the IED case, and if the user wishes to see the first circuit signal of this BI1A module, the user can identify its signal† using the element ID (8001001172) and the function ID of IO#1 slot‡.

†Note: The user can see the signals of the binary input circuits on the IED screen. Chapter *User interface: Monitoring-sub menu* discusses how to see the state of the binary input circuits.

‡Note: Function IDs identify every IO slots. For example, IO#1 slot has been identified by the function ID “200B001”. Therefore, when the user wishes to program the signal “BI1-CPL” on BI1A at IO#1, the user should designate its signal using the function ID “200B001” and Element ID “8001001172”. On the other hand, when the signal “BI2-CPL” on BI1A at IO#2 is required to program, the user should designate that signal using the function ID “200B002” and Element ID “8001001172”. For more information with regard to the function ID and the Data ID at IO#1, see sections 5.4.6(i), 5.4.7(i), and others.

(i) Setting threshold level

(i)-1 For Standard type (BI1A and others)

The selection switch is used to adjust the threshold of an input signal; it is designated as [**THRES_Lvl**]. If an external device signal is lower than DC 110V[1], the user should set **Low** for scheme switch [**THRES_Lvl**]. Conversely if an external device signal is higher than DC 220V[1], the user should set **High** for the scheme switch. Note that scheme switch [**THRES_Lvl**] is used to control all binary input circuits. The user must ensure that the input voltage is higher than DC 77V[1] when the setting '**Low'** is applied; the input voltage should be higher than DC 136V[1] when the setting '**High'** is applied.

(i)-2 For Variable type (exclusive for BI2A and BIO4A)

BI2A and BIO4A have a unique feature as a substitute for setting (i)-1 in order that the user can determine the guaranteed-minimum-pick-up voltages (thresholds) as required. This unique feature is performed with settings [**BI1-3_PICKUP**], [**BI4-6_PICKUP**], [**BI7-9_PICKUP**], and [**BI10-12_PICKUP**]; every setting is applied to a group of three binary input circuits.

Provided that the user uses BI2A, then binary input circuits #1 to #3 follow the setting [**BI1-3_PICKUP**] and the user should set the value between 18 to 222V DC[2] for this setting. For the setting [**BI4-6_PICKUP**], the above mentioned value holds true for #4 to #6 binary input circuits; similarly the setting [**BI7-9_PICKUP**] is used for #7 to #9 binary input circuits; and finally the setting [**BI10-12_PICKUP**] is used for #10 to #12 binary input circuits.

On the other hand, when BIO4A is used, the binary input circuits #1 to #3 follow the setting [**BI1-3_PICKUP**]; and the binary input circuits #4 to #6 follow the setting [**BI4-6_PICKUP**]. Since BIO4A has six binary input circuits, the other settings [**BI7-9_PICKUP**] and [**BI10-12_PICKUP**] are not required here.

[1]Note: The threshold value is fixed for all binary IO module types with the exception of BI2A and BIO4A. The user should notice that "binary IO module voltage type" influences these values (see the 1st note in Table 5.4-1). These particular values are found when 220V dc type is used.

[2]Note: In the variable type, the user can set the threshold arbitrarily between 18 to 222V in DC, and can regulate its threshold voltage in a voltage step. Table 5.4-5 shows the corresponding values with regard to guaranteed and typical thresholds in response to the setting values. Note that the operation in the variable type is segmented into 'Operate', 'Intermediate', 'and 'Non-operate' areas, which are decided by the guaranteed-pick-up, typical-pick-up, and guaranteed-drop-off levels, as illustrated in Figure 5.4-2.

Table 5.4-5 Guaranteed and typical thresholds in the variable type

Setting values [V]	Guaranteed levels		Typical levels
	Pick-up voltage [V]	Drop-off voltage [V]	Pick-up voltage [V]
18	17.9	10.5	14.2
19	18.5	11.1	14.8
20	19.9	12.3	16.1
21	20.5	12.9	16.7
22 to 29	21.8	14.0	17.9
30	29.3	20.8	25.0
31 to 32	30.8	22.2	26.5
33	32.5	23.7	28.1
34 to 35	34.0	25.0	29.5
36 to 37	36.0	26.8	31.4
38 to 39	37.5	28.3	32.9
40	39.2	29.8	34.5
41 to 49	40.8	31.2	36.0
50 to 52	49.8	39.4	44.6
53 to 56	53.0	42.2	47.6
57 to 59	56.3	45.3	50.8
60 to 61	59.5	48.1	53.8
62 to 63	61.8	50.2	56.0
64 to 65	63.6	51.8	57.7
66	65.9	53.9	59.9
67 to 70	66.7	54.7	60.7
71	70.1	57.7	63.9
71 to 73	70.3	57.9	64.1
74	73.2	60.6	66.9
75 to 79	74.4	61.6	68.0
80 to 83	79.7	66.4	73.0
84 to 88	83.7	70.1	76.9
89 to 92	88.2	74.0	81.1
93 to 99	92.3	77.8	85.0
100 to 106	99.4	84.2	91.8
107 to 111	106.4	90.6	98.5
112 to 113	111.4	95.0	103.2
114 to 119	114.0	97.4	105.7
120	119.3	102.3	110.8
121 to 127	121.0	103.8	112.4
128 to 130	128.0	110.1	119.0
131	130.1	112.0	121.0
132 to 135	131.9	113.7	122.8
136 to 137	135.9	117.3	126.6
138 to 141	137.1	118.3	127.7
142 to 143	141.5	122.3	131.9
144	143.9	124.5	134.2
145 to 146	144.6	125.2	134.9
147 to 151	146.1	126.5	136.3
152 to 154	151.8	131.6	141.7
155 to 161	154.4	134.0	144.2
162	161.3	140.3	150.8
163 to 165	162.6	141.4	152.0
166 to 170	165.8	144.3	155.0
171 to 173	170.6	148.6	159.6
174 to 176	173.6	151.4	162.5
177 to 183	176.3	153.8	165.0
184 to 189	183.3	160.1	171.7
190 to 193	189.7	165.9	177.8
194 to 200	193.6	169.4	181.5
201 to 203	200.3	175.5	187.9
204 to 211	203.1	178.1	190.6
212 to 221	211.5	185.7	198.6
222	222.0	195.2	208.6

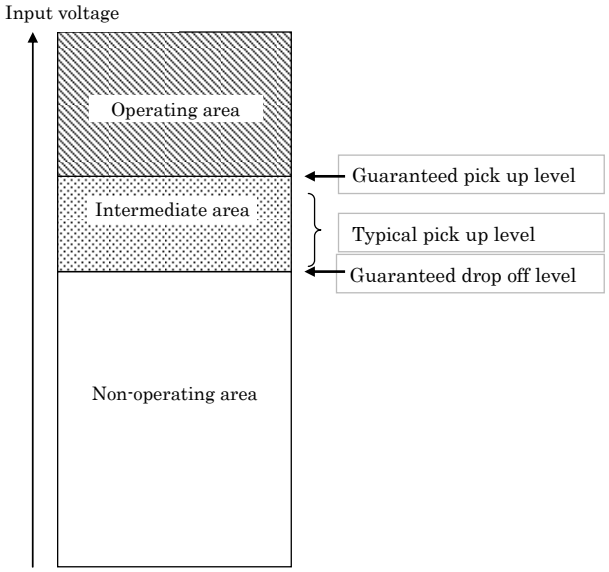


Figure 5.4-2 Operating area in the variable type

Note: In practice, the pick-up voltages depend on respective binary circuits physically This means the characteristics are not affected by the ambient conditions and the applied voltages.

(ii) Comparison feature for contact chatter

The input circuit incorporates a comparison feature that protects against contact chatter and this feature is configured using the setting [**CMP_NUM**]. Figure 5.4-3 illustrates this feature; the comparison feature removes contact chatter. The period '**t**' applied for the removal of contact chatter can be configured by setting a value for [**CMP_NUM**]. The formula for the calculation of 't' is,

$$[\mathbf{CPM_NUM}] \times \frac{1}{\text{System Frequency} \times 12}$$

The setting [**CMP_NUM**] is provided for all binary input circuits.

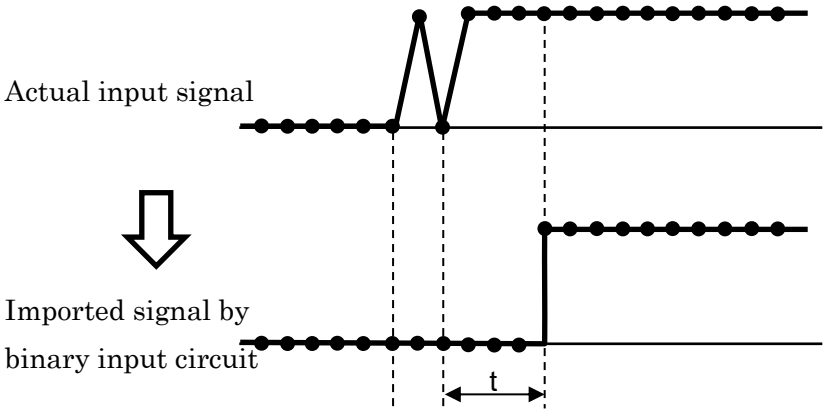


Figure 5.4-3 Chattering countermeasure (e.g. [CMP_NUM] = 4)

(iii) CPL switch

If the user needs to operate the CPL for binary input circuit #1, the user should set **On** for scheme switch [**BI1_CPL**]. Conversely, the user should set **Off** for scheme switch [**BI1_CPL**] if CPL is not required. Since the entire range of binary input circuits have CPLs, a setting of **On** or **Off** is a pre-requisite for every binary input circuit. The number of CPL is equal to number of binary input circuits: that is, if BI1A is selected, the number of CPLs is 18.

(iv) Delayed pick-up and delayed drop-off signal

Both an on-delay timer and an off-delay timer are provided in CPL; both are used to adjust the timing for input signals, the user should set their respective time values for settings [**On Delay Timer**] and [**Off Delay Timer**].

(v) Logic level inversion

The Logic inversion function can invert the input signal and is provided for each binary input circuit; the user can invert an input signal by setting **Inverse** for scheme switch [**INVERSE-SW**]. A setting of **Normal** is also provided when inversion is not required.

(vi) How to set the settings for binary input circuits

Figure 5.4-4 illustrates an example of the binary IO module arrangement for the binary input circuit printed circuit boards (PCBs); it illustrates the setting targets are on BI1A at IO#1 and BIO1A at IO#3. The user should key the settings with regard to BI1A and BIO1A using the setting tables for IO_SLOT1 and IO_SLOT3. As the setting points are for BI1A and BIO1A at IO#1 and IO#3, the user should take the setting table of the standard type (in sec. 5.4.6).

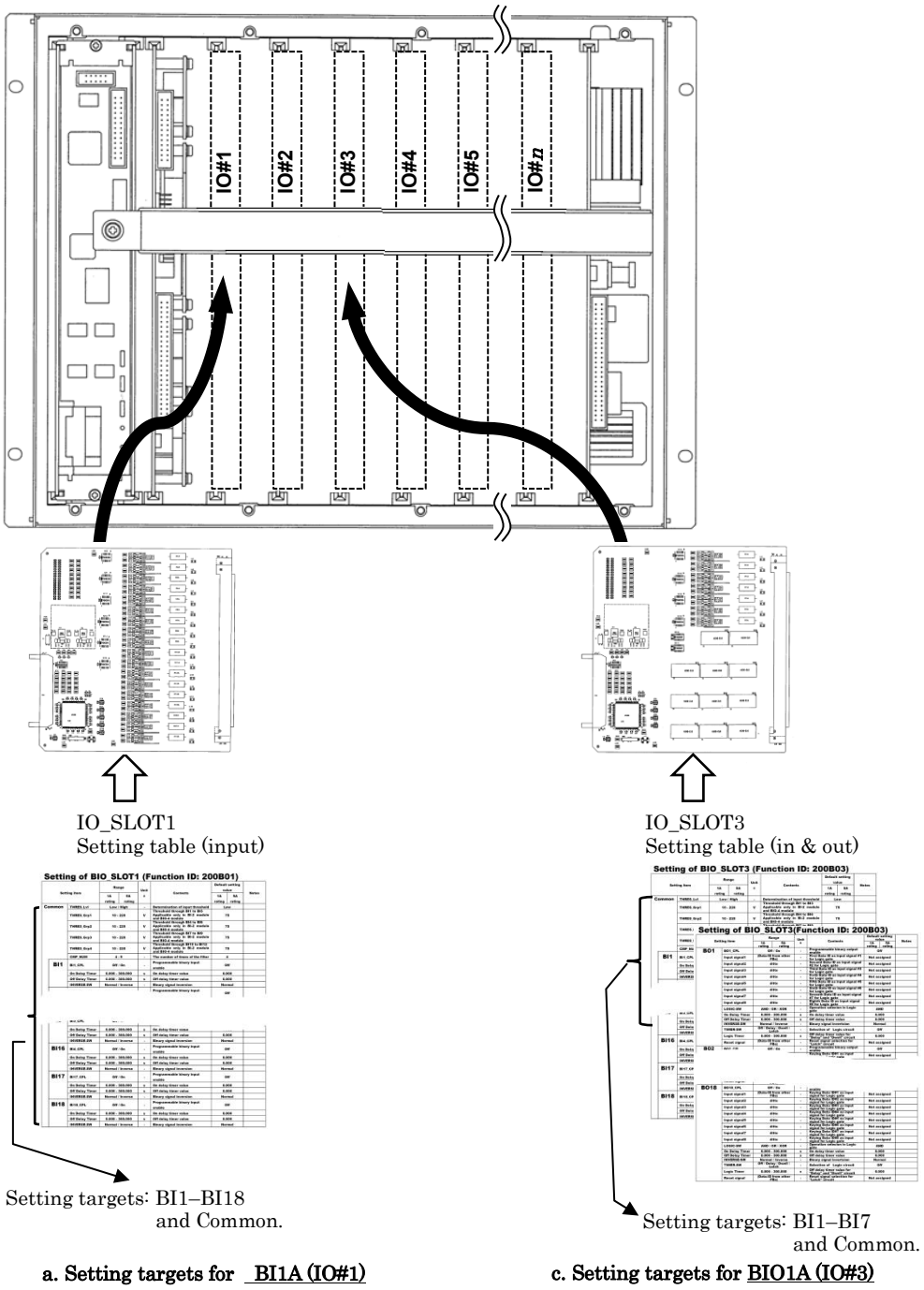


Figure 5.4-4 BO and BIO setting tables related to IO_slot1 and IO_slot3

The setting table of section 5.4.6 is available for all binary IO modules except for BI2A and BIO4A; thus, the user should understand and select the setting points that are relevant to BI1A. That is, for BI1A the user should choose the setting items of reference (i.e., binary input circuits #1 to #18) from IO_SLOT1 setting table. On the other hand, for BIO1A the user should choose the setting items of reference (i.e., binary input circuits #1 to #7) from IO_SLOT3 setting table. The IO_SLOT3 setting table for the binary input circuits are shown in sec. 5.4.6. The setting operation via the IED screen is discussed later. (See chapter *User interface: I/O setting sub-menu*)

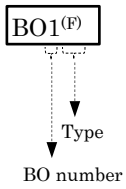
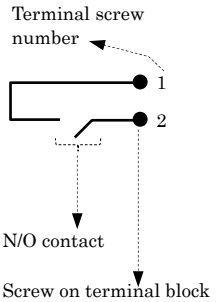
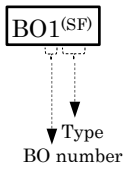
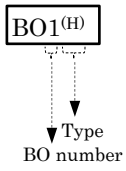
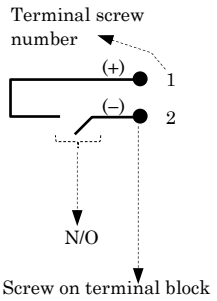
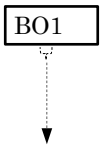
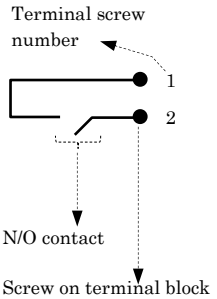
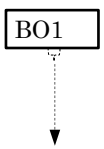
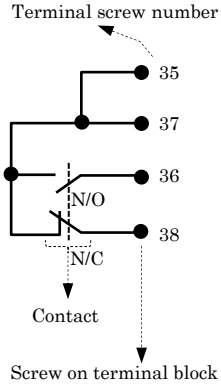
5.4.3 Binary output feature

A binary output circuit (BO) along with the CPL drives a single contact. There are five types of BOs; different types of BOs are provided which are suitable for controlling the speed and capacity of current in a variety of external devices, as listed below:

(1) Fast operating
(2) Semi-fast operating
(3) Hybrid
(4) Auxiliary
(5) BO with Form-C

The arrangement of the BO types is determined for every binary IO module, as shown in Table 5.4-1 and Table 5.4-6. The difference in the types and number of BOs are also found in section 5.4.5.

Table 5.4-6 Output circuits and features associated with binary IO module

No	Type	Binary output feature	Example sign	Symbol	Applied module
1	Fast operating (F)	-Normally open (N/O) -Dry contact -Closure is the fastest amongst all of the BO types. -Make & Carry: 5A cont. -Break: 0.15A at 290Vdc -OP Time: 3ms (typical)			BIO3A
2	Semi-fast operating (SF)	-Normally open (N/O) -Dry contact -Closure is faster than normal. -Make and carry: 8A cont. -Break: 0.1A at 250Vdc 0.2A at 125Vdc -OP Time: 6ms (typical)			BO1A BIO1A BIO2A
3	Hybrid (H)	-Normally open (N/O) -Polarity dependent -Interruption capability for high-current (up to 10A) -Consisting of an IGBT device and a contact -Make and carry: 8A cont. -Break: 10A at 220/110Vdc -OP Time: 1ms			BO2A BIO4A
4	Auxiliary	-Normally open (N/O) -Dry contact -Normal speed closure -Make and carry: 8A cont. -Break: 0.1A at 250Vdc 0.2A at 125Vdc -OP Time: 8ms (typical)			BO1A BIO1A BIO2A BIO3A
5	Form-C	-Uses a N/C and a N/O contact -Shares a common connections -Make and carry: 8A cont. -Break: 0.1A at 250Vdc 0.2A at 125Vdc -OP Time: 8ms (typical)			BIO2A BIO3A BIO4A

5.4.4 Binary output circuit

Either a CPL logic or a PLC signal can drive a binary output circuit. Table 5.4-7 shows the settings summary of CPL function.

Table 5.4-7 Setting items for binary output circuits

Setting items		Setting-range or Data_ID	Unit	Contents	Default
BO1	BO1_CPL	Off / On	–	Switch On for programmable operation	Off
	Input signal1	(Preferred Data ID)	–	Set a Data ID at the first input on BO1.	Not assigned[1]
	Input signal2	(Preferred Data ID)	–	Set a Data ID at the second input on BO1.	Not assigned[1]
	Input signal3	(Preferred Data ID)	–	Set a Data ID at the third input on BO1.	Not assigned[1]
	Input signal4	(Preferred Data ID)	–	Set a Data ID at the forth input on BO1.	Not assigned[1]
	Input signal5	(Preferred Data ID)	–	Set a Data ID at the fifth input on BO1.	Not assigned[1]
	Input signal6	(Preferred Data ID)	–	Set a Data ID at the sixth input on BO1.	Not assigned[1]
	Input signal7	(Preferred Data ID)	–	Set a Data ID at the seventh input on BO1.	Not assigned[1]
	Input signal8	(Preferred Data ID)	–	Set a Data ID at the eighth input on BO1.	Not assigned[1]
	LOGIC-SW	AND/OR/XOR	–	Switch for logic-gate operation on BO1	AND
	On Delay Timer	0.000 to 300.000	s	Set a value for an on-delay-timer on BO1	0.000
	Off Delay Timer	0.000 to 300.000	s	Set a value for an off-delay-timer on BO1	0.000
	INVERSE-SW	Normal / Inverse	s	Inversion operation of BO1 signal	Normal
	TIMER-SW	OFF/Delay/Dwell/Latch	–	Selection of a type in the delay timer on BO1	OFF
	Logic Timer	0.000 to 300.000	s	Setting Off Delay Timer for Delay and Dwell	0.000
	Reset signal	(Preferred Data ID)	–	Setting Data ID for Latch	Not assigned[1]
BO2	BO2_CPL	Off / On	–	Switch On for programmable operation	Off
	Input signal1	(Preferred Data ID)	–	Set a Data ID at the first input on BO2.	Not assigned[1]
	.....	.....		.....	.....
	Input signal8	(Preferred Data ID)	–	Set a Data ID at the eighth input on BO2	Not assigned[1]
	LOGIC-SW	AND/OR/XOR	–	Switch for logic-gate operation on BO2	AND
	On Delay Timer	0.000 to 300.000	s	Set a value for an on-delay-timer on BO2	0.000
	Off Delay Timer	0.000 to 300.000	s	Set a value for an off-delay-timer on BO2	0.000
	INVERSE-SW	Normal / Inverse	–	Inversion operation of BO2 signal	Normal
	TIMER-SW	OFF/Delay/Dwell/Latch	–	Selection of a type in the delay timer on BO2	OFF
	Logic Timer	0.000 to 300.000	s	Setting Off Delay Timer for Delay and Dwell	0.000
	Reset signal	(Preferred Data ID)	–	Setting Data ID for Latch	Not assigned[1]
.....					
BO*n*	BO*n*_CPL	Off / On	–	Switch On for programmable operation	Off
	Input signal1	(Preferred Data ID)	–	Set a Data ID at the first input on BO*n*	Not assigned[1]
	.....	.....		.....	.....
	Input signal8	(Preferred Data ID)	–	Set a Data ID at the eighth input on BO*n*	Not assigned[1]
	LOGIC-SW	AND/OR/XOR	–	Switch for logic-gate operation on BO*n*	AND
	On Delay Timer	0.000 to 300.000	s	Set a value for an on-delay-timer on BO*n*	0.000
	Off Delay Timer	0.000 to 300.000	s	Set a value for an off-delay-timer on BO*n*	0.000
	INVERSE-SW	Normal / Inverse	–	Inversion operation of BO*n* signal	Normal
	TIMER-SW	OFF/Delay/Dwell/Latch	–	Selection of a type in the delay timer on BO*n*	OFF
	Logic Timer	0.000 to 300.000	s	Setting Off Delay Timer for Delay and Dwell	0.000
	Reset signal	(Preferred Data ID)	–	Setting Data ID for Latch	Not assigned[1]

[1]Note: The user can set a reset signal and eight input signals with Data IDs. Data IDs are listed as a signal monitoring point for each function. Setting items are summarized in each slot. (See sections 5.4.8(i) and 5.4.8(ii))

Figure 5.4-5 shows the binary output circuits on BO1A in order to help understand the settings. BO1A consists of 18 binary output circuits and every circuit has timers and switches. The features of the CPLs are divided into the five components as listed below:

CPL switch

Selection of input signals

Logic gate switch

Delayed pick-up/delayed drop-off

Logic level inversion

Logic timer switch

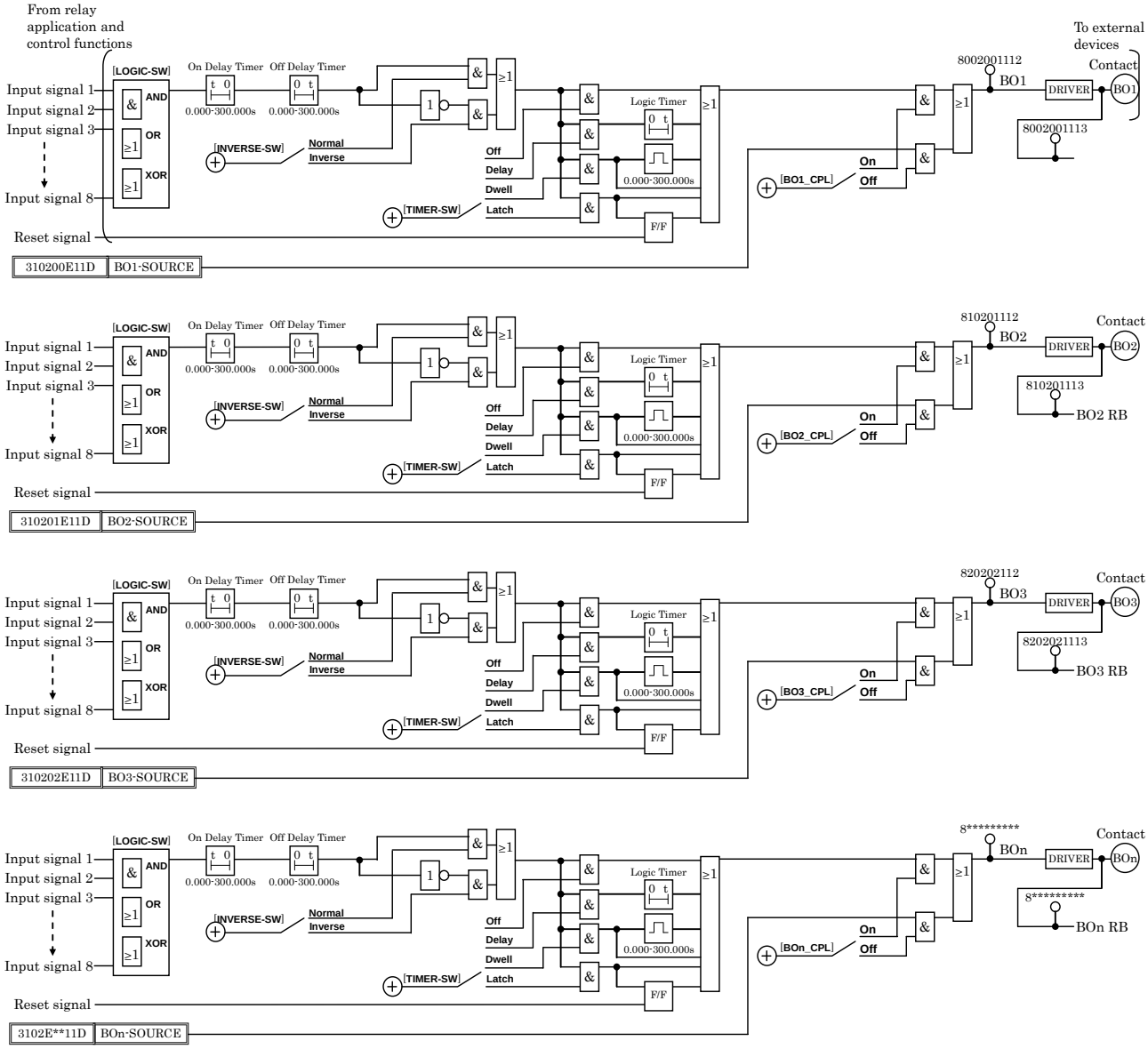


Figure 5.4-5 Binary Output Circuit for BO1A (#1 to #n=18)

In Figure 5.4-5 respective element IDs (i.e., 8002001112 and others) designate respective signal monitoring points of the binary output circuits. The user can monitor the operations of

the binary output circuit using element ID together with function ID. When we assume that BO1A module is at IO#2 slot in the IED case, and if the user wishes to monitor the first-circuit in the BO1A module, the user can see the operation using the element ID (8002001112) and the function ID† of IO#2 slot.

†Note: A function ID identifies every IO slots. For example, with regard to the function ID and the Data ID at IO#1 slot, see section 5.4.9(i). On the other hand, for IO#2 slot see section 5.4.9(ii).

(i) CPL switch

When the user needs to operate the CPL for binary output circuit #1, the user should set **On** for the scheme switch [**BO1_CPL**]. Conversely, the user should set **Off** for the scheme switch [**BO1_CPL**] if CPL is not required. Since all binary output circuits have CPLs setting between **On** and **Off** is required for every binary output circuit. The number of CPL is equal to the number of binary output circuits: that is, if the BO1A module is selected, the number of CPLs is 18. Note that the subsequent PLC settings described later require that **Off** be set for the scheme switch.

(ii) Selection of input signals

Since a binary input circuit is operated by commands introduced from other functions, eight ports for input signals are provided, designated as *input-signal1* to *input-signal8*. The user must ensure that *input-signal1* to *input-signal8* are configured with eight DataIDs. That is, the user can select input-signals that are available from other functions, these input-signals are designated using DataIDs. The user can key the DataIDs into settings [**Input signal1**] to [**Input signal8**]. The DataIDs are selected from the *Signal monitoring point* list, which is provided for every function.

(iii) Logic gate switch

A binary input circuit has a logic scheme for the eight input signals, and can combine the eight input signals as required using scheme switch [**LOGIC-SW**] for which the user should set either **AND**, **OR** or **XOR**.

(iv) Delayed pick-up/delayed drop-off signal

An on-delay timer and an off-delay timer are provided in the CPL; both are used to adjust the timing for binary output circuits, the user should set their respective time values for settings [**On Delay Timer**] and [**Off Delay Timer**].

(v) Logic level inversion

The logic inversion function can invert the input signal for each binary output circuit; the user

can invert an input output when the user sets **Inverse** for the scheme switch [**INVERSE-SW**]. **Normal** setting is also provided when logic inversion is not required for processing.

(vi) Logic timer switch

In order that the binary output circuit can have a programmable reset characteristic, a scheme switch and a setting are provided. The programmable reset characteristic consists of four types and the user can select the type required using a scheme switch: (1) dwell type, (2) delay type, (3) latch type, and (4) instantaneous type:

(vi)-1 Instant type

When the user uses a binary output signal without the following characteristics, the user should set **Off** for the scheme switch [**TIMER-SW**].

(vi)-2 Delay type

If the user requires a binary output signal with a delayed characteristic, the user should set **Delay** for scheme switch [**TIMER-SW**] and set the value of the pulse width using setting [**Logic timer**].

(vi)-3 Dwell type

For instance, if the user requires a binary output signal as a one shot pulse, the user should set **Dwell** for scheme switch [**TIMER-SW**] and set the value of the pulse width using setting [**Logic timer**]. If the input signals received have a shorter duration than the set value in the setting [**Logic timer**], the pulse width will be equal to the setting value. On the other hand, if the duration of the input signals are longer than that of the set value, the pulse width will be equal to the width of the input signals.

(vi)-4 Latch type

If the user requires a binary output signal to be removed by a reset signal, the user should set **Latch** for scheme switch [**TIMER-SW**] and key the Data ID of the reset signal for setting [**Reset signal**]. Since the binary output signal is removed with the Data ID, the user should determine the Data ID from other functions. The Data ID is designated by the signal monitoring point for each function and the user should set the [**Reset signal**] setting.

Note: When **Latch** is set, the state of BO circuit will be sustained during power turn-on/off.

(vii) How to set the settings for binary output circuits

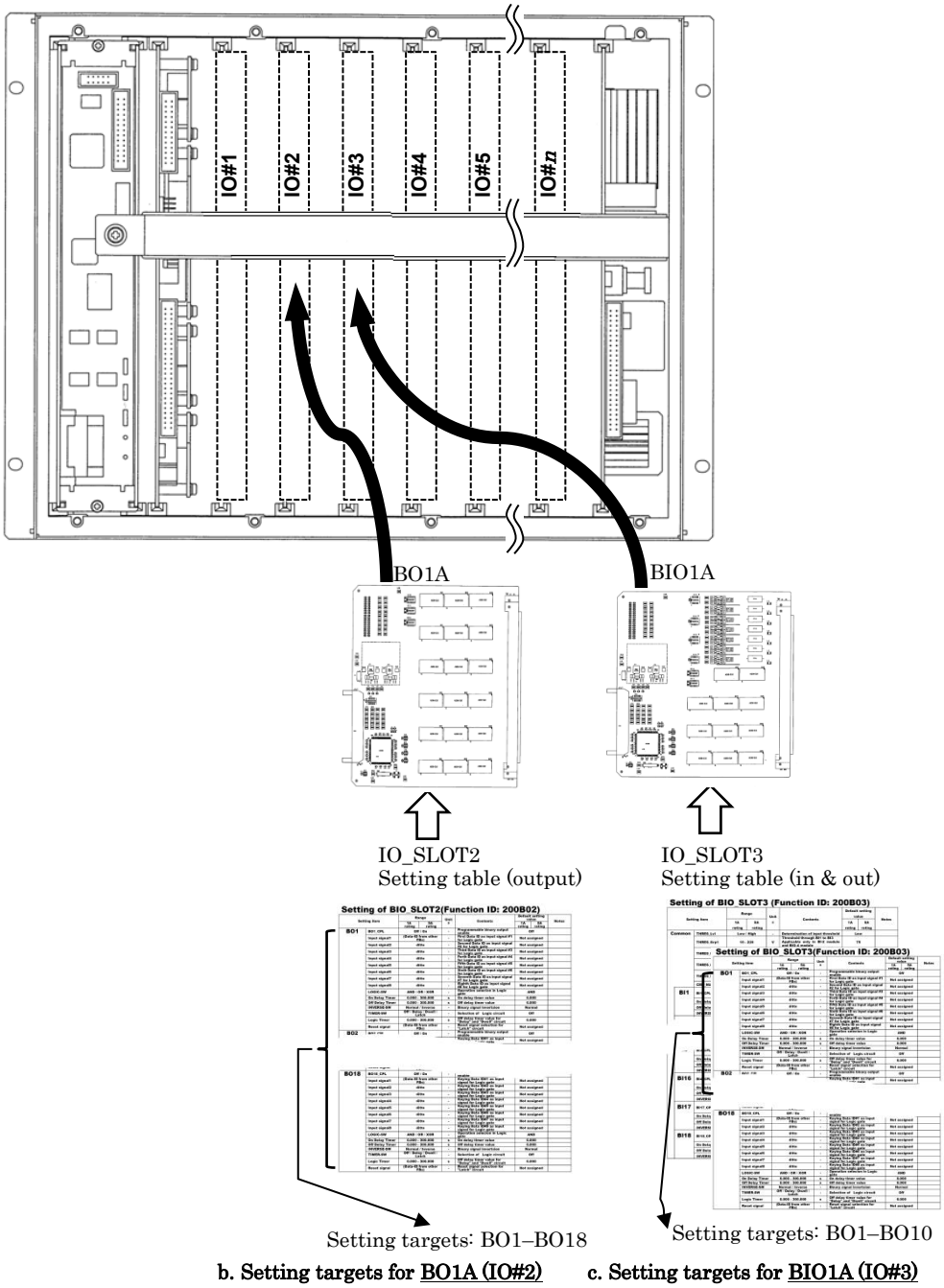


Figure 5.4-6 BO and BIO modules and setting tables related to IO_SLOT2 and IO_SLOT3

Figure 5.4-6 illustrates an example of a binary IO module arrangement and the binary output circuit printed circuit boards (PCBs). If the user wishes to set the binary output circuits, the setting targets are on BO1A and BIO1A at locations IO#2 and IO#3. The user should key the CPL settings from the setting tables for the IO2_SLOT and IO3_SLOT.

The setting table is available for all binary IO modules; thus, the user should understand and select setting points that are relevant to BO1A and BIO1A. That is, for BO1A the user should choose the setting terms of reference (i.e., binary output circuits #1 to #18) from

IO_SLOT2. On the other hand, for BIO1A, the setting terms of reference (i.e., binary output circuits #1 to #10) are from IO_SLOT3. These setting tables are shown in section 5.4.8(ii).

(viii) PLC and the binary output circuits

The Programmable logic controller (PLC) is also available for the control of binary output circuits as a substitute for the CPL, and is able to signal an output command directly. In the case that the binary output circuit is controlled by the PLC, the user is required to connect the PLC to the binary output circuit. In Figure 5.4-5, the PLC logic connection points are designated with BO1-SOURCE, BO2-SOURCE, and others. (The PLC is discussed separately. Note that Connection points on the PLC are shown with the DataIDs of BIO_SLOT. See section 5.4.9(i)-3 and 5.4.9(ii)-3. (For more information of PLC function, see Chapter *PLC function*)

5.4.5 Structure of binary IO Module

Binary IO modules consist of a number of module types and the arrangement of the respective inputs-and-outputs are particular to each binary IO module type, as shown in Figure 5.4-7 to Figure 5.4-11. Referring to the figures on the left, the user can for example, identify the actual terminal blocks of the binary IO module. Corresponding circuits are drawn on the right in the form of schematic diagrams. If the wiring of BI1A is considered, the wiring objects are designated with terminal screw numbers 1 to 40. The terminal screw numbers are shown next to the terminal blocks. Here the user can find a slot number labeled with alpha-numeric reference "T*". The asterisk sign (*) is substituted for any one of the slot numbers. For the actual implementation of a binary IO module, the user should examine the arrangement of binary IO modules from *External connection figures*, which are shown separately. (See *Appendix: Typical external connection*)

Note that some input and output circuits have polarity, which is designated with either a plus sign (+) or a minus sign (–) respectively.

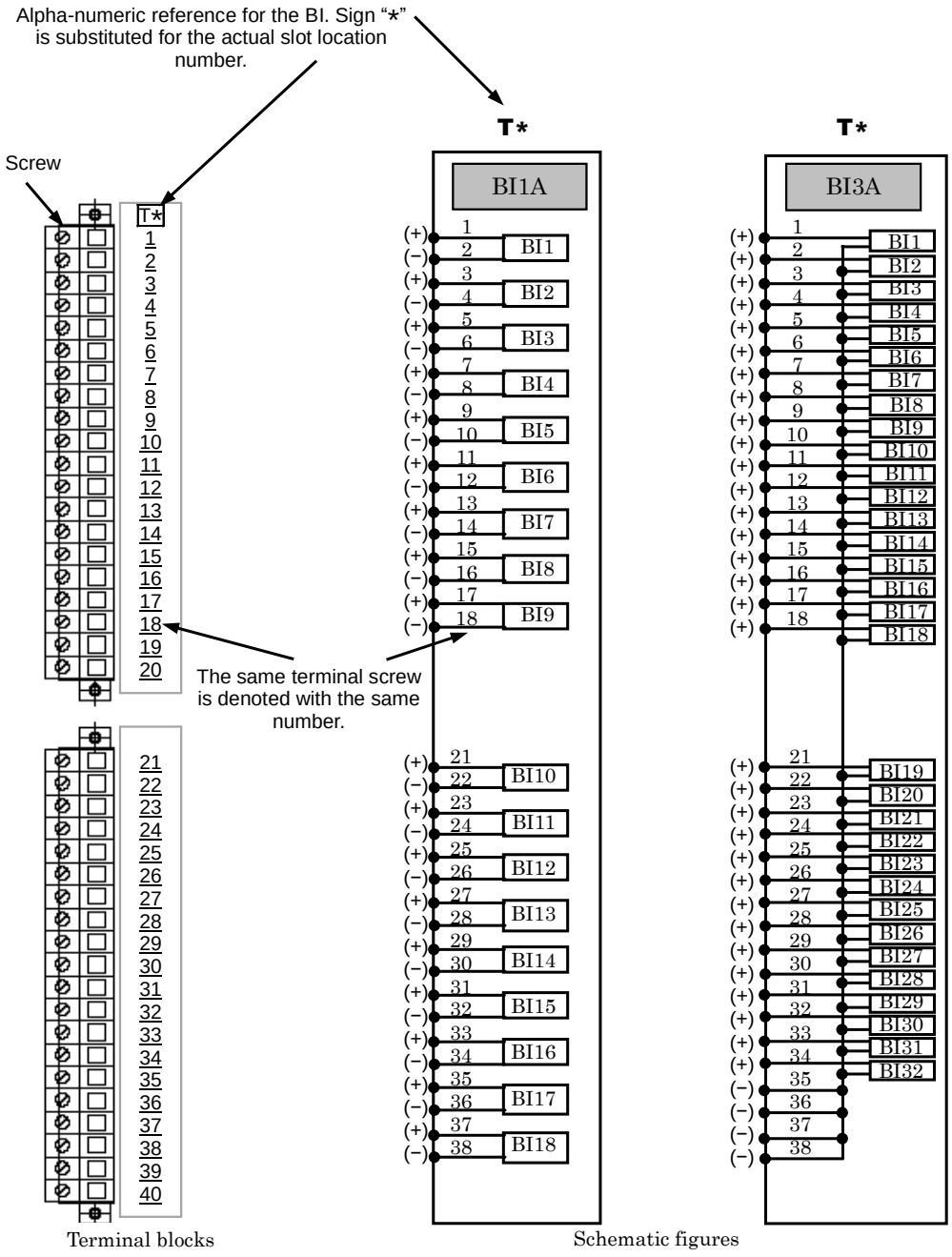


Figure 5.4-7 Input arrangements for BI1A and BI3A

Note: For more detailed circuit information, refer to Table 5.4-2 or Table 5.4-6.

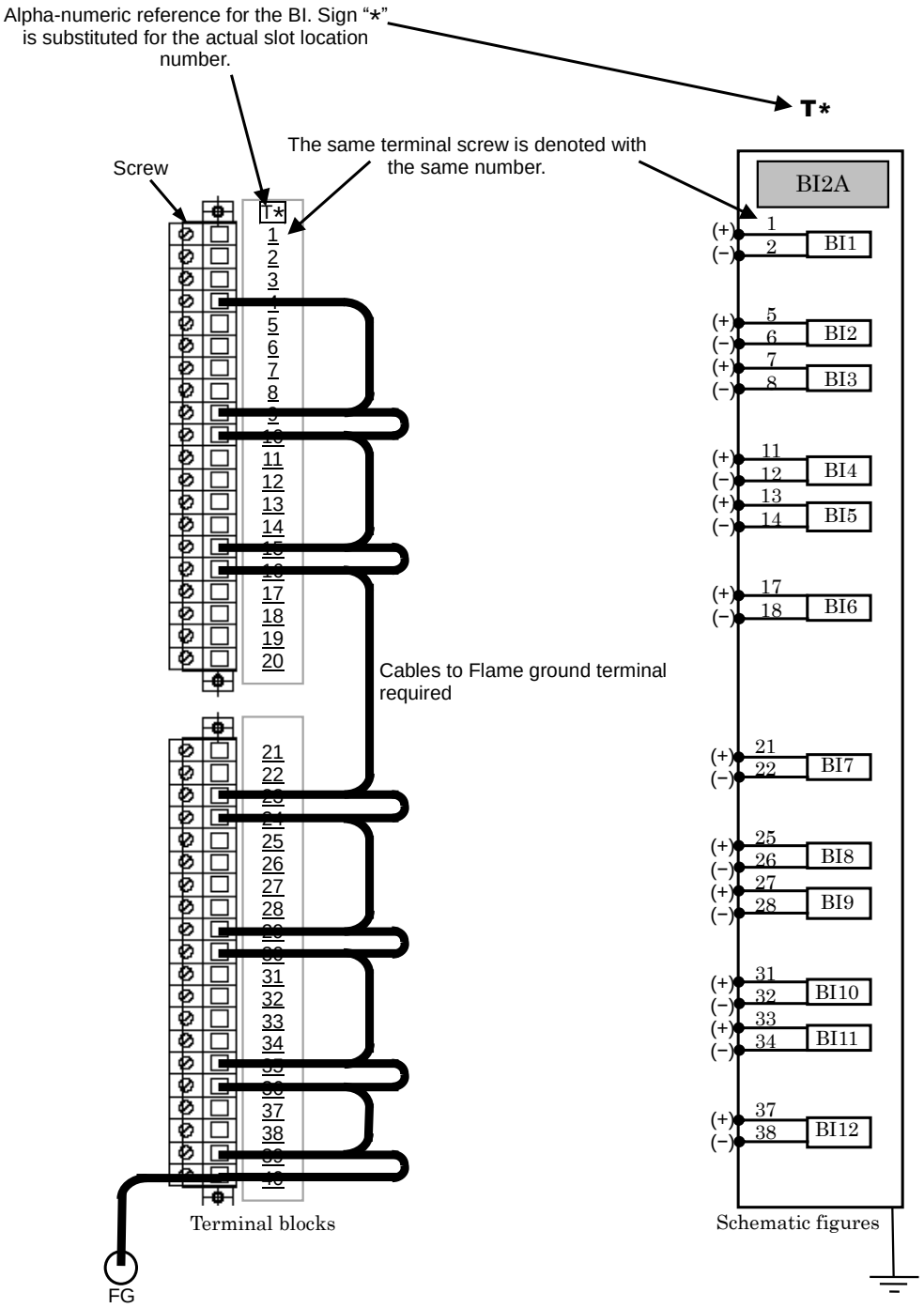


Figure 5.4-8 Input arrangements for BI2A

Note: For more detailed circuit information, refer to Table 5.4-2 or Table 5.4-6.

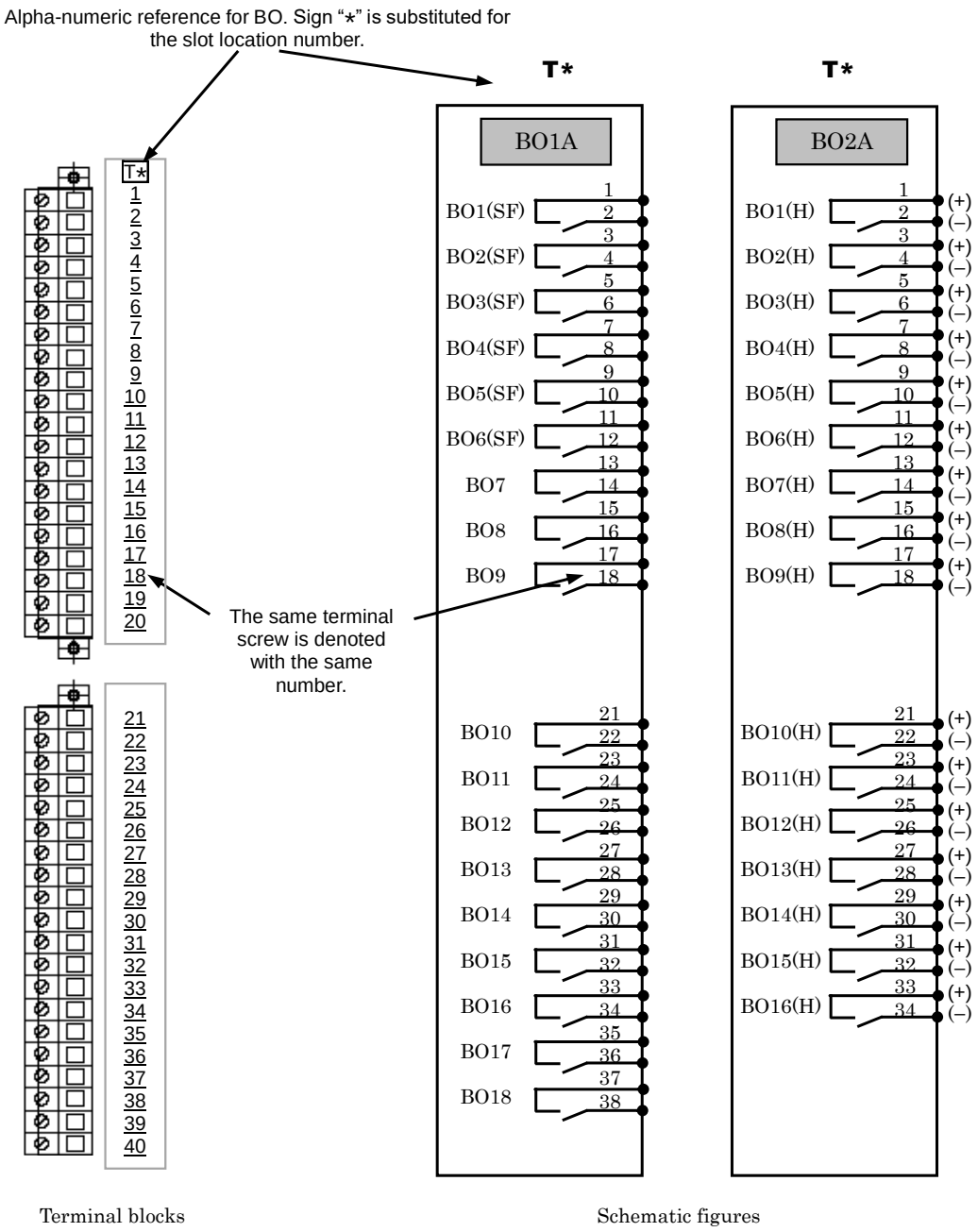


Figure 5.4-9 Output arrangements in BO1A and BO2A

Note: For more detailed circuit information, refer to Table 5.4-2 or Table 5.4-6.

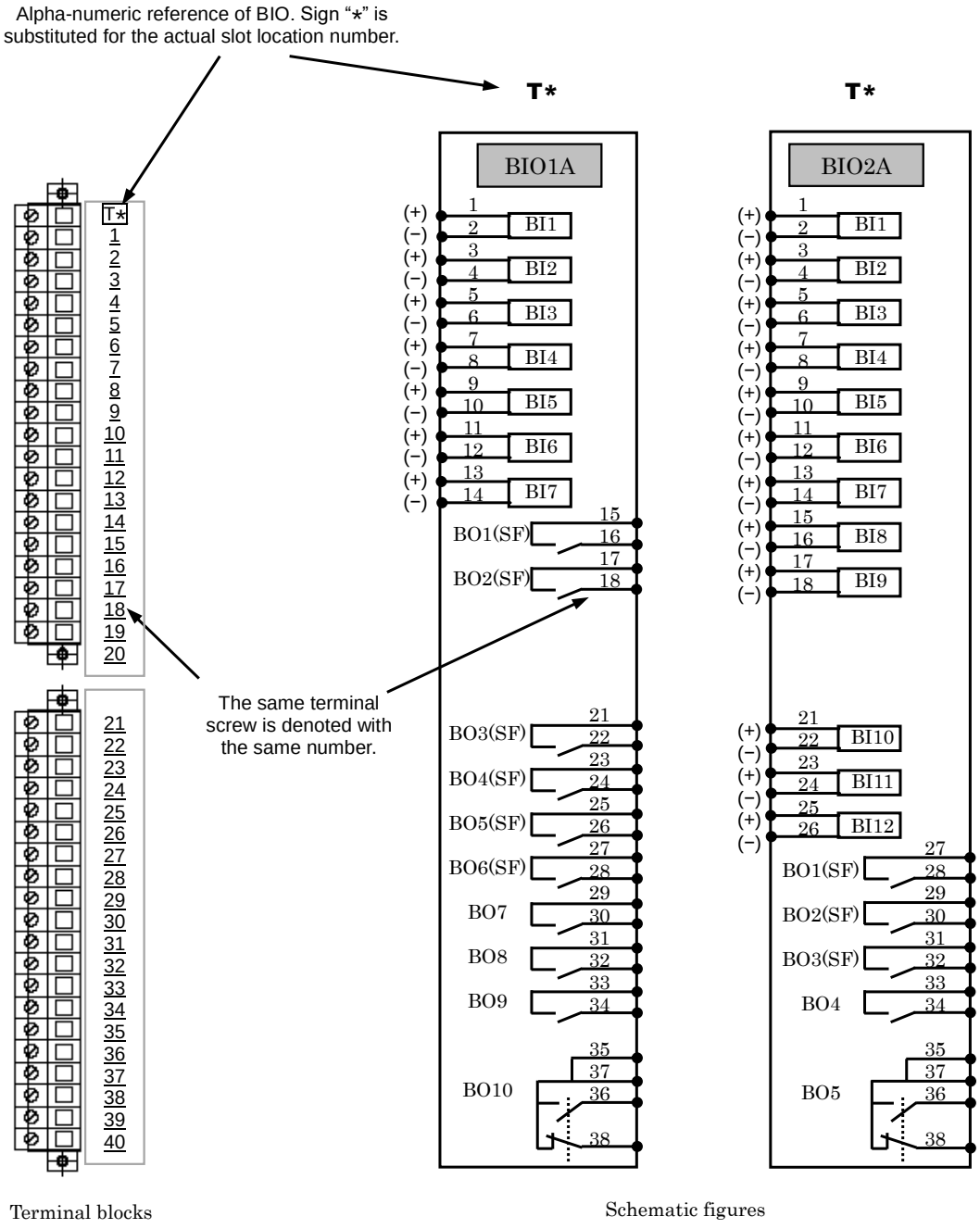


Figure 5.4-10 Input and output arrangements in BIO1A and BIO2A

Note: For more detailed circuit information, refer to Table 5.4-2 or Table 5.4-6.

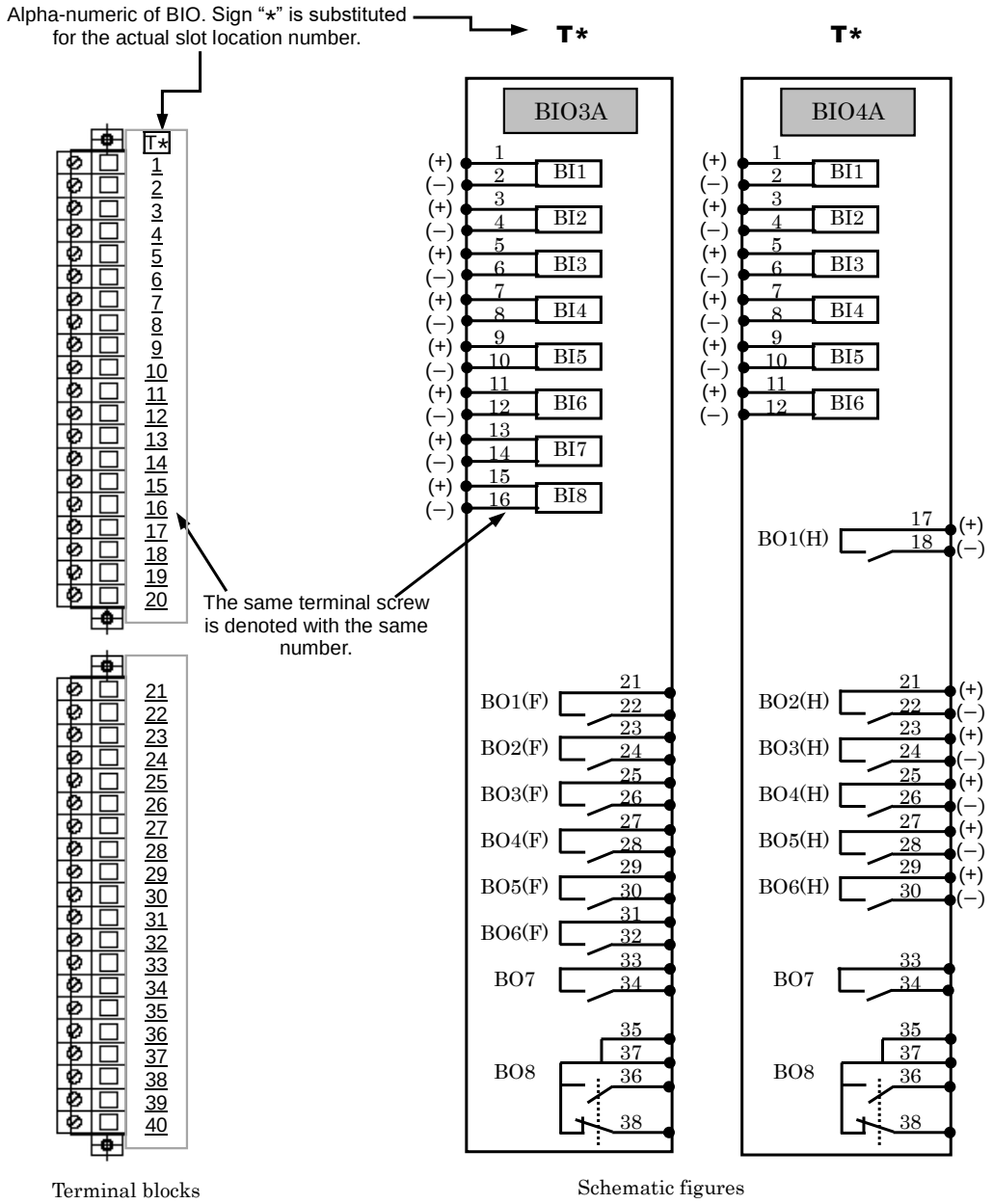


Figure 5.4-11 Input and output arrangements in BIO3A and BIO4A

Note: PHOENIX CONTACT ® is the manufacturer of the terminal block. The model of this terminal is described as "FRONT-MSTB 2.5/20-STF 5.08". The user can connect a cable to this terminal directly without a cable ferrule; hence, the recommended cables are AWG14 and their stripping lengths are 10mm. Use a cable ferrule made in PHOENIX CONTACT ® when required.

5.4.6 Settings of binary input circuits

(i) Setting table (IO_SLOT1) at IO#1 (Function ID: 200B01)

(i)-1 For the standard type being furnished

Setting item			Range	Unit s	Contents	Default setting value	Notes
Common		THRES_Lvl	Low / High	-	Determination of input threshold	Low	
		CMP_NUM	4 - 9	-	Number of times filtered	4	
	BI1	BI1_CPL	Off / On	-	Programmable binary input enable	Off	
		On Delay Timer	0.000 - 300.000	s	On delay timer value	0.000	
		Off Delay Timer	0.000 - 300.000	s	Off delay timer value	0.000	
		INVERSE-SW	Normal / Inverse	-	Binary signal inversion	Normal	
	BI2	BI2_CPL	Off / On	-	Programmable binary input enable	Off	
		On Delay Timer	0.000 - 300.000	s	On delay timer value	0.000	
		Off Delay Timer	0.000 - 300.000	s	Off delay timer value	0.000	
		INVERSE-SW	Normal / Inverse	-	Binary signal inversion	Normal	
	.....	.....	.....		.....	.....	
	BI32	BI32_CPL	Off / On	-	Programmable binary input enable	Off	
		On Delay Timer	0.000 - 300.000	s	On delay timer value	0.000	
		Off Delay Timer	0.000 - 300.000	s	Off delay timer value	0.000	
		INVERSE-SW	Normal / Inverse	-	Binary signal inversion	Normal	

(i)-2 For the variable type being furnished

Setting item			Range	Unit s	Contents	Default setting value	Notes
Common		THRES_Lvl	Low / High	-	Determination of input threshold	Low	
		THRES_Grp1	10 - 220	V	Threshold through BI1 to BI3 Applicable only in BI-2 module and BIO-4 module	75	
		THRES_Grp2	10 - 220	V	Threshold through BI4 to BI6 Applicable only in BI-2 module and BIO-4 module	75	
		THRES_Grp3	10 - 220	V	Threshold through BI7 to BI9 Applicable only in BI-2 module and BIO-4 module	75	
		THRES_Grp4	10 - 220	V	Threshold through BI10 to BI12 Applicable only in BI-2 module and BIO-4 module	75	
		CMP_NUM	4 - 9	-	Number of times filtered	4	
	BI1	BI1_CPL	Off / On	-	Programmable binary input enable	Off	
		On Delay Timer	0.000 - 300.000	s	On delay timer value	0.000	
		Off Delay Timer	0.000 - 300.000	s	Off delay timer value	0.000	
		INVERSE-SW	Normal / Inverse	-	Binary signal inversion	Normal	
	BI2	BI2_CPL	Off / On	-	Programmable binary input enable	Off	
		On Delay Timer	0.000 - 300.000	s	On delay timer value	0.000	
		Off Delay Timer	0.000 - 300.000	s	Off delay timer value	0.000	
		INVERSE-SW	Normal / Inverse	-	Binary signal inversion	Normal	
	.....	.....	.....		.....	.....	
	BI12	BI12_CPL	Off / On	-	Programmable binary input enable	Off	
		On Delay Timer	0.000 - 300.000	s	On delay timer value	0.000	
		Off Delay Timer	0.000 - 300.000	s	Off delay timer value	0.000	
		INVERSE-SW	Normal / Inverse	-	Binary signal inversion	Normal	

(ii) Setting tables (IO_SLOT2 to SLOT*n*) at IO#2 to IO#*n* (Function ID: 200B02 to 200B0n)

(ii)-1 For the standard type being furnished

Setting table is the same as the table for the IO#1 (in previous section (i)-1)

(ii)-2 For the variable type being furnished

Setting table is the same as the table for the IO#2 (in previous section (i)-2)

5.4.7 Signals (Data ID) of binary input circuits

(i) Table (IO_SLOT1) at IO#1 (Function ID: 200B01)

(i)-1 Before the filer

◆ Signal monitoring points (before the filter)

Element ID	Name	Description
8001001111	BI1-NC	BI1 signal without filter
8101011111	BI2-NC	BI2 signal without filter
8201021111	BI3-NC	BI3 signal without filter
8301031111	BI4-NC	BI4 signal without filter
8401041111	BI5-NC	BI5 signal without filter
8501051111	BI6-NC	BI6 signal without filter
8601061111	BI7-NC	BI7 signal without filter
8701071111	BI8-NC	BI8 signal without filter
8801081111	BI9-NC	BI9 signal without filter
8901091111	BI10-NC	BI10 signal without filter
8A010A1111	BI11-NC	BI5 signal without filter
8B010B1111	BI12-NC	BI7 signal without filter
8C010C1111	BI13-NC	BI9 signal without filter
8D010D1111	BI14-NC	BI11 signal without filter
8E010E1111	BI15-NC	BI13 signal without filter
8F010F1111	BI16-NC	BI15 signal without filter
8001101111	BI17-NC	BI17 signal without filter
8101111111	BI18-NC	BI18 signal without filter
8201121111	BI19-NC	BI19 signal without filter
8301131111	BI20-NC	BI20 signal without filter
8401141111	BI21-NC	BI21 signal without filter
8501151111	BI22-NC	BI22 signal without filter
8601161111	BI23-NC	BI23 signal without filter
8701171111	BI24-NC	BI24 signal without filter
8801181111	BI25-NC	BI25 signal without filter
8901191111	BI26-NC	BI26 signal without filter
8A011A1111	BI27-NC	BI27 signal without filter
8B011B1111	BI28-NC	BI28 signal without filter
8C011C1111	BI29-NC	BI29 signal without filter
8D011D1111	BI30-NC	BI30 signal without filter
8F011F1111	BI32-NC	BI31 signal without filter
8E011E1111	BI31-NC	BI32 signal without filter

(i)-2 After the filter

◆ Signal monitoring points (after the filer)

Element ID	Name	Description
8001001110	BI1	BI1 signal with filter
8101011110	BI2	BI2 signal with filter
8201021110	BI3	BI3 signal with filter
8301031110	BI4	BI4 signal with filter
8401041110	BI5	BI5 signal with filter

◆ Signal monitoring points (after the filer)

Element ID	Name	Description
8501051110	BI6	BI6 signal with filter
8601061110	BI7	BI7 signal with filter
8701071110	BI8	BI8 signal with filter
8801081110	BI9	BI9 signal with filter
8901091110	BI10	BI10 signal with filter
8A010A1110	BI11	BI11 signal with filter
8B010B1110	BI12	BI12 signal with filter
8C010C1110	BI13	BI13 signal with filter
8D010D1110	BI14	BI14 signal with filter
8E010E1110	BI15	BI15 signal with filter
8F010F1110	BI16	BI16 signal with filter
8001101110	BI17	BI17 signal with filter
8101111110	BI18	BI18 signal with filter
8201121110	BI19	BI19 signal with filter
8301131110	BI20	BI20 signal with filter
8401141110	BI21	BI21 signal with filter
8501151110	BI22	BI22 signal with filter
8601161110	BI23	BI23 signal with filter
8701171110	BI24	BI24 signal with filter
8801181110	BI25	BI25 signal with filter
8901191110	BI26	BI26 signal with filter
8A011A1110	BI27	BI27 signal with filter
8B011B1110	BI28	BI28 signal with filter
8C011C1110	BI29	BI29 signal with filter
8D011D1110	BI30	BI30 signal with filter
8E011E1110	BI31	BI31 signal with filter
8F011F1110	BI32	BI32 signal with filter

(i)-3 The ends of binary input circuits

◆ Signal monitoring points (at the end of binary input circuit)

Element ID	Name	Description
8001001172	BI1-CPL	BI1 signal with filter and programmable logic
8101011172	BI2-CPL	BI2 signal with filter and programmable logic
8201021172	BI3-CPL	BI3 signal with filter and programmable logic
8301031172	BI4-CPL	BI4 signal with filter and programmable logic
8401041172	BI5-CPL	BI5 signal with filter and programmable logic
8501051172	BI6-CPL	BI6 signal with filter and programmable logic
8601061172	BI7-CPL	BI7 signal with filter and programmable logic
8701071172	BI8-CPL	BI8 signal with filter and programmable logic
8801081172	BI9-CPL	BI9 signal with filter and programmable logic
8901091172	BI10-CPL	BI10 signal with filter and programmable logic
8A010A1172	BI11-CPL	BI11 signal with filter and programmable logic
8B010B1172	BI12-CPL	BI12 signal with filter and programmable logic
8C010C1172	BI13-CPL	BI13 signal with filter and programmable logic
8D010D1172	BI14-CPL	BI14 signal with filter and programmable logic

◆ Signal monitoring points (at the end of binary input circuit)

Element ID	Name	Description
8E010E1172	BI15-CPL	BI15 signal with filter and programmable logic
8F010F1172	BI16-CPL	BI16 signal with filter and programmable logic
8001101172	BI17-CPL	BI17 signal with filter and programmable logic
8101111172	BI18-CPL	BI18 signal with filter and programmable logic
8201121172	BI19-CPL	BI19signal with filter and programmable logic
8301131172	BI20-CPL	BI20ignal with filter and programmable logic
8401141172	BI21-CPL	BI21 signal with filter and programmable logic
8501151172	BI22-CPL	BI22 signal with filter and programmable logic
8601161172	BI23-CPL	BI23 signal with filter and programmable logic
8701171172	BI24-CPL	BI24 signal with filter and programmable logic
8801181172	BI25-CPL	BI25 signal with filter and programmable logic
8901191172	BI26-CPL	BI26 signal with filter and programmable logic
8A011A1172	BI27-CPL	BI27 signal with filter and programmable logic
8B011B1172	BI28-CPL	BI28 signal with filter and programmable logic
8C011C1172	BI29-CPL	BI29 signal with filter and programmable logic
8D011D1172	BI30-CPL	BI30 signal with filter and programmable logic
8E011E1172	BI31-CPL	BI31 signal with filter and programmable logic
8F011F1172	BI32-CPL	BI32 signal with filter and programmable logic

(ii) Tables (IO_SLOT2 to SLOT*n*) at IO#2 to IO#*n* (Function ID: 200B02 to 200B0*n*)

(ii)-1 Before the filter

Table is the same as the table in previous section (i)-1.

(ii)-2 After the filter

Table is the same as the table in previous section (i)-2.

(ii)-3 The ends of binary input circuits

Table is the same as the table in previous section (i)-3.

5.4.8 Settings of binary output circuits

(i) Setting table (IO_SLOT1) at IO#1 (Function ID 200B01)

Setting item		Range	Units	Contents	Default setting value	Notes
BO1	BO1_CPL	Off / On	-	Programmable binary output enable	Off	
	Input signal1	(Data-ID from other FBs)	-	First Data ID as input signal #1 for Logic gate	Not assigned	
	Input signal2	ditto	-	Second Data ID as input signal #2 for Logic gate	Not assigned	
	Input signal3	ditto	-	Third Data ID as input signal #3 for Logic gate	Not assigned	
	Input signal4	ditto	-	Forth Data ID as input signal #4 for Logic gate	Not assigned	
	Input signal5	ditto	-	Fifth Data ID as input signal #5 for Logic gate	Not assigned	
	Input signal6	ditto	-	Sixth Data ID as input signal #6 for Logic gate	Not assigned	
	Input signal7	ditto	-	Seventh Data ID as input signal #7 for Logic gate	Not assigned	
	Input signal8	ditto	-	Eighth Data ID as input signal #8 for Logic gate	Not assigned	
	LOGIC-SW	AND / OR / XOR	-	Operation selection in Logic gate	AND	
	On Delay Timer	0.000 - 300.000	s	On delay timer value	0.000	
	Off Delay Timer	0.000 - 300.000	s	Off delay timer value	0.000	
	INVERSE-SW	Normal / Inverse	-	Binary signal inversion	Normal	
	TIMER-SW	Off / Delay / Dwell / Latch	-	Selection of Logic circuit	Off	
	Logic Timer	0.000 - 300.000	s	Off delay timer value for "Delay" and "Dwell" circuit	0.000	
	Reset signal	(Data-ID from other FBs)	-	Reset signal selection for "Latch" circuit	Not assigned	
BO2	BO2_CPL	Off / On	-	Programmable binary output enable	Off	
	Input signal1	(Data-ID from other FBs)	-	Keying Data ID#1 as input signal for Logic gate	Not assigned	
	Input signal2	ditto	-	Keying Data ID#2 as input signal for Logic gate	Not assigned	
	Input signal3	ditto	-	Keying Data ID#3 as input signal for Logic gate	Not assigned	
	Input signal4	ditto	-	Keying Data ID#4 as input signal for Logic gate	Not assigned	
	Input signal5	ditto	-	Keying Data ID#5 as input signal for Logic gate	Not assigned	
	Input signal6	ditto	-	Keying Data ID#6 as input signal for Logic gate	Not assigned	
	Input signal7	ditto	-	Keying Data ID#7 as input signal for Logic gate	Not assigned	
	Input signal8	ditto	-	Keying Data ID#8 as input signal for Logic gate	Not assigned	
	LOGIC-SW	AND / OR / XOR	-	Operation selection in Logic gate	AND	
	On Delay Timer	0.000 - 300.000	s	On delay timer value	0.000	
	Off Delay Timer	0.000 - 300.000	s	Off delay timer value	0.000	
	INVERSE-SW	Normal / Inverse	-	Binary signal inversion	Normal	
	TIMER-SW	Off / Delay / Dwell / Latch	-	Selection of Logic circuit	Off	
	Logic Timer	0.000 - 300.000	s	Off delay timer value for "Delay" and "Dwell" circuit	0.000	
	Reset signal	(Data-ID from other FBs)	-	Reset signal selection for "Latch" circuit	Not assigned	
.....	.....	.....		.....	.....	
BO18	BO18_CPL	Off / On	-	Programmable binary output enable	Off	
	Input signal1	(Data-ID from other FBs)	-	Keying Data ID#1 as input signal for Logic gate	Not assigned	
	.....	.....		.....	.....	
	Input signal8	ditto	-	Keying Data ID#8 as input signal for Logic gate	Not assigned	
	LOGIC-SW	AND / OR / XOR	-	Operation selection in Logic gate	AND	
	On Delay Timer	0.000 - 300.000	s	On delay timer value	0.000	
	Off Delay Timer	0.000 - 300.000	s	Off delay timer value	0.000	
	INVERSE-SW	Normal / Inverse	-	Binary signal inversion	Normal	
	TIMER-SW	Off / Delay / Dwell / Latch	-	Selection of Logic circuit	Off	
	Logic Timer	0.000 - 300.000	s	Off delay timer value for "Delay" and "Dwell" circuit	0.000	
	Reset signal	(Data-ID from other FBs)	-	Reset signal selection for "Latch" circuit	Not assigned	

(ii) Setting tables (IO_SLOT2 to SLOT*n*) at IO#2 to IO#*n* (Function ID 200B02 to 200B0*n*)

Setting table is the same as the table for the IO#1 (in section (i))

5.4.9 Signals (Data ID) of binary output circuits

(i) Table (IO_SLOT1) at IO#1 (Function ID: 200B01)

(i)-1 Before the contact-driver

◆ Signal monitoring points (before the contact-driver)

Element ID	Name	Description
8002001112	BO1	BO1 signal
8102011112	BO2	BO2 signal
8202021112	BO3	BO3 signal
8302031112	BO4	BO4 signal
8402041112	BO5	BO5 signal
8502051112	BO6	BO6 signal
8602061112	BO7	BO7 signal
8702071112	BO8	BO8 signal
8802081112	BO9	BO9 signal
8902091112	BO10	BO10 signal
8A020A1112	BO11	BO11 signal
8B020B1112	BO12	BO12 signal
8C020C1112	BO13	BO13 signal
8D020D1112	BO14	BO14 signal
8E020E1112	BO15	BO15 signal
8F020F1112	BO16	BO16 signal
8002101112	BO17	BO17 signal
8102111112	BO18	BO18 signal

(i)-2 After the contact-driver

◆ Signal monitoring points (after the contact-driver)

Element ID	Name	Description
8002001113	BO1 RB	BO1 driver read signal
8102011113	BO2 RB	BO2 driver read signal
8202021113	BO3 RB	BO3 driver read signal
8302031113	BO4 RB	BO4 driver read signal
8402041113	BO5 RB	BO5 driver read signal
8502051113	BO6 RB	BO6 driver read signal
8602061113	BO7 RB	BO7 driver read signal
8702071113	BO8 RB	BO8 driver read signal
8802081113	BO9 RB	BO9 driver read signal
8902091113	BO10 RB	BO10 driver read signal
8A020A1113	BO11 RB	BO11 driver read signal
8B020B1113	BO12 RB	BO12 driver read signal
8C020C1113	BO13 RB	BO13 driver read signal
8D020D1113	BO14 RB	BO14 driver read signal
8E020E1113	BO15 RB	BO15 driver read signal
8F020F1113	BO16 RB	BO16 driver read signal
8002101113	BO17 RB	BO17 driver read signal
8102111113	BO18 RB	BO18 driver read signal

(i)-3 Connection points for the PLC

◆ Connection point in PLC logic

Element ID	Name	Description
310200E11D	BO1-SOURCE	BO1 output command by PLC-logic
310201E11D	BO2-SOURCE	BO2 output command by PLC-logic
310202E11D	BO3-SOURCE	BO3 output command by PLC-logic
310203E11D	BO4-SOURCE	BO4 output command by PLC-logic
310204E11D	BO5-SOURCE	BO5 output command by PLC-logic
310205E11D	BO6-SOURCE	BO6 output command by PLC-logic
310206E11D	BO7-SOURCE	BO7 output command by PLC-logic
310207E11D	BO8-SOURCE	BO8 output command by PLC-logic
310208E11D	BO9-SOURCE	BO9 output command by PLC-logic
310209E11D	BO10-SOURCE	BO10 output command by PLC-logic
31020AE11D	BO11-SOURCE	BO11 output command by PLC-logic
31020BE11D	BO12-SOURCE	BO12 output command by PLC-logic
31020CE11D	BO13-SOURCE	BO13 output command by PLC-logic
31020DE11D	BO14-SOURCE	BO14 output command by PLC-logic
31020EE11D	BO15-SOURCE	BO15 output command by PLC-logic
31020FE11D	BO16-SOURCE	BO16 output command by PLC-logic
310210E11D	BO17-SOURCE	BO17 output command by PLC-logic
310211E11D	BO18-SOURCE	BO18 output command by PLC-logic

(ii) Tables (IO_SLOT2 to SLOT*n*) at IO#2 to IO#*n* (Function ID: 200B02 to 200B0*n*)

(ii)-1 Before the contact-driver

Table is the same as the table in previous section (i)-1.

(ii)-2 After the contact-driver

Table is the same as the table in previous section (i)-2.

(ii)-3 Connection points for the PLC

Table is the same as the table in previous section (i)-3.

5.5 Power supply module (PWS)

The power supply module (PWS) consists of a DC/DC converter and line noise filters. The input range rating of the PWS is 110 to 250 V DC.

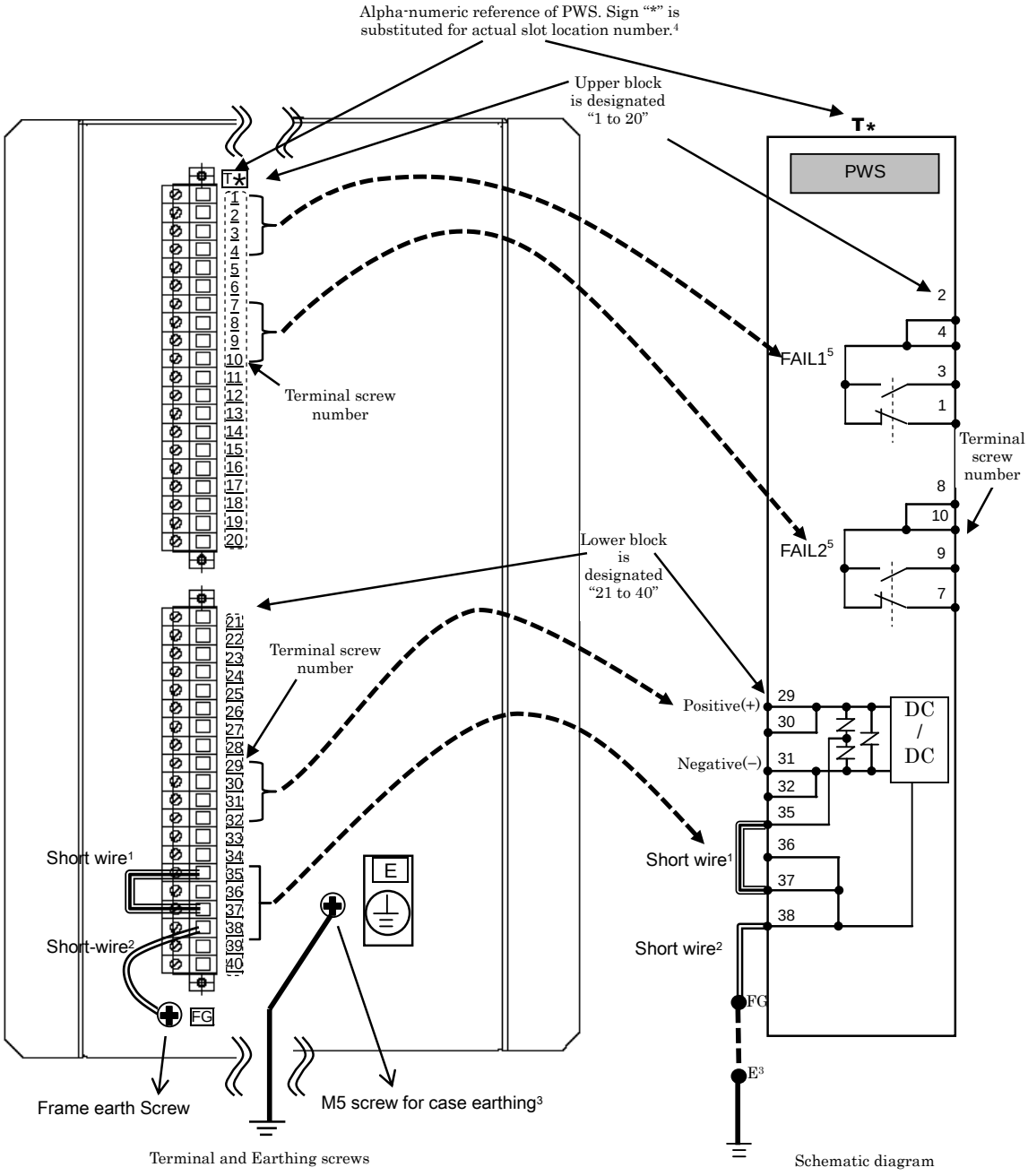


Figure 5.5-1 PWS terminal block (Rear view)

PWS consists of a pair of terminal blocks[4] (which are labeled with alpha-numeric reference "T*"; a number replaces the asterisk "*" to designate the slot numbers.) The left of Figure 5.5-1 shows the PWS terminal blocks, and the schematic figure for PWS is also shown on the right.

Terminal screws No. 1 to 4 (FAIL1) and No. 7 to 10 (FAIL2) are provided to output the

failure results of the automatic supervision function[5]. Terminal screws No. 29(+) and 31(–) are linked to the power supply. Other terminal screws No. 30(+) and 31(–) are also provided for the power terminal and are used when bus distribution is required or when the safety improvement of the cable capacity is required because the power cable is thin. Terminal screw No. 38 and FG, by default, are linked with a short-wire and also terminal screw No. 35 and terminal screw No. 37. The user should connect the IED case to the earth with the earth screw. The other terminal screws are not used.

The actual terminal slot location is also found in external connection figures. (See *Appendix: Typical External connection*)

Table 5.5-1 PWS specifications

Input voltage rating[6]	Voltage fluctuation permissible	Description
DC: 110 to 250V	DC: 88 to 300V	Input voltage (110/125Vdc, 220/250Vdc) is available where the voltage varies in ±20% of the rated voltage (110V× 80% to 250V×120%).

⚠CAUTION

[1]Note: The connection (triplet lines) between terminal screw No. 35 and terminal screw No. 37 is made with a short-wire, which is installed by the manufacturer. Read *Appendix: Notes for the dielectric voltage test* carefully and follow the instructions during testing.

[2]Note: The connection (double lines) between terminal screw 38 and screw labeled "FG" is made with a short-wire by the manufacturer.

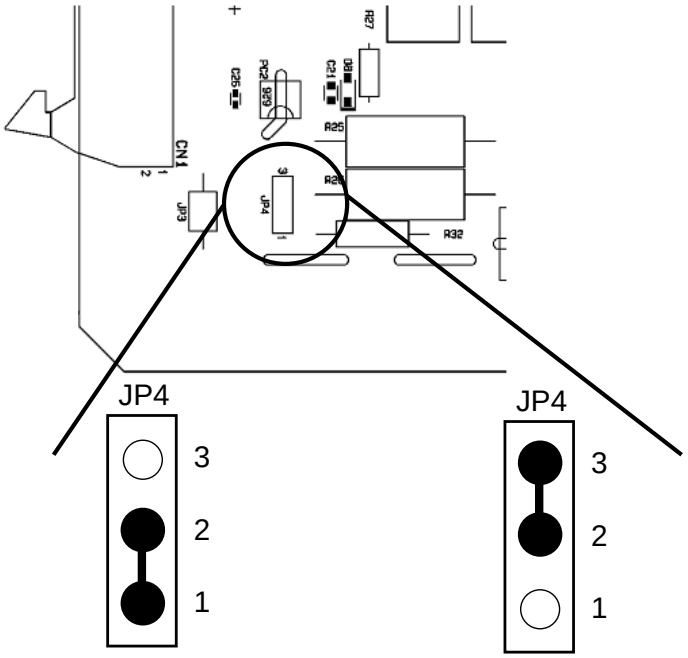
[3]Note: For installation, the user should connect the case earth screw labeled "E" to the protective earth of the panel or others using earthing wire, such that its cross-section is AWG9 or larger.

[4]Note:The user can connect a cable to this terminal directly without a cable ferrule; hence, the recommended cables are AWG14 and their stripping lengths are 10mm. Use "AI 2.5 -10 BU" ferrule for AWG14 when the user wishes to use a cable ferrule made by PHOENIX CONTACT®.

[5]Note: The PWS module monitors DC voltages. The supervision function can issue a power failure when the DC voltage is less than 85V (default threshold; for more information about the failure, see *Chapter Automatic supervision function*). The user can change the 85V threshold to 170V by inserting a shunt connecter (1-2) at JP4 on the PWS module (see Figure 5.5-2).

[6]Note: IED (PWS module) can run on AC power supply (100–220Vac), but the operation is not guaranteed. Power failure (error) is issued when the supervision function is not

disabled, if the IED runs on AC power supply for testing etc.



Setting to 170V (typical)
(Position '1-2')

Setting to 85V (typical)
(Default position '2-3')

Figure 5.5-2 Alarm threshold for DC voltage dropping on the PWS module

5.6 Human Machine Interface (HMI)

5.6.1 Outlook

Figure 5.6-1 shows the outlook of human machine interface module (HMI) on the front panel. The HMI has a screen (standard LCD or large LCD 'MIMIC'), LED indicators (#1– #26), operation keys, function keys (F1–F7), monitoring jacks (Term A/B/C) and a USB receptacle. The LCD can display information; e.g. IED operation menu, status, setting data, monitoring, fault records and others. We shall see the menus on the display in Chapter *User interface* later. A USB receptacle in B-type is provided for the connection to the PC. Thus, the user can connect the engineering tools (GR-TIEMS®) or the PLC editor (MULTIPLOG®) with the IED using the USB receptacle.

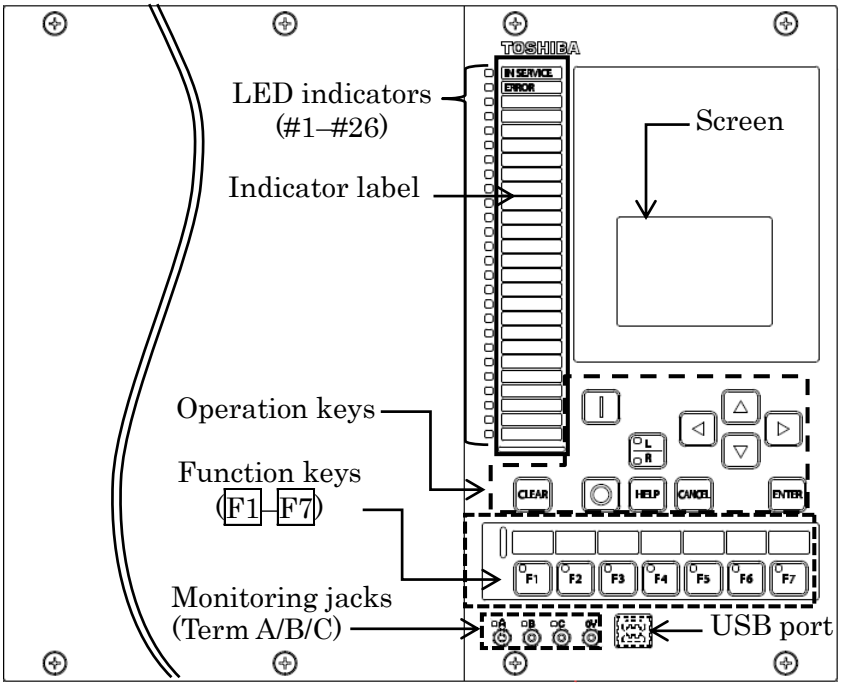


Figure 5.6-1 HMI on front panel

5.6.2 LED Indicators

The LED indicators #1 and #2 are used to indicate the IED statuses. The others (#3 to #26) are provided to indicate statuses, which the user wishes to check; the settings or by the PLC function can control to indicate the statuses. The user can make a new indicator label using the label maker of the GR-TIEMS®. (See *Chapter Engineering tool*)

The LED indicators‡ (#3 to #26) are also provided as user-programmable indicators. Figure 5.6-2 shows the schematic diagrams. Each LED indicator can be lit and controlled using a logic-gate-switch setting and others. For simplicity, we discuss setting the LED indicator #3 only, but the user can take account that setting the other LED indicators (#4 to #26) is the same as the #3. Table 5.6-1 shows the LED indicator settings; Table 5.6-2 shows the signal monitoring points on all LED indicator logics.

‡Note:Setting menus of the LED indicator are also discussed in Chapter *User interface: I/O setting sub-menu*.

(i) Selection of input signals

The LED indicator (#3) is lit by entering signals from other functions; eight ports are provided for the entering signals, designated as *input-signal1* to *input-signal8*. The user should ensure one or more DataIDs are set for the *input-signal1* to *input-signal8*. Entering signals are designated using DataIDs, respectively; the user should set respective DataIDs for the settings [**Input signal1**] to [**Input signal8**].

(ii) Logic gate switch

In the LED indicator logic #3 a logic scheme is provide for the eight entering signals; the entering signals are grouped by the selection using scheme switch [**LOGIC-SW**] for which the user should set either **AND**, **OR** or **XOR**.

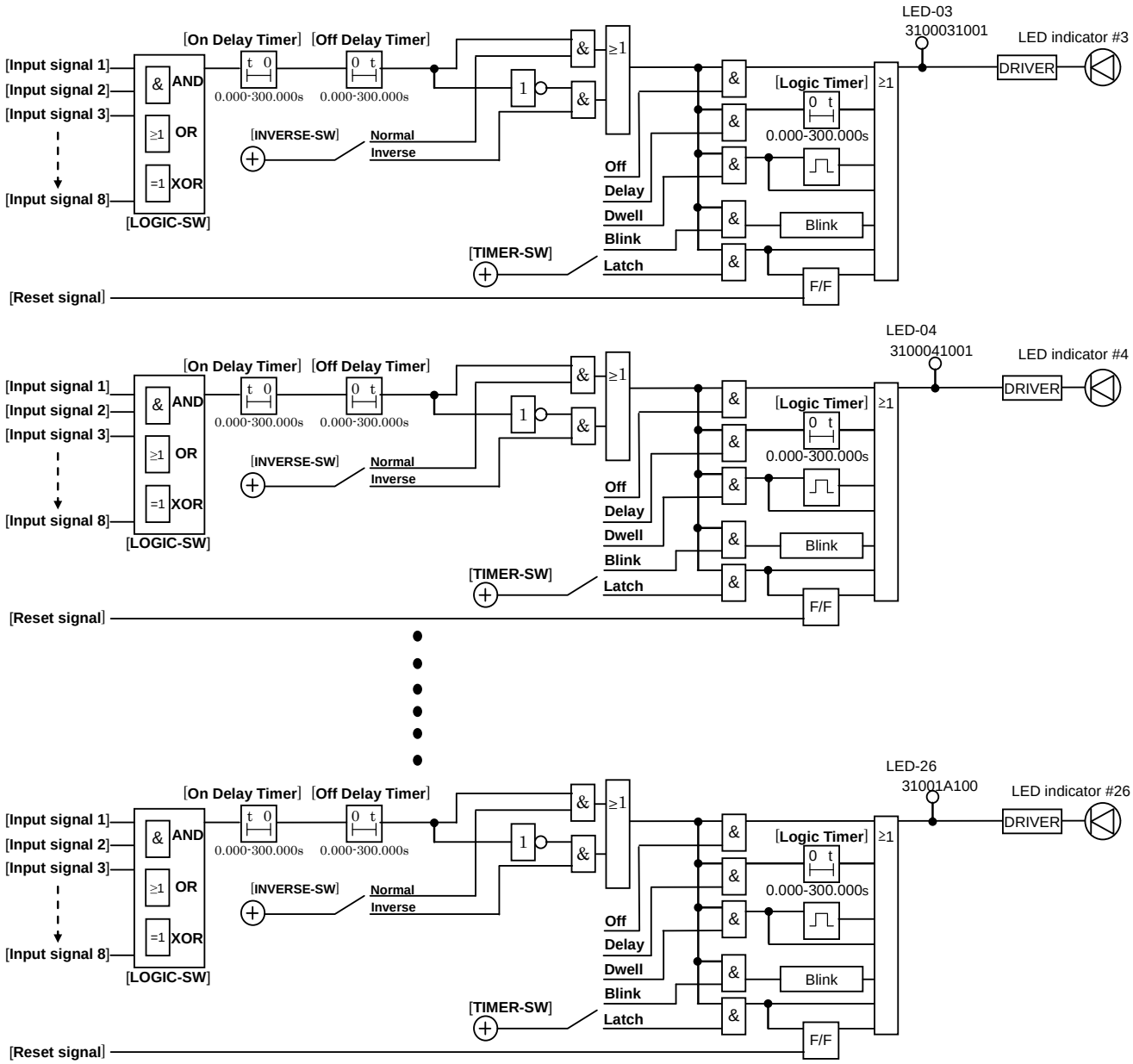


Figure 5.6-2 LED indicator logics (#3 to #26)

(iii) Delayed pick-up/delayed drop-off signal

For the LED indicator logic #3 the user can use an on-delay timer and an off-delay timer; both are used to adjust the timing for lighting the LED indicator #3. The user should set their respective time values for settings [**On Delay Timer**] and [**Off Delay Timer**].

(iv) Logic level inversion

On the LED indicator logic #3 the entering signal is inverted by the logic inversion function; inverting an entering signal is carried out when the user sets **Inverse** for the scheme switch [**INVERSE-SW**]. Set **Normal** for the scheme switch when logic inversion is not required.

(v) Logic timer switch

The LED indicator #3 can have programmable reset characteristics using scheme switch [**TIMER-SW**]. Four types are available: (1) dwell type, (2) delay type, (3) latch type, and (4) instantaneous type:

(v)-1 Instant type

When required not to have the below characteristics (v)-2, (v)-3, and (v)-4, the user should set **Off** for the scheme switch [**TIMER-SW**].

(v)-2 Delay type

If the user requires lighting the LED indicator with a delayed characteristic, the user should set **Delay** for scheme switch [**TIMER-SW**] and set the value of the pulse width using setting [**Logic timer**].

(v)-3 Dwell type

For instance, if the user requires lighting the LED indicator as a one shot pulse, the user should set **Dwell** for scheme switch [**TIMER-SW**] and set the value of the pulse width using setting [**Logic timer**]. If the input signals received have a shorter duration than the set value in the setting [**Logic timer**], the pulse width will be equal to the setting value. On the other hand, if the duration of the input signals are longer than that of the set value, the pulse width will be equal to the width of the input signals.

(v)-4 Latch type

If the user requires lighting the LED indicator to be removed by a reset signal, the user should set **Latch** for scheme switch [**TIMER-SW**]; the user should set the Data ID of the reset signal for setting [**Reset signal**]. Since lighting the LED indicator is cleared with the Data ID, the user should determine the Data ID from other functions. The Data ID is designated by the signal monitoring point for each function and the user should set the [**Reset signal**] setting.

(vi) Selection of the LED color

For the LED indicator #3, color selection of either RED/GREEN/YELLOW is possible using the setting [**Color**].

Table 5.6-1 Settings of LED indictors #3 to #26 (Function ID: 201B01))

Setting items		Range	Units	Contents	Default setting value
LED#3	Color	RED / GREEN / YELLOW	-	LED#3 color selection	RED
	Input signal1	(Preferred Data ID)	-	Set a Data ID at the first input on LED3	(No Assigned)
	Input signal2	(Preferred Data ID)	-	Set a Data ID at the second input on LED#3.	(No Assigned)
	Input signal3	(Preferred Data ID)	-	Set a Data ID at the third input on LED#3.	(No Assigned)
	Input signal4	(Preferred Data ID)	-	Set a Data ID at the forth input on LED#3.	(No Assigned)
	Input signal5	(Preferred Data ID)	-	Set a Data ID at the fifth input on LED#3.	(No Assigned)
	Input signal6	(Preferred Data ID)	-	Set a Data ID at the sixth input on LED#3.	(No Assigned)
	Input signal7	(Preferred Data ID)	-	Set a Data ID at the seventh input on LED#3.	(No Assigned)
	Input signal8	(Preferred Data ID)	-	Set a Data ID at the eighth input on LED#3.	(No Assigned)
	LOGIC-SW	AND / OR / XOR	-	Switch for logic-gate operation on LED#3	AND
	On Delay Timer	0.00 – 300.00	s	Set a value for an on-delay-timer on LED#3	0.00
	Off Delay Timer	0.00 – 300.00	s	Set a value for an off-delay-timer on LED#3	0.00
	INVERSE-SW	Normal / Inverse	-	Inversion operation of LED#3 signal	Normal
	TIMER-SW	Off/Delay/Dwell/Latch/Blink	-	Selection of a type in the delay timer on LED#3	Off
	Logic Timer	0.00 – 300.00	s	Off delay timer value for "Delay" and "Dwell" circuit	0.00
	Reset signal	(Preferred Data ID)	-	Setting Data ID for "Latch" circuit	(No Assigned)
LED#4	Color	RED / GREEN / YELLOW	-	LED#4 color selection	RED
	Input signal1	(Preferred Data ID)	-	Set a Data ID at the first input on LED#4	(No Assigned)
	Input signal2	(Preferred Data ID)	-	Set a Data ID at the second input on LED#4.	(No Assigned)
	Input signal3	(Preferred Data ID)	-	Set a Data ID at the third input on LED#4.	(No Assigned)
	Input signal4	(Preferred Data ID)	-	Set a Data ID at the forth input on LED#4.	(No Assigned)
	Input signal5	(Preferred Data ID)	-	Set a Data ID at the fifth input on LED#4.	(No Assigned)
	Input signal6	(Preferred Data ID)	-	Set a Data ID at the sixth input on LED#4.	(No Assigned)
	Input signal7	(Preferred Data ID)	-	Set a Data ID at the seventh input on LED#4.	(No Assigned)
	Input signal8	(Preferred Data ID)	-	Set a Data ID at the eighth input on LED#4.	(No Assigned)
	LOGIC-SW	AND / OR / XOR	-	Switch for logic-gate operation on LED#4	AND
	On Delay Timer	0.00 – 300.00	s	Set a value for an on-delay-timer on LED#4	0.00
	Off Delay Timer	0.00 – 300.00	s	Set a value for an off-delay-timer on LED#4	0.00
	INVERSE-SW	Normal / Inverse	-	Inversion operation of LED#4 signal	Normal
	TIMER-SW	Off/Delay/Dwell/Latch/Blink	-	Selection of a type in the delay timer on LED#4	Off
	Logic Timer	0.00 – 300.00	s	Off delay timer value for "Delay" and "Dwell" circuit	0.00
	Reset signal	(Preferred Data ID)	-	Setting Data ID for "Latch" circuit	(No Assigned)
• • • • • • • • • •					
LED#26	Color	RED / GREEN / YELLOW	-	LED#26 color selection	RED
	Input signal1	(Preferred Data ID)	-	Set a Data ID at the first input on LED#26	(No Assigned)
	Input signal2	(Preferred Data ID)	-	Set a Data ID at the second input on LED#26.	(No Assigned)
	Input signal3	(Preferred Data ID)	-	Set a Data ID at the third input on LED#26.	(No Assigned)
	Input signal4	(Preferred Data ID)	-	Set a Data ID at the forth input on LED#26.	(No Assigned)
	Input signal5	(Preferred Data ID)	-	Set a Data ID at the fifth input on LED#26.	(No Assigned)
	Input signal6	(Preferred Data ID)	-	Set a Data ID at the sixth input on LED#26.	(No Assigned)
	Input signal7	(Preferred Data ID)	-	Set a Data ID at the seventh input on LED#26.	(No Assigned)
	Input signal8	(Preferred Data ID)	-	Set a Data ID at the eighth input on LED#26.	(No Assigned)
	LOGIC-SW	AND / OR / XOR	-	Switch for logic-gate operation on LED#26	AND
	On Delay Timer	0.00 – 300.00	s	Set a value for an on-delay-timer on LED#26	0.00
	Off Delay Timer	0.00 – 300.00	s	Set a value for an off-delay-timer on LED#26	0.00
	INVERSE-SW	Normal / Inverse	-	Inversion operation of LED#26 signal	Normal
	TIMER-SW	Off/Delay/Dwell/Latch/Blink	-	Selection of a type in the delay timer on LED#26	Off
	Logic Timer	0.00 – 300.00	s	Off delay timer value for "Delay" and "Dwell" circuit	0.00
	Reset signal	(Preferred Data ID)	-	Setting Data ID for "Latch" circuit	(No Assigned)

Table 5.6-2 Signal monitoring points on all LED indicator (Function ID: 201B01)

Element ID	Name	Description
3100021001	ERROR	Error LED
3100011001	IN SERV	In service LED
3100031001	LED-03	Output signal of the LED indicator #3
3100041001	LED-04	Output signal of the LED indicator #4
3100051001	LED-05	Output signal of the LED indicator #5
3100061001	LED-06	Output signal of the LED indicator #6
3100071001	LED-07	Output signal of the LED indicator #7
3100081001	LED-08	Output signal of the LED indicator #8
3100091001	LED-09	Output signal of the LED indicator #9
31000A1001	LED-10	Output signal of the LED indicator #10
31000B1001	LED-11	Output signal of the LED indicator #11
31000C1001	LED-12	Output signal of the LED indicator #12
31000D1001	LED-13	Output signal of the LED indicator #13
31000E1001	LED-14	Output signal of the LED indicator #14
31000F1001	LED-15	Output signal of the LED indicator #15
3100101001	LED-16	Output signal of the LED indicator #16
3100111001	LED-17	Output signal of the LED indicator #17
3100121001	LED-18	Output signal of the LED indicator #18
3100131001	LED-19	Output signal of the LED indicator #19
3100141001	LED-20	Output signal of the LED indicator #20
3100151001	LED-21	Output signal of the LED indicator #21
3100161001	LED-22	Output signal of the LED indicator #22
3100171001	LED-23	Output signal of the LED indicator #23
3100181001	LED-24	Output signal of the LED indicator #24
3100191001	LED-25	Output signal of the LED indicator #25
31001A1001	LED-26	Output signal of the LED indicator #26

5.6.3 Function keys with LEDs

The function keys (F1 to F7) are provided to jump to other menus during the LCD operation; the jump destinations are already set as factory default (see Table 5.6-3). However, the user can program the F1 to F7 keys to jump to user-preferred menus using settings. Incidentally, the user can program the function key so that a binary signal is generated when the user presses the function key.

Table 5.6-3 Function keys and jump destinations (default)

Function Key#	Jump destination as default	LED lit when pressing
F1	Metering menu	Yellow
F2	Fault Record menu	Yellow
F3	Event Record1 menu	Yellow
F4	Event Record2 menu	Yellow
F5	Event Record3 menu	Yellow
F6	Diagnostics menu	Yellow
F7	(Not defined)	Yellow

For testing, the user can also program to generate binary signals when the user presses the F1 to F7 keys. The F1 to F7 circuits have LEDs; accordingly, the user can also program to light the LEDs using the settings.

(i) Screen jump pressing the function key

The user can program the F1 to F7 keys as the user-preferred jump keys. For example, when the user wishes to use the F1 key to jump to another screen, set **Screen jump** for scheme switch [**Function**] in the F1 key (see Table 5.6-6). We shall see the setting in Chapter *User interface: Setting sub-menu: Configuration of Function keys.*

(ii) Binary signal generated pressing the function key

When the user wishes to generate a binary signal upon occurrence of pressing the F1 key, set **Assign Signal** for scheme switch [**Function**] in the F1 key. For instance, if the user wishes to send a signal generated pressing F1 to the binary output circuit (BO1‡) at the IO#1 slot, set the Data ID of "FUNC-KEY1(**240001 310001730**)" for the setting [**Input signal 1**] of the BO1‡ circuit. Note that the user should set **On** for the scheme switch [**BO1_CPL**] when the connection is done using the setting [**Input signal 1**]. Figure 5.6-3 shows that a generate signal is outputted at the FUNC-KEY1 SIGNAL. Table 5.6-7 shows the other FUNC-KEY2 to 7 points. We shall see the setting procedure in Chapter *User interface: Setting sub-menu: Signal control function.*

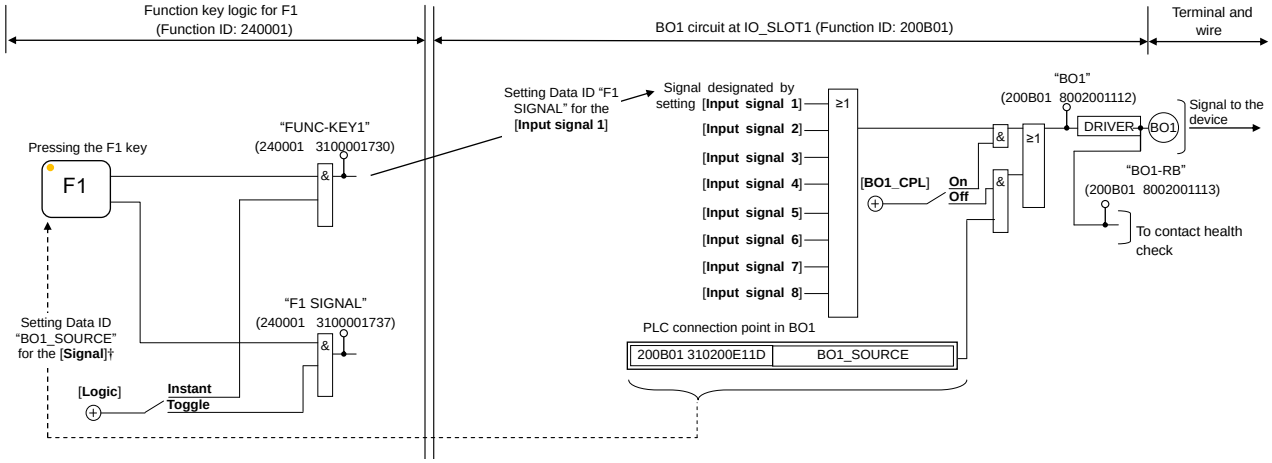


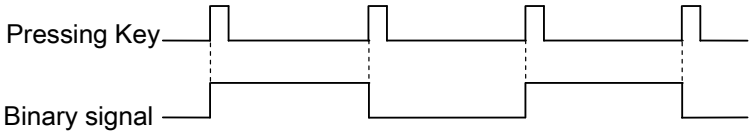
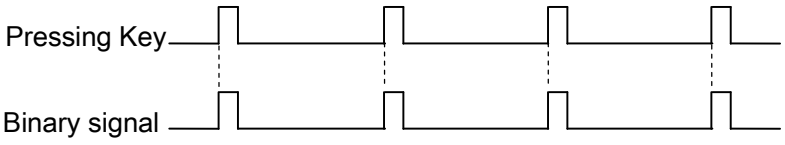
Figure 5.6-3 F1 key connected with the BO1‡

‡Note: The BO1 circuit is used just for an explanation; it is discussed in Chapter *Technical description: Binary IO module*.

†Note: When the user wishes to inject the signal at the PLC connection point of the "BO1-SOURCE (**200B01 31200E11D** at the IO#1 slot)", the user should set the BO1-SOURCE (**200B01 31200E11D**) for the setting [**Signal**] of the F1 key. Then, set **Off** for the scheme switch [**BO1_CPL**]

The user can select either **Toggle** or **Instant** modes for the signal generation using scheme switch [**LOGIC**], as shown in Table 5.6-4. Thus, the user can substitute "F1-SIGNAL (**240001 310001737**)" for the "FUNC-KEY1 SIGNAL (**240001 310001730**)", provided the **Toggle** mode is preferred. In the Table 5.6-7 the other FUNC-KEY2 to FUNC-KEY7 are shown.

Table 5.6-4 Signal mode selection using setting [LOGIC]

Setting	Generated signal corresponding to pressing the function key
Toggle	
Instant	

(iii) Lighting LEDs on F1 to F7

Figure 5.6-4 shows the F1 to F7 LED logics. Programing to light the LEDs (F1 to F7) is the same as the programing of the LED indicators (#3 to #26) (for the programming, see section 5.6.2). As a default, e.g., the "FUNC-KEY1 (**240001 310001730**)" is set for the setting [**Input signal 1**] of the F1 LED logic. The LED-F2 to F7 points are listed in Table 5.6-8.

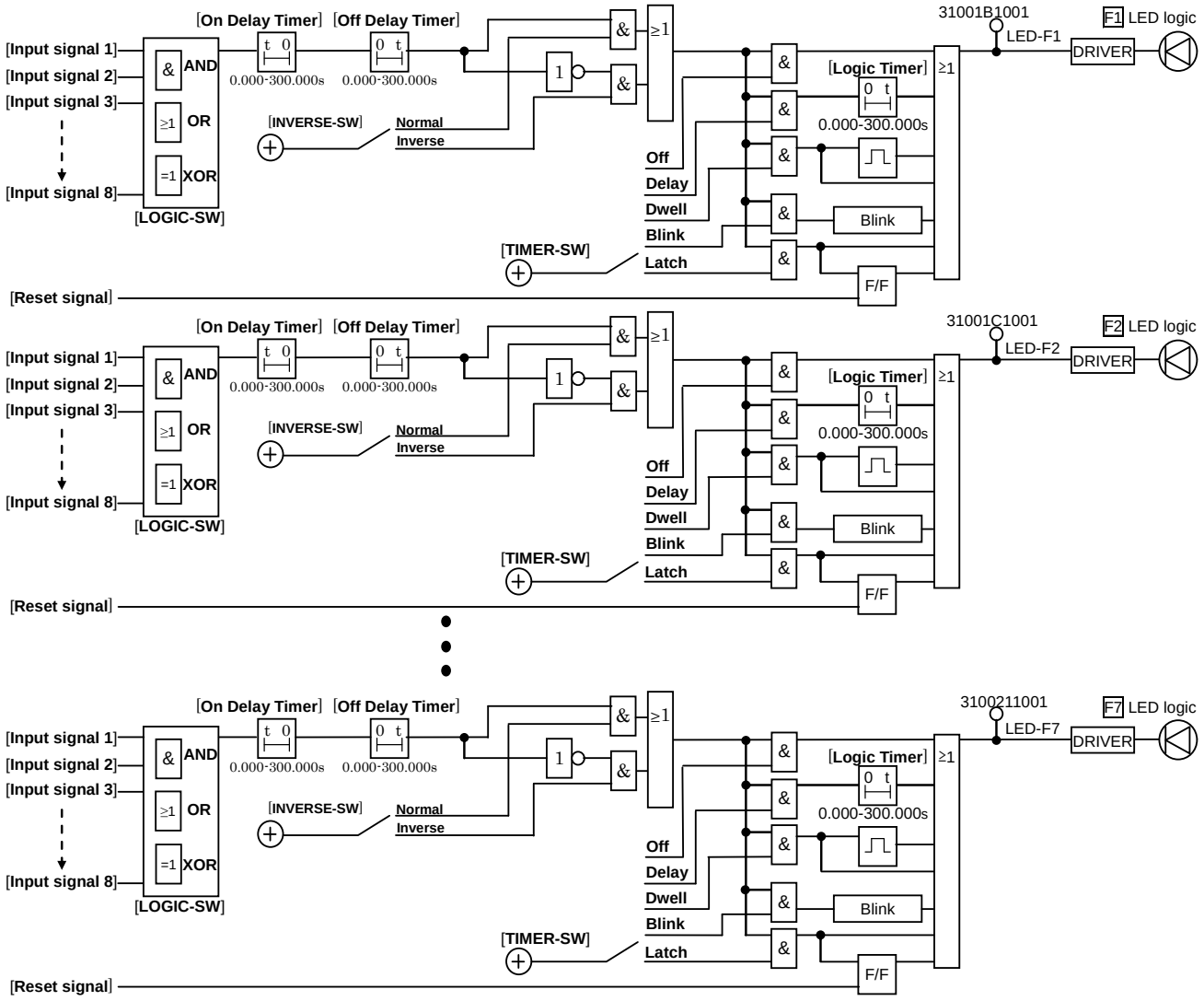


Figure 5.6-4 LED logics on the function keys F1 to F7

Table 5.6-5 Settings of Function keys (Function ID: 240001)

Setting items		Range	Units	Contents	Default setting value
F1	Function	Screen Jump / Assign Signal / No Assign	-	Operation mode for the F1 key	Screen Jump
	Signal	(Preferred Data ID)	-	Set a Data ID at the input on F1 key	(No Assigned)
	Logic	Instant / Toggle	-	Switch for logic-gate operation on F1	Instant
F2	Function	Screen Jump / Assign Signal / No Assign	-	Operation mode for the F2 key	Screen Jump
	Signal	(Preferred Data ID)	-	Set a Data ID at the input on F2 key	(No Assigned)
	Logic	Instant / Toggle	-	Switch for logic-gate operation on F2	Instant
•••••••••••					
F7	Function	Screen Jump / Assign Signal / No Assign	-	Operation mode for the F7 key	Screen Jump
	Signal	(Preferred Data ID)	-	Set a Data ID at the input on F7 key	(No Assigned)
	Logic	Instant / Toggle	-	Switch for logic-gate operation on F7	Instant

Table 5.6-6 Settings of LEDs on the Function keys (Function ID: 240001)

Setting items		Range	Units	Contents	Default setting value
F1	Input signal1	(Preferred Data ID)	-	Set a Data ID at the first input on F1	(No Assigned)
	Input signal2	(Preferred Data ID)	-	Set a Data ID at the second input on F1.	(No Assigned)
	Input signal3	(Preferred Data ID)	-	Set a Data ID at the third input on F1.	(No Assigned)
	Input signal4	(Preferred Data ID)	-	Set a Data ID at the forth input on F1.	(No Assigned)
	Input signal5	(Preferred Data ID)	-	Set a Data ID at the fifth input on F1.	(No Assigned)
	Input signal6	(Preferred Data ID)	-	Set a Data ID at the sixth input on F1.	(No Assigned)
	Input signal7	(Preferred Data ID)	-	Set a Data ID at the seventh input on F1.	(No Assigned)
	Input signal8	(Preferred Data ID)	-	Set a Data ID at the eighth input on F1.	(No Assigned)
	Reset signal	(Preferred Data ID)	-	Setting Data ID for "Latch" circuit	(No Assigned)
	LOGIC-SW	AND / OR / XOR	-	Switch for logic-gate operation on F1	AND
	INVERSE-SW	Normal / Inverse	-	Inversion operation of F1 signal	Normal
	TIMER-SW	Off/Delay/Dwell/Latch/Blink	-	Selection of a type in the delay timer on F1	Off
	On Delay Timer	0.00 – 300.00	s	Set a value for an on-delay-timer on F1	0.00
	Off Delay Timer	0.00 – 300.00	s	Set a value for an off-delay-timer on F1	0.00
	Logic Timer	0.00 – 300.00	s	Off delay timer value for "Delay" and "Dwell" circuit	0.00
F2	Input signal1	(Preferred Data ID)	-	Set a Data ID at the first input on F2	(No Assigned)
	Input signal2	(Preferred Data ID)	-	Set a Data ID at the second input on F2.	(No Assigned)
	Input signal3	(Preferred Data ID)	-	Set a Data ID at the third input on F2.	(No Assigned)
	Input signal4	(Preferred Data ID)	-	Set a Data ID at the forth input on F2.	(No Assigned)
	Input signal5	(Preferred Data ID)	-	Set a Data ID at the fifth input on F2.	(No Assigned)
	Input signal6	(Preferred Data ID)	-	Set a Data ID at the sixth input on F2.	(No Assigned)
	Input signal7	(Preferred Data ID)	-	Set a Data ID at the seventh input on F2.	(No Assigned)
	Input signal8	(Preferred Data ID)	-	Set a Data ID at the eighth input on F2.	(No Assigned)
	Reset signal	(Preferred Data ID)	-	Setting Data ID for "Latch" circuit	(No Assigned)
	LOGIC-SW	AND / OR / XOR	-	Switch for logic-gate operation on F2	AND
	INVERSE-SW	Normal / Inverse	-	Inversion operation of F2 signal	Normal
	TIMER-SW	Off/Delay/Dwell/Latch/Blink	-	Selection of a type in the delay timer on F2	Off
	On Delay Timer	0.00 – 300.00	s	Set a value for an on-delay-timer on F2	0.00
	Off Delay Timer	0.00 – 300.00	s	Set a value for an off-delay-timer on F2	0.00
	Logic Timer	0.00 – 300.00	s	Off delay timer value for "Delay" and "Dwell" circuit	0.00
• • • • • • • • • •					
F7	Input signal1	(Preferred Data ID)	-	Set a Data ID at the first input on F7	(No Assigned)
	Input signal2	(Preferred Data ID)	-	Set a Data ID at the second input on F7.	(No Assigned)
	Input signal3	(Preferred Data ID)	-	Set a Data ID at the third input on F7.	(No Assigned)
	Input signal4	(Preferred Data ID)	-	Set a Data ID at the forth input on F7.	(No Assigned)
	Input signal5	(Preferred Data ID)	-	Set a Data ID at the fifth input on F7.	(No Assigned)
	Input signal6	(Preferred Data ID)	-	Set a Data ID at the sixth input on F7.	(No Assigned)
	Input signal7	(Preferred Data ID)	-	Set a Data ID at the seventh input on F7.	(No Assigned)
	Input signal8	(Preferred Data ID)	-	Set a Data ID at the eighth input on F7.	(No Assigned)
	Reset signal	(Preferred Data ID)	-	Setting Data ID for "Latch" circuit	(No Assigned)
	LOGIC-SW	AND / OR / XOR	-	Switch for logic-gate operation on F7	AND
	INVERSE-SW	Normal / Inverse	-	Inversion operation of F7 signal	Normal
	TIMER-SW	Off/Delay/Dwell/Latch/Blink	-	Selection of a type in the delay timer on F7	Off
	On Delay Timer	0.00 – 300.00	s	Set a value for an on-delay-timer on F7	0.00
	Off Delay Timer	0.00 – 300.00	s	Set a value for an off-delay-timer on F7	0.00
	Logic Timer	0.00 – 300.00	s	Off delay timer value for "Delay" and "Dwell" circuit	0.00

Table 5.6-7 Signal monitoring points for KEYINPUT (Function ID: 240001)

Element ID	Name	Description
3100001737	F1 SIGNAL	Signal generated when pressing F1 referring the setting [**LOGIC**]
3100011737	F2 SIGNAL	Signal generated when pressing F2 referring the setting [**LOGIC**]
3100021737	F3 SIGNAL	Signal generated when pressing F3 referring the setting [**LOGIC**]
3100031737	F4 SIGNAL	Signal generated when pressing F4 referring the setting [**LOGIC**]
3100041737	F5 SIGNAL	Signal generated when pressing F5 referring the setting [**LOGIC**]
3100051737	F6 SIGNAL	Signal generated when pressing F6 referring the setting [**LOGIC**]
3100061737	F7 SIGNAL	Signal generated when pressing F7 referring the setting [**LOGIC**]
3100001730	FUNC-KEY1	Signal generated directly when pressing F1
3100011730	FUNC-KEY2	Signal generated directly when pressing F2
3100021730	FUNC-KEY3	Signal generated directly when pressing F3
3100031730	FUNC-KEY4	Signal generated directly when pressing F4
3100041730	FUNC-KEY5	Signal generated directly when pressing F5
3100051730	FUNC-KEY6	Signal generated directly when pressing F6
3100061730	FUNC-KEY7	Signal generated directly when pressing F7

Table 5.6-8 Signal monitoring points for function LEDs (Function ID: 201B01)

Element ID	Name	Description
31001B1001	LED-F1	Signal generated during pressing the F1 key
31001C1001	LED-F2	Signal generated during pressing the F2 key
31001D1001	LED-F3	Signal generated during pressing the F3 key
31001E1001	LED-F4	Signal generated during pressing the F4 key
31001F1001	LED-F5	Signal generated during pressing the F5 key
3100201001	LED-F6	Signal generated during pressing the F6 key
3100211001	LED-F7	Signal generated during pressing the F7 key

5.6.4 Monitoring jacks

A monitoring jack including a LED is provided so that the user can monitor a binary signal on the logic straightforwardly. For example, when the user wishes to monitor the operating state of a relay function, set the signal number (Data ID) that the user wishes to monitor; then the user can see lighting the LED when the relay is operated. Using with an oscilloscope, the user can also observe the binary signal that comes from the monitoring jack; three monitoring jacks (Term A, B, and C) are available on the front panel.

Table 5.6-9 Output terminals for signal monitoring (No default setting)

Jack	Jack name	LED Color	Remarks
A	Term A	Yellow	Set user's preferred signal number
B	Term B	Yellow	Set user's preferred signal number
C	Term C	Yellow	Set user's preferred signal number

When the user wishes to test the phase-A element the OC1 relay using an oscilloscope, for example, set the phase-A monitoring point (**44001 8000011C20**†) for the setting [**Term A**], as shown in Figure 5.6-5. Consequently, the OC1 operating signal is outputted to the jack at the Term A. The LED at the Term A is also lit in step with the output signal. The user can use to monitor the phase-B and phase-C signals using by settings respective Data IDs for the [**Term B**] and [**Term C**]. We shall see the menus for the Term A to Term C in Chapter *User interface: Test sub-menu: Signal monitoring screen.*

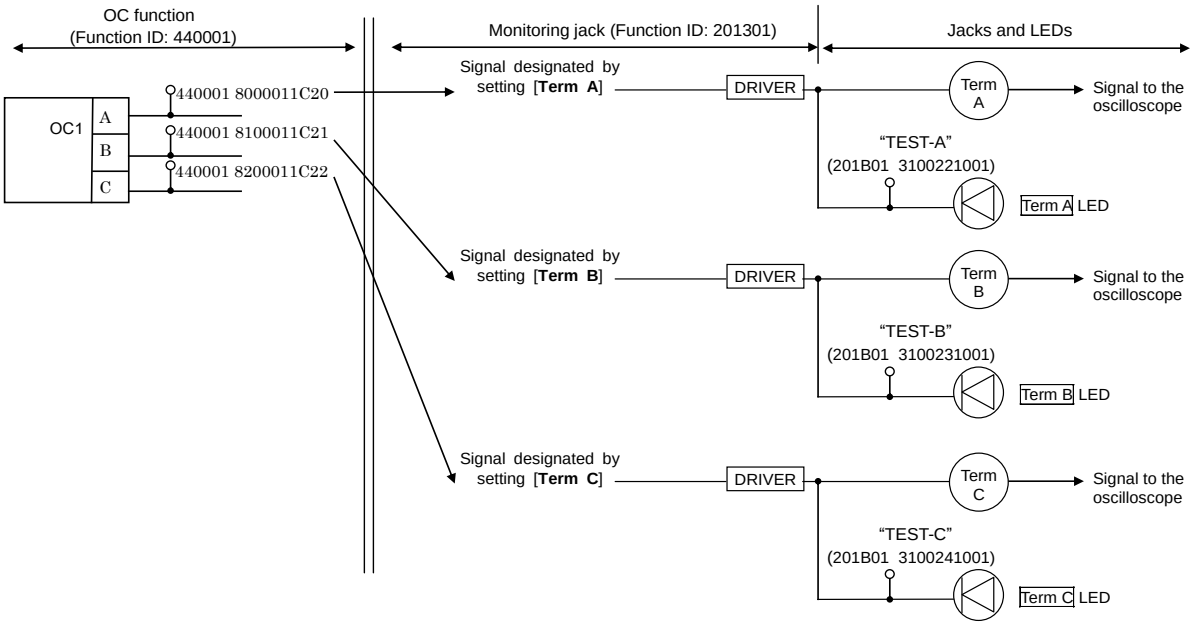


Figure 5.6-5 Monitoring logics A, B and C

†Note: The monitoring point is just selected for the explanation; the user can select a monitoring point from the relay applications and the control and monitoring applications. The monitoring points is listed as PLC monitoring points in each function.

Table 5.6-10 Settings of Monitoring jacks (Function ID: 201301)

Setting items		Range	Units	Contents	Default setting value
	Term A	(Preferred Data ID)	-	Select a signal for Term A	(No Assigned)
	Term B	(Preferred Data ID)	-	Select a signal for Term B	(No Assigned)
	Term C	(Preferred Data ID)	-	Select a signal for Term C	(No Assigned)

Table 5.6-11 Signal monitoring points for monitoring jack LEDs (Function ID: 201B01)

Element ID	Name	Description
3100221001	TEST-A	TEST-A
3100231001	TEST-B	TEST-B
3100241001	TEST-C	TEST-C

5.6.5 Operation keys

(i) L/R key

The IED has two LEDs on the L/R key; either LEDs is lit in response to a local mode or a remote mode. Lighting the LED is instructed by the LOCRMT function. Table 5.6-12 shows the signal monitoring points on the L/R LEDs.

Table 5.6-12 Signal monitoring points for L/R LEDs (Function ID: 201B01)

Element ID	Name	Description
3100251001	LOC LED	Local
3100261001	REM LED	Remote

(ii) Operation keys except L/R key

Like in the function keys (F1 to F7), the operation keys can provide signals when pressing the keys; the user can monitor the signals at the signal monitoring points in Table 5.6-13.

Table 5.6-13 Signal monitoring points for KEYINPUT (Function ID: 240001)

Element ID	Name	Description
3100081730	CANCEL	Key situation of CANCEL
31000E1730	CLEAR	Key situation of CLEAR
31000D1730	CLOSE	Key situation of CLOSE
31000F1730	DOWN	Key situation of DOWN
3100071730	ENTER	Key situation of ENTER
3100091730	HELP	Key situation of HELP
3100111730	LEFT	Key situation of LEFT
31000A1730	LOC/REM	Key situation of LOC/REM
31000C1730	OPEN	Key situation of OPEN
3100121730	RIGHT	Key situation of RIGHT
3100101730	UP	Key situation of UP

5.7 Clock function

Clock function (or time function) provides the time information for recording upon occurrence of the fault; it includes a synchronization function when the reference clock is available out of the IED. The clock is operated referring the Coordinated Universal Time (UTC‡) when the UTC is selected; the clock can run in accordance with the user's time zone and summer time(DST)† by referring the UTC when the time zone and the DST are set. The explanation is also found in Chapter *User interface: Time sub-menu*.

†Note: In other words, it is called "daylight saving time (DST)". For setting, see section 5.7.5.

‡Note: For example, the Internet and World Wide Web standards run in the UTC. For more information, see section 5.7.4.

5.7.1 Clock setting

The user can set the time using the time sub-menu as shown in Figure 5.7-1. The user also can set the time using the GR-TIEMS†.

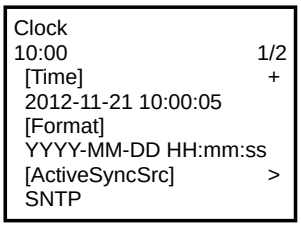


Figure 5.7-1 Time sub-menu in Clock menu

†Note: Make the calibration the when the clock is set using the GR-TIMES. This is because the transmission time is required from the PC to the IED.

5.7.2 Selection of date and time formats

The user can select user-preferred date/time format; setting [**Data_fmt**] is provided for the selection of the format. For example, 'March 24th 2014 10:48' can be displayed when the format "DDMMYYYY" is selected.

- "2014-03-24 10:48" is displayed upon the selection of "YYYYMMDD".
- "03-24-2014 10:48" is displayed upon the selection of "MMDDYYYY".
- "24-03-2014 10:48" is displayed upon the selection of "DDMMYYYY".

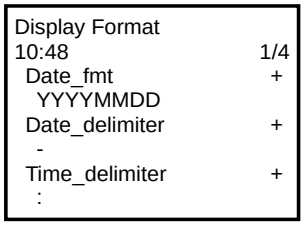


Figure 5.7-2 Setting screen of Display format

5.7.3 Time Synchronization

The synchronization function can run when a synchronized signal is provided for respective IEDs; the user should select one of the following synchronization methods using the setting [**Time Sync Src**]:

- **SNTP** method
- **IRIG-B** method
- Binary Input (**BI**) method

(i) Synchronization using SNTP

(i)-1 Example of SNTP synchronization

The SNTP method is possible when IEDs connect with time-servers. Figure 5.7-3 exemplifies two servers are connected with the IEDs using the LAN.

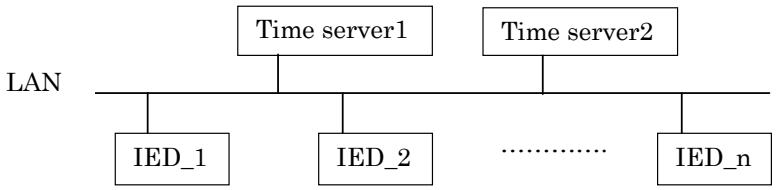


Figure 5.7-3 Two time servers connected on the LAN

(i)-2 Setting procedure

The user should make the following steps in respective IEDs.

1) Set **SNTP** for the setting [**Time Sync Src**]; then set **On** for the setting [**SNTP**].
2) Set the address of a time server using settings [**Server1**]. The settings [**Server2**], [**Server3**], and [**Server4**] are provided for other time-servers.
3) Check that the **SNTP** is shown under the ActivSyncSrc, as shown in Figure 5.7-4.
4) Check to see that the time zone and the DST are set correctly (see 5.7.4 and 5.7.5).

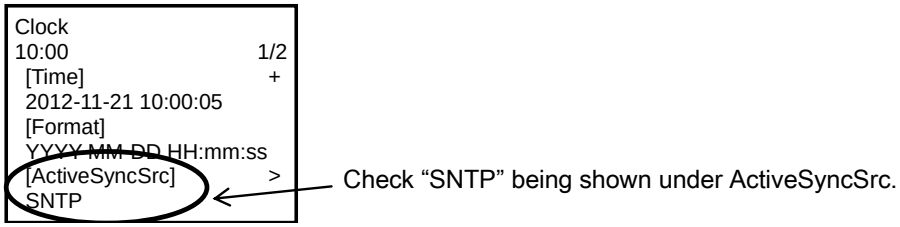


Figure 5.7-4 Time setting for SNTP

Table 5.7-1 Settings for the SNTP synchronization

Setting item	Range	Contents	Setting example	Notes
TimeSyncSrc	SNTP / BI / IRIG-B	Selection of sync method	SNTP	
SNTP	Off /On	Operation of SNTP	0On	
Server1	000.000.000.000–255.255.255.255	Setting for Time server 1	197.1.23.11	
Server2	000.000.000.000–255.255.255.255	Setting for Time server 2	000.000.000.000	
Server3	000.000.000.000–255.255.255.255	Setting for Time server 3	000.000.000.000	
Server4	000.000.000.000–255.255.255.255	Setting for Time server 4	000.000.000.000	

(ii) Synchronization using IRIG-B

(ii)-1 Example of IRIG-B synchronization

The IRIG-B method is possible when a synchronization signal in the IRIG-B format is provided. The synchronization signal is transferred using the IRIG-B000 module†.

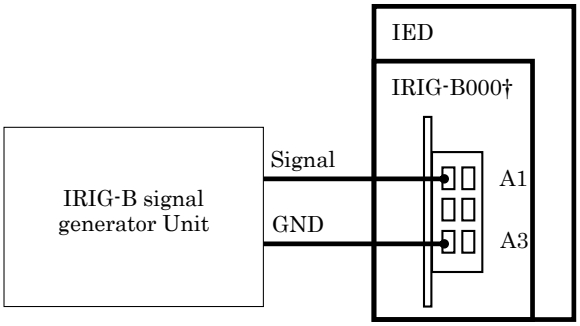


Figure 5.7-5 IED connected with the signal generator unit using IRIG-B000 module

†Note:See Chapter *Technical description: Signal processing and communication module*.

(ii)-2 Setting procedure

The user should make the following steps in respective IEDs.

1) Set **IRIG-B** for the setting [**Time Sync Src**]; then set **On** for the setting [**IRIG-SYNC**].

2) Check that the **IRIG-B** is shown under the ActivSyncSrc, as shown in Figure 5.7-6.

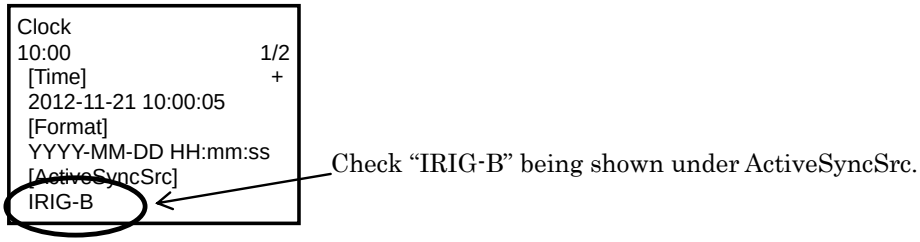


Figure 5.7-6 Time setting for IRIG-B

(ii)-3 Setting year in IRIG-B

When the IRIG-B data is generated in the IEEE C37.118 / IRIG-B000 format, the user should set **On** for setting [**USE_BCDYEAR**]. Conversely, when the IRIG-B data with absence the C37.118† is generated, **Off** should be set for the setting [**USE_BCDYEAR**].

†Note: "Year" is informed from the IED clock itself when the C37.118 is absent.

(ii)-4 Setting UTC/local time

When the IRIG-B data is generated in the UTC†, set **Off** for the setting [**USE_LOCALTIME**]. Conversely, when the IRIG-B data is generated in the local time‡, set **On** for setting [**USE_LOCALTIME**]; set **Off** for the setting [**IS_UTC_base**].

†Note:We shall see the settings of the UTS in section 5.7.4.

‡Note:In the IRIG-B signal generator unit, the DST settings should be corresponded to the DST settings of the IED. We shall see the DST settings in section 5.7.5.

Table 5.7-2 Settings for the IRIG-B Time synchronization

Setting item	Range	Contents	Setting example	Notes
TimeSyncSrc	SNTP / BI / IRIG-B	Selection of sync method	IRIG-B	
IRIG-SYNC	Off /On	Operation of IRIG-B	On	
USE_BCDYEAR	Off / On	Selection of IEEE C37.118/IRIG-B000	Off	
USE_LOCALTIME	Off / On	Operation in the local time	Off	

(iii) Synchronization using BI signal

When accurate1Hz square-wave can be supplied as a reference clock, the clock function can make the time synchronization. The 1Hz square-wave is transferred using a binary input circuit (BI).

(iii)-1 Example of time synchronization via BI circuit

Figure 5.7-7 exemplifies that the 1Hz square-wave is provided via the BI1 circuit†.

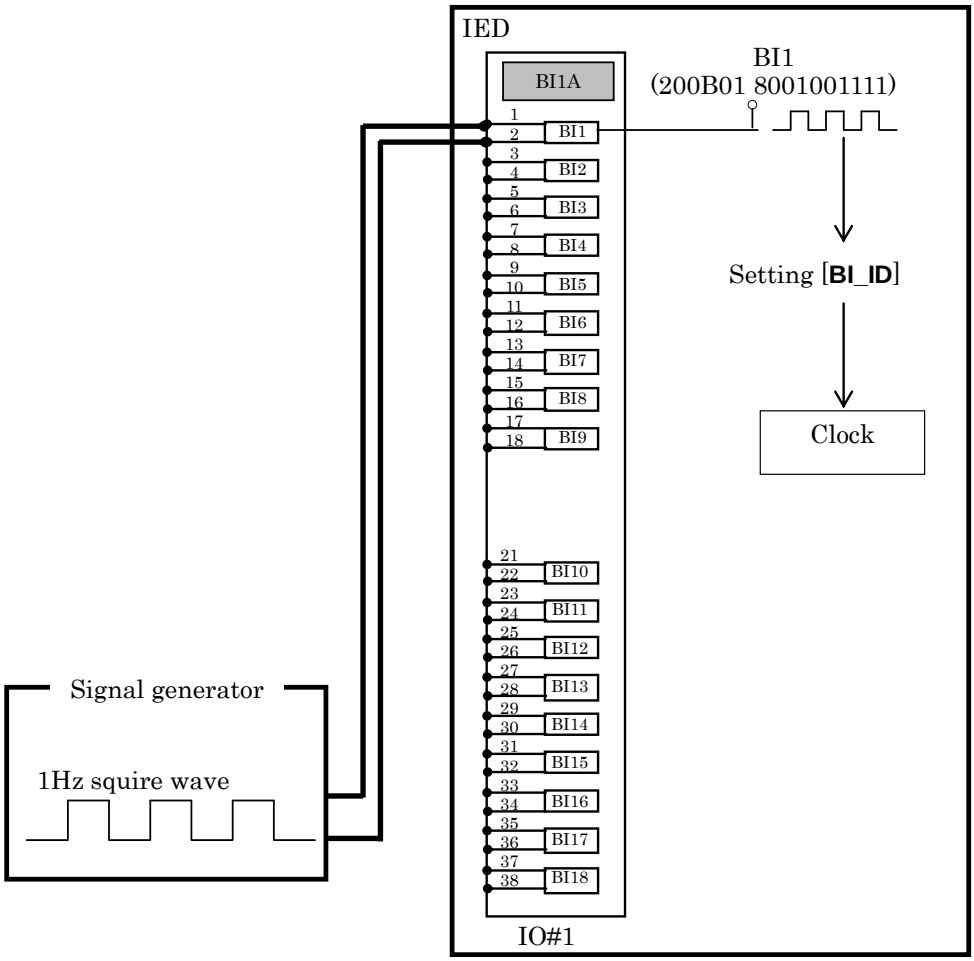


Figure 5.7-7 IED connected with the signal generator via BI module

†Note:The BI1 circuit is just used for the explanation; hence, an actual BI circuit should be selected in accordance with wiring cables. For more information of the BI circuit, see Chapter *Technical description: Binary IO module*.

(iii)-2 Setting procedure

The user should make the following steps in respective IEDs.

1) Set **BI** for the setting [**Time Sync Src**]; then set **On** for the setting [**BI-SYNC**].

2) Check **BI** is shown under the ActivSyncSrc, as shown in Figure 5.7-8.

3) Set a Data ID for setting [**BI_ID**]. For example, as shown in the Figure 5.7-7, when the user wishes to inject the signal at the BI1 on the IO#1 slot, the user should set BI1(200B01 8001001111) for the setting [**BI_ID**].

4) Set a time adjuster for the setting [**SYNC ADJ**]. For example, set a value (e.g., −0.050s) for setting [**SYNC ADJ**]. The setting is used when the clock function should be synchronized before reaching the 1Hz square-wave due to the propagation or the operating time on the BI circuit.

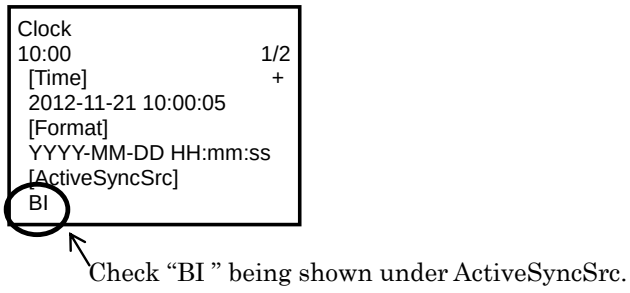


Figure 5.7-8 Time setting for BI

Table 5.7-3 Setting items for the BI Time synchronization

Setting item	Range	Contents	Setting example	Notes
TimeSyncSrc	SNTP / BI / IRIG-B	Selection of sync method	BI	
BI-SYNC	Off /On	Operation of BI	On	
BI_ID	[Preferred ID]	Signal monitoring point	200B01 8001001111	
SYNC ADJ	−0.050 to +0.050	Time adjust factor (in sec.)	0.000	− : Leading the clock + : Delaying the clock

5.7.4 Setting time zone

When the clock should run in the UTC, the user should set **On** for the setting [**IS_UTC_base**]. Additionally, the user should set the time zone† when the time should be displayed in the Local standard time. The time zone is divided in every 15 minutes; the user can set it using 0.25 units (i.e., 15 min = 0.25 unit). For example, if the IED is used in Venezuela (UTC-04:30), the user should set "−4.50" for the setting, as shown Figure 5.7-9.

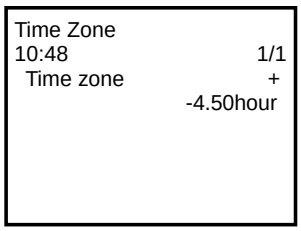


Figure 5.7-9 Setting screen of Time zone

Table 5.7-4 Example time offsets and locations

Time offset†	Example locations
UTC−10:00	United States (Hawaii)
UTC−09:00	United States (Anchorage)
UTC−08:00	United States (PST)
UTC−06:00	Canada , Costa Rica, El Salvador, Ecuador, Mexico, United States (CST)
UTC−05:00	Brazil (Acre), Colombia, Cuba, Jamaica, Panama, Peru, United States (EST)
UTC−04:30	Venezuela
UTC−04:00	Bolivia, Brazil, Dominican Republic, Puerto Rico, Barbados
UTC−03:00	Argentina, Brazil (Bahia, Pernambuco), Chile
UTC−02:00	Brazil (Fernando de Noronha)
UTC±00:00	United kingdom, Iceland, Ireland, Senegal, Saint Helena, Mali
UTC+01:00	Germany, Hungary, Italy, France, Montenegro
UTC+02:00	Egypt, Estonia, Finland, Slovenia, Greece
UTC+03:00	Ethiopia, Iraq, Kenya, Madagascar, Russia, Saudi Arabia, Turkey
UTC+04:00	Armenia, Azerbaijan, Oman, Seychelles, United Arab Emirates
UTC+05:00	Pakistan
UTC+05:30	India, Sri Lanka
UTC+06:00	Bangladesh, Bhutan, Kazakhstan
UTC+06:30	Myanmar
UTC+07:00	Western Indonesia, Thailand, Vietnam, Cambodia, Laos
UTC+08:00	China, Malaysia, Philippines, Australia (Western Australia), Mongolia
UTC+09:00	Japan, South Korea
UTC+10:00	Australia (Queensland)
UTC+12:00	New Zealand

†Note:Time zone is expressed in the difference between UTC and the local standard time (wintertime).

Table 5.7-5 Setting time zone

Setting item	Range	Contents	Setting example	Notes
IS_UTC_base	On / Off	Selection of either the UTC or the local time	On	

5.7.5 DST setting (Summer time setting)

When the summer time (DST) is applied, the user should set the beginning and the ending dates of the DST in the clock function. The user should set **On** for the setting [**Summer time**] for DST.

Note: The clock function is not designed for particular DSTs such as they are depending on the religious events and the astronomy.

(i) DST set by the day (Mon to Sun) of week

For example, when the DST starts at 01:00 a.m. on Sunday of the fifth week in March and it ends at 2:00 a.m. on Sunday of the fourth week in October, the user has the following settings. Note that transposing the calendar is required, as shown in Figure 5.7-10; accordingly the first of the month is located at the first row and the first column of the transposed calendar.

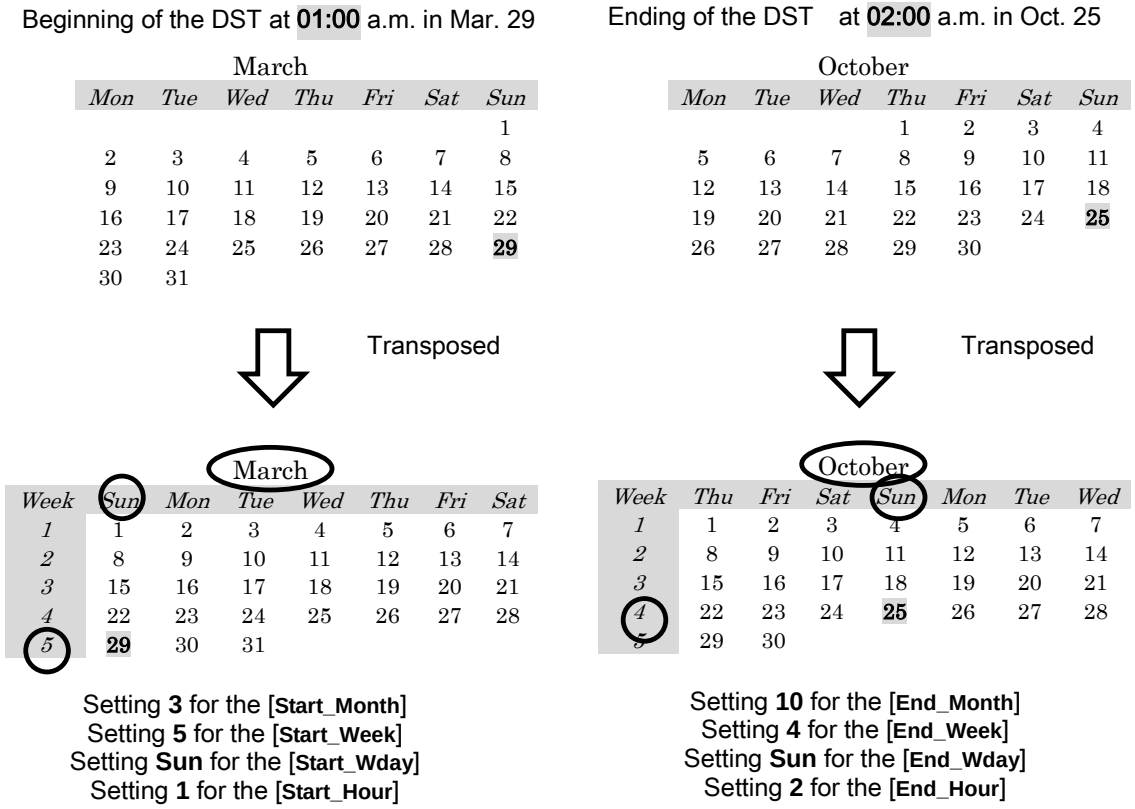


Figure 5.7-10 DST setting examples by the day of week

(ii) DST set by the day (1st or 15th) of month

For example, when the DST starts at 01:00 p.m. on the first day in March and it ends at 3:00 p.m. on the middle day in October; the user has the following settings.

March

Week	Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	1	2	3	4	5	6	7
2	8	9	10	11	12	13	14
3	15	16	17	18	19	20	21
4	22	23	24	25	26	27	28
5	29	30	31				

Beginning of the DST
at **01:00** p.m. in Mar. 1

Setting **3** for the [**Start_Month**]
Setting **1** for the [**Start_Week**]
Setting **–** for the [**Start_Wday**]
Setting **13** for the [**Start_Hour**]

October

Week	Thu	Fri	Sat	Sun	Mon	Tue	Wed
1	1	2	3	4	5	6	7
2	8	9	10	11	12	13	14
3	15	16	17	18	19	20	21
4	22	23	24	25	26	27	28
5	29	30					

Ending of the DST
at **03:00** p.m. in Oct. 15

Setting **10** for the [**End_Month**]
Setting **3** for the [**End_Week**]
Setting **–** for the [**End_Wday**]
Setting **15** for the [**End_Hour**]

Figure 5.7-11 DST setting examples by the day (1st or 15th) of month

(iii) Time shift

After setting the DST, the clock is forwarded by 1 hour at the DST start; the clock is backed by 1 hour at the DST end.

Table 5.7-6 DST settings

Setting item	Range	Contents	Setting example	Notes
Summer time	On / Off	Enabling DST operation	On	
Start_Month	1 to 12	Set the beginning of DST in the month	3	
Start_Week	1 to 5	Set the beginning of DST in the week	5	
Start_Wday	–, Sun, Mon, Tue, Wed, Thu, Fri, Sat	Set the beginning of DST in the day	Sun	
Start_Hour	0 to 23	Set the beginning of DST in 24 hour-clock	1	
End_Month	1 to 12	Set the end of DST in the month	10	
End_Week	1 to 5	Set the end of DST in the week	5	
End_Wday	–, Sun, Mon, Tue, Wed, Thu, Fri, Sat	Set the end of DST in the day	Sun	
End_Hour	0 to 23	Set the beginning of DST in 24 hour-clock	2	

5.7.6 Setting

Setting of CLOCK (Function ID: 200301)

Setting item		Range	Units	Contents	Default setting value	Notes
	Timezone	-14.00 - 14.00	hour	Time zone	0.00	
	TimeSyncSrc	--- / SNTP / BI / MODBUS / IRIG-B	-	Time sync source	SNTP	
	Date_fmt	YYYYMMDD / MMDDYYYY / DDMMYYYY	-	YMD/MDY/DMY	YYYYMMDD	
	Date_delimiter	- / / / .	-	- or / or .	-	
	Time_delimiter	: / .	-	: or period	:	
	Sec_delimiter	. / ,	-	. or ,	.	
	SummerTime	Off / On	-	Summer time enable	Off	
	IS_UTC_base	Off / On	-	Is setting value base on UTC?	On	
	Start_Month	1 - 12	-	Start month	3	
	Start_Week	1 - 5	-	Start week	5	
	Start_Wday	--- / Sun. / Mon. / Tue. / Wed. / Thr. / Fri. / Sat.	-	Start day of week	Sun.	
	Start_Hour	0 - 23	-	Start hour	1	
	End_Month	1 - 12	-	End month	10	
	End_Week	1 - 5	-	End week	5	
	End_Wday	--- / Sun. / Mon. / Tue. / Wed. / Thr. / Fri. / Sat.	-	End day of week	Sun.	
	End_Hour	0 - 23	-	End hour	1	

Setting of SNTP_SYNC (Function ID: 200A01)

Setting item		Range	Units	Contents	Default setting value	Notes
	SNTP	Off / On	-	Enabling SNTP synchronization	On	
	Server1	0 - 255	-	IP address#1	0. 0. 0. 0	
	Server2	0 - 255	-	IP address#2	0. 0. 0. 0	
	Server3	0 - 255	-	IP address#3	0. 0. 0. 0	
	Server4	0 - 255	-	IP address#4	0. 0. 0. 0	

Setting of BI_SYNC (Function ID: 202001)

Setting item		Range	Units	Contents	Default setting value	Notes
	BI SYNC	Off / On	-	BI sync switch	Off	
	BI_ID	[Preferred ID]	-	Source BI Data ID		
	SYNC ADJ	-0.050 to 0.050	s	Time adjust factor	0.000	

Setting of IRIG_SYNC (Function ID: 202101)

Setting item		Range	Units	Contents	Default setting value	Notes
	IRIG SYNC	Off / On	-	IRIGB sync switch	Off	
	USE_BCDYEAR	Off / On	-	Use BCD year code	Off	
	USE_LOCALTIME	Off / On	-	Use local time	Off	

6 Engineering tool

6.1 Overview of GR-TIEMS

When engineering, monitoring, record viewing, and test support functions are required in the IED, the user can handle these advanced and integrated functions using GR-Series Toshiba IED Engineering and Monitoring Software (GR-TIEMS). The GR-TIEMS should be installed into a PC prior to engineering. After that, the user can view the IED states (Table 6.1-1) on a PC screen connected with the IED. The user can also program the IED using the GR-TIEMS.

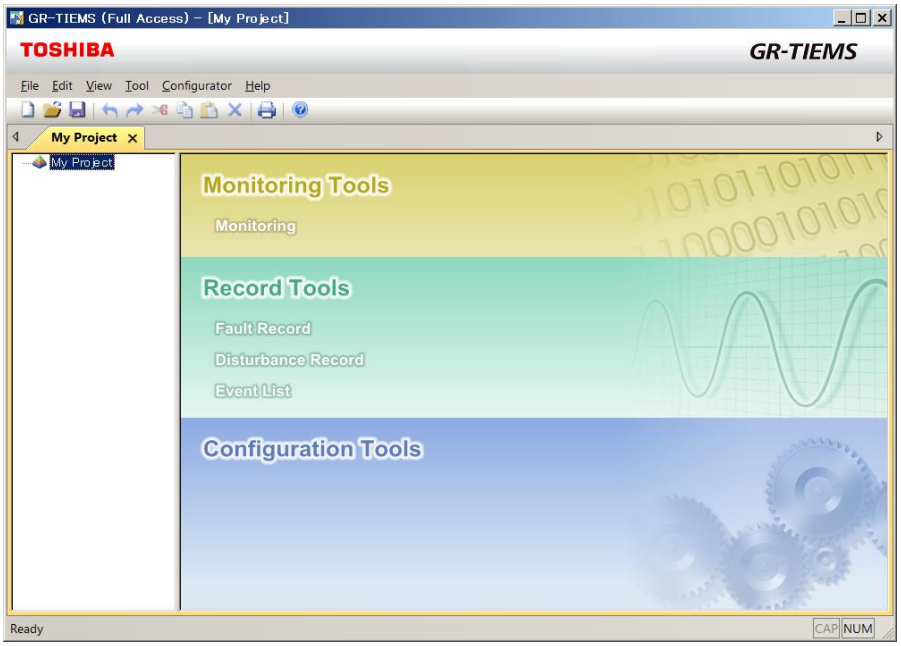


Figure 6.1-1 GR-TIEMS® screen on PC

Table 6.1-1 Information on the GR-TIEMS

Information	Displaying format
Display of voltage and current waveform	Oscillograph, vector display
Symmetrical component analysis	On arbitrary time span
Harmonic analysis	On arbitrary time span
Frequency analysis	On arbitrary time span

The GR-TIEMS is software to retrieve and analyze power system quantities, fault and event records. The user can change the settings in the respective IEDs when the PC is connected with the IED via a USB or a LAN. For more information in the GR-TIEMS operations, see separate manual "*Operation manual GR-TIEMS (6F2M1082)*".

6.2 Connection

The user can connect the GR-TIEMS with the IED using either the LAN or the USB, as shown in Figure 6.2-1.

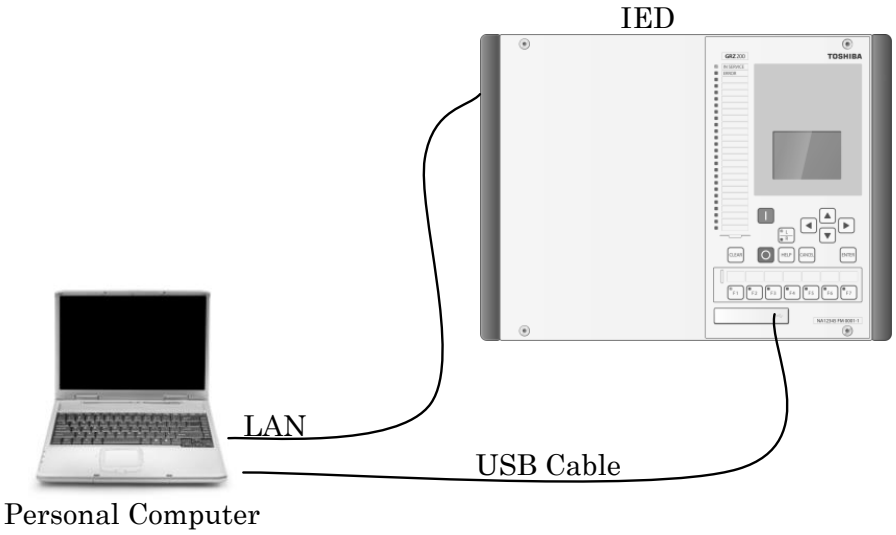


Figure 6.2-1 GR-TIEMS connected with IED

6.3 Common tools

(i) Project management

Project files are required to engage sub-engineering tools. The user can manage to read/write the project file of the IED using the project management function. The user can also see the contents of the project files.

(ii) Comparison

When the user wishes to get the comparison between respective IEDs, using the compare function the user can get the comparison data about Settings, Disturbance record binary signals, PLCs, Interlock, Large LCD (MIMIC)†, IEC61850, and IEC60870-5-103 data†.

(iii) Pocket label creator

The user can create the name label of LEDs and Function keys for the IED front panel using a pocket label sheet, which is provided together with the IED. For more information with regard the LEDs and Function keys, see Chapter *Technical description: Human machine interface*.

(iv) Logging

The user can view the recorded data with regard to the logging date/time. As the user can also find operation recorded when an operator/engineer logs into the IED, analyzing a problem is possible when an error is detected during the IED operations.

6.4 Monitoring tools

The user can monitor status and measurement value obtained in the IED using the monitoring tools. All signals monitored are tabulated in the monitoring list dialog. When the user wishes to monitor a signal, select a signal in the monitoring list dialog after the operation of the drag-drop on the monitoring window. The monitoring tools can generate an exporting layout file in the CSV; it also can obtain the layout file in the CSV.

6.5 Record tools

(i) Fault record

Fault records are including measuring information before and after the occurrence of the faults. Accordingly, the user can see information before the fault so that the user can analyze the fault more precisely. The user can select a fault from the recorded lists; the user can save it into the fault information file in the CSV. The user can also view the fault records when the exported data file in the CSV are retrieved into the IED.

(ii) Disturbance record

Disturbance record is a kind of module information measured so that the user can see them in several graphs: an oscilloscope chart, a harmonic graph, a 3D harmonic graph, a vector in relay operation analysis (ROA) chart. The user can see disturbance records when the disturbance records file in COMTRADE are provided. The user can also save disturbance records into the COMTRADE file.

(iii) Event list

The event list is recorded events information in the IED. The user can generate events information file in the CSV; the user can retrieve events data file into the IED to view when the file is in the CSV.

Note: In the IED the date and time is clocked in the coordinated universal time (UTC) when the clock is selected to operate in UTC. In the record tools within the PC the date and time is treated in the UTC. Notice that the time in the UTC is converted for the local time when the recording time is displayed on the PC. For the clock operation if the user selects neither the UTC, the time zone or the daylight saving time (the summer time), displaying incorrect time may result in between the IED and the PC. For more information about the clock and time, see Chapter *Technical description: Clock function*.

6.6 Generic configuration tools

(i) Setting (general setting for the relay and controlling functions)

The user can make the IED settings on the GR-TIEMS; the IED settings are transferred into

the IED by the connection between the IED and the GR-TIEMS.

(ii) Setting I/O

The user can see and make the setting with regard to binary input/output circuits (BIO), LEDs using the setting I/O function. For more information about the BIO, and the LED, see chapter *Technical description*.

(iii) Setting event list

The user can set information with regard to the event of an IED using the event list function.

6.7 IEC 61850 configuration tool

The user can configure conversion data for the IEC61850 communication†, provided the IED exchanges the data with the SAS. The user also configures a logical device, a logical node, Goose publish information, and Goose subscribe information. For setting and configuration for the IEC61850 communication see Chapter *Communication protocol: IEC 61850 communication*".

†Note: The configuration is possible when the IED software has the IEC61850 protocol. To confirmed the implementation of IEC61850 protocol, the user needs to check the IED ordering code (for more information, see *Appendix: Ordering*).

6.8 IEC 60870-5-103 configuration tool

The user can edit the data of the IEC 60870-5-103 protocol† to perform communications between IEDs. The IEC 60870-5-103 data consists of the IEC 60870-5-103 Slave and the IEC60870-5-103 Master data; the user can edit either the Slave Data or the Master Data‡ at a time.

†Note: The configuration is possible when the IED software has the IEC 60870-5-103. To confirmed the implementation of IEC61850 protocol, the user needs to check the IED ordering code (for more information, see *Appendix: Ordering*). The tool is not shown when the IED software does not have the IEC 60870-5-103.

‡Note: Editing the master data is not available at present.

6.9 MIMIC configuration tool

When the IED has a large LCD, the user can create user-preferred screens using the MIMIC configurator. The large LCD will be able to display measurement values, diagrams and others after the configuration. Note that the MIMIC is not available when the standard LCD is equipped for the IED.

7 PLC function

7.1 Overview of PLC function

PLC (Programmable Logic Controller) software is used for configuring the Inputs/outputs (I/Os), alarms, indications, recording and others. PLC logic consist of “timers”, “flip-flops”, and logic gates “AND, OR, XOR, NOT”. The user can configure PLC-logic using the PLC editor (MULTIPROG®), which should be installed in the user’s PC. Figure 7.1-1 shows the screen for the PLC editor.

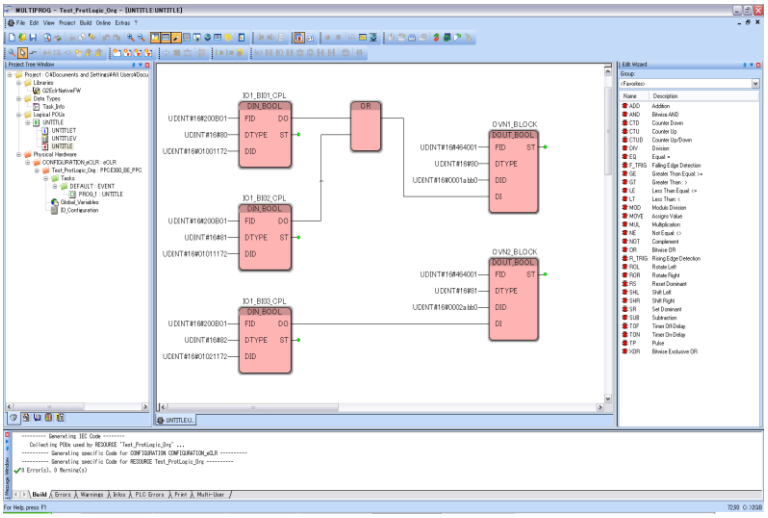


Figure 7.1-1 PC screen of MULTIPROG®

Note: To handle the PLC editor on the PC, the user shall purchase a software license (EP-261; see *Appendix: Ordering*) from Toshiba sales representative. For more information of PLC and MULTIPROG®, see separate manual *Basic manual: Programmable Logic Controller and PLC editor (6F2S1904))*.

7.2 PLC data error

The Automatic supervision reports the error information when an error occurs in PLC logic. The error information† is shown in the Monitoring sub-menu on the IED screen. See Chapter *Automatic supervision: Supervision tasks: Supervision of data in PLC function*.

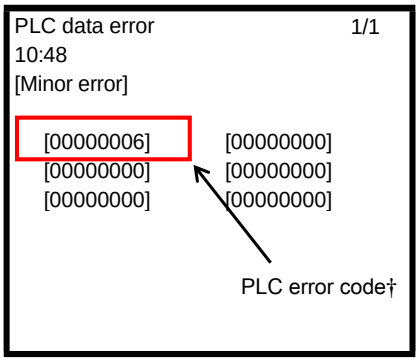


Figure 7.2-1 Error code at 1st row and 1st column on Monitoring sub-menu

7.3 PLC driver

Figure 7.3-1 illustrates that a function logic, modules, and the 61850 communication are linked with the PLC logic; a PLC driver is provided as one of coupling methods between. One hundred and twenty-eight PLC drivers are provided in the function "PLC_DRV (Function ID: 230301)"; the PLC drivers are termed "BIT_xx_x".

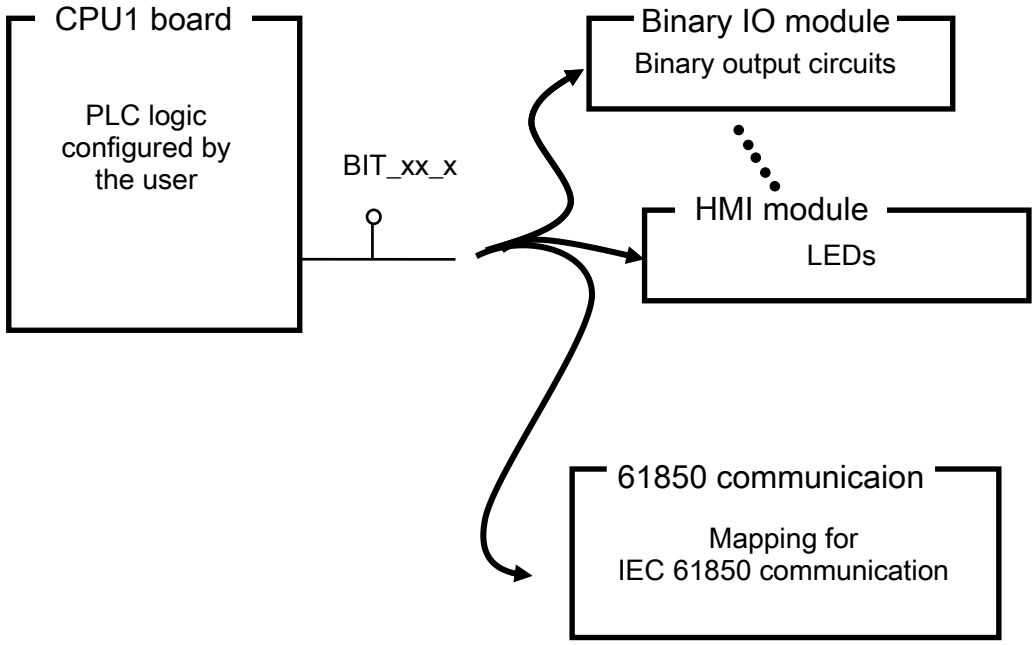


Figure 7.3-1 Communication between boards operated by the BIT

Table 7.3-1 PLC drivers

◆ Monitoring point at PLC Driver

PLC_DRV (Function ID: 230301)

Name	Element ID	Description
BIT_00_0	8810101BB0	(not used in the default configuration)
BIT_00_1	8910101BB1	(not used in the default configuration)
BIT_00_2	8A10101BB2	(not used in the default configuration)
BIT_00_3	8B10101BB3	(not used in the default configuration)
BIT_00_4	8C10101BB4	(not used in the default configuration)
BIT_00_5	8D10101BB5	(not used in the default configuration)
BIT_00_6	8E10101BB6	(not used in the default configuration)
BIT_00_7	8F10101BB7	(not used in the default configuration)
BIT_01_0	8010101BB8	(not used in the default configuration)
BIT_01_1	8110101BB9	(not used in the default configuration)
BIT_01_2	8210101BBA	(not used in the default configuration)
BIT_01_3	8310101BBB	(not used in the default configuration)
BIT_01_4	8410101BBC	(not used in the default configuration)
BIT_01_5	8510101BBD	(not used in the default configuration)

◆ Monitoring point at PLC Driver

PLC_DRV (Function ID: 230301)

Name	Element ID	Description
BIT_01_6	8610101BBE	(not used in the default configuration)
BIT_01_7	8710101BBF	(not used in the default configuration)
BIT_02_0	8810111BB0	(not used in the default configuration)
BIT_02_1	8910111BB1	(not used in the default configuration)
BIT_02_2	8A10111BB2	(not used in the default configuration)
BIT_02_3	8B10111BB3	(not used in the default configuration)
BIT_02_4	8C10111BB4	(not used in the default configuration)
BIT_02_5	8D10111BB5	(not used in the default configuration)
BIT_02_6	8E10111BB6	(not used in the default configuration)
BIT_02_7	8F10111BB7	(not used in the default configuration)
BIT_03_0	8010111BB8	(not used in the default configuration)
BIT_03_1	8110111BB9	(not used in the default configuration)
BIT_03_2	8210111BBA	(not used in the default configuration)
BIT_03_3	8310111BBB	(not used in the default configuration)
BIT_03_4	8410111BBC	(not used in the default configuration)
BIT_03_5	8510111BBD	(not used in the default configuration)
BIT_03_6	8610111BBE	(not used in the default configuration)
BIT_03_7	8710111BBF	(not used in the default configuration)
BIT_04_0	8810121BB0	(not used in the default configuration)
BIT_04_1	8910121BB1	(not used in the default configuration)
BIT_04_2	8A10121BB2	(not used in the default configuration)
BIT_04_3	8B10121BB3	(not used in the default configuration)
BIT_04_4	8C10121BB4	(not used in the default configuration)
BIT_04_5	8D10121BB5	(not used in the default configuration)
BIT_04_6	8E10121BB6	(not used in the default configuration)
BIT_04_7	8F10121BB7	(not used in the default configuration)
BIT_05_0	8010121BB8	(not used in the default configuration)
BIT_05_1	8110121BB9	(not used in the default configuration)
BIT_05_2	8210121BBA	(not used in the default configuration)
BIT_05_3	8310121BBB	(not used in the default configuration)
BIT_05_4	8410121BBC	(not used in the default configuration)
BIT_05_5	8510121BBD	(not used in the default configuration)
BIT_05_6	8610121BBE	(not used in the default configuration)
BIT_05_7	8710121BBF	(not used in the default configuration)
BIT_06_0	8810131BB0	(not used in the default configuration)
BIT_06_1	8910131BB1	(not used in the default configuration)
BIT_06_2	8A10131BB2	(not used in the default configuration)
BIT_06_3	8B10131BB3	(not used in the default configuration)
BIT_06_4	8C10131BB4	(not used in the default configuration)
BIT_06_5	8D10131BB5	(not used in the default configuration)
BIT_06_6	8E10131BB6	(not used in the default configuration)
BIT_06_7	8F10131BB7	(not used in the default configuration)

◆ Monitoring point at PLC Driver

PLC_DRV (Function ID: 230301)

Name	Element ID	Description
BIT_07_0	8010131BB8	(not used in the default configuration)
BIT_07_1	8110131BB9	(not used in the default configuration)
BIT_07_2	8210131BBA	(not used in the default configuration)
BIT_07_3	8310131BBB	(not used in the default configuration)
BIT_07_4	8410131BBC	(not used in the default configuration)
BIT_07_5	8510131BBD	(not used in the default configuration)
BIT_07_6	8610131BBE	(not used in the default configuration)
BIT_07_7	8710131BBF	(not used in the default configuration)
BIT_08_0	8810141BB0	(not used in the default configuration)
BIT_08_1	8910141BB1	(not used in the default configuration)
BIT_08_2	8A10141BB2	(not used in the default configuration)
BIT_08_3	8B10141BB3	(not used in the default configuration)
BIT_08_4	8C10141BB4	(not used in the default configuration)
BIT_08_5	8D10141BB5	(not used in the default configuration)
BIT_08_6	8E10141BB6	(not used in the default configuration)
BIT_08_7	8F10141BB7	(not used in the default configuration)
BIT_09_0	8010141BB8	(not used in the default configuration)
BIT_09_1	8110141BB9	(not used in the default configuration)
BIT_09_2	8210141BBA	(not used in the default configuration)
BIT_09_3	8310141BBB	(not used in the default configuration)
BIT_09_4	8410141BBC	(not used in the default configuration)
BIT_09_5	8510141BBD	(not used in the default configuration)
BIT_09_6	8610141BBE	(not used in the default configuration)
BIT_09_7	8710141BBF	(not used in the default configuration)
BIT_10_0	8810151BB0	(not used in the default configuration)
BIT_10_1	8910151BB1	(not used in the default configuration)
BIT_10_2	8A10151BB2	(not used in the default configuration)
BIT_10_3	8B10151BB3	(not used in the default configuration)
BIT_10_4	8C10151BB4	(not used in the default configuration)
BIT_10_5	8D10151BB5	(not used in the default configuration)
BIT_10_6	8E10151BB6	(not used in the default configuration)
BIT_10_7	8F10151BB7	(not used in the default configuration)
BIT_11_0	8010151BB8	(not used in the default configuration)
BIT_11_1	8110151BB9	(not used in the default configuration)
BIT_11_2	8210151BBA	(not used in the default configuration)
BIT_11_3	8310151BBB	(not used in the default configuration)
BIT_11_4	8410151BBC	(not used in the default configuration)
BIT_11_5	8510151BBD	(not used in the default configuration)
BIT_11_6	8610151BBE	(not used in the default configuration)
BIT_11_7	8710151BBF	(not used in the default configuration)
BIT_12_0	8810161BB0	(not used in the default configuration)
BIT_12_1	8910161BB1	(not used in the default configuration)

◆ Monitoring point at PLC Driver

PLC_DRV (Function ID: 230301)

Name	Element ID	Description
BIT_12_2	8A10161BB2	(not used in the default configuration)
BIT_12_3	8B10161BB3	(not used in the default configuration)
BIT_12_4	8C10161BB4	(not used in the default configuration)
BIT_12_5	8D10161BB5	(not used in the default configuration)
BIT_12_6	8E10161BB6	(not used in the default configuration)
BIT_12_7	8F10161BB7	(not used in the default configuration)
BIT_13_0	8010161BB8	(not used in the default configuration)
BIT_13_1	8110161BB9	(not used in the default configuration)
BIT_13_2	8210161BBA	(not used in the default configuration)
BIT_13_3	8310161BBB	(not used in the default configuration)
BIT_13_4	8410161BBC	(not used in the default configuration)
BIT_13_5	8510161BBD	(not used in the default configuration)
BIT_13_6	8610161BBE	(not used in the default configuration)
BIT_13_7	8710161BBF	(not used in the default configuration)
BIT_14_0	8810171BB0	(not used in the default configuration)
BIT_14_1	8910171BB1	(not used in the default configuration)
BIT_14_2	8A10171BB2	(not used in the default configuration)

8 Recording function

The recording function consists of three recording features: (1) Fault recorder, (2) Event recorder, and (3) Disturbance recorder. The fault recorder collects the information about the power system quantities when a fault occurs. The event recorder groups state information when the changes are detected. The disturbance recorder is designed to memory the various quantities—numerical analog data and logic data (binary data)—from the monitoring function and the BIO modules; it is possible to analyze the disturbance using the engineering tool (GR-TIMES), which can draw several chronological waves.

8.1 Fault recorder

During the fault, the fault recorder can memorize reasons by equipment failures/operation states, system information etc. It commences by injecting a signal coming from the TRC alarm-signal generation logic, but is also started by a trigger provided by PLC function. The fault recorder captures the following items for each fault:

- Date and time at the fault
- Tripped phase information
- Operating mode information
- FL calculation result (if the FL function operates)
- Evolving faults (if the ARC function operates)
- Fault and pre-fault quantities

8.1.1 Types of recording information

The fault recorder can cyclically memory past eight faults; the oldest memory will be erased cyclically if another fault occurs. The memorized information has 1ms accuracy. If a fault occurs, the fault recorder is directed to operate to memory operating modes etc. about the fault.

(i) Date and time at fault

The date and time at the fault is recorded. The date and time information is provided by the clock function (see Chapter *Technical description: Clock function*).

(ii) Tripped phase information

Information about tripped phases (i.e., faulted phases) are recorded using the recording identifiers ('OPT-PHASE-A,B,C, and -N' signals), which the TRC function provides.

(iii) Mode information

At the occurrence of a fault, the protection functions gives the fault recorder the reasons of tripping; the reasons are brought using operation identifiers† and logical signals‡. The fault recorder can have up to 192 of all identifiers and signals in the IED. The operation identifiers are chosen using the settings [**OP Mode ID1**] to [**OP Mode ID128**]. The settings [**OP Mode ID201**] to [**OP Mode ID264**] are used for general purposes to record the logical signals.

†Note: A number of the operation identifiers are provided by the protection functions. For example, the 'OC1-OPT-A' operation identifier is used to identify the pickup in the first element of the overcurrent function (OC1) in phase-A. See respective protection functions in Chapter *Relay application*.

‡Note: 64 logical signals are selectable for recording. For example in this purpose, the user may choose an operation signal on the circuits of the BIO modules (BIOs).

(iv) FL calculation result

The location of the fault occurrence is recoded if the fault locator function (FL) operates.

(v) Evolving faults

The fault recorder is able to record evolving faults† during the operation of the ARC function. Strikes number for reclosing CB is also recorded.

†Note: The evolving faults are found during the 'ARC_IN_PROG' signal being generating. For more information, see Chapter *Relay application: Autoreclose*.

(vi) Fault quantities and pre-fault-quantities

Several quantity items (amplitude and phase angle of current, etc.) are memorized in the fault recorder, as shown in Table 8.1-1. Quantities just before the fault are also memorized. The pre-fault quantities are captured 10 seconds before tripping, but it is possible to take back longer using the setting [**Pre-Fault time**].

Table 8.1-1 Recording quantities before the fault and at the fault

Abbreviations	Displayed quantities
I_a, I_b, I_c, I_{ab}, I_{bc}, I_{ca}, I_e (2) I_1, I_2, I_0 (1)	Current in phase, phase-to-phase , symmetrical, residual currents
I_{em} (2)	Residual current in the other side of the parallel line
V_a, V_b, V_c V_{ab}, V_{bc}, V_{ca} V_1, V_2, V_0 (1)	Voltage in phase, phase-to-phase, and symmetrical
V_s, V_{s2}	One or two reference (busbar) voltages
I_a–L, I_b–L, I_c–L, I_e–L I_a–R1, I_b–R1, I_c–R1, I_e–R1 I_a–R2, I_b–R2, I_c–R2, I_e–R2 V_1–L, V_1–R1, V_1–R2	Resultant currents and voltages at local-end (L) and remote-ends (R1 and R2)

Abbreviations	Displayed quantities
I_{da}, I_{db}, I_{dc}	DIFL differential currents (Id) in three-phases
I_{d0}	DIFL differential currents(Ido) in zero-sequence
I_{ra}, I_{rb}, I_{rc}	DIFGL restraining-currents (Ir) in three-phases
I_{r0}	DIFGL restraining-currents (Ir) in zero-sequence
R_a, R_b, R_c ,R_{ab}, R_{bc}, R_{ca} X_a, X_b, X_c ,X_{ab}, X_{bc}, X_{ca}	Impedance and reactance components at Fault
CH1 Delay, CH2 Delay(3)	Propagation delay times at port1(CH1) and port2(CH2)
CH1 DT, CH2 DT(3)	Sampling difference between terminals at port1(CH1) and port2(CH2)
Df/dt(4)	Rate of frequency change
I2/I1(4)	Rate of positive-sequence-current to negative-sequence-current
THM-Capacity(4)	Rate of thermal capacity in %

[1]Note: Terms 'I_0 (i.e., $3I_0$)' and 'V_0 (i.e., $3V_0$)' are calculated using three-phase quantities.

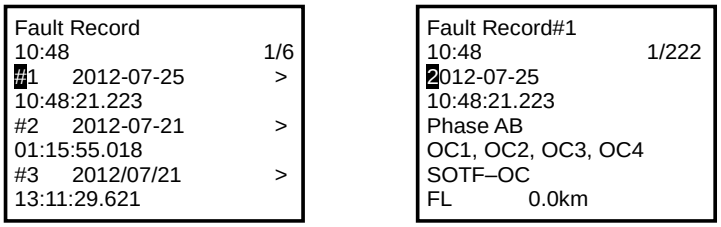
[2]Note: The 'I_e' and 'I_{em}' are obtained usually with corresponding 'I_e' and 'I_{em}' circuits in the VCT.

[3]Note: 'CH2' is available when two signaling modules exist in the IED, which is dependent on the model. Check the ordering number at the C position referring to the ordering (See *Appendix: Ordering*)

[4]Note: Those recoding items are provided by the special software, which is selected using the 'Software selection' in the ordering.

8.1.2 Screen information

Figure 8.1-1 illustrates the information displayed on the IED screen†, which can display up to eight fault records (#1 to #8). Figure 8.1-2 illustrates the structure of the first fault record#1. The line ⓒ indicates the tripped phase. The lines ⓓ show how tripping occurred. The lines ⓕ have the information about evolving faults, which is able to memory up to 32 developing faults. Quantitates when the fault occurred are shown below messages ⓖ ⓗ.



List of fault records (#1 to #8) Details of #1 information

Figure 8.1-1 Information of the fault recorder displayed on the IED screen

†Note: For more screen information, see Chapter *User interface: Record sub-menu*. For more information about the FL calculation, see Chapter *Relay application: Single-end fault locator*.

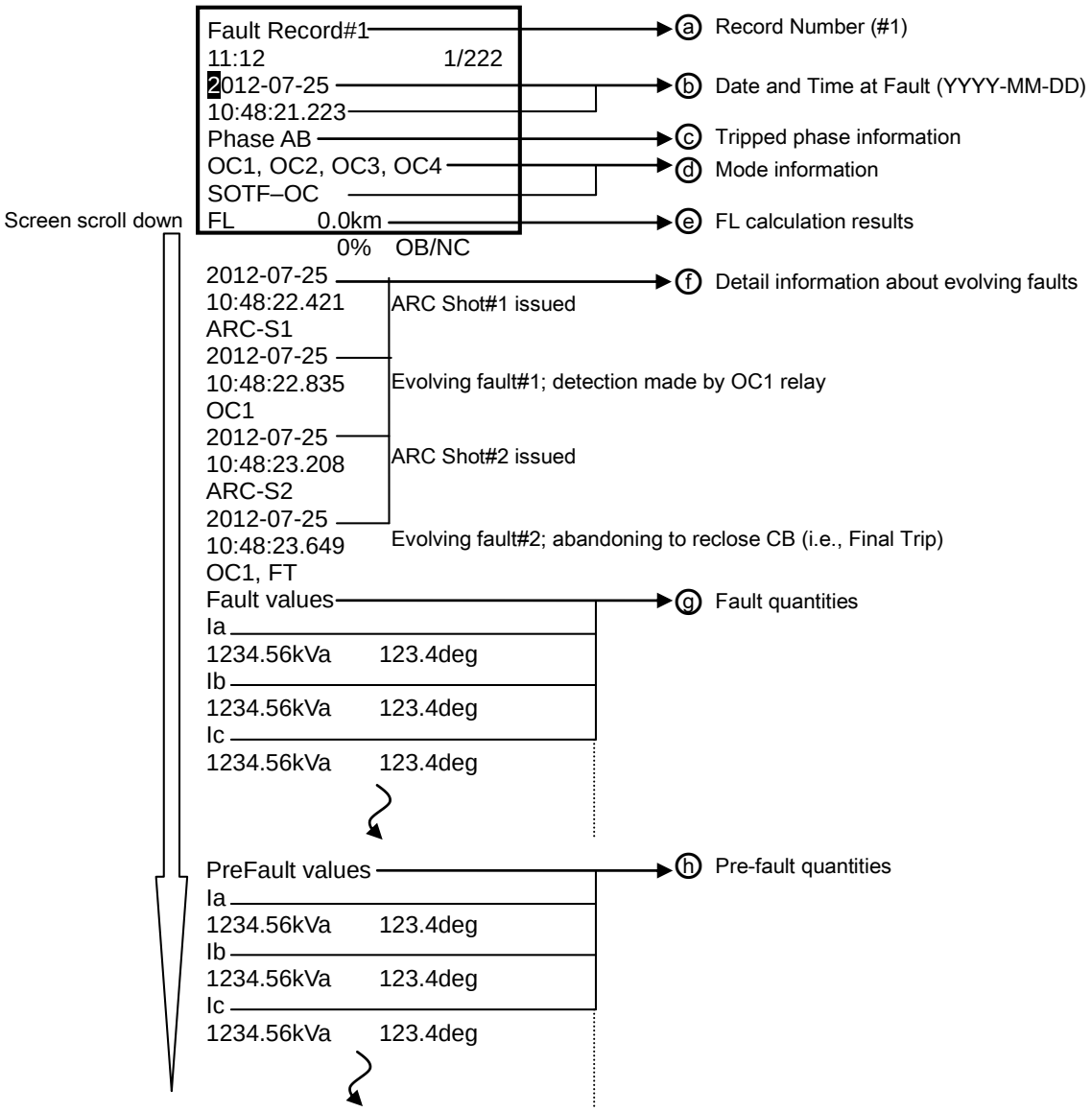


Figure 8.1-2 Screen structure about the information #1.

8.1.3 Setup for the fault recorder

(i) Operation identifiers (ID1–ID128)

The user can select the operation identifies arbitrarily using the settings [**OP Mode ID1**] etc. For example, when the operation result with regard to the overcurrent relay element (i.e., OC1 in phase-A) shall be recorded, choose the operated signal 'OC1-OPT-A (440001 800011B68)" and set it for the [**OP Mode ID1**]. Remember to program the displaying name about the OC1-OPT-A using the setting [**OP Mode Name1**] (e.g., "OC1-A relay OP-ed"). Note that the length of the displaying name should be less than 18 letters. The user should find blanks in the setting list, because several IDs have been already set.

(ii) Logical signals (ID201–ID264)

Wishing to record a logical level '1 (TRUE)' or '0 (FALSE)' on the circuits, the user can pick the

logical signal using settings the [**OP Mode ID265**] etc. For example, the user wishes to record the output level of the binary output circuit#1 (BO1) at the IO#1 slot, set its PLC monitoring point '200B01 8002001112' for the setting [**OP Mode ID265**]; set the displaying name using the [**OP Mode Name265**].

(iii) Additional triggers for the recording

Wishing to start the fault recorder except for the trip instruction, the user can use the PLC connection points 'ADD_F.RECORD_TRIG1' to 'ADD_F.RECORD_TRIG4', respectively.

(iv) Time setting for Pre-fault

The instant before the trip is programmable using the setting [**Pre-Fault Time**] among 10s, 50s, 100s, 200s, 300s.

(v) Unit setting for the quantities

To change the units of power quantities, go to the metering function discussed in *Chapter Metering function*.

Table 8.1-2 Default settings (ID1–ID128 and ID201–ID264)

Settings in Fault recorder				Actual PLC connection points
Data IDs		Screen names		
[OP Mode ID1]	410001 8000001B61	[OP Mode Name1]	DIFL-A	DIFL-A-OPT
[OP Mode ID2]	410001 8100001B62	[OP Mode Name2]	DIFL-B	DIFL-B-OPT
[OP Mode ID3]	410001 8200001B63	[OP Mode Name3]	DIFL-C	DIFL-C-OPT
[OP Mode ID4]	410001 8100001B66	[OP Mode Name4]	DIFstub	DIFL-STUB-COND
[OP Mode ID5]	410001 8200001B6E	[OP Mode Name5]	DIFL-R	REMOTE.DIFL-OPT
[OP Mode ID6]	411001 8000001B23	[OP Mode Name6]	DIFGL	DIFGL-TRIP
[OP Mode ID7]	411001 8100001B63	[OP Mode Name7]	DIFGL-R	REMOTE.DIFGL-OPT
[OP Mode ID8]	430001 8000011B23	[OP Mode Name8]	Z1S	Z1S-OPT
[OP Mode ID9]	430001 8100061B23	[OP Mode Name9]	Z1XS	Z1XS-OPT
[OP Mode ID10]	430001 8200021B23	[OP Mode Name10]	Z2S	Z2S-OPT
[OP Mode ID11]	430001 8300031B23	[OP Mode Name11]	Z3S	Z3S-OPT
[OP Mode ID12]	430001 8400041B23	[OP Mode Name12]	Z4S	Z4S-OPT
[OP Mode ID13]	430001 8500051B23	[OP Mode Name13]	Z5S	Z5S-OPT
[OP Mode ID14]	430001 8300001B2B	[OP Mode Name14]	SOTF-ZS	SOTF-ZS-TRIP
[OP Mode ID15]	431001 8000011B69	[OP Mode Name15]	Z1G	Z1G-OPT
[OP Mode ID16]	431001 8100061B69	[OP Mode Name16]	Z1XG	Z1XG-OPT
[OP Mode ID17]	431001 8200021B69	[OP Mode Name17]	Z2G	Z2G-OPT
[OP Mode ID18]	431001 8300031B69	[OP Mode Name18]	Z3G	Z3G-OPT
[OP Mode ID19]	431001 8400041B69	[OP Mode Name19]	Z4G	Z4G-OPT
[OP Mode ID20]	431001 8500051B69	[OP Mode Name20]	Z5G	Z5G-OPT
[OP Mode ID21]	431001 8300001B2B	[OP Mode Name21]	SOTF-ZG	SOTF-ZG-TRIP
[OP Mode ID22]	436001 8300001B76	[OP Mode Name22]	DISC	DISCAR-OPT
[OP Mode ID23]	436001 8300001B72	[OP Mode Name23]	DISC_WI	DISCAR_WITRIP
[OP Mode ID24]	437001 8300001B77	[OP Mode Name24]	DEFC	DEFCAR-OPT
[OP Mode ID25]	437001 8300001B73	[OP Mode Name25]	DEFC_WI	DEFCAR_WITRIP
[OP Mode ID26]	440001 8000011B68	[OP Mode Name26]	OC1	OC1-OPT
[OP Mode ID27]	440001 8100021B68	[OP Mode Name27]	OC2	OC2-OPT
[OP Mode ID28]	440001 8200031B68	[OP Mode Name28]	OC3	OC3-OPT
[OP Mode ID29]	440001 8300041B68	[OP Mode Name29]	OC4	OC4-OPT
[OP Mode ID30]	441001 8000011B60	[OP Mode Name30]	EF1	EF1-OPT
[OP Mode ID31]	441001 8100021B60	[OP Mode Name31]	EF2	EF2-OPT
[OP Mode ID32]	441001 8200031B60	[OP Mode Name32]	EF3	EF3-OPT
[OP Mode ID33]	441001 8300041B60	[OP Mode Name33]	EF4	EF4-OPT
[OP Mode ID34]	443001 8000011B60	[OP Mode Name34]	OCN1	OCN1-OPT
[OP Mode ID35]	443001 8100021B60	[OP Mode Name35]	OCN2	OCN2-OPT
[OP Mode ID36]	443001 8200031B60	[OP Mode Name36]	OCN3	OCN3-OPT
[OP Mode ID37]	443001 8300041B60	[OP Mode Name37]	OCN4	OCN4-OPT
[OP Mode ID38]	*Not assigned*	[OP Mode Name38]	-	*Not assigned*
[OP Mode ID39]	*Not assigned*	[OP Mode Name39]	-	*Not assigned*
[OP Mode ID40]	451001 8000011B60	[OP Mode Name40]	THM-A	THM-ALARM
[OP Mode ID41]	451001 8100021B60	[OP Mode Name41]	THM	THM-TRIP
[OP Mode ID42]	452001 8000001B60	[OP Mode Name42]	BCD	BCD-OPT
[OP Mode ID43]	454001 8300001B23	[OP Mode Name43]	SOTF-OC	SOTFOC-TRIP
[OP Mode ID44]	*Not assigned*	[OP Mode Name44]	-	*Not assigned*
[OP Mode ID45]	460001 8000011B65	[OP Mode Name45]	OV1	OV1-OPT
[OP Mode ID46]	460001 8100021B65	[OP Mode Name46]	OV2	OV2-OPT
[OP Mode ID47]	461001 8000011B65	[OP Mode Name47]	OVS1	OVS1-OPT
[OP Mode ID48]	461001 8100021B65	[OP Mode Name48]	OVS2	OVS2-OPT
[OP Mode ID49]	*Not assigned*	[OP Mode Name49]	-	*Not assigned*
[OP Mode ID50]	*Not assigned*	[OP Mode Name50]	-	*Not assigned*
[OP Mode ID51]	*Not assigned*	[OP Mode Name51]	-	*Not assigned*
[OP Mode ID52]	*Not assigned*	[OP Mode Name52]	-	*Not assigned*
[OP Mode ID53]	*Not assigned*	[OP Mode Name53]	-	*Not assigned*
[OP Mode ID54]	*Not assigned*	[OP Mode Name54]	-	*Not assigned*
[OP Mode ID55]	470001 8000011B65	[OP Mode Name55]	UV1	UV1-OPT
[OP Mode ID56]	470001 8100021B65	[OP Mode Name56]	UV2	UV2-OPT
[OP Mode ID57]	471001 8000011B65	[OP Mode Name57]	UVS1	UVS1-OPT
[OP Mode ID58]	471001 8100021B65	[OP Mode Name58]	UVS2	UVS2-OPT
[OP Mode ID59]	*Not assigned*	[OP Mode Name59]	-	*Not assigned*
[OP Mode ID60]	*Not assigned*	[OP Mode Name60]	-	*Not assigned*
[OP Mode ID61]	475001 8000011BB1	[OP Mode Name61]	FRQ-S1	FRQ-S1-OPT
[OP Mode ID62]	475001 8100021BB1	[OP Mode Name62]	FRQ-S2	FRQ-S2-OPT
[OP Mode ID63]	475001 8200031BB1	[OP Mode Name63]	FRQ-S3	FRQ-S3-OPT
[OP Mode ID64]	475001 8300041BB1	[OP Mode Name64]	FRQ-S4	FRQ-S4-OPT
[OP Mode ID65]	475001 8400051BB1	[OP Mode Name65]	FRQ-S5	FRQ-S5-OPT
[OP Mode ID66]	475001 8500061BB1	[OP Mode Name66]	FRQ-S6	FRQ-S6-OPT
[OP Mode ID67]	475001 8000111BB1	[OP Mode Name67]	DFRQ-S1	DFRQ-S1-OPT
[OP Mode ID68]	475001 8100121BB1	[OP Mode Name68]	DFRQ-S2	DFRQ-S2-OPT
[OP Mode ID69]	475001 8200131BB1	[OP Mode Name69]	DFRQ-S3	DFRQ-S3-OPT
[OP Mode ID70]	475001 8300141BB1	[OP Mode Name70]	DFRQ-S4	DFRQ-S4-OPT
[OP Mode ID71]	475001 8400151BB1	[OP Mode Name71]	DFRQ-S5	DFRQ-S5-OPT
[OP Mode ID72]	475001 8500161BB1	[OP Mode Name72]	DFRQ-S6	DFRQ-S6-OPT
[OP Mode ID73]	*Not assigned*	[OP Mode Name73]	-	*Not assigned*
[OP Mode ID74]	*Not assigned*	[OP Mode Name74]	-	*Not assigned*
[OP Mode ID75]	*Not assigned*	[OP Mode Name75]	-	*Not assigned*
[OP Mode ID76]	*Not assigned*	[OP Mode Name76]	-	*Not assigned*
[OP Mode ID77]	*Not assigned*	[OP Mode Name77]	-	*Not assigned*
[OP Mode ID78]	*Not assigned*	[OP Mode Name78]	-	*Not assigned*
[OP Mode ID79]	*Not assigned*	[OP Mode Name79]	-	*Not assigned*
[OP Mode ID80]	*Not assigned*	[OP Mode Name80]	-	*Not assigned*
[OP Mode ID81]	*Not assigned*	[OP Mode Name81]	-	*Not assigned*
[OP Mode ID82]	*Not assigned*	[OP Mode Name82]	-	*Not assigned*
[OP Mode ID83]	*Not assigned*	[OP Mode Name83]	-	*Not assigned*
[OP Mode ID84]	*Not assigned*	[OP Mode Name84]	-	*Not assigned*
[OP Mode ID85]	*Not assigned*	[OP Mode Name85]	-	*Not assigned*
[OP Mode ID86]	*Not assigned*	[OP Mode Name86]	-	*Not assigned*
[OP Mode ID87]	*Not assigned*	[OP Mode Name87]	-	*Not assigned*
[OP Mode ID88]	*Not assigned*	[OP Mode Name88]	-	*Not assigned*
[OP Mode ID89]	*Not assigned*	[OP Mode Name89]	-	*Not assigned*
[OP Mode ID90]	*Not assigned*	[OP Mode Name90]	-	*Not assigned*
[OP Mode ID91]	*Not assigned*	[OP Mode Name91]	-	*Not assigned*
[OP Mode ID92]	*Not assigned*	[OP Mode Name92]	-	*Not assigned*
[OP Mode ID93]	*Not assigned*	[OP Mode Name93]	-	*Not assigned*
[OP Mode ID94]	*Not assigned*	[OP Mode Name94]	-	*Not assigned*
[OP Mode ID95]	*Not assigned*	[OP Mode Name95]	-	*Not assigned*
[OP Mode ID96]	*Not assigned*	[OP Mode Name96]	-	*Not assigned*

Settings in Fault recorder				Actual PLC connection points
Data IDs		Screen names		
[OP Mode ID97]	*Not assigned*	[OP Mode Name97]	-	*Not assigned*
[OP Mode ID98]	*Not assigned*	[OP Mode Name98]	-	*Not assigned*
[OP Mode ID99]	*Not assigned*	[OP Mode Name99]	-	*Not assigned*
[OP Mode ID100]	*Not assigned*	[OP Mode Name100]	-	*Not assigned*
[OP Mode ID101]	*Not assigned*	[OP Mode Name101]	-	*Not assigned*
[OP Mode ID102]	*Not assigned*	[OP Mode Name102]	-	*Not assigned*
[OP Mode ID103]	*Not assigned*	[OP Mode Name103]	-	*Not assigned*
[OP Mode ID104]	*Not assigned*	[OP Mode Name104]	-	*Not assigned*
[OP Mode ID105]	*Not assigned*	[OP Mode Name105]	-	*Not assigned*
[OP Mode ID106]	*Not assigned*	[OP Mode Name106]	-	*Not assigned*
[OP Mode ID107]	*Not assigned*	[OP Mode Name107]	-	*Not assigned*
[OP Mode ID108]	*Not assigned*	[OP Mode Name108]	-	*Not assigned*
[OP Mode ID109]	*Not assigned*	[OP Mode Name109]	-	*Not assigned*
[OP Mode ID110]	*Not assigned*	[OP Mode Name110]	-	*Not assigned*
[OP Mode ID111]	*Not assigned*	[OP Mode Name111]	-	*Not assigned*
[OP Mode ID112]	*Not assigned*	[OP Mode Name112]	-	*Not assigned*
[OP Mode ID113]	*Not assigned*	[OP Mode Name113]	-	*Not assigned*
[OP Mode ID114]	*Not assigned*	[OP Mode Name114]	-	*Not assigned*
[OP Mode ID115]	*Not assigned*	[OP Mode Name115]	-	*Not assigned*
[OP Mode ID116]	*Not assigned*	[OP Mode Name116]	-	*Not assigned*
[OP Mode ID117]	*Not assigned*	[OP Mode Name117]	-	*Not assigned*
[OP Mode ID118]	*Not assigned*	[OP Mode Name118]	-	*Not assigned*
[OP Mode ID119]	*Not assigned*	[OP Mode Name119]	-	*Not assigned*
[OP Mode ID120]	*Not assigned*	[OP Mode Name120]	-	*Not assigned*
[OP Mode ID121]	*Not assigned*	[OP Mode Name121]	-	*Not assigned*
[OP Mode ID122]	*Not assigned*	[OP Mode Name122]	-	*Not assigned*
[OP Mode ID123]	*Not assigned*	[OP Mode Name123]	-	*Not assigned*
[OP Mode ID124]	*Not assigned*	[OP Mode Name124]	-	*Not assigned*
[OP Mode ID125]	*Not assigned*	[OP Mode Name125]	-	*Not assigned*
[OP Mode ID126]	*Not assigned*	[OP Mode Name126]	-	*Not assigned*
[OP Mode ID127]	*Not assigned*	[OP Mode Name127]	-	*Not assigned*
[OP Mode ID128]	*Not assigned*	[OP Mode Name128]	-	*Not assigned*
[OP Mode ID201]	*Not assigned*	[OP Mode Name201]	-	*Not assigned*
[OP Mode ID202]	479001 8200001B61	[OP Mode Name202]	OSTV	OSTV-OPT
[OP Mode ID203]	*Not assigned*	[OP Mode Name203]	-	*Not assigned*
[OP Mode ID204]	*Not assigned*	[OP Mode Name204]	-	*Not assigned*
[OP Mode ID205]	453001 8300011B23	[OP Mode Name205]	CBF1-RE	CBF1-RETRIP
[OP Mode ID206]	453001 8B00011B27	[OP Mode Name206]	CBF1	CBF1_TRIP
[OP Mode ID207]	453001 8300021B23	[OP Mode Name207]	CBF2-RE	CBF2-RETRIP
[OP Mode ID208]	453001 8B00021B27	[OP Mode Name208]	CBF2	CBF2_TRIP
[OP Mode ID209]	485001 8000011B60	[OP Mode Name209]	DTT1	DTT1-OPT
[OP Mode ID210]	485001 8100021B60	[OP Mode Name210]	DTT2	DTT2-OPT
[OP Mode ID211]	*Not assigned*	[OP Mode Name211]	-	*Not assigned*
[OP Mode ID212]	*Not assigned*	[OP Mode Name212]	-	*Not assigned*
[OP Mode ID213]	*Not assigned*	[OP Mode Name213]	-	*Not assigned*
[OP Mode ID214]	*Not assigned*	[OP Mode Name214]	-	*Not assigned*
[OP Mode ID215]	*Not assigned*	[OP Mode Name215]	-	*Not assigned*
[OP Mode ID216]	*Not assigned*	[OP Mode Name216]	-	*Not assigned*
[OP Mode ID217]	*Not assigned*	[OP Mode Name217]	-	*Not assigned*
[OP Mode ID218]	*Not assigned*	[OP Mode Name218]	-	*Not assigned*
[OP Mode ID219]	*Not assigned*	[OP Mode Name219]	-	*Not assigned*
[OP Mode ID220]	*Not assigned*	[OP Mode Name220]	-	*Not assigned*
[OP Mode ID221]	*Not assigned*	[OP Mode Name221]	-	*Not assigned*
[OP Mode ID222]	*Not assigned*	[OP Mode Name222]	-	*Not assigned*
[OP Mode ID223]	*Not assigned*	[OP Mode Name223]	-	*Not assigned*
[OP Mode ID224]	*Not assigned*	[OP Mode Name224]	-	*Not assigned*
[OP Mode ID225]	*Not assigned*	[OP Mode Name225]	-	*Not assigned*
[OP Mode ID226]	*Not assigned*	[OP Mode Name226]	-	*Not assigned*
[OP Mode ID227]	*Not assigned*	[OP Mode Name227]	-	*Not assigned*
[OP Mode ID228]	*Not assigned*	[OP Mode Name228]	-	*Not assigned*
[OP Mode ID229]	*Not assigned*	[OP Mode Name229]	-	*Not assigned*
[OP Mode ID230]	*Not assigned*	[OP Mode Name230]	-	*Not assigned*
[OP Mode ID231]	*Not assigned*	[OP Mode Name231]	-	*Not assigned*
[OP Mode ID232]	*Not assigned*	[OP Mode Name232]	-	*Not assigned*
[OP Mode ID233]	4A6001 8000011B63	[OP Mode Name233]	SPAR1	ARC1_MODE_SPAR
[OP Mode ID234]	4A6001 8100011B64	[OP Mode Name234]	TPAR1	ARC1_TPAR
[OP Mode ID235]	4A6001 8200011B65	[OP Mode Name235]	ORGAR1	ARC1_ORGAR
[OP Mode ID236]	*Not assigned*	[OP Mode Name236]	-	*Not assigned*
[OP Mode ID237]	4A6001 8100011B67	[OP Mode Name237]	ARC-S2	ARC1 SHOT2
[OP Mode ID238]	4A6001 8200011B68	[OP Mode Name238]	ARC-S3	ARC1 SHOT3
[OP Mode ID239]	4A6001 8300011B69	[OP Mode Name239]	ARC-S4	ARC1 SHOT4
[OP Mode ID240]	4A6001 8400011B6A	[OP Mode Name240]	ARC-S5	ARC1 SHOT5
[OP Mode ID241]	4A6001 8400011B6E	[OP Mode Name241]	FT1	ARC1 FT
[OP Mode ID242]	4A6001 8700011B70	[OP Mode Name242]	AR1	ARC1 RESET
[OP Mode ID243]	4A6001 8C00011B71	[OP Mode Name243]	AF1	ARC1 CLOSE FAIL
[OP Mode ID244]	4A6001 8000011B72	[OP Mode Name244]	AS1	ARC1 CLOSE SUCCESS
[OP Mode ID245]	4A6001 8000021B63	[OP Mode Name245]	SPAR2	ARC2_SPAR
[OP Mode ID246]	4A6001 8100021B64	[OP Mode Name246]	TPAR2	ARC2_TPAR
[OP Mode ID247]	4A6001 8200021B65	[OP Mode Name247]	ORGAR2	ARC2_ORGAR
[OP Mode ID248]	*Not assigned*	[OP Mode Name248]	-	*Not assigned*
[OP Mode ID249]	4A6001 8400021B6A	[OP Mode Name249]	FT2	ARC2 FT
[OP Mode ID250]	4A6001 8700021B6C	[OP Mode Name250]	AR2	ARC2 RESET
[OP Mode ID251]	4A6001 8C00021B6D	[OP Mode Name251]	AF2	ARC2 CLOSE FAIL
[OP Mode ID252]	4A6001 8000021B6E	[OP Mode Name252]	AS2	ARC2 CLOSE SUCCESS
[OP Mode ID253]	4A6001 8300001B64	[OP Mode Name253]	EXT-STA	EXT.ARC_START
[OP Mode ID254]	*Not assigned*	[OP Mode Name254]	-	*Not assigned*
[OP Mode ID255]	*Not assigned*	[OP Mode Name255]	-	*Not assigned*
[OP Mode ID256]	*Not assigned*	[OP Mode Name256]	-	*Not assigned*
[OP Mode ID257]	*Not assigned*	[OP Mode Name257]	-	*Not assigned*
[OP Mode ID258]	*Not assigned*	[OP Mode Name258]	-	*Not assigned*
[OP Mode ID259]	*Not assigned*	[OP Mode Name259]	-	*Not assigned*
[OP Mode ID260]	*Not assigned*	[OP Mode Name260]	-	*Not assigned*
[OP Mode ID261]	*Not assigned*	[OP Mode Name261]	-	*Not assigned*
[OP Mode ID262]	*Not assigned*	[OP Mode Name262]	-	*Not assigned*
[OP Mode ID263]	*Not assigned*	[OP Mode Name263]	-	*Not assigned*
[OP Mode ID264]	*Not assigned*	[OP Mode Name264]	-	*Not assigned*

8.1.4 Scheme logic

The operation of the fault recorder can be directed by the TRC function, protection functions (FC1 to FC40†), and the PLC function, as shown in Figure 8.1-3.

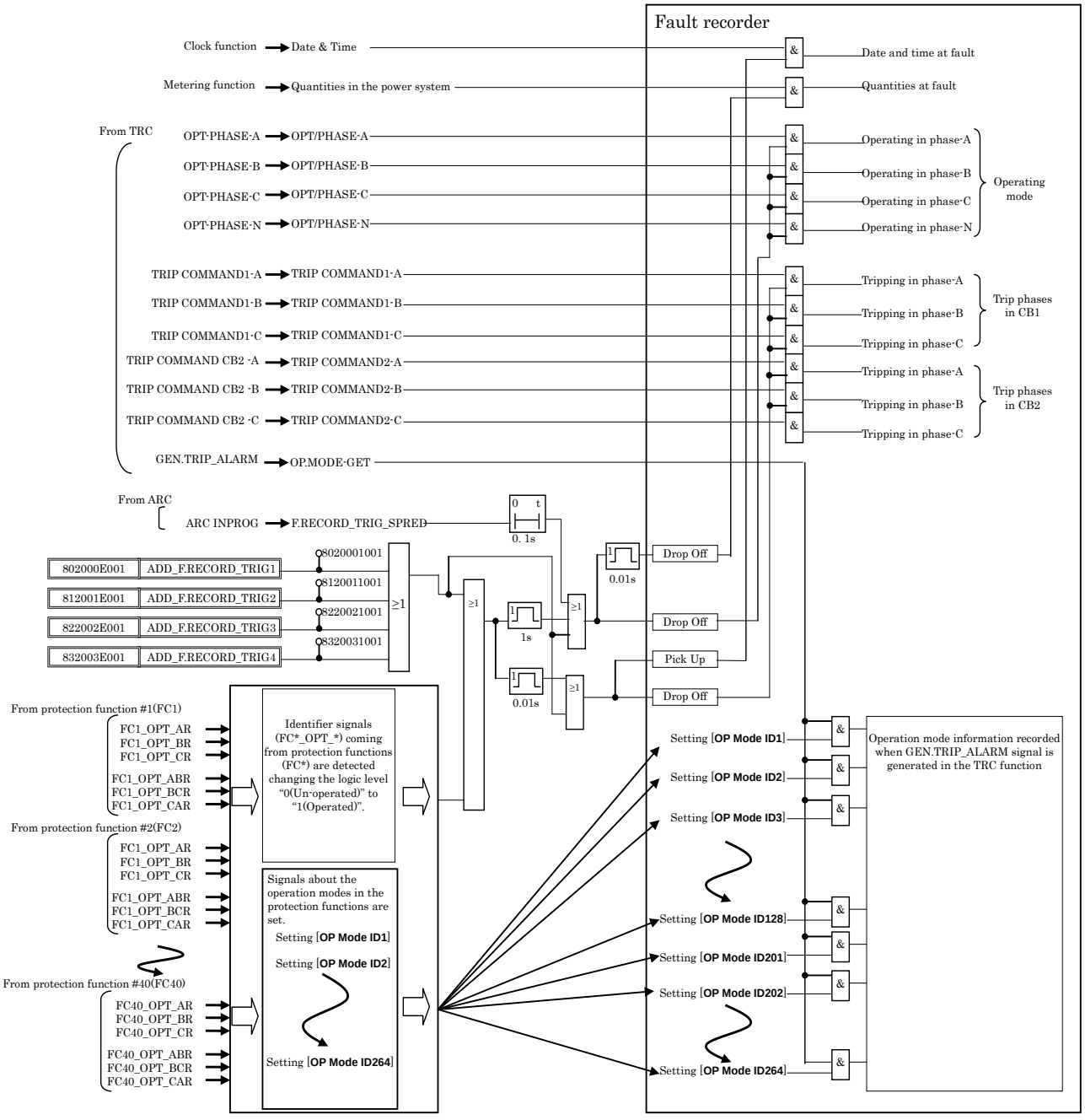


Figure 8.1-3 Fault record circuit

†Note:The correspondences table for the FC numbers are discussed in Chapter *Relay application: Trip circuit*.

8.1.5 Setting

Setting of FAULT_RECORD(Function ID: 200602)

Setting item		Range	Units	Contents	Default setting value	Notes
	Pre-Fault Time	10s/ 50 / 100 / 200 / 300	Sec.	Recording time before the fault	10	
	Op Mode Name1	(Preferred name)	–	Name of the operation mode for ID1	–	
	Op Mode ID1	(Preferred DataID)	–	Signal of the operation identifier	–	
	Op Mode Name2	(Preferred name)	–	Name of the operation mode for ID2	–	
	Op Mode ID2	(Preferred DataID)	–	Signal of the operation identifier2	–	
	Op Mode Name3	(Preferred name)	–	Name of the operation mode for ID3	–	
	Op Mode ID3	(Preferred DataID)	–	Signal of the operation identifier3	–	
	.....	.....	–	.....	–	
	.....	.....	–	.....	–	
	.....	.....	–	.....	–	
	.....	.....	–	.....	–	
	Op Mode Name264	(Preferred name)	–	Name of the operation mode for ID264	–	
	Op Mode ID264	(Preferred DataID)	–	Signal of the operation identifier264	–	

8.1.6 Signal (Data ID)

◆ Signal monitoring point

FAULT_RECORD (Function ID: 200602)

Name	Element ID	Description
ADD_F.RECORD_TRIG1	8020001001	Receiving Trigger1
ADD_F.RECORD_TRIG2	8120011001	Receiving Trigger2
ADD_F.RECORD_TRIG3	8220021001	Receiving Trigger3
ADD_F.RECORD_TRIG4	8320031001	Receiving Trigger4
FAULT RECORD TRIG1	8000011001	TRIG1 signal generated
FAULT RECORD TRIG3	8200031001	TRIG3 signal generated
FLTRCDING	8020101001	Data writing in the fault recorder
FR_CLR	3000001001	Data erasing in the fault recorder

◆ Connection point on PLC logic

FAULT_RECORD (Function ID: 200602)

Name	Element ID	Description
ADD_F.RECORD_TRIG1	802000E001	Input1 for the external trigger
ADD_F.RECORD_TRIG2	812001E001	Input2 for the external trigger
ADD_F.RECORD_TRIG3	822002E001	Input3 for the external trigger
ADD_F.RECORD_TRIG4	832003E001	Input4 for the external trigger

8.2 Event recorder

Signals are generated in the logics of BIO modules etc. in the IED. The event recorder can memory the generated signals as events. To operate the event recorder, the user should pick a preferred signal as a trigger of the event recorder; the event recorder can have 768 triggers, some of which have been set as a default. The user can group the triggers into three categories; consequently, it is possible that a number of the events are divided depending on the degree of the errors, the meaning of the operations, and the signals of relay elements, etc. The user can also program how an event is to be detected. An event is recorded with millisecond accuracy. The information are memorized until the number of the events reaching 1024; the oldest event will be deleted when a new event appears.

8.2.1 Trigger signals

The event is memorized when the event recorder detects changing the trigger signal that is connected with the logic signal; they are defined using settings [**Trigger ID1**] to [**Trigger ID768**]. Settings [**End of E.Record-1**] and [**End of E.Record-2**] are provided for grouping†; the user can adjust the size of the 'Event Record1' group using the [**End of E.Record-1**]. The next 'Event Record2' group is set with the [**End of E.Record-2**]. The remains are set for the 'Event Record3' group. Remember that the [**Trigger ID1**] etc. are required to set together with the [**Event Name1**] etc.; user's preferred names should be less than 18 letters.

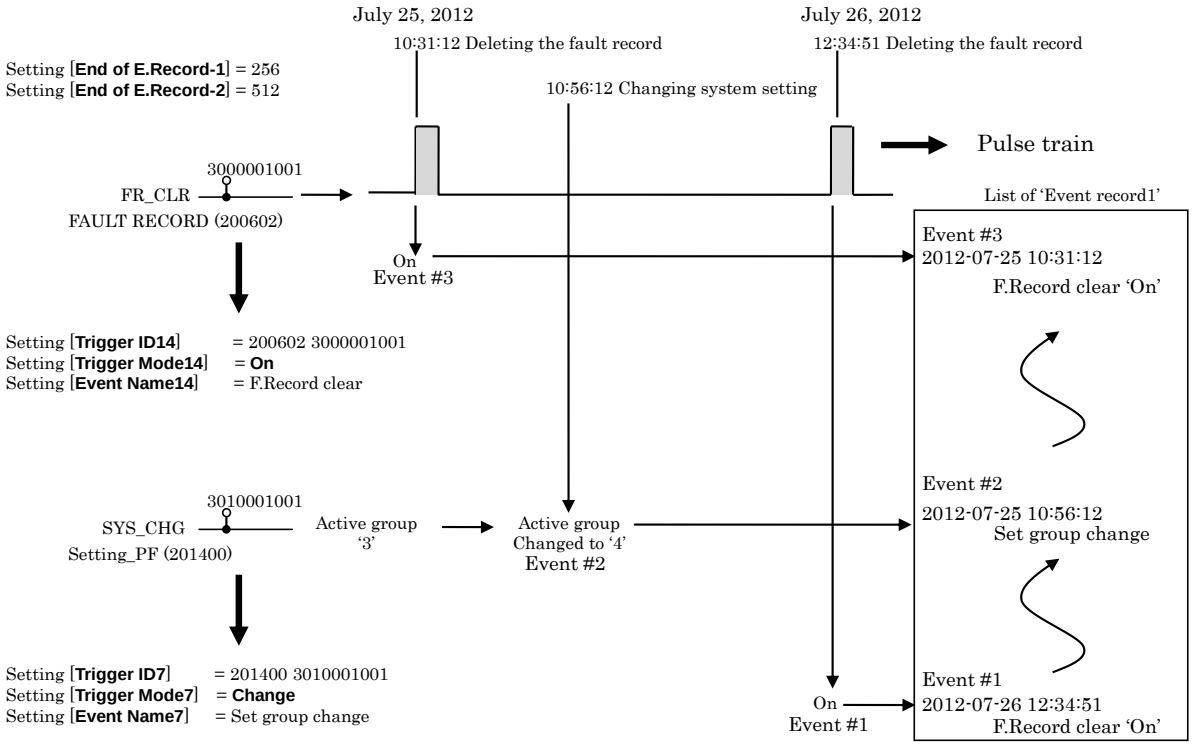


Figure 8.2-1 Relation between function signals and triggers for Event record1

Figure 8.2-1 illustrates signals connected with triggers in the event recorder. For example, 'SYS_CHG' is connected with trigger#7 using the [**Trigger ID7**] and 'FR_CLR' is connected with

trigger#14 using the [**Trigger ID14**]. Note that the both triggers (#7 and #14) are smaller than the setting [**End of E.Record-1**]=256; hence, the both are listed in the 'Event recored1' list. Keep in mind that the event names are set by the [**Event Name7**] and [**Event Name14**]. All ones are tabulated in Table 8.2-1 to Table 8.2-3.

†Note:The GR-TIEMS uses terms 'Level1', 'Level2', and 'Level3' to represent the 'Event Record1', 'Event Record2', and 'Event Record3'. The scope of each level is the same as the scope of each group. The GR-TIEMS does not show unused triggers and Trigger ID numbers automatically when the triggers are displayed on the screen.

Table 8.2-1 Event1 group set with [End of E.Record-1]=256

Triggers	Data IDs	Modes	Names
[Trigger ID1]	220001 3110201001	On-Off	Serious error
[Trigger ID2]	220001 3110211001	On-Off	ErrorLevel2
[Trigger ID3]	220001 3110221001	On-Off	Minor error
[Trigger ID4]	220001 3110231001	On-Off	ErrorLevel4
[Trigger ID5]	220001 3110241001	On-Off	ErrorLevel5
[Trigger ID6]	(Not Assigned)	Off	-
[Trigger ID7]	201400 3200001001	Change	Set. group change
[Trigger ID8]	201400 3010001001	On	System set. change
[Trigger ID9]	201400 3010011001	On	Comm. set. change
[Trigger ID10]	201400 3010021001	On	Prot. set. change
[Trigger ID11]	201400 3010031001	On	Ctrl. set. change
[Trigger ID12]	(Not Assigned)	Off	-
[Trigger ID13]	(Not Assigned)	Off	-
[Trigger ID14]	200602 3000001001	On	F.Record clear
[Trigger ID15]	200710 3001001001	On	E.Record1 clear
[Trigger ID16]	200710 3002001001	On	E.Record2 clear
[Trigger ID17]	200710 3003001001	On	E.Record3 clear
[Trigger ID18]	20040130A0001001	On	D.Record clear
[Trigger ID19]	(Not Assigned)	Off	-
[Trigger ID20]	(Not Assigned)	Off	-
[Trigger ID21]	(Not Assigned)	Off	-
[Trigger ID22]	(Not Assigned)	Off	-
[Trigger ID23]	(Not Assigned)	Off	-
[Trigger ID24]	(Not Assigned)	Off	-
[Trigger ID25]	(Not Assigned)	Off	-
[Trigger ID26]	(Not Assigned)	Off	-
[Trigger ID27]	(Not Assigned)	Off	-
[Trigger ID28]	(Not Assigned)	Off	-
[Trigger ID29]	(Not Assigned)	Off	-
[Trigger ID30]	(Not Assigned)	Off	-
[Trigger ID31]	(Not Assigned)	Off	-
[Trigger ID32]	(Not Assigned)	Off	-
[Trigger ID33]	(Not Assigned)	Off	-
[Trigger ID34]	(Not Assigned)	Off	-
[Trigger ID35]	(Not Assigned)	Off	-
[Trigger ID36]	(Not Assigned)	Off	-
[Trigger ID37]	(Not Assigned)	Off	-
[Trigger ID38]	(Not Assigned)	Off	-
[Trigger ID39]	(Not Assigned)	Off	-
[Trigger ID40]	(Not Assigned)	Off	-
[Trigger ID41]	(Not Assigned)	Off	-
[Trigger ID42]	(Not Assigned)	Off	-
[Trigger ID43]	(Not Assigned)	Off	-
[Trigger ID44]	(Not Assigned)	Off	-
[Trigger ID45]	(Not Assigned)	Off	-
[Trigger ID46]	(Not Assigned)	Off	-
[Trigger ID47]	(Not Assigned)	Off	-
[Trigger ID48]	(Not Assigned)	Off	-
[Trigger ID49]	(Not Assigned)	Off	-
[Trigger ID50]	(Not Assigned)	Off	-
[Trigger ID51]	(Not Assigned)	Off	-
[Trigger ID52]	(Not Assigned)	Off	-
[Trigger ID53]	(Not Assigned)	Off	-
[Trigger ID54]	(Not Assigned)	Off	-
[Trigger ID55]	(Not Assigned)	Off	-
[Trigger ID56]	(Not Assigned)	Off	-
[Trigger ID57]	(Not Assigned)	Off	-
[Trigger ID58]	(Not Assigned)	Off	-
[Trigger ID59]	(Not Assigned)	Off	-
[Trigger ID60]	(Not Assigned)	Off	-
[Trigger ID61]	(Not Assigned)	Off	-
[Trigger ID62]	(Not Assigned)	Off	-
[Trigger ID63]	(Not Assigned)	Off	-
[Trigger ID64]	(Not Assigned)	Off	-
[Trigger ID65]	(Not Assigned)	Off	-
[Trigger ID66]	(Not Assigned)	Off	-
[Trigger ID67]	(Not Assigned)	Off	-
[Trigger ID68]	(Not Assigned)	Off	-
[Trigger ID69]	(Not Assigned)	Off	-
[Trigger ID70]	(Not Assigned)	Off	-
[Trigger ID71]	(Not Assigned)	Off	-
[Trigger ID72]	(Not Assigned)	Off	-
[Trigger ID73]	(Not Assigned)	Off	-
[Trigger ID74]	(Not Assigned)	Off	-
[Trigger ID75]	(Not Assigned)	Off	-
[Trigger ID76]	(Not Assigned)	Off	-
[Trigger ID77]	(Not Assigned)	Off	-
[Trigger ID78]	(Not Assigned)	Off	-
[Trigger ID79]	(Not Assigned)	Off	-
[Trigger ID80]	(Not Assigned)	Off	-
[Trigger ID81]	(Not Assigned)	Off	-
[Trigger ID82]	(Not Assigned)	Off	-
[Trigger ID83]	(Not Assigned)	Off	-
[Trigger ID84]	(Not Assigned)	Off	-
[Trigger ID85]	(Not Assigned)	Off	-
[Trigger ID86]	(Not Assigned)	Off	-
[Trigger ID87]	(Not Assigned)	Off	-
[Trigger ID88]	(Not Assigned)	Off	-
[Trigger ID89]	(Not Assigned)	Off	-
[Trigger ID90]	(Not Assigned)	Off	-
[Trigger ID91]	(Not Assigned)	Off	-
[Trigger ID92]	(Not Assigned)	Off	-
[Trigger ID93]	(Not Assigned)	Off	-
[Trigger ID94]	(Not Assigned)	Off	-
[Trigger ID95]	(Not Assigned)	Off	-
[Trigger ID96]	(Not Assigned)	Off	-
[Trigger ID97]	(Not Assigned)	Off	-
[Trigger ID98]	(Not Assigned)	Off	-
[Trigger ID99]	(Not Assigned)	Off	-
[Trigger ID100]	(Not Assigned)	Off	-
[Trigger ID101]	(Not Assigned)	Off	-
[Trigger ID102]	(Not Assigned)	Off	-
[Trigger ID103]	(Not Assigned)	Off	-
[Trigger ID104]	(Not Assigned)	Off	-
[Trigger ID105]	(Not Assigned)	Off	-
[Trigger ID106]	(Not Assigned)	Off	-
[Trigger ID107]	(Not Assigned)	Off	-
[Trigger ID108]	(Not Assigned)	Off	-
[Trigger ID109]	(Not Assigned)	Off	-
[Trigger ID110]	(Not Assigned)	Off	-
[Trigger ID111]	(Not Assigned)	Off	-
[Trigger ID112]	(Not Assigned)	Off	-
[Trigger ID113]	(Not Assigned)	Off	-
[Trigger ID114]	(Not Assigned)	Off	-
[Trigger ID115]	(Not Assigned)	Off	-
[Trigger ID116]	(Not Assigned)	Off	-
[Trigger ID117]	(Not Assigned)	Off	-
[Trigger ID118]	(Not Assigned)	Off	-
[Trigger ID119]	(Not Assigned)	Off	-
[Trigger ID120]	(Not Assigned)	Off	-
[Trigger ID121]	(Not Assigned)	Off	-
[Trigger ID122]	(Not Assigned)	Off	-
[Trigger ID123]	(Not Assigned)	Off	-
[Trigger ID124]	(Not Assigned)	Off	-
[Trigger ID125]	(Not Assigned)	Off	-
[Trigger ID126]	(Not Assigned)	Off	-
[Trigger ID127]	(Not Assigned)	Off	-
[Trigger ID128]	(Not Assigned)	Off	-
[Trigger ID129]	48A001 8000001B73	On-Off	CB1-A_CLOSE
[Trigger ID130]	48A001 8100001B74	On-Off	CB1-B_CLOSE
[Trigger ID131]	48A001 8200001B75	On-Off	CB1-C_CLOSE
[Trigger ID132]	48A001 8000001B7C	On-Off	CB2-A_CLOSE
[Trigger ID133]	48A001 8100001B7D	On-Off	CB2-B_CLOSE
[Trigger ID134]	48A001 8200001B7E	On-Off	CB2-C_CLOSE
[Trigger ID135]	48A001 8E00001B85	On-Off	DS_CLOSE
[Trigger ID136]	48A001 8000001B9C	On-Off	DEAD_LINE_DETECT
[Trigger ID137]	(Not Assigned)	Off	-
[Trigger ID138]	4A6001 8000011B60	On-Off	ARC1 READY
[Trigger ID139]	4A6001 8000021B60	On-Off	ARC2 READY
[Trigger ID140]	4A6001 8200001BB4	On-Off	ARC_BLOCK
[Trigger ID141]	4A6001 8000001BB3	On-Off	ARC NO ACT
[Trigger ID142]	4A6001 8000001BB0	On-Off	EXT.ARC_START-A
[Trigger ID143]	4A6001 8100001BB1	On-Off	EXT.ARC_START-B
[Trigger ID144]	4A6001 8200001BB2	On-Off	EXT.ARC_START-C
[Trigger ID145]	4A6001 8000011B6C	On-Off	ARC1 CLOSE COMMAND
[Trigger ID146]	4A6001 8100021B68	On-Off	ARC2 CLOSE COMMAND
[Trigger ID147]	(Not Assigned)	Off	-
[Trigger ID148]	490001 8000001B61	On-Off	VTF DETECT
[Trigger ID149]	490001 8100001BB1	On-Off	EXTERNAL VTF
[Trigger ID150]	(Not Assigned)	Off	-
[Trigger ID151]	491001 8000001B62	On-Off	CTF DETECT
[Trigger ID152]	491001 8100001BB1	On-Off	EXTERNAL CTF
[Trigger ID153]	(Not Assigned)	Off	-
[Trigger ID154]	4A0001 8000001B6C	On-Off	GEN.TRIP-A
[Trigger ID155]	4A0001 8100001B6D	On-Off	GEN.TRIP-B
[Trigger ID156]	4A0001 8200001B6E	On-Off	GEN.TRIP-C
[Trigger ID157]	4A0001 8300001B6F	On-Off	GEN.TRIP
[Trigger ID158]	4A0001 8400001B64	On-Off	GEN.ALARM
[Trigger ID159]	4A0001 8000001B71	On-Off	OPT.PHASE-A
[Trigger ID160]	4A0001 8100001B72	On-Off	OPT.PHASE-B
[Trigger ID161]	4A0001 8200001B73	On-Off	OPT.PHASE-C
[Trigger ID162]	4A0001 8300001B74	On-Off	OPT.PHASE-N
[Trigger ID163]	(Not Assigned)	Off	-
[Trigger ID164]	(Not Assigned)	Off	-
[Trigger ID165]	(Not Assigned)	Off	-
[Trigger ID166]	(Not Assigned)	Off	-
[Trigger ID167]	(Not Assigned)	Off	-
[Trigger ID168]	(Not Assigned)	Off	-
[Trigger ID169]	453001 8000011BB0	On-Off	EXT.CBF1_START-A
[Trigger ID170]	453001 8100011BB1	On-Off	EXT.CBF1_START-B
[Trigger ID171]	453001 8200011BB2	On-Off	EXT.CBF1_START-C
[Trigger ID172]	453001 8000021BB0	On-Off	EXT.CBF2_START-A
[Trigger ID173]	453001 8100021BB1	On-Off	EXT.CBF2_START-B
[Trigger ID174]	453001 8200021BB2	On-Off	EXT.CBF2_START-C
[Trigger ID175]	(Not Assigned)	Off	-
[Trigger ID176]	(Not Assigned)	Off	-
[Trigger ID177]	(Not Assigned)	Off	-
[Trigger ID178]	(Not Assigned)	Off	-
[Trigger ID179]	(Not Assigned)	Off	-
[Trigger ID180]	(Not Assigned)	Off	-
[Trigger ID181]	436001 8000001B60	On-Off	EXT.DISCAR-R1
[Trigger ID182]	436001 8100001B62	On-Off	EXT.DISCAR-R2
[Trigger ID183]	(Not Assigned)	Off	-
[Trigger ID184]	437001 8000001B60	On-Off	EXT.DEFCAR-R1
[Trigger ID185]	437001 8100001B62	On-Off	EXT.DEFCAR-R2
[Trigger ID186]	(Not Assigned)	Off	-
[Trigger ID187]	438001 8000001BB0	On-Off	CAR_BLOCK
[Trigger ID188]	(Not Assigned)	Off	-
[Trigger ID189]	432001 8000001BB0	On-Off	Z1CNT_MPROT
[Trigger ID190]	432001 8000001B62	On-Off	Z1CNT-TPBLK
[Trigger ID191]	432001 8100001B63	On-Off	Z1CNT-3PTP
[Trigger ID192]	432001 8200001B64	On-Off	Z1CNT-ARCBLK
[Trigger ID193]	432001 8300001B65	On-Off	Z1CNT-INSTOP
[Trigger ID194]	No Assign	Off	-
[Trigger ID195]	410001 8F00001BB2	On-Off	DIFL_BLOCK
[Trigger ID196]	(Not Assigned)	Off	-
[Trigger ID197]	(Not Assigned)	Off	-
[Trigger ID198]	(Not Assigned)	Off	-
[Trigger ID199]	(Not Assigned)	Off	-
[Trigger ID200]	(Not Assigned)	Off	-
[Trigger ID201]	(Not Assigned)	Off	-
[Trigger ID202]	(Not Assigned)	Off	-
[Trigger ID203]	(Not Assigned)	Off	-
[Trigger ID204]	(Not Assigned)	Off	-
[Trigger ID205]	(Not Assigned)	Off	-
[Trigger ID206]	(Not Assigned)	Off	-
[Trigger ID207]	(Not Assigned)	Off	-
[Trigger ID208]	(Not Assigned)	Off	-
[Trigger ID209]	(Not Assigned)	Off	-
[Trigger ID210]	(Not Assigned)	Off	-
[Trigger ID211]	(Not Assigned)	Off	-
[Trigger ID212]	(Not Assigned)	Off	-
[Trigger ID213]	(Not Assigned)	Off	-
[Trigger ID214]	(Not Assigned)	Off	-
[Trigger ID215]	(Not Assigned)	Off	-
[Trigger ID216]	(Not Assigned)	Off	-
[Trigger ID217]	(Not Assigned)	Off	-
[Trigger ID218]	(Not Assigned)	Off	-
[Trigger ID219]	(Not Assigned)	Off	-
[Trigger ID220]	(Not Assigned)	Off	-
[Trigger ID221]	(Not Assigned)	Off	-
[Trigger ID222]	(Not Assigned)	Off	-
[Trigger ID223]	(Not Assigned)	Off	-
[Trigger ID224]	(Not Assigned)	Off	-
[Trigger ID225]	(Not Assigned)	Off	-
[Trigger ID226]	(Not Assigned)	Off	-
[Trigger ID227]	(Not Assigned)	Off	-
[Trigger ID228]	(Not Assigned)	Off	-
[Trigger ID229]	(Not Assigned)	Off	-
[Trigger ID230]	(Not Assigned)	Off	-
[Trigger ID231]	(Not Assigned)	Off	-
[Trigger ID232]	(Not Assigned)	Off	-
[Trigger ID233]	(Not Assigned)	Off	-
[Trigger ID234]	(Not Assigned)	Off	-
[Trigger ID235]	(Not Assigned)	Off	-
[Trigger ID236]	(Not Assigned)	Off	-
[Trigger ID237]	(Not Assigned)	Off	-
[Trigger ID238]	(Not Assigned)	Off	-
[Trigger ID239]	(Not Assigned)	Off	-
[Trigger ID240]	(Not Assigned)	Off	-
[Trigger ID241]	(Not Assigned)	Off	-
[Trigger ID242]	(Not Assigned)	Off	-
[Trigger ID243]	(Not Assigned)	Off	-
[Trigger ID244]	(Not Assigned)	Off	-
[Trigger ID245]	(Not Assigned)	Off	-
[Trigger ID246]	(Not Assigned)	Off	-
[Trigger ID247]	(Not Assigned)	Off	-
[Trigger ID248]	(Not Assigned)	Off	-
[Trigger ID249]	(Not Assigned)	Off	-
[Trigger ID250]	(Not Assigned)	Off	-
[Trigger ID254]	(Not Assigned)	Off	-
[Trigger ID252]	(Not Assigned)	Off	-
[Trigger ID253]	(Not Assigned)	Off	-
[Trigger ID254]	(Not Assigned)	Off	-
[Trigger ID255]	(Not Assigned)	Off	-
[Trigger ID256]	(Not Assigned)	Off	-

Table 8.2-2 Event2 group set with [End of E.Record-1]=256 and [End of E.Record-2]=512

Triggers	Data IDs	Modes	Names	Triggers	Data IDs	Modes	Names	Triggers	Data IDs	Modes	Names
[Trigger ID257]	(Not Assigned)	Off	-	[Trigger ID347]	(Not Assigned)	Off	-	[Trigger ID437]	(Not Assigned)	Off	-
[Trigger ID258]	(Not Assigned)	Off	-	[Trigger ID348]	(Not Assigned)	Off	-	[Trigger ID438]	(Not Assigned)	Off	-
[Trigger ID259]	(Not Assigned)	Off	-	[Trigger ID349]	(Not Assigned)	Off	-	[Trigger ID439]	(Not Assigned)	Off	-
[Trigger ID260]	(Not Assigned)	Off	-	[Trigger ID350]	(Not Assigned)	Off	-	[Trigger ID440]	(Not Assigned)	Off	-
[Trigger ID261]	(Not Assigned)	Off	-	[Trigger ID351]	(Not Assigned)	Off	-	[Trigger ID441]	(Not Assigned)	Off	-
[Trigger ID262]	(Not Assigned)	Off	-	[Trigger ID352]	(Not Assigned)	Off	-	[Trigger ID442]	(Not Assigned)	Off	-
[Trigger ID263]	(Not Assigned)	Off	-	[Trigger ID353]	(Not Assigned)	Off	-	[Trigger ID443]	(Not Assigned)	Off	-
[Trigger ID264]	(Not Assigned)	Off	-	[Trigger ID354]	(Not Assigned)	Off	-	[Trigger ID444]	(Not Assigned)	Off	-
[Trigger ID265]	(Not Assigned)	Off	-	[Trigger ID355]	(Not Assigned)	Off	-	[Trigger ID445]	(Not Assigned)	Off	-
[Trigger ID266]	(Not Assigned)	Off	-	[Trigger ID356]	(Not Assigned)	Off	-	[Trigger ID446]	(Not Assigned)	Off	-
[Trigger ID267]	(Not Assigned)	Off	-	[Trigger ID357]	(Not Assigned)	Off	-	[Trigger ID447]	(Not Assigned)	Off	-
[Trigger ID268]	(Not Assigned)	Off	-	[Trigger ID358]	(Not Assigned)	Off	-	[Trigger ID448]	(Not Assigned)	Off	-
[Trigger ID269]	(Not Assigned)	Off	-	[Trigger ID359]	(Not Assigned)	Off	-	[Trigger ID449]	(Not Assigned)	Off	-
[Trigger ID270]	(Not Assigned)	Off	-	[Trigger ID360]	(Not Assigned)	Off	-	[Trigger ID450]	(Not Assigned)	Off	-
[Trigger ID271]	(Not Assigned)	Off	-	[Trigger ID361]	(Not Assigned)	Off	-	[Trigger ID451]	(Not Assigned)	Off	-
[Trigger ID272]	(Not Assigned)	Off	-	[Trigger ID362]	(Not Assigned)	Off	-	[Trigger ID452]	(Not Assigned)	Off	-
[Trigger ID273]	(Not Assigned)	Off	-	[Trigger ID363]	(Not Assigned)	Off	-	[Trigger ID453]	(Not Assigned)	Off	-
[Trigger ID274]	(Not Assigned)	Off	-	[Trigger ID364]	(Not Assigned)	Off	-	[Trigger ID454]	(Not Assigned)	Off	-
[Trigger ID275]	(Not Assigned)	Off	-	[Trigger ID365]	(Not Assigned)	Off	-	[Trigger ID455]	(Not Assigned)	Off	-
[Trigger ID276]	(Not Assigned)	Off	-	[Trigger ID366]	(Not Assigned)	Off	-	[Trigger ID456]	(Not Assigned)	Off	-
[Trigger ID277]	(Not Assigned)	Off	-	[Trigger ID367]	(Not Assigned)	Off	-	[Trigger ID457]	(Not Assigned)	Off	-
[Trigger ID278]	(Not Assigned)	Off	-	[Trigger ID368]	(Not Assigned)	Off	-	[Trigger ID458]	(Not Assigned)	Off	-
[Trigger ID279]	(Not Assigned)	Off	-	[Trigger ID369]	(Not Assigned)	Off	-	[Trigger ID459]	(Not Assigned)	Off	-
[Trigger ID280]	(Not Assigned)	Off	-	[Trigger ID370]	(Not Assigned)	Off	-	[Trigger ID460]	(Not Assigned)	Off	-
[Trigger ID281]	(Not Assigned)	Off	-	[Trigger ID371]	(Not Assigned)	Off	-	[Trigger ID461]	(Not Assigned)	Off	-
[Trigger ID282]	(Not Assigned)	Off	-	[Trigger ID372]	(Not Assigned)	Off	-	[Trigger ID462]	(Not Assigned)	Off	-
[Trigger ID283]	(Not Assigned)	Off	-	[Trigger ID373]	(Not Assigned)	Off	-	[Trigger ID463]	(Not Assigned)	Off	-
[Trigger ID284]	(Not Assigned)	Off	-	[Trigger ID374]	(Not Assigned)	Off	-	[Trigger ID464]	(Not Assigned)	Off	-
[Trigger ID285]	(Not Assigned)	Off	-	[Trigger ID375]	(Not Assigned)	Off	-	[Trigger ID465]	(Not Assigned)	Off	-
[Trigger ID286]	(Not Assigned)	Off	-	[Trigger ID376]	(Not Assigned)	Off	-	[Trigger ID466]	(Not Assigned)	Off	-
[Trigger ID287]	(Not Assigned)	Off	-	[Trigger ID377]	(Not Assigned)	Off	-	[Trigger ID467]	(Not Assigned)	Off	-
[Trigger ID288]	(Not Assigned)	Off	-	[Trigger ID378]	(Not Assigned)	Off	-	[Trigger ID468]	(Not Assigned)	Off	-
[Trigger ID289]	(Not Assigned)	Off	-	[Trigger ID379]	(Not Assigned)	Off	-	[Trigger ID469]	(Not Assigned)	Off	-
[Trigger ID290]	(Not Assigned)	Off	-	[Trigger ID380]	(Not Assigned)	Off	-	[Trigger ID470]	(Not Assigned)	Off	-
[Trigger ID291]	(Not Assigned)	Off	-	[Trigger ID381]	(Not Assigned)	Off	-	[Trigger ID471]	(Not Assigned)	Off	-
[Trigger ID292]	(Not Assigned)	Off	-	[Trigger ID382]	(Not Assigned)	Off	-	[Trigger ID472]	(Not Assigned)	Off	-
[Trigger ID293]	(Not Assigned)	Off	-	[Trigger ID383]	(Not Assigned)	Off	-	[Trigger ID473]	(Not Assigned)	Off	-
[Trigger ID294]	(Not Assigned)	Off	-	[Trigger ID384]	(Not Assigned)	Off	-	[Trigger ID474]	(Not Assigned)	Off	-
[Trigger ID295]	(Not Assigned)	Off	-	[Trigger ID385]	(Not Assigned)	Off	-	[Trigger ID475]	(Not Assigned)	Off	-
[Trigger ID296]	(Not Assigned)	Off	-	[Trigger ID386]	(Not Assigned)	Off	-	[Trigger ID476]	(Not Assigned)	Off	-
[Trigger ID297]	(Not Assigned)	Off	-	[Trigger ID387]	(Not Assigned)	Off	-	[Trigger ID477]	(Not Assigned)	Off	-
[Trigger ID298]	(Not Assigned)	Off	-	[Trigger ID388]	(Not Assigned)	Off	-	[Trigger ID478]	(Not Assigned)	Off	-
[Trigger ID299]	(Not Assigned)	Off	-	[Trigger ID389]	(Not Assigned)	Off	-	[Trigger ID479]	(Not Assigned)	Off	-
[Trigger ID300]	(Not Assigned)	Off	-	[Trigger ID390]	(Not Assigned)	Off	-	[Trigger ID480]	(Not Assigned)	Off	-
[Trigger ID301]	(Not Assigned)	Off	-	[Trigger ID391]	(Not Assigned)	Off	-	[Trigger ID481]	(Not Assigned)	Off	-
[Trigger ID302]	(Not Assigned)	Off	-	[Trigger ID392]	(Not Assigned)	Off	-	[Trigger ID482]	(Not Assigned)	Off	-
[Trigger ID303]	(Not Assigned)	Off	-	[Trigger ID393]	(Not Assigned)	Off	-	[Trigger ID483]	(Not Assigned)	Off	-
[Trigger ID304]	(Not Assigned)	Off	-	[Trigger ID394]	(Not Assigned)	Off	-	[Trigger ID484]	(Not Assigned)	Off	-
[Trigger ID305]	(Not Assigned)	Off	-	[Trigger ID395]	(Not Assigned)	Off	-	[Trigger ID485]	(Not Assigned)	Off	-
[Trigger ID306]	(Not Assigned)	Off	-	[Trigger ID396]	(Not Assigned)	Off	-	[Trigger ID486]	(Not Assigned)	Off	-
[Trigger ID307]	(Not Assigned)	Off	-	[Trigger ID397]	(Not Assigned)	Off	-	[Trigger ID487]	(Not Assigned)	Off	-
[Trigger ID308]	(Not Assigned)	Off	-	[Trigger ID398]	(Not Assigned)	Off	-	[Trigger ID488]	(Not Assigned)	Off	-
[Trigger ID309]	(Not Assigned)	Off	-	[Trigger ID399]	(Not Assigned)	Off	-	[Trigger ID489]	(Not Assigned)	Off	-
[Trigger ID310]	(Not Assigned)	Off	-	[Trigger ID400]	(Not Assigned)	Off	-	[Trigger ID490]	(Not Assigned)	Off	-
[Trigger ID311]	(Not Assigned)	Off	-	[Trigger ID401]	(Not Assigned)	Off	-	[Trigger ID491]	(Not Assigned)	Off	-
[Trigger ID312]	(Not Assigned)	Off	-	[Trigger ID402]	(Not Assigned)	Off	-	[Trigger ID492]	(Not Assigned)	Off	-
[Trigger ID313]	(Not Assigned)	Off	-	[Trigger ID403]	(Not Assigned)	Off	-	[Trigger ID493]	(Not Assigned)	Off	-
[Trigger ID314]	(Not Assigned)	Off	-	[Trigger ID404]	(Not Assigned)	Off	-	[Trigger ID494]	(Not Assigned)	Off	-
[Trigger ID315]	(Not Assigned)	Off	-	[Trigger ID405]	(Not Assigned)	Off	-	[Trigger ID495]	(Not Assigned)	Off	-
[Trigger ID316]	(Not Assigned)	Off	-	[Trigger ID406]	(Not Assigned)	Off	-	[Trigger ID496]	(Not Assigned)	Off	-
[Trigger ID317]	(Not Assigned)	Off	-	[Trigger ID407]	(Not Assigned)	Off	-	[Trigger ID497]	(Not Assigned)	Off	-
[Trigger ID318]	(Not Assigned)	Off	-	[Trigger ID408]	(Not Assigned)	Off	-	[Trigger ID498]	(Not Assigned)	Off	-
[Trigger ID319]	(Not Assigned)	Off	-	[Trigger ID409]	(Not Assigned)	Off	-	[Trigger ID499]	(Not Assigned)	Off	-
[Trigger ID320]	(Not Assigned)	Off	-	[Trigger ID410]	(Not Assigned)	Off	-	[Trigger ID500]	(Not Assigned)	Off	-
[Trigger ID321]	(Not Assigned)	Off	-	[Trigger ID411]	(Not Assigned)	Off	-	[Trigger ID501]	(Not Assigned)	Off	-
[Trigger ID322]	(Not Assigned)	Off	-	[Trigger ID412]	(Not Assigned)	Off	-	[Trigger ID502]	(Not Assigned)	Off	-
[Trigger ID323]	(Not Assigned)	Off	-	[Trigger ID413]	(Not Assigned)	Off	-	[Trigger ID503]	(Not Assigned)	Off	-
[Trigger ID324]	(Not Assigned)	Off	-	[Trigger ID414]	(Not Assigned)	Off	-	[Trigger ID504]	(Not Assigned)	Off	-
[Trigger ID325]	(Not Assigned)	Off	-	[Trigger ID415]	(Not Assigned)	Off	-	[Trigger ID505]	(Not Assigned)	Off	-
[Trigger ID326]	(Not Assigned)	Off	-	[Trigger ID416]	(Not Assigned)	Off	-	[Trigger ID506]	(Not Assigned)	Off	-
[Trigger ID327]	(Not Assigned)	Off	-	[Trigger ID417]	(Not Assigned)	Off	-	[Trigger ID507]	(Not Assigned)	Off	-
[Trigger ID328]	(Not Assigned)	Off	-	[Trigger ID418]	(Not Assigned)	Off	-	[Trigger ID508]	(Not Assigned)	Off	-
[Trigger ID329]	(Not Assigned)	Off	-	[Trigger ID419]	(Not Assigned)	Off	-	[Trigger ID509]	(Not Assigned)	Off	-
[Trigger ID330]	(Not Assigned)	Off	-	[Trigger ID420]	(Not Assigned)	Off	-	[Trigger ID510]	(Not Assigned)	Off	-
[Trigger ID331]	(Not Assigned)	Off	-	[Trigger ID421]	(Not Assigned)	Off	-	[Trigger ID511]	(Not Assigned)	Off	-
[Trigger ID332]	(Not Assigned)	Off	-	[Trigger ID422]	(Not Assigned)	Off	-	[Trigger ID512]	(Not Assigned)	Off	-
[Trigger ID333]	(Not Assigned)	Off	-	[Trigger ID423]	(Not Assigned)	Off	-				
[Trigger ID334]	(Not Assigned)	Off	-	[Trigger ID424]	(Not Assigned)	Off	-				
[Trigger ID335]	(Not Assigned)	Off	-	[Trigger ID425]	(Not Assigned)	Off	-				
[Trigger ID336]	(Not Assigned)	Off	-	[Trigger ID426]	(Not Assigned)	Off	-				
[Trigger ID337]	(Not Assigned)	Off	-	[Trigger ID427]	(Not Assigned)	Off	-				
[Trigger ID338]	(Not Assigned)	Off	-	[Trigger ID428]	(Not Assigned)	Off	-				
[Trigger ID339]	(Not Assigned)	Off	-	[Trigger ID429]	(Not Assigned)	Off	-				
[Trigger ID340]	(Not Assigned)	Off	-	[Trigger ID430]	(Not Assigned)	Off	-				
[Trigger ID341]	(Not Assigned)	Off	-	[Trigger ID431]	(Not Assigned)	Off	-				
[Trigger ID342]	(Not Assigned)	Off	-	[Trigger ID432]	(Not Assigned)	Off	-				
[Trigger ID343]	(Not Assigned)	Off	-	[Trigger ID433]	(Not Assigned)	Off	-				
[Trigger ID344]	(Not Assigned)	Off	-	[Trigger ID434]	(Not Assigned)	Off	-				
[Trigger ID345]	(Not Assigned)	Off	-	[Trigger ID435]	(Not Assigned)	Off	-				
[Trigger ID346]	(Not Assigned)	Off	-	[Trigger ID436]	(Not Assigned)	Off	-				

Table 8.2-3 Event3 group set with [End of E.Record-2]=512

Triggers	Data IDs	Modes	Names	Triggers	Data IDs	Modes	Names	Triggers	Data IDs	Modes	Names
[Trigger ID513]	(Not Assigned)	Off	-	[Trigger ID603]	(Not Assigned)	Off	-	[Trigger ID693]	(Not Assigned)	Off	-
[Trigger ID514]	(Not Assigned)	Off	-	[Trigger ID604]	(Not Assigned)	Off	-	[Trigger ID694]	(Not Assigned)	Off	-
[Trigger ID515]	(Not Assigned)	Off	-	[Trigger ID605]	(Not Assigned)	Off	-	[Trigger ID695]	(Not Assigned)	Off	-
[Trigger ID516]	(Not Assigned)	Off	-	[Trigger ID606]	(Not Assigned)	Off	-	[Trigger ID696]	(Not Assigned)	Off	-
[Trigger ID517]	(Not Assigned)	Off	-	[Trigger ID607]	(Not Assigned)	Off	-	[Trigger ID697]	(Not Assigned)	Off	-
[Trigger ID518]	(Not Assigned)	Off	-	[Trigger ID608]	(Not Assigned)	Off	-	[Trigger ID698]	(Not Assigned)	Off	-
[Trigger ID519]	(Not Assigned)	Off	-	[Trigger ID609]	(Not Assigned)	Off	-	[Trigger ID699]	(Not Assigned)	Off	-
[Trigger ID520]	(Not Assigned)	Off	-	[Trigger ID610]	(Not Assigned)	Off	-	[Trigger ID700]	(Not Assigned)	Off	-
[Trigger ID521]	(Not Assigned)	Off	-	[Trigger ID611]	(Not Assigned)	Off	-	[Trigger ID701]	(Not Assigned)	Off	-
[Trigger ID522]	(Not Assigned)	Off	-	[Trigger ID612]	(Not Assigned)	Off	-	[Trigger ID702]	(Not Assigned)	Off	-
[Trigger ID523]	(Not Assigned)	Off	-	[Trigger ID613]	(Not Assigned)	Off	-	[Trigger ID703]	(Not Assigned)	Off	-
[Trigger ID524]	(Not Assigned)	Off	-	[Trigger ID614]	(Not Assigned)	Off	-	[Trigger ID704]	(Not Assigned)	Off	-
[Trigger ID525]	(Not Assigned)	Off	-	[Trigger ID615]	(Not Assigned)	Off	-	[Trigger ID705]	(Not Assigned)	Off	-
[Trigger ID526]	(Not Assigned)	Off	-	[Trigger ID616]	(Not Assigned)	Off	-	[Trigger ID706]	(Not Assigned)	Off	-
[Trigger ID527]	(Not Assigned)	Off	-	[Trigger ID617]	(Not Assigned)	Off	-	[Trigger ID707]	(Not Assigned)	Off	-
[Trigger ID528]	(Not Assigned)	Off	-	[Trigger ID618]	(Not Assigned)	Off	-	[Trigger ID708]	(Not Assigned)	Off	-
[Trigger ID529]	(Not Assigned)	Off	-	[Trigger ID619]	(Not Assigned)	Off	-	[Trigger ID709]	(Not Assigned)	Off	-
[Trigger ID530]	(Not Assigned)	Off	-	[Trigger ID620]	(Not Assigned)	Off	-	[Trigger ID710]	(Not Assigned)	Off	-
[Trigger ID531]	(Not Assigned)	Off	-	[Trigger ID621]	(Not Assigned)	Off	-	[Trigger ID711]	(Not Assigned)	Off	-
[Trigger ID532]	(Not Assigned)	Off	-	[Trigger ID622]	(Not Assigned)	Off	-	[Trigger ID712]	(Not Assigned)	Off	-
[Trigger ID533]	(Not Assigned)	Off	-	[Trigger ID623]	(Not Assigned)	Off	-	[Trigger ID713]	(Not Assigned)	Off	-
[Trigger ID534]	(Not Assigned)	Off	-	[Trigger ID624]	(Not Assigned)	Off	-	[Trigger ID714]	(Not Assigned)	Off	-
[Trigger ID535]	(Not Assigned)	Off	-	[Trigger ID625]	(Not Assigned)	Off	-	[Trigger ID715]	(Not Assigned)	Off	-
[Trigger ID536]	(Not Assigned)	Off	-	[Trigger ID626]	(Not Assigned)	Off	-	[Trigger ID716]	(Not Assigned)	Off	-
[Trigger ID537]	(Not Assigned)	Off	-	[Trigger ID627]	(Not Assigned)	Off	-	[Trigger ID717]	(Not Assigned)	Off	-
[Trigger ID538]	(Not Assigned)	Off	-	[Trigger ID628]	(Not Assigned)	Off	-	[Trigger ID718]	(Not Assigned)	Off	-
[Trigger ID539]	(Not Assigned)	Off	-	[Trigger ID629]	(Not Assigned)	Off	-	[Trigger ID719]	(Not Assigned)	Off	-
[Trigger ID540]	(Not Assigned)	Off	-	[Trigger ID630]	(Not Assigned)	Off	-	[Trigger ID720]	(Not Assigned)	Off	-
[Trigger ID541]	(Not Assigned)	Off	-	[Trigger ID631]	(Not Assigned)	Off	-	[Trigger ID721]	(Not Assigned)	Off	-
[Trigger ID542]	(Not Assigned)	Off	-	[Trigger ID632]	(Not Assigned)	Off	-	[Trigger ID722]	(Not Assigned)	Off	-
[Trigger ID543]	(Not Assigned)	Off	-	[Trigger ID633]	(Not Assigned)	Off	-	[Trigger ID723]	(Not Assigned)	Off	-
[Trigger ID544]	(Not Assigned)	Off	-	[Trigger ID634]	(Not Assigned)	Off	-	[Trigger ID724]	(Not Assigned)	Off	-
[Trigger ID545]	(Not Assigned)	Off	-	[Trigger ID635]	(Not Assigned)	Off	-	[Trigger ID725]	(Not Assigned)	Off	-
[Trigger ID546]	(Not Assigned)	Off	-	[Trigger ID636]	(Not Assigned)	Off	-	[Trigger ID726]	(Not Assigned)	Off	-
[Trigger ID547]	(Not Assigned)	Off	-	[Trigger ID637]	(Not Assigned)	Off	-	[Trigger ID727]	(Not Assigned)	Off	-
[Trigger ID548]	(Not Assigned)	Off	-	[Trigger ID638]	(Not Assigned)	Off	-	[Trigger ID728]	(Not Assigned)	Off	-
[Trigger ID549]	(Not Assigned)	Off	-	[Trigger ID639]	(Not Assigned)	Off	-	[Trigger ID729]	(Not Assigned)	Off	-
[Trigger ID550]	(Not Assigned)	Off	-	[Trigger ID640]	(Not Assigned)	Off	-	[Trigger ID730]	(Not Assigned)	Off	-
[Trigger ID551]	(Not Assigned)	Off	-	[Trigger ID641]	(Not Assigned)	Off	-	[Trigger ID731]	(Not Assigned)	Off	-
[Trigger ID552]	(Not Assigned)	Off	-	[Trigger ID642]	(Not Assigned)	Off	-	[Trigger ID732]	(Not Assigned)	Off	-
[Trigger ID553]	(Not Assigned)	Off	-	[Trigger ID643]	(Not Assigned)	Off	-	[Trigger ID733]	(Not Assigned)	Off	-
[Trigger ID554]	(Not Assigned)	Off	-	[Trigger ID644]	(Not Assigned)	Off	-	[Trigger ID734]	(Not Assigned)	Off	-
[Trigger ID555]	(Not Assigned)	Off	-	[Trigger ID645]	(Not Assigned)	Off	-	[Trigger ID735]	(Not Assigned)	Off	-
[Trigger ID556]	(Not Assigned)	Off	-	[Trigger ID646]	(Not Assigned)	Off	-	[Trigger ID736]	(Not Assigned)	Off	-
[Trigger ID557]	(Not Assigned)	Off	-	[Trigger ID647]	(Not Assigned)	Off	-	[Trigger ID737]	(Not Assigned)	Off	-
[Trigger ID558]	(Not Assigned)	Off	-	[Trigger ID648]	(Not Assigned)	Off	-	[Trigger ID738]	(Not Assigned)	Off	-
[Trigger ID559]	(Not Assigned)	Off	-	[Trigger ID649]	(Not Assigned)	Off	-	[Trigger ID739]	(Not Assigned)	Off	-
[Trigger ID560]	(Not Assigned)	Off	-	[Trigger ID650]	(Not Assigned)	Off	-	[Trigger ID740]	(Not Assigned)	Off	-
[Trigger ID561]	(Not Assigned)	Off	-	[Trigger ID651]	(Not Assigned)	Off	-	[Trigger ID741]	(Not Assigned)	Off	-
[Trigger ID562]	(Not Assigned)	Off	-	[Trigger ID652]	(Not Assigned)	Off	-	[Trigger ID742]	(Not Assigned)	Off	-
[Trigger ID563]	(Not Assigned)	Off	-	[Trigger ID653]	(Not Assigned)	Off	-	[Trigger ID743]	(Not Assigned)	Off	-
[Trigger ID564]	(Not Assigned)	Off	-	[Trigger ID654]	(Not Assigned)	Off	-	[Trigger ID744]	(Not Assigned)	Off	-
[Trigger ID565]	(Not Assigned)	Off	-	[Trigger ID655]	(Not Assigned)	Off	-	[Trigger ID745]	(Not Assigned)	Off	-
[Trigger ID566]	(Not Assigned)	Off	-	[Trigger ID656]	(Not Assigned)	Off	-	[Trigger ID746]	(Not Assigned)	Off	-
[Trigger ID567]	(Not Assigned)	Off	-	[Trigger ID657]	(Not Assigned)	Off	-	[Trigger ID747]	(Not Assigned)	Off	-
[Trigger ID568]	(Not Assigned)	Off	-	[Trigger ID658]	(Not Assigned)	Off	-	[Trigger ID748]	(Not Assigned)	Off	-
[Trigger ID569]	(Not Assigned)	Off	-	[Trigger ID659]	(Not Assigned)	Off	-	[Trigger ID749]	(Not Assigned)	Off	-
[Trigger ID570]	(Not Assigned)	Off	-	[Trigger ID660]	(Not Assigned)	Off	-	[Trigger ID760]	(Not Assigned)	Off	-
[Trigger ID571]	(Not Assigned)	Off	-	[Trigger ID661]	(Not Assigned)	Off	-	[Trigger ID761]	(Not Assigned)	Off	-
[Trigger ID572]	(Not Assigned)	Off	-	[Trigger ID662]	(Not Assigned)	Off	-	[Trigger ID762]	(Not Assigned)	Off	-
[Trigger ID573]	(Not Assigned)	Off	-	[Trigger ID663]	(Not Assigned)	Off	-	[Trigger ID763]	(Not Assigned)	Off	-
[Trigger ID574]	(Not Assigned)	Off	-	[Trigger ID664]	(Not Assigned)	Off	-	[Trigger ID764]	(Not Assigned)	Off	-
[Trigger ID575]	(Not Assigned)	Off	-	[Trigger ID665]	(Not Assigned)	Off	-	[Trigger ID765]	(Not Assigned)	Off	-
[Trigger ID576]	(Not Assigned)	Off	-	[Trigger ID666]	(Not Assigned)	Off	-	[Trigger ID766]	(Not Assigned)	Off	-
[Trigger ID577]	(Not Assigned)	Off	-	[Trigger ID667]	(Not Assigned)	Off	-	[Trigger ID767]	(Not Assigned)	Off	-
[Trigger ID578]	(Not Assigned)	Off	-	[Trigger ID668]	(Not Assigned)	Off	-	[Trigger ID768]	(Not Assigned)	Off	-
[Trigger ID579]	(Not Assigned)	Off	-	[Trigger ID669]	(Not Assigned)	Off	-				
[Trigger ID580]	(Not Assigned)	Off	-	[Trigger ID670]	(Not Assigned)	Off	-				
[Trigger ID581]	(Not Assigned)	Off	-	[Trigger ID671]	(Not Assigned)	Off	-				
[Trigger ID582]	(Not Assigned)	Off	-	[Trigger ID672]	(Not Assigned)	Off	-				
[Trigger ID583]	(Not Assigned)	Off	-	[Trigger ID673]	(Not Assigned)	Off	-				
[Trigger ID584]	(Not Assigned)	Off	-	[Trigger ID674]	(Not Assigned)	Off	-				
[Trigger ID585]	(Not Assigned)	Off	-	[Trigger ID675]	(Not Assigned)	Off	-				
[Trigger ID586]	(Not Assigned)	Off	-	[Trigger ID676]	(Not Assigned)	Off	-				
[Trigger ID587]	(Not Assigned)	Off	-	[Trigger ID677]	(Not Assigned)	Off	-				
[Trigger ID588]	(Not Assigned)	Off	-	[Trigger ID678]	(Not Assigned)	Off	-				
[Trigger ID589]	(Not Assigned)	Off	-	[Trigger ID679]	(Not Assigned)	Off	-				
[Trigger ID590]	(Not Assigned)	Off	-	[Trigger ID680]	(Not Assigned)	Off	-				
[Trigger ID591]	(Not Assigned)	Off	-	[Trigger ID681]	(Not Assigned)	Off	-				
[Trigger ID592]	(Not Assigned)	Off	-	[Trigger ID682]	(Not Assigned)	Off	-				
[Trigger ID593]	(Not Assigned)	Off	-	[Trigger ID683]	(Not Assigned)	Off	-				
[Trigger ID594]	(Not Assigned)	Off	-	[Trigger ID684]	(Not Assigned)	Off	-				
[Trigger ID595]	(Not Assigned)	Off	-	[Trigger ID685]	(Not Assigned)	Off	-				
[Trigger ID596]	(Not Assigned)	Off	-	[Trigger ID686]	(Not Assigned)	Off	-				
[Trigger ID597]	(Not Assigned)	Off	-	[Trigger ID687]	(Not Assigned)	Off	-				
[Trigger ID598]	(Not Assigned)	Off	-	[Trigger ID688]	(Not Assigned)	Off	-				
[Trigger ID599]	(Not Assigned)	Off	-	[Trigger ID689]	(Not Assigned)	Off	-				
[Trigger ID600]	(Not Assigned)	Off	-	[Trigger ID690]	(Not Assigned)	Off	-				
[Trigger ID601]	(Not Assigned)	Off	-	[Trigger ID691]	(Not Assigned)	Off	-				
[Trigger ID602]	(Not Assigned)	Off	-	[Trigger ID692]	(Not Assigned)	Off	-				

8.2.2 Trigger modes

We can simplify the trigger signals into four: 'On', 'Off', 'On and Off', and 'Change' modes. Thus, the user can should set a mode for respective triggers using [**Trigger Mode1**] and others.

(i) 'On' mode

In the 'On' mode, the event recorder can take an action when the trigger signal is switched to 'On', as shown in Figure 8.2-2. For the operation, set **On** for the [**Trigger Mode***].

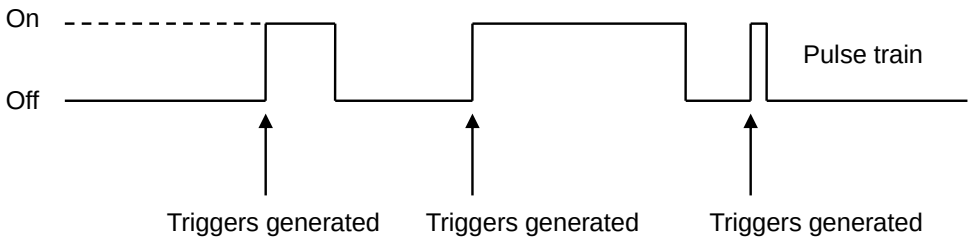


Figure 8.2-2 Trigger generated at 'On' mode

(ii) 'Off' mode

The 'Off' mode is the other way of the 'On' mode; set **Off** for the operation.

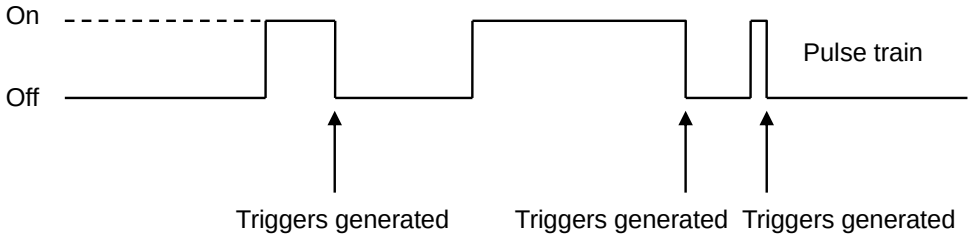


Figure 8.2-3 Trigger generated at 'Off' mode

(iii) 'On-Off' mode

In the 'On-Off' mode, the trigger signal is generated when the pulse train is changed from 'On to Off' and 'Off to On' both, as shown in Figure 8.2-4. Set **On-Off** for the operation

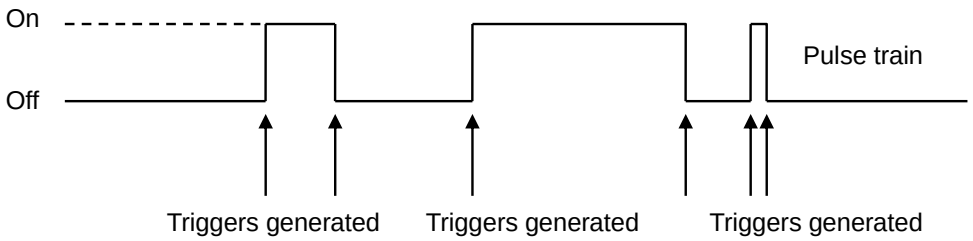


Figure 8.2-4 Trigger generated at 'On-Off' mode

(iv) 'Change' mode

The 'Change mode' is provided to detect the increment or the decrement of a number, where the PLC logic generates. For example, this mode allows to detect the change of group settings

(e.g., the 'SYS_CHG' signal; which has been connected with the trigger#9 using the setting [**Trigger ID9**], as default; we have been discussed in Chapter *Technical description: Group setting for protection functions*.)

8.2.3 Screen information

Figure 8.2-5 illustrates the structure about the 'Event Recored1' group, which can be shown the latest event#1 at the top structure (line ⓑ). The lines ⓒ and ⓓ describes how an event occurred for the event#1. Preceding event#2, event#3, etc. are shown below the event#1. Similarly, the information about the 'Event Record2' and 'Event Record3' groups are displayed on the IED screen.

†Note:For more information about the screen operation, see Chapter *User interface: Record sub-menu*.

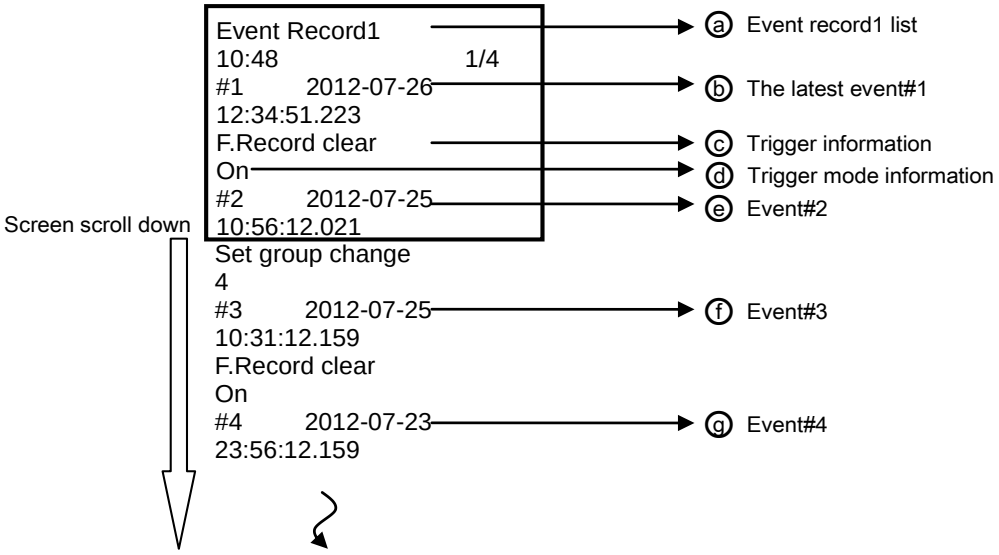


Figure 8.2-5 Event information grouped in the Event record1

8.2.4 Setup for the event recorder

Consider that a trip-command, which is denoted with Data ID '4A1001 8300001B6F', should be sorted into the 'Event record1' group. The settings [**End of E.Record-1**]=256 and [**End of E.Record-2**]=512 have been made as default; hence, we may select it with the trigger#157 by setting the [**Trigger ID157**]= '4A1001 8300001B6F'. Set **On-OFF** for the [**Trigger Mode157**], because the pulse-train of the trip command should be recorded along the pick-up and drop-off times. Remember that the preferred name for the Trigger ID157 should be set using the [**Event Name157**].

8.2.5 Setting

Setting of EVENTRECORD(Function ID: 200710)

Setting item		Range	Units	Contents	Default setting value	Notes
	End of E.Record-1	0 to 768	–	The last position of the event group1	256	
	End of E.Record-2	0 to 768	–	The last position of the event group2	521	
	Trigger ID1	(Preferred DataID)	–	Trigger signal1 for the operation	–	
	Tigger Mode1	On / Off / On-Off / Change	–	Mode setting for the detection	–	
	Event name1	(Preferred name)	–	Name of the trigger signal1	–	
	Trigger ID2	(Preferred DataID)	–	Trigger signal2 for the operation	–	
	Tigger Mode2	On / Off / On-Off / Change	–	Mode setting for the detection	–	
	Event name2	(Preferred name)	–	Name of the trigger signal2	–	
	……	……	–	……	–	
	……	……	–	……	–	
	……	……	–	……	–	
	Trigger ID768	(Preferred DataID)	–	Trigger signal768 for the operation	–	
	Tigger Mode768	On / Off / On-Off / Change	–	Mode setting for the detection	–	
	Event name768	(Preferred name)	–	Name of the trigger signal768	–	

8.2.6 Signal (Data ID)

◆ Signal monitoring point

EVENTRECORD (Function ID: 200710)

Name	Element ID	Description
ER1_CLR	3001001001	Clearing the data in Event group1
ER2_CLR	3002001001	Clearing the data in Event group2
ER3_CLR	3003001001	Clearing the data in Event group3
POWER ON	3100001001	Detection of switch On

8.3 Disturbance recorder

Disturbance recorder is to record the phenomenon about the occurrences of the fault with 1ms accuracy; the disturbance recorder is operated with the reception of the TRC trip command. The disturbance recorder has exclusive overcurrent and other relays; thus, they can also start the disturbance recorder when the exclusive relays detects abnormal phenomenon. Additionally, the disturbance recorder can accept the instruction of the PLC function using settings. The recording time and the sampling time are programmable; thus, the measuring values about currents, voltage, frequency, and logic signals are collected in accordance with the recording and the sampling times. The logic signals are also memorized during the disturbance phenomenon; the disturbance recorder can hold up to 256 signals. The recording number of the disturbance phenomena is limited by the recording and sampling times.

8.3.1 Recording time and amount

(i) Time settings

Period of the recording is set using the [**Record Time**]. The disturbance recorder can operate before the occurrence of the fault; the time before the fault occurrence can be set using the [**Pre-fault Time**]. The user can choose a time among 0.1 sec. to 10.0 sec.

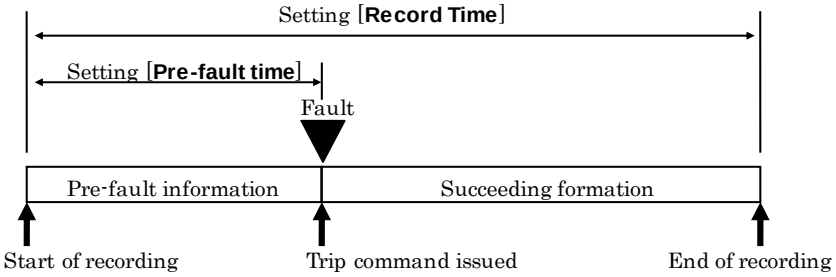


Figure 8.3-1 Period of recording time

(ii) Sampling rate setting

Sampling time is defined with setting [**Sampling rate**]; it can be can choose from 7.5 electrical degree to 15.0 electrical degree. For example, if the user set **7.5** for the [**Sampling rate**], the disturbance recorder starts to collect the date in the sampling rate (2400Hz) in 50Hz system.

(iii) Trip command setting

As shown in Figure 8.3-1, the disturbance recorder starts when the trip command is issued, provided **On** is set for the [**Trip Trig.Sw**]. If the disturbance recorder shall not start with the trip command, set **Off**.

8.3.2 Relays within disturbance recorder

Four relays are provided in the disturbance recorder exclusively: OC-DRT, EF-DRT, UV-DRT, and UVS-DRT relays.

(i) OC-DRT relay setting

An overcurrent relay within the disturbance recorder (OC-DRT) is provided. The user should set a pick-up value for the relay to commence the disturbance recorder. Use the setting [**OC-DRT**]; then set **On** for the [**OC-DRT-EN**] if this relay operation is required to commence the recording.

(ii) EF-DRT relay setting

An earth fault relay (EF-DRT) is provided; set the pick-up value for the [**EF-DRT**]; then set **On** for the [**EF-DRT-EN**].

(iii) UV-DRT relay setting

An under-voltage relay (Line-ground) (UV-DRT) is provided. Set the value for the [**UV-DRT**]; then set **On** for the [**UV-DRT-EN**].

(iv) UVS-DRT relay setting

An under-voltage relay (Line-Line) (UVS-DRT) is provided. Set the value for the [**UVS-DRT**]; then set **On** for the [**UVS-DRT-EN**].

8.3.3 Maximum number for recording disturbance phenomena

Note that the maximum number for recording the disturbance phenomena depends on the recording time and the sampling rate. Table 8.3-1 illustrates the maximum number. For example, the 77 phenomena can be memorized in the disturbance recorder, when the [**Record Time**] =1 and the [**Sampling Rate**] =7.5° elec., if the IED operates in 50Hz system. The user can also check the maximum number on the IED screen (See Figure 8.3-2).

Table 8.3-1 Max number depending on time settings

Recording period set with [**Record Time**]	Max. recording number for Disturbance phenomena			
	Setting [**Sampling Rate**] in 50Hz sys.		Setting [**Sampling Rate**] in 60Hz sys.	
	7.5°	**15°**	**7.5°**	**15°**
1 sec	77	151	64	126
3 sec	26	51	21	43
5 sec	15	31	13	26

8.3.4 Number of analog quantities and logical signals for disturbance recorder

Ten analog quantities and 256 logical signals are record in a disturbance phenomenon.

(i) Number of analog quantities

For example, when VCT11B is used in the IED, currents (Ia, Ib, Ic, Ie, Iem) and the voltages (Va, Vb, Vc, Vs, Vs2) are recorded. For more information about the VCT, see Chapter *Technical description: Transformer module for AC analog input*.

Table 8.3-2 Recording number of logic signals depending on time settings

VCT type	11B	12B
Voltages	V_a	V_a
	V_b	V_b
	V_c	V_c
	Vs	Vs
	Vs2	Vs2
Currents	Ia	Ia
	Ib	Ib
	Ic	Ic
	Ie	Ie
	Iem	Iem
Number of recording	10	10

(ii) Number of logical signals

As mentioned earlier, the disturbance recorder can hold the traces of logic signals during the recording time. Using settings [**Binary Signal***], the user can select 256 logic signal arbitrary. The logic signals that the user has selected should be termed with user's preferred names using settings [**Binary Sig.Name***]. Table 8.3-3 tabulates the settings. For example, 'CB1-A_CLOSE' signal of the PROT_COMM function may be chosen to record using the setting [**Binary Signal1**]; we should term it 'CB1-A_CLOSE' using the [**Binary Sig.Name1**].

Table 8.3-3 Setting list for logic signals

Settings	Data IDs	[Binary Sig. Name]	Origins
[Binary Signal1]	48A001 8000001B73	CB1-A_CLOSE	PROT_COMM
[Binary Signal2]	48A001 8100001B74	CB1-B_CLOSE	PROT_COMM
[Binary Signal3]	48A001 8200001B75	CB1-C_CLOSE	PROT_COMM
[Binary Signal4]	48A001 8000001B7C	CB2-A_CLOSE	PROT_COMM
[Binary Signal5]	48A001 8100001B7D	CB2-B_CLOSE	PROT_COMM
[Binary Signal6]	48A001 8200001B7E	CB2-C_CLOSE	PROT_COMM
[Binary Signal7]	48A001 8E00001B85	DS_CLOSE	PROT_COMM
[Binary Signal8]	4A0001 8300001B6F	GEN.TRIP	TRC
[Binary Signal9]	4A0001 8000001B6C	GEN.TRIP-A	TRC
[Binary Signal10]	4A0001 8100001B6D	GEN.TRIP-B	TRC
[Binary Signal11]	4A0001 8200001B6E	GEN.TRIP-C	TRC
[Binary Signal12]	4A0001 8400001B64	GEN.ALARM	TRC
[Binary Signal13]	490001 8000001B61	VTF_DETECT	VTF
[Binary Signal14]	491001 8000001B62	CTF_DETECT	CTF
[Binary Signal15]	410001 8000001B20	DIFL-TRIP-A	DIFL
[Binary Signal16]	410001 8100001B21	DIFL-TRIP-B	DIFL
[Binary Signal17]	410001 8200001B22	DIFL-TRIP-C	DIFL
[Binary Signal18]	411001 8000001B23	DIFLG-TRIP	DIFL
[Binary Signal19]	4A9001 8000111C30	RY_BLOCK-CH1	COMM_APPL
[Binary Signal20]	4A9001 8100111C31	RY_BLOCK-CH2	COMM_APPL
[Binary Signal21]	430001 8300011B63	Z1S-ORX	ZS
[Binary Signal22]	430001 8700061B63	Z1XS-ORX	ZS
[Binary Signal23]	430001 8300021B63	Z2S-ORX	ZS
[Binary Signal24]	430001 8700031B63	Z3S-ORX	ZS
[Binary Signal25]	430001 8000011B23	Z1S-OPT	ZS
[Binary Signal26]	430001 8100061B23	Z1XS-OPT	ZS
[Binary Signal27]	430001 8200021B23	Z2S-OPT	ZS
[Binary Signal28]	430001 8300031B23	Z3S-OPT	ZS
[Binary Signal29]	430001 8000081B61	PSBS_DET	ZS
[Binary Signal30]	431001 8300011B63	Z1G-ORX	ZG
[Binary Signal31]	431001 8700061B63	Z1XG-ORX	ZG
[Binary Signal32]	431001 8300021B63	Z2G-ORX	ZG
[Binary Signal33]	431001 8700031B63	Z3G-ORX	ZG
[Binary Signal34]	431001 8000011B69	Z1G-OPT	ZG
[Binary Signal35]	431001 8100061B69	Z1XG-OPT	ZG
[Binary Signal36]	431001 8200021B69	Z2G-OPT	ZG
[Binary Signal37]	431001 8300031B69	Z3G-OPT	ZG
[Binary Signal38]	431001 8000081B70	PSBG_DET	ZG
[Binary Signal39]	4A6001 8000011B60	ARC1_READY	ARC
[Binary Signal40]	4A6001 8000021B60	ARC2_READY	ARC
[Binary Signal41]	4A6001 8000011B6C	ARC1_CLOSE_COMMAND	ARC
[Binary Signal42]	4A6001 8100021B68	ARC2_CLOSE_COMMAND	ARC
[Binary Signal43]	4A6001 8400011B6E	ARC1_FT	ARC
[Binary Signal44]	4A6001 8400021B6A	ARC2_FT	ARC
[Binary Signal45]	4A6001 8200001BB4	ARC_BLOCK	ARC
[Binary Signal46]	436001 8300001B76	DISCA	DISCAR
[Binary Signal47]	437001 8300001B77	DEFCA	DEFCAR
[Binary Signal48]	(Not Assigned)	-	....
[Binary Signal49]	(Not Assigned)	-	....
[Binary Signal50]	(Not Assigned)	-	....
[Binary Signal51]	(Not Assigned)	-	....
[Binary Signal52]	(Not Assigned)	-	....
[Binary Signal53]	(Not Assigned)	-	....
[Binary Signal54]	(Not Assigned)	-	....
[Binary Signal55]	(Not Assigned)	-	....
[Binary Signal56]	(Not Assigned)	-	....
[Binary Signal57]	(Not Assigned)	-	....
[Binary Signal58]	(Not Assigned)	-	....
[Binary Signal59]	(Not Assigned)	-	....
[Binary Signal60]	(Not Assigned)	-	....
[Binary Signal61]	(Not Assigned)	-	....
[Binary Signal62]	(Not Assigned)	-	....
[Binary Signal63]	(Not Assigned)	-	....
[Binary Signal64]	(Not Assigned)	-	....
[Binary Signal65]	(Not Assigned)	-	....
[Binary Signal66]	(Not Assigned)	-	....
[Binary Signal67]	(Not Assigned)	-	....
[Binary Signal68]	(Not Assigned)	-	....
[Binary Signal69]	(Not Assigned)	-	....
[Binary Signal70]	(Not Assigned)	-	....
[Binary Signal71]	(Not Assigned)	-	....
[Binary Signal72]	(Not Assigned)	-	....
[Binary Signal73]	(Not Assigned)	-	....
[Binary Signal74]	(Not Assigned)	-	....
[Binary Signal75]	(Not Assigned)	-	....
[Binary Signal76]	(Not Assigned)	-	....
[Binary Signal77]	(Not Assigned)	-	....
[Binary Signal78]	(Not Assigned)	-	....
[Binary Signal79]	(Not Assigned)	-	....
[Binary Signal80]	(Not Assigned)	-	....
[Binary Signal81]	(Not Assigned)	-	....
[Binary Signal82]	(Not Assigned)	-	....
[Binary Signal83]	(Not Assigned)	-	....
[Binary Signal84]	(Not Assigned)	-	....
[Binary Signal85]	(Not Assigned)	-	....
[Binary Signal86]	(Not Assigned)	-	....
[Binary Signal87]	(Not Assigned)	-	....
[Binary Signal88]	(Not Assigned)	-	....
[Binary Signal89]	(Not Assigned)	-	....
[Binary Signal90]	(Not Assigned)	-	....

Settings	Data IDs	[Binary Sig. Name]	Origins
[Binary Signal91]	(Not Assigned)	-	....
[Binary Signal92]	(Not Assigned)	-	....
[Binary Signal93]	(Not Assigned)	-	....
[Binary Signal94]	(Not Assigned)	-	....
[Binary Signal95]	(Not Assigned)	-	....
[Binary Signal96]	(Not Assigned)	-	....
[Binary Signal97]	(Not Assigned)	-	....
[Binary Signal98]	(Not Assigned)	-	....
[Binary Signal99]	(Not Assigned)	-	....
[Binary Signal100]	(Not Assigned)	-	....
[Binary Signal101]	(Not Assigned)	-	....
[Binary Signal102]	(Not Assigned)	-	....
[Binary Signal103]	(Not Assigned)	-	....
[Binary Signal104]	(Not Assigned)	-	....
[Binary Signal105]	(Not Assigned)	-	....
[Binary Signal106]	(Not Assigned)	-	....
[Binary Signal107]	(Not Assigned)	-	....
[Binary Signal108]	(Not Assigned)	-	....
[Binary Signal109]	(Not Assigned)	-	....
[Binary Signal110]	(Not Assigned)	-	....
[Binary Signal111]	(Not Assigned)	-	....
[Binary Signal112]	(Not Assigned)	-	....
[Binary Signal113]	(Not Assigned)	-	....
[Binary Signal114]	(Not Assigned)	-	....
[Binary Signal115]	(Not Assigned)	-	....
[Binary Signal116]	(Not Assigned)	-	....
[Binary Signal117]	(Not Assigned)	-	....
[Binary Signal118]	(Not Assigned)	-	....
[Binary Signal119]	(Not Assigned)	-	....
[Binary Signal120]	(Not Assigned)	-	....
[Binary Signal121]	(Not Assigned)	-	....
[Binary Signal122]	(Not Assigned)	-	....
[Binary Signal123]	(Not Assigned)	-	....
[Binary Signal124]	(Not Assigned)	-	....
[Binary Signal125]	(Not Assigned)	-	....
[Binary Signal126]	(Not Assigned)	-	....
[Binary Signal127]	(Not Assigned)	-	....
[Binary Signal128]	(Not Assigned)	-	....
[Binary Signal129]	(Not Assigned)	-	....
[Binary Signal130]	(Not Assigned)	-	....
[Binary Signal131]	(Not Assigned)	-	....
[Binary Signal132]	(Not Assigned)	-	....
[Binary Signal133]	(Not Assigned)	-	....
[Binary Signal134]	(Not Assigned)	-	....
[Binary Signal135]	(Not Assigned)	-	....
[Binary Signal136]	(Not Assigned)	-	....
[Binary Signal137]	(Not Assigned)	-	....
[Binary Signal138]	(Not Assigned)	-	....
[Binary Signal139]	(Not Assigned)	-	....
[Binary Signal150]	(Not Assigned)	-	....
[Binary Signal151]	(Not Assigned)	-	....
[Binary Signal152]	(Not Assigned)	-	....
[Binary Signal153]	(Not Assigned)	-	....
[Binary Signal154]	(Not Assigned)	-	....
[Binary Signal155]	(Not Assigned)	-	....
[Binary Signal156]	(Not Assigned)	-	....
[Binary Signal157]	(Not Assigned)	-	....
[Binary Signal158]	(Not Assigned)	-	....
[Binary Signal159]	(Not Assigned)	-	....
[Binary Signal160]	(Not Assigned)	-	....
[Binary Signal161]	(Not Assigned)	-	....
[Binary Signal162]	(Not Assigned)	-	....
[Binary Signal163]	(Not Assigned)	-	....
[Binary Signal164]	(Not Assigned)	-	....
[Binary Signal165]	(Not Assigned)	-	....
[Binary Signal166]	(Not Assigned)	-	....
[Binary Signal167]	(Not Assigned)	-	....
[Binary Signal168]	(Not Assigned)	-	....
[Binary Signal169]	(Not Assigned)	-	....
[Binary Signal170]	(Not Assigned)	-	....
[Binary Signal171]	(Not Assigned)	-	....
[Binary Signal172]	(Not Assigned)	-	....
[Binary Signal173]	(Not Assigned)	-	....
[Binary Signal174]	(Not Assigned)	-	....
[Binary Signal175]	(Not Assigned)	-	....
[Binary Signal176]	(Not Assigned)	-	....
[Binary Signal177]	(Not Assigned)	-	....
[Binary Signal178]	(Not Assigned)	-	....
[Binary Signal179]	(Not Assigned)	-	....
[Binary Signal180]	(Not Assigned)	-	....
[Binary Signal181]	(Not Assigned)	-	....
[Binary Signal182]	(Not Assigned)	-	....
[Binary Signal183]	(Not Assigned)	-	....
[Binary Signal184]	(Not Assigned)	-	....
[Binary Signal185]	(Not Assigned)	-	....
[Binary Signal186]	(Not Assigned)	-	....
[Binary Signal187]	(Not Assigned)	-	....
[Binary Signal188]	(Not Assigned)	-	....
[Binary Signal189]	(Not Assigned)	-	....
[Binary Signal190]	(Not Assigned)	-	....

Settings	Data IDs	[Binary Sig. Name]	Origins
[Binary Signal191]	(Not Assigned)	-	....
[Binary Signal192]	(Not Assigned)	-	....
[Binary Signal193]	(Not Assigned)	-	....
[Binary Signal194]	(Not Assigned)	-	....
[Binary Signal195]	(Not Assigned)	-	....
[Binary Signal196]	(Not Assigned)	-	....
[Binary Signal197]	(Not Assigned)	-	....
[Binary Signal198]	(Not Assigned)	-	....
[Binary Signal199]	(Not Assigned)	-	....
[Binary Signal200]	(Not Assigned)	-	....
[Binary Signal201]	(Not Assigned)	-	....
[Binary Signal202]	(Not Assigned)	-	....
[Binary Signal203]	(Not Assigned)	-	....
[Binary Signal204]	(Not Assigned)	-	....
[Binary Signal205]	(Not Assigned)	-	....
[Binary Signal206]	(Not Assigned)	-	....
[Binary Signal207]	(Not Assigned)	-	....
[Binary Signal208]	(Not Assigned)	-	....
[Binary Signal209]	(Not Assigned)	-	....
[Binary Signal210]	(Not Assigned)	-	....
[Binary Signal211]	(Not Assigned)	-	....
[Binary Signal212]	(Not Assigned)	-	....
[Binary Signal213]	(Not Assigned)	-	....
[Binary Signal214]	(Not Assigned)	-	....
[Binary Signal215]	(Not Assigned)	-	....
[Binary Signal216]	(Not Assigned)	-	....
[Binary Signal217]	(Not Assigned)	-	....
[Binary Signal218]	(Not Assigned)	-	....
[Binary Signal219]	(Not Assigned)	-	....
[Binary Signal220]	(Not Assigned)	-	....
[Binary Signal221]	(Not Assigned)	-	....
[Binary Signal222]	(Not Assigned)	-	....
[Binary Signal223]	(Not Assigned)	-	....
[Binary Signal224]	(Not Assigned)	-	....
[Binary Signal225]	(Not Assigned)	-	....
[Binary Signal226]	(Not Assigned)	-	....
[Binary Signal227]	(Not Assigned)	-	....
[Binary Signal228]	(Not Assigned)	-	....
[Binary Signal229]	(Not Assigned)	-	....
[Binary Signal230]	(Not Assigned)	-	....
[Binary Signal231]	(Not Assigned)	-	....
[Binary Signal232]	(Not Assigned)	-	....
[Binary Signal233]	(Not Assigned)	-	....
[Binary Signal234]	(Not Assigned)	-	....
[Binary Signal235]	(Not Assigned)	-	....
[Binary Signal236]	(Not Assigned)	-	....
[Binary Signal237]	(Not Assigned)	-	....
[Binary Signal238]	(Not Assigned)	-	....
[Binary Signal239]	(Not Assigned)	-	....
[Binary Signal250]	(Not Assigned)	-	....
[Binary Signal251]	(Not Assigned)	-	....
[Binary Signal252]	(Not Assigned)	-	....
[Binary Signal253]	(Not Assigned)	-	....
[Binary Signal254]	(Not Assigned)	-	....
[Binary Signal255]	(Not Assigned)	-	....
[Binary Signal256]	(Not Assigned)	-	....

8.3.5 Trigger settings for PLC programming

If the PLC program instructs the operation of the disturbance recorder, the user should set the [**Trigger ID1**] to [**Trigger ID4**]. That is, the program-output points should be set for the settings [**Trigger ID1**] to [**Trigger ID4**]; then, set **On** for the [**Trigger SW1**] to [**Trigger SW4**], respectively.

8.3.6 Screen information

Figure 8.3-2 indicates the maximum number of the recording operations as the number is changed depending on the time settings, which are shown in Table 8.3-1. Figure 8.3-3 shows the operation time and the date for the disturbance recorder and the figure illustrates five disturbance phenomena have been memorized in the IED.

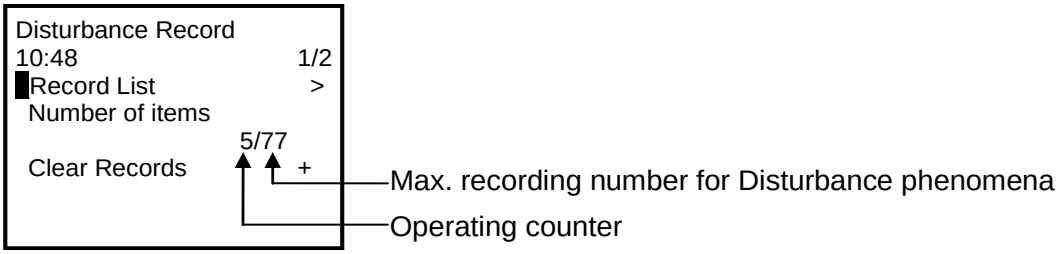


Figure 8.3-2 Running counter and Max number in the disturbance recorder

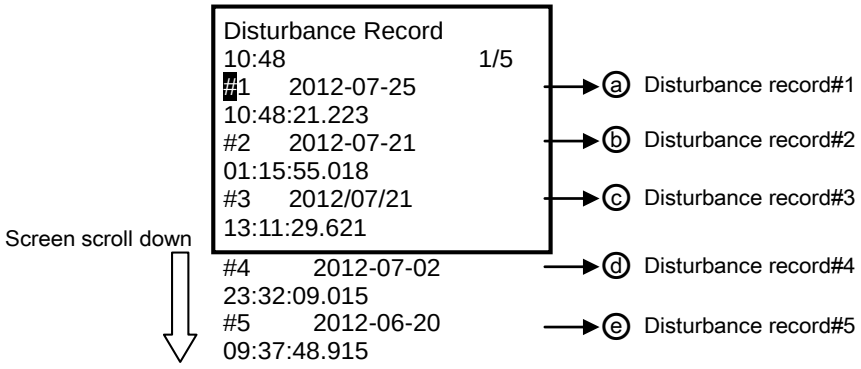


Figure 8.3-3 Detail information in the disturbance recorder

The information in the disturbance recorder are managed in the COMTRADE format, hence, the user can transferor the disturbance recording file to the PC using the engineering tool 'GR-TIEMS'. Figure 8.3-4 shows the example of the GR-TIMES screen. For more information, see *Chapter Engineering tool*.

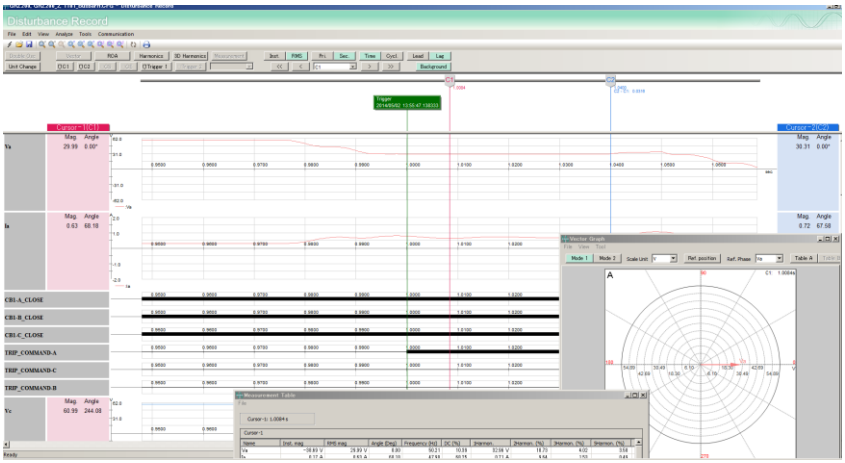


Figure 8.3-4 Screen shot from GR-TIEMS

8.3.7 Setting

Setting of DRT_LP(Function ID: 4B0001)

Setting item		Range		Units	Contents	Default setting value		Notes
		1A rating	5A rating			1A	5A	
	OC-DRT-EN	Off / On		–	Disturbance Record Trigger OC-DRT enable	Off		
	OC-DRT	0.10 - 50.00	0.50 - 250.00	A	OC-DRT relay operating value	1.00	5.00	
	EF-DRT-EN	Off / On		–	Disturbance Record Trigger EF-DRT enable	Off		
	EF-DRT	0.10 - 50.00	0.50 - 250.00	A	EF-DRT relay operating value	0.20	1.00	
	UV-DRT-EN	Off / On		–	Disturbance Record Trigger UV-DRT enable	–		
	UV-DRT	5.0 - 130.0		–	UV-DRT relay operating value	–		
	UVS-DRT-EN	Off / On		–	Disturbance Record Trigger UVS-DRT enable	–		
	UVS-DRT	5.0 - 130.0		V	UVS-DRT relay operating value	–		

Setting of DISTURB_REC(Function ID: 200401)

Setting item		Range	Units	Contents	Default setting value	Notes
	Record Time	0.1 - 10.0	s	Time for disturbance recording	3.0	
	Sampling Rate	7.5 - 15.0	deg	Sampling rate in electrical degree	7.5	
	Pre-fault Time	0.1 - 10.0	s	Pre-fault time	0.3	
	Trigger ID1	(Preferred DataID)	–	Signal1 generated in User's program	No Assign	
	Trigger SW1	Off / On	–	Enabling the signal1 of user's program	Off	
	Trigger ID2	-	–	Signal2 generated in User's program	No Assign	
	Trigger SW2	Off / On	–	Enabling the signal2 of user's program	Off	
	Trigger ID3	-	–	Signal3 generated in User's program	No Assign	
	Trigger SW3	Off / On	–	Enabling the signal3 of user's program	Off	
	Trigger ID4	-	–	Signal4 generated in User's program	No Assign	
	Trigger SW4	Off / On	–	Enabling the signal4 of user's program	Off	
	Trip Trig.SW	Off / On	–	Operation with the TRC trip command	On	
	Binary Signal1	(Preferred DataID)	–	Logic signal1 for the operation	–	
	Binary Sig.Name1	(Preferred name)	–	Name of the logic signal1	–	
	Binary Signal2	(Preferred DataID)	–	Logic signal2 for the operation	–	
	Binary Sig.Name2	(Preferred name)	–	Name of the logic signal2	–	
	Binary Signal3	(Preferred DataID)	–	Logic signal3 for the operation	–	
	Binary Sig.Name3	(Preferred name)	–	Name of the logic signal3	–	
	……	……	–	……	–	
	……	……	–	……	–	
	Binary Signal256	(Preferred DataID)	–	Mode setting for the detection	–	
	Binary Sig.Name256	(Preferred name)	–	Name of the trigger signal768	–	

8.3.8 Signal (Data ID)

◆ Signal monitoring point

DRT_LP (Function ID: 4B0001)

Element ID	Name	Description
8000001C20	DRT-LP	DRT-LP protection operated
8400021C23	EF-DRT	EF-DRT relay element operated
8000011C20	OC-DRT-A	OC-DRT relay element operated (phase-A)
8100011C21	OC-DRT-B	OC-DRT relay element operated (phase-B)
8200011C22	OC-DRT-C	OC-DRT relay element operated (phase-C)
8800031C20	UV-DRT-A	UV-DRT relay element operated (phase-A)
8900031C21	UV-DRT-B	UV-DRT relay element operated (phase-B)
8A00031C22	UV-DRT-C	UV-DRT relay element operated (phase-C)
8C00041C20	UVS-DRT-AB	UVS-DRT relay element operated (phase-AB)
8D00041C21	UVS-DRT-BC	UVS-DRT relay element operated (phase-BC)
8E00041C22	UVS-DRT-CA	UVS-DRT relay element operated (phase-CA)

◆ Signal monitoring point

DISTURB_REC (Function ID: 200401)

Element ID	Name	Description
80A0041001	DSTRING	Writing the disturbance data
30A0001001	DSTR_CLR	Data erased
80A0031001	DSTR_MADE	Completion for writing the disturbance data
32A0011001	DSTR_MAX	Maximum possible number of the operations
32A0021001	DSTR_NUM	Operation counter

9 Monitoring function

9.1 Outline

The monitoring function is provided to measure the number of power quantities and statistics data obtained within the VCT and BI circuits†. When the measuring instruments start measures power quantities, mathematical means is applied to the data from the VCT so that the data are shown accurately on the IED screen.

†Note:The VCT/BIO structures and their features are discussed in Chapter *Technical description*.

9.2 Metering data (Metering group)

Several abbreviations are screened for metering data, which is shown in the below Tables[1–4].

[1]Note: Terms 'I_0 (i.e., $3I_0$)' and 'V_0 (i.e., $3V_0$)' are calculated using three-phase quantities.

[2]Note: The 'I_e' and 'I_{em}' are obtained usually with corresponding 'I_e' and 'I_{em}' circuits in the VCT.

[3]Note: 'CH2' is available when two signaling modules exist in the IED, which is dependent on the model. Check the ordering number at the C position referring to the ordering (See *Appendix: Ordering*)

[4]Note: Those metering items are provided for the special models, which are designated at ordering made.

Table 9.2-1 Metering data

Groups	Abbreviations	Displayed quantities
Metering	I_a, I_b, I_c, I_{ab}, I_{bc}, I_{ca}, I_e (2) I_1, I_2, I_0 (1)	Current in phase, phase-to-phase , symmetrical, residual currents
	I_{em} (2)	Residual current in the other side of the parallel line
	V_a, V_b, V_c V_{ab}, V_{bc}, V_{ca} V_1, V_2, V_0 (1)	Voltage in phase, phase-to-phase, and symmetrical
	V_s, V_{s2}	One or two reference (busbar) voltages
	I_a–L, I_b–L, I_c–L, I_e–L I_a–R1, I_b–R1, I_c–R1, I_e–R1 I_a–R2, I_b–R2, I_c–R2, I_e–R2 V_1–L, V_1–R1, V_1–R2	Resultant currents and voltages at local-end (L) and remote-ends (R1 and R2)
	f	Frequency
	Pa, Pb, Pc / P	Active(real) power in phase-a,-b,-c / three-phase
	Qa, Qb, Qc / Q	Reactive power in phase-a,-b,-c / three-phase
	Sa, Sb, Sc / S	Complex (apparent) power in phase-a,-b,-c / three-phase
	PFa, PFb, PFc / PF	Power factors in phase-a,-b,-c / three-phase
	Wh, varh	Watt-hour (plus/minus), var-hour (plus/minus)
	I_{da}, I_{db}, I_{dc}	DIFL differential currents (Id) in three-phases
	I_{d0}	DIFL differential currents(Ido) in zero-sequence
	I_{dapu}, I_{dbpu}, I_{dcpu}, I_{d0pu}	Pickup currents in DIFL
	I_{ra}, I_{rb}, I_{rc}	DIFGL restraining-currents (Ir) in three-phases
	I_{r0}	DIFGL restraining-currents (Ir) in zero-sequence

Groups	Abbreviations	Displayed quantities
	CH1 Delay, CH2 Delay(3)	Propagation delay times at port1(CH1) and port2(CH2)
	CH1 DT, CH2 DT(3)	Sampling difference between terminals at port1(CH1) and port2(CH2)
	Df/dt(4)	Rate of frequency change
	I2/I1(4)	Rate of positive-sequence-current to negative-sequence-current
	THM-Capacity(4)	Rate of thermal capacity in %

9.2.1 Metering information on the screen

The user can examine the values provided by the metering function on the IED screen; Figure 9.2-1 illustrates the information about currents. A reference phasor is defined to examine a complex data in the metering and a positive-sequence voltage (V1) is defined as the reference. The metering function has minimum sensing threshold; thus, the user shall notice that zero (0) is displayed, if the provided data is lesser than the threshold.

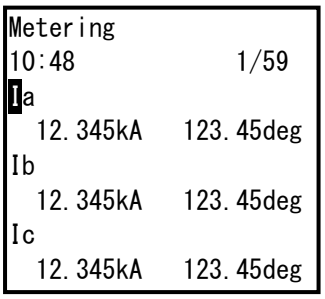


Figure 9.2-1 Current meter on the IED screen

Note: If any quantity does not enter to the VCT, the value on the screen is displayed such as "***.**" and "———".

9.2.2 Setting for measurements

(i) Selecting either primary/secondary values

The value at the primary side is screened when the default setting is applied; the unit of a value can be set in kV when the value is larger than 1000 volts. When wishing to display the value at the secondary side, the user should set **Secondary** for the setting [**Display Value**].Table 9.2-2 shows the effective digit when **Secondary** is set.

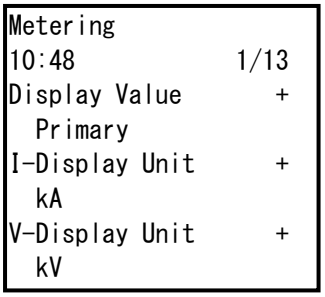


Figure 9.2-2 Metering setting in the setting screen

Note: For the operation of the menu, see Chapter *User interface: Setting sub-menu*.

Table 9.2-2 Effective digits for metering in the secondary side

Metering items	Rated values rulued at the secondary	Number of significatnt figures	
		Current or voltage	Phase angle
Voltage	100/110/115/120 volt	3 digit number with 2 decimal places (***.**V)	(±***.*°)
Current	1 amper / 5 amper	3 digit number with 2 decimal places (***.**A)	

(ii) Unit setting

For example, if preferred to be displayed in kA unit, set **kA** for the [**I-Display Unit**]. Table 9.2-3 shows the unit lists in the metering funciton.

Table 9.2-3 Selection of units to display

Metering items	Settings	Selection of a unit to display
Voltage (V)	[**V-Display Unit**]	Volt (**V**) or kilo-volt (**kV**)
Current (I)	[**I-Display Unit**]	Ampare (**A**) or kilo-ampare (**kA**)
Active power (P)	[**P-Display Unit**]	Kilo-watt (**kW**) or Mega-watt (**MW**)
Reactive power (Q)	[**Q-Display Unit**]	Kilo-var (**kvar**) or Mega-var (**Mvar**)
Apprent power (S)	[**S-Display Unit**]	Kilo-VA (**kVA**) or Mega-VA (**MVA**)

9.2.3 Diminishing a very small value to display zero

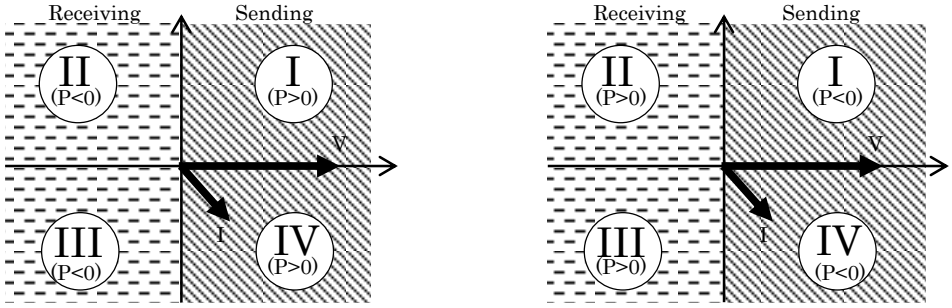
In the metering function, negligible metering values will be considered as zero. The user can set the level to diminish in % using settings [**I-Valid Level**] and [**V-Valid Level**], at which values '4.00' and '0.30' are set, as default, respectively. Thus, zero (0) will be displayed when the applied quantities at the VCT, which are lesser than the setting levels.

9.2.4 Flow settings for active/reactive/apparent powers

The user should set the rules for the metering P, Q, and S

(i) Metering in active power (P)

When the metering function measures the value for supplying power, the user should set **Send** for the [**Power**]. Conversely, if the metering function should operate for absorbing power, set **Receive** for the setting. Figure 9.2-3 illustrates the sign of the active power (P), which is polarized with the voltage (V). In Figure 9.2-3.a exemplifies the metering function operating for the supplying power so that the value P will have plus (+) sign (i.e., the I lags the V, which shown in Quadrant IV). In Figure 9.2-3.b, the value P will have minus (–) sign when the I lags the V, provided **Receive** is set for the setting.



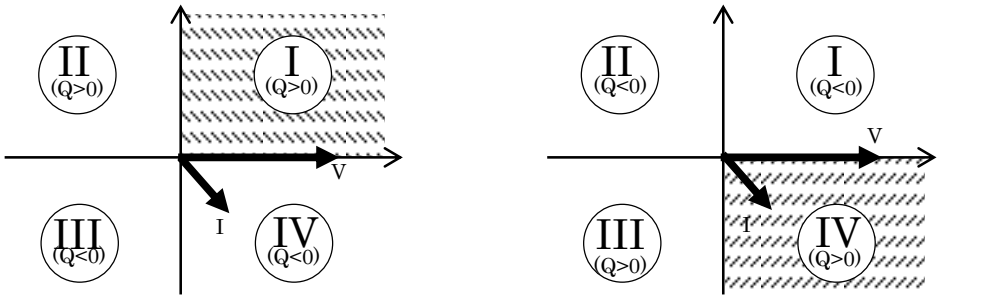
a. Metering (P) for supplying power
[**Power**]=**Send**

b. Metering (P) for absorbing power
[**Power**]=**Receive**

Figure 9.2-3 Sign of the active power (P) ruled by setting [Power]

(ii) Metering in reactive power (Q)

Similar to the active power (P), the user should set the metering sign for the reactive power (Q). The Q value will have the minus sign (–) based on the P value, when **Lag** is set for setting [**Current**] (Figure 9.2-4.a). On the other hand, the Q value will have the plus sign (+) based on the P value, when **Lead** set for the setting (Figure 9.2-4.b).



a. Q (shown in quadrant IV) has a minus sign because the Q is supplied by the outside source. The decision is made with the P (shown in the quadrant IV, defined with [**Power**]=**Send**) having "a plus sign" when the current lags the voltage.

[**Current**]=**Lag**

b. Q (shown in quadrant IV) has a plus sign because the Q is absorbed by the outside source. The decision is based on the P (shown in the quadrant I, defined with [**Power**]=**Receive**) having "a minus sign" when the current leads the voltage.

[**Current**]=**Lead**

Figure 9.2-4 Sign of the reactive power (Q) ruled by setting [Current]

9.3 Statistics data (Power value group)

Table 9.3-1 shows the statistics information and its abbreviation in power value data.

Table 9.3-1 Power value data

Groups	Displayed quantities	Abbreviations
Power values	Watt-hour (plus/minus), var-hour (plus/minus)	Wh, varh

9.3.1 Power information on the screen

Figure 9.3-1 shows the information about the watt-hour and var-hour (Wh and varh).

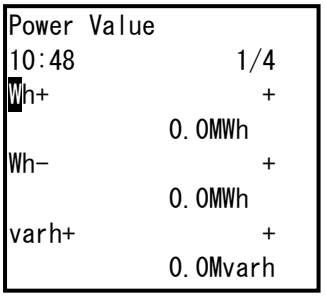


Figure 9.3-1 Example of Power Value screen

Note: See Chapter *User interface: Monitoring sub-menu: Statistics sub-menu*.

9.3.2 Setting for power values

The user can select the unit for each power value. For example, set the [**Wh-Display Unit**]=**kWh**, when kWh is perferred to display.

Table 9.3-2 Selection of units for displaying

Statisics items	Settings	Selection of a unit fot the displaying
Watt-hour	**Wh-Display Unit**	Kilo-watt-hour (**kWh**) or Mega-watt-hour (**MWh**)
Var-hour	**Varh-Display Unit**	Kilo-var-hour (**kvarh**) or Mega-var-hour (**Mvarh**)

9.3.3 Regulation of power values

The number of digits for the power value can be reduced based on the units kWh, MWh and kvarh+. For instance when the power is measured as "123,456kWh" then it is displayed as "123MWh". If this value has to be changed then the user can key in a new compensated value. For example, if "78MWh" should be displayed on the IED screen even though the measured value is "123,456kWh" then the user can set the new value of "78MWh". Note that the compensated value "78MWh" is "78,000kWh", and it is not "78,456kWh" or "123,456kWh"; the compensated value will be affected when a change in the setting of VCT ratio. That is, the user can set a value of "78MW" during the CT ratio of "2000:1", but the CT ratio would be changed from "2000:1" to "4000:1"; hence, the value will be displayed as "156MW" on the IED screen later. Therefore, when the CT ratio setting is required to be changed, remember to set the value of "78MW" again to display the compensated value.

9.4 Statistics data (Demand value group)

The user can keep track of the variable power quantities using the demand feature; the statistical information (such as maximum load, minimum load, and averaged load) are collected in every defined period.

Table 9.4-1 Demand data

Groups	Displayed quantities	Abbreviations
Demand value	Current in phase-a (Max., Min., and Averaged data)	I_a Max, I_a Min, I_a Ave
	Current in phase-b (Max., Min., and Averaged data)	I_b Max, I_b Min, I_b Ave
	Current in phase-c (Max., Min., and Averaged data)	I_c Max, I_c Min, I_c Ave
	Residual current (Max., Min., and Averaged data)	I_e Max, I_e Min, I_e Ave(1)
	The other residual current on parallel lines (Max., Min., and Averaged)	I_{em} Max, I_{em} Min, I_{em} Ave(1)
	Voltage applied at phase-a (Max., Min., and Averaged data)	V_a Max, V_a Min, V_a Ave
	Voltage applied at phase-b (Max., Min., and Averaged data)	V_b Max, V_b Min, V_b Ave
	Voltage applied at phase-c (Max., Min., and Averaged data)	V_c Max, V_c Min, V_c Ave
	Voltage applied between phases-a-to-b (Max., Min., and Averaged data)	V_{ab} Max, V_{ab} Min, V_{ab} Ave
	Voltage applied between phases-b-to-b (Max., Min., and Averaged data)	V_{bc} Max, V_{bc} Min, V_{bc} Ave
	Voltage applied between phases-c-to-a (Max., Min., and Averaged data)	V_{ca} Max, V_{ca} Min, V_{ca} Ave
	Zero-sequence voltage (Max., Min., and Averaged data)	V_0 Max, V_0 Min, V_0 Ave(2)
	Reference voltages (Max., Min., and Averaged data)	V_s Max, V_s Min, V_s Ave
	The other reference voltages (Max., Min., and Averaged data)	V_{s2} Max, V_{s2} Min, V_{s2} Ave

[1]Note: The 'I_e' and 'I_{em}' are taken usually with corresponding VCT circuits .

[2]Note: Terms 'I_0 (i.e., $3I_0$)' and 'V_0 (i.e., $3V_0$)' are gotten in the software calculation using three-phase quantities.

9.4.1 Demand information on the screen

The statistics feature can provides the information about maximum, minimum, and averaged values. Figure 9.4-1 shows the example about the current information

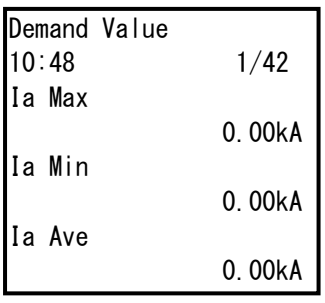


Figure 9.4-1 Example of Demand Value screen

9.4.2 Max/Min/Averaged information about the demand feature

The demand feature is used to calculate the active power (P), the reactive power (P), and the complex power (S) that are weighted with the plus (+) or minus (–) sign; the calculation will be made by the following rules:

(i) Maximum and minimum value

For example, the demand feature gets to have both a minus (e.g., –100 watt) and a plus (e.g., +50 watt) values, '–100 watt' is taken to the minimum data and '+50 watt' is taken to the maximum data. Note that given values do not come out as absolute values.

(ii) Averaged value

If the demand feature gets a data (e.g. +100 watt) in the first period and the other data (that is, –100 watt) in the later period, the data is taken into the absolute value calculation (that is, |–100W|+|100W|=200W; 200W/2=100W).

9.4.3 Demand cycle

The data is taken into the memory every second; the demand feature will calculate the Max/Min/Ave values by the function by collecting the latest data in the memory. When setting 15 minutes for the [**Demand_period**], for example, the calculation is done using the data during the latest 15 minutes. The user can have the cycle of the demand feature be selected among 1min, 5min, 10min, 15min, 30min, and 60min.

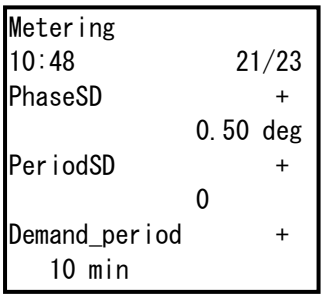


Figure 9.4-2 Demand cycle setting in the setting screen

9.4.4 Resetting data in demand features

The data will be cleared by the following cases:

(a) To energize the IED or to make the initialization about the IED functions

(b) To set a value for the setting [**Demand_period**]

(c) To operate "Reset All Values" on the IED menu

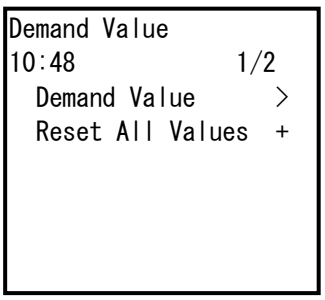


Figure 9.4-3 Reset menu for Demand values

9.5 Statistics data (Peak-demand value group)

Similar to the demand feature (Demand value group), the user can have another peak-demand feature that provides the Max/Min/Ave data that can be obtained from the initialized time to the current time; note these data have been calculated from the first energizing moment of the IED. That is, the data of the peak-demand feature gets to have the latest values in every cycle; the data will be replaced if the past data is not needed. The user can find that the nature of the collected values in the peak-demand values being identical to the one of the Demand value group.

9.5.1 Max/Min/Averaged information about the peak-demand feature

(i) Maximum value

The peak-demand feature starts to collect the data in every cycle after the IED energized; the peak-demand feature will have the largest data. If the present data is larger than the past one with the peak-demand feature will replace the past one for the present one. The maximum value will be cleared when the data is reset.

(ii) Minimum value

Similarly, for the minimum value, the IED displays the smallest data after energizing; the data will be replaced when the present data is smaller than the past one.

(iii) Averaged value

The averaged value is computed using the data in the IED memory, the data which was collected after energizing. Collecting data stays on for a long time; hence, when the counter with regard to the data collection gets to be 2,147,483,647(=0x7FFFFFFF; almost 68 years), resetting data is performed.

9.5.2 Resetting data of peak-demand features

The data will be cleared by the following operations:

(a) To energize the IED or to make the initialization about the IED functions

(b) To operate “Reset All Values” on the IED menu

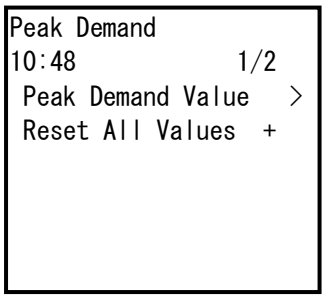


Figure 9.5-1 Reset menu for Peak demand values

9.6 Statistics data (Counter group)

The user can check the counting numbers provided by the general counter function†. Table 9.6-1 shows the user to find the count numbers in the counter group.

Table 9.6-1 Counter data

Group	Counter number displayed	Origin of info (default)	Correspondences to GCNTs†
Counter	ARC1 CLOSE COMMAND	ARC function‡	GCNT01
	ARC1_SPAR	ARC function	GCNT02
	ARC1_TPAR	ARC function	GCNT03
	ARC1_MPAR	ARC function	GCNT04
	ARC2 CLOSE COMMAND	ARC function	GCNT05
	ARC2_SPAR	ARC function	GCNT06
	ARC2_TPAR	ARC function	GCNT07
	ARC2_MPAR	ARC function	GCNT08
	COUNT9	(Not assigned)	GCNT09
	COUNT10	(Not assigned)	GCNT10
	....	....	....
	COUNT32	(Not assigned)	GCNT32

†Note:See Chapter *General control function: Counter function for the general (GCNT)*.

‡Note:See Chapter *Relay application: Autoreclose* for more information.

9.6.1 Count information on the screen

The user can see the count number in the counter group. Figure 9.6-1 illustrates the count numbers provided by the ARC function.

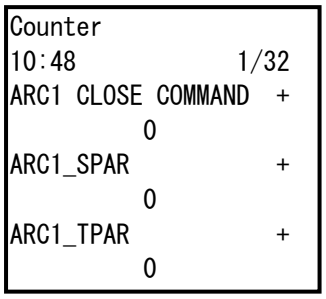


Figure 9.6-1 Example of Counter screen

Note: See Chapter *User interface: Monitoring sub-menu: Statistics sub-menu*.

9.6.2 Report setting for GCNT (Dead band feature)

The data collected with the GCNT functions will be sent to the network; thus, the user should set a regulation value using the SD feature in the GCNT function. See section Setting for the report (Dead band) in the GCNT function.

9.7 Statistics data (Total time group)

Total times are provided by the total time measurement function†, as shown in Table 9.6-1.

Table 9.7-1 Total time data

Group	Displayed quantities	Origin of time data	Correspondences to TOTALTIM†
Total time	TOTAL TIME 1	TOTALTIM01 function	TT1
	TOTAL TIME 2	TOTALTIM02 function	TT2
	TOTAL TIME 3	TOTALTIM03 function	TT3
	….	….	….
	TOTAL TIME 12	TOTALTIM03 function	TT12

†Note:See Chapter *Control and monitoring application: Total time measurement function*

9.7.1 Time information on the screen

The user can see the total times on the IED screen.

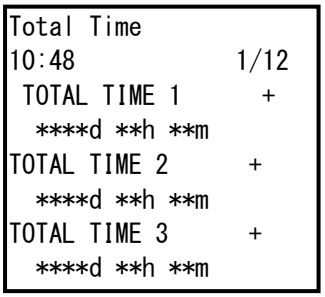


Figure 9.7-1 Example of Total Time screen

Note: See Chapter *User interface: Monitoring sub-menu: Statistics sub-menu*.

9.7.2 Report setting for TOTALTIM (Dead band feature)

The data collected with the TOTALTIM function will be sent to the network; thus, the user should set a regulation value using the SD feature in the TOTALTIME function. See section *Setting for the report (Dead band)* in the TOTALTIME function.

9.8 Statistics data (Accumulated time)

Over all running time for which the IED has operated is provided in “Accumulated Time”. The user can see the overall time on the Accumulated Time screen. The time will be cleared when the IED is switched off.

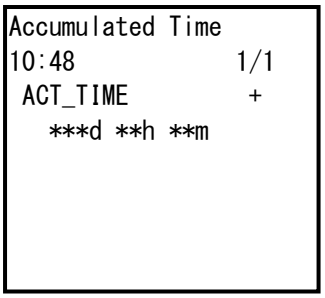


Figure 9.8-1 Example of Accumulated Time screen

Note: The user can also clear the Accumulated time in the screen menu. For key operation, see Chapter *User interface: Monitoring sub-menu: Statistics sub-menu*.

9.9 Monitoring for miscellaneous functions

Operating status of relay elements, binary IO modules, communication modules, GOOSE, and diagnostics are displayed in the monitoring function.

(i) Relay element

(For more information about the menu operation, see Chapter *User interface: Monitoring sub-menu: Relay Elements*. The relay functions and their characteristics are discussed in Chapter *Relay application*).

(ii) Communication

(For more information about the menu operation, see Chapter *User interface: Monitoring sub-menu: Communication*. The communication features about the LAN port is discussed in Chapter *Communication protocol: LAN communication*. The hardware information is discussed in Chapter *Technical description: Signal processing and communication module*).

(iii) Binary IO

(For more information about the menu operation, see Chapter *User interface: Monitoring sub-menu: Binary I/O*. The structure and its operation is discussed in Chapter *Technical description: Binary IO module*).

(iv) Goose monitoring

(For more information about the menu operation, see Chapter *User interface: Monitoring sub-menu: Goose monitoring*. The information about the GOOSE is discussed in Chapter *Communication protocol: IEC 61850 communication*).

(v) Diagnostics

(For more information about the menu operation, see Chapter *User interface: Monitoring sub-menu: Diagnostics sub-menu*. The information about the diagnostics is discussed in Chapter *Automatic supervision*).

9.10 Setting

Metering settings in MES (Function ID: 710001)

Setting item		Range	Units	Contents	Default setting value	Notes
	Display Value	Primary/Secondary	–	Display selection of primary or secondary	Primary	
	Power	Send/Receive	–	Power flow definition (Supply or absorb)	Send	
	Current	Lead/Lag	–	The angle compared with the voltage	Lead	
	I-Valid Level	0.10 to 5.00	%	Cutting off small entering current	4.00	
	V-Valid Level	0.10 to 5.00	%	Cutting off small applied voltage	0.30	
	I-Display Unit	A/kA	–	Current shown in Ampere or Kilo-Ampere	kA	
	V-Display Unit	V/kV	–	Voltage shown in Volt or Kilo-Volt	kV	
	P-Display Unit	kW/MW	–	Active power shown in Kilo- or Mega-watt	MW	
	Q-Display Unit	kvar/Mvar	–	Reactive power shown in Kilo- or Mega-var	Mvar	
	S-Display Unit	kVA/MVA	–	Apparent power shown in Kilo- or Mega-VA	MVA	

Statistics settings in MES (Function ID: 710001)

Setting item		Range	Units	Contents	Default setting value	Notes
	Wh-Display Unit	kWh/MWh	–	Watt-hour shown in Kilo- or Mega-Wh	MWh	
	varh-Display Unit	kvarh/Mvarh	–	Var-hour shown in Kilo- or Mega-varh	Mvarh	

Demand settings in MES (Function ID: 712001)

Setting item		Range	Units	Contents	Default setting value	Notes
	Demand_period	1min / 5min / 10min / 15min / 30min / 60min	–	Period of demand calculation	10min	

9.11 Data ID

◆ Signal monitoring point

MES_MANAGEMENT (Function ID: 711001)

Element ID	Name	Description
3100901060	CT-ERR	CT Monitoring Result
3100911060	I0-ERR	I0 Monitoring Result
3100921060	V0-ERR	V0 Monitoring Result
3100961060	V02-ERR	V02 Monitoring Result
3100931060	V2-ERR	V2 Monitoring Result
3100971060	V22-ERR	V22 Monitoring Result

◆ Signals generated for the 61850

MES_MANAGEMENT (Function ID: 711001)

Element ID	Name	Description
4201601051	Ia-Angle	Ia measurement angle(for IEC61850)
4201601053	Ib-Angle	Ib measurement angle(for IEC61850)
4201601055	Ic-Angle	Ic measurement angle(for IEC61850)
4201611051	Iab-Angle	Iab measurement angle(for IEC61850)
4201611053	Ibc-Angle	Ibc measurement angle(for IEC61850)
4201611055	Ica-Angle	Ica measurement angle(for IEC61850)
4201691051	Ia2-Angle	Ia2 measurement angle(for IEC61850)
4201691053	Ib2-Angle	Ib2 measurement angle(for IEC61850)
4201691055	Ic2-Angle	Ic2 measurement angle(for IEC61850)
42016a1051	Iab2-Angle	Iab2 measurement angle(for IEC61850)
42016a1053	Ibc2-Angle	Ibc2 measurement angle(for IEC61850)
42016a1055	Ica2-Angle	Ica2 measurement angle(for IEC61850)
4201621051	I1-Angle	I1 measurement angle(for IEC61850)
4201621053	I2-Angle	I2 measurement angle(for IEC61850)
4201621057	I0-Angle	I0 measurement angle(for IEC61850)
42016b1051	I12-Angle	I12 measurement angle(for IEC61850)
42016b1053	I22-Angle	I22 measurement angle(for IEC61850)
42016b1057	I02-Angle	I02 measurement angle(for IEC61850)
4201631057	Iem-Angle	Iem measurement angle(for IEC61850)
4202641051	Va-Angle	Va measurement angle(for IEC61850)
4202641053	Vb-Angle	Vb measurement angle(for IEC61850)
4202641055	Vc-Angle	Vc measurement angle(for IEC61850)
4202651051	Vab-Angle	Vab measurement angle(for IEC61850)
4202651053	Vbc-Angle	Vbc measurement angle(for IEC61850)
4202651055	Vca-Angle	Vca measurement angle(for IEC61850)
4202661051	V1-Angle	V1 measurement angle(for IEC61850)
4202661053	V2-Angle	V2 measurement angle(for IEC61850)
4202661057	V0-Angle	V0 measurement angle(for IEC61850)
4202671057	Vs-Angle	Vs measurement angle(for IEC61850)
4202681057	Vs2-Angle	Vs2 measurement angle(for IEC61850)
4201601076	Ia	Ia measurement primary(for IEC61850)
4201601078	Ib	Ib measurement primary(for IEC61850)
420160107A	Ic	Ic measurement primary(for IEC61850)

◆ Signals generated for the 61850

MES_MANAGEMENT (Function ID: 711001)

Element ID	Name	Description
4201611076	Iab	Iab measurement primary(for IEC61850)
4201611078	Ibc	Ibc measurement primary(for IEC61850)
420161107A	Ica	Ica measurement primary(for IEC61850)
4201691076	Ia2	Ia2 measurement primary(for IEC61850)
4201691078	Ib2	Ib2 measurement primary(for IEC61850)
420169107A	Ic2	Ic2 measurement primary(for IEC61850)
42016a1076	Iab2	Iab2 measurement primary(for IEC61850)
42016a1078	Ibc2	Ibc2 measurement primary(for IEC61850)
42016a107A	Ica2	Ica2 measurement primary(for IEC61850)
4201621076	I1	I1 measurement primary(for IEC61850)
4201621078	I2	I2 measurement primary(for IEC61850)
420162107C	I0	I0 measurement primary(for IEC61850)
42016b1076	I12	I12 measurement primary(for IEC61850)
42016b1078	I22	I22 measurement primary(for IEC61850)
42016b107C	I02	I02 measurement primary(for IEC61850)
420163107C	Iem	Iem measurement primary(for IEC61850)
4202641076	Va	Va measurement primary(for IEC61850)
4202641078	Vb	Vb measurement primary(for IEC61850)
420264107A	Vc	Vc measurement primary(for IEC61850)
4202651076	Vab	Vab measurement primary(for IEC61850)
4202651078	Vbc	Vbc measurement primary(for IEC61850)
420265107A	Vca	Vca measurement primary(for IEC61850)
4202661076	V1	V1 measurement primary(for IEC61850)
4202661078	V2	V2 measurement primary(for IEC61850)
420266107C	V0	V0 measurement primary(for IEC61850)
420267107C	Vs	Vs measurement primary(for IEC61850)
420268107C	Vs2	Vs2 measurement primary(for IEC61850)
42066c105C	f	Frequency measurement(for IEC61850)
42016d1051	Ia-R1-Angle	Ia Remote CH1 measurement angle(for IEC61850)
42016d1053	Ib-R1-Angle	Ib Remote CH1 measurement angle(for IEC61850)
42016d1055	Ic-R1-Angle	Ic Remote CH1 measurement angle(for IEC61850)
42016e1057	Ie-R1-Angle	Ie Remote CH1 measurement angle(for IEC61850)
42016f1051	Ia2-R1-Angle	Ia2 Remote CH1 measurement angle(for IEC61850)
42016f1053	Ib2-R1-Angle	Ib2 Remote CH1 measurement angle(for IEC61850)
42016f1055	Ic2-R1-Angle	Ic2 Remote CH1 measurement angle(for IEC61850)
4201701057	Ie2-R1-Angle	Ie2 Remote CH1 measurement angle(for IEC61850)
4201711051	Ia-R2-Angle	Ia Remote CH2 measurement angle(for IEC61850)
4201711053	Ib-R2-Angle	Ib Remote CH2 measurement angle(for IEC61850)
4201711055	Ic-R2-Angle	Ic Remote CH2 measurement angle(for IEC61850)
4201721057	Ie-R2-Angle	Ie Remote CH2 measurement angle(for IEC61850)
4201731051	Ia2-R2-Angle	Ia2 Remote CH2 measurement angle(for IEC61850)
4201731053	Ib2-R2-Angle	Ib2 Remote CH2 measurement angle(for IEC61850)
4201731055	Ic2-R2-Angle	Ic2 Remote CH2 measurement angle(for IEC61850)
4201741057	Ie2-R2-Angle	Ie2 Remote CH2 measurement angle(for IEC61850)

◆ Signals generated for the 61850

MES_MANAGEMENT (Function ID: 711001)

Element ID	Name	Description
42016d1076	Ia-R1	Ia Remote CH1 measurement primary(for IEC61850)
42016d1078	Ib-R1	Ib Remote CH1 measurement primary(for IEC61850)
42016d107A	Ic-R1	Ic Remote CH1 measurement primary(for IEC61850)
42016e107C	Ie-R1	Ie Remote CH1 measurement primary(for IEC61850)
42016f1076	Ia2-R1	Ia2 Remote CH1 measurement primary(for IEC61850)
42016f1078	Ib2-R1	Ib2 Remote CH1 measurement primary(for IEC61850)
42016f107A	Ic2-R1	Ic2 Remote CH1 measurement primary(for IEC61850)
420170107C	Ie2-R1	Ie2 Remote CH1 measurement primary(for IEC61850)
4201711076	Ia-R2	Ia Remote CH2 measurement primary(for IEC61850)
4201711078	Ib-R2	Ib Remote CH2 measurement primary(for IEC61850)
420171107A	Ic-R2	Ic Remote CH2 measurement primary(for IEC61850)
420172107C	Ie-R2	Ie Remote CH2 measurement primary(for IEC61850)
4201731076	Ia2-R2	Ia2 Remote CH2 measurement primary(for IEC61850)
4201731078	Ib2-R2	Ib2 Remote CH2 measurement primary(for IEC61850)
420173107A	Ic2-R2	Ic2 Remote CH2 measurement primary(for IEC61850)
420174107C	Ie2-R2	Ie2 Remote CH2 measurement primary(for IEC61850)
4209751057	Ise-Angle	Ise measurement angle(for IEC61850)
420975107C	Ise	Ise measurement primary(for IEC61850)
4202761051	Va2-Angle	Va2 measurement angle(for IEC61850)
4202761053	Vb2-Angle	Vb2 measurement angle(for IEC61850)
4202761055	Vc2-Angle	Vc2 measurement angle(for IEC61850)
4202771051	Vab2-Angle	Vab2 measurement angle(for IEC61850)
4202771053	Vbc2-Angle	Vbc2 measurement angle(for IEC61850)
4202771055	Vca2-Angle	Vca2 measurement angle(for IEC61850)
4202781051	V12-Angle	V12 measurement angle(for IEC61850)
4202781053	V22-Angle	V22 measurement angle(for IEC61850)
4202781057	V02-Angle	V02 measurement angle(for IEC61850)
4202791057	V4-Angle	V4 measurement angle(for IEC61850)
4202761076	Va2	Va2 measurement primary(for IEC61850)
4202761078	Vb2	Vb2 measurement primary(for IEC61850)
420276107A	Vc2	Vc2 measurement primary(for IEC61850)
4202771076	Vab2	Vab2 measurement primary(for IEC61850)
4202771078	Vbc2	Vbc2 measurement primary(for IEC61850)
420277107A	Vca2	Vca2 measurement primary(for IEC61850)
4202781076	V12	V12 measurement primary(for IEC61850)
4202781078	V22	V22 measurement primary(for IEC61850)
420278107C	V02	V02 measurement primary(for IEC61850)
420279107C	V4	V4 measurement primary(for IEC61850)
42017a1076	DIFL-Ida	Ida measurement primary(for IEC61850)
42017a1078	DIFL-Idb	Idb measurement primary(for IEC61850)
42017a107A	DIFL-Idc	Idc measurement primary(for IEC61850)
42017b1076	DIFL-Ira	Ira measurement primary(for IEC61850)
42017b1078	DIFL-Irb	Irb measurement primary(for IEC61850)
42017b107A	DIFL-Irc	Irc measurement primary(for IEC61850)

◆ Signals generated for the 61850

MES_MANAGEMENT (Function ID: 711001)

Element ID	Name	Description
42017c107C	DIFGL-Id0	Id0 measurement primary(for IEC61850)
42017d107C	DIFGL-Ir0	Ir0 measurement primary(for IEC61850)
42037e1095	Pa	Pa measurement primary(for IEC61850)
42037e1096	Pb	Pb measurement primary(for IEC61850)
42037e1097	Pc	Pc measurement primary(for IEC61850)
42037e1098	P	P measurement primary(for IEC61850)
42047f1095	Qa	Qa measurement primary(for IEC61850)
42047f1096	Qb	Qb measurement primary(for IEC61850)
42047f1097	Qc	Qc measurement primary(for IEC61850)
42047f1098	Q	Q measurement primary(for IEC61850)
4205801095	Sa	Sa measurement primary(for IEC61850)
4205801096	Sb	Sb measurement primary(for IEC61850)
4205801097	Sc	Sc measurement primary(for IEC61850)
4205801098	S	S measurement primary(for IEC61850)
4203811095	Pa2	Pa2 measurement primary(for IEC61850)
4203811096	Pb2	Pb2 measurement primary(for IEC61850)
4203811097	Pc2	Pc2 measurement primary(for IEC61850)
4203811098	P2	P2 measurement primary(for IEC61850)
4204821095	Qa2	Qa2 measurement primary(for IEC61850)
4204821096	Qb2	Qb2 measurement primary(for IEC61850)
4204821097	Qc2	Qc2 measurement primary(for IEC61850)
4204821098	Q2	Q2 measurement primary(for IEC61850)
4205831095	Sa2	Sa2 measurement primary(for IEC61850)
4205831096	Sb2	Sb2 measurement primary(for IEC61850)
4205831097	Sc2	Sc2 measurement primary(for IEC61850)
4205831098	S2	S2 measurement primary(for IEC61850)
420684105C	f2	Frequency measurement(for IEC61850)
4200851091	PFa	PFa measurement(for IEC61850)
4200851092	PFb	PFb measurement(for IEC61850)
4200851093	PFc	PFc measurement(for IEC61850)
4200851094	PF	PF measurement(for IEC61850)
4200861091	PFa2	PFa measurement(for IEC61850)
4200861092	PFb2	PFb measurement(for IEC61850)
4200861093	PFc2	PFc measurement(for IEC61850)
4200861094	PF2	PF measurement(for IEC61850)
4202871095	VR1	Running voltage of SyncRy1 (for IEC61850)
4202871096	VI1	Incoming voltage of SyncRy1 (for IEC61850)
4202871097	dV-SyncRy1	Differential voltage of SyncRy1's VR and VI (for IEC61850)
4200881099	dAng.-SyncRy1	Differential angle of SyncRy1's VR and VI (for IEC61850)
420689109E	df-SyncRy1	Differential frequency of SyncRy1's VR and VI (for IEC61850)
42068a109E	VR1-f	Frequency of SyncRy1's VR (for IEC61850)
42068b109E	VI1-f	Frequency of SyncRy1's VI (for IEC61850)
42028a1095	VR2	Running voltage of SyncRy2 (for IEC61850)
42028a1096	VI2	Incoming voltage of SyncRy2 (for IEC61850)

◆ Signals generated for the 61850

MES_MANAGEMENT (Function ID: 711001)

Element ID	Name	Description
42028a1097	dV-SyncRy2	Differential voltage of SyncRy2's VR and VI (for IEC61850)
42008b1099	dAng.-SyncRy2	Differential angle of SyncRy2's VR and VI (for IEC61850)
42068c109E	df-SyncRy2	Differential frequency of SyncRy2's VR and VI (for IEC61850)
42068d109E	VR2-f	Frequency of SyncRy2's VR (for IEC61850)
42068e109E	VI2-f	Frequency of SyncRy2's VI (for IEC61850)
4317601098	Wh+	Wh+ measurement primary(for IEC61850)
4317611098	Wh-	Wh- measurement primary(for IEC61850)
4318621098	varh+	varh+ measurement primary(for IEC61850)
4318631098	varh-	varh- measurement primary(for IEC61850)
4317641098	Wh2+	Wh2+ measurement primary(for IEC61850)
4317651098	Wh2-	Wh2- measurement primary(for IEC61850)
4318661098	varh2+	varh2+ measurement primary(for IEC61850)
4318671098	varh2-	varh2- measurement primary(for IEC61850)
4212681095	VB	Busbar Voltage (for IEC61850)
4212681096	VL	Line Voltage (for IEC61850)
4212681097	dV-SYN1	Differential voltage of SYN1's VB and VL (for IEC61850)
4210691099	dAng.-SYN1	Differential angle of SYN1's VB and VL (for IEC61850)
42166a109E	df-SYN1	Differential frequency of SYN1's VB and VL (for IEC61850)
42126b1095	VL2	Line2 voltage (for IEC61850)
42126b1097	dV-SYN2	Differential voltage of SYN2's VL2 and VL (for IEC61850)
42106c1099	dAng.-SYN2	Differential angle of SYN2's VL2 and VL (for IEC61850)
42166d109E	df-SYN2	Differential frequency of SYN2's VL2 and VL (for IEC61850)

10 Automatic supervision

10.1 Outline of automatic supervision

In power system, the protection function is not required to operate during normal conditions. That is, the protection function should stay silent for the unfaulty conditions, but it has to start respond immediately upon the occurrence of the fault. Therefore, as for the operation of the protection system, the detection of an unhealthy condition, such as malfunction or errors in the hardware or in the software, is requisite within the IED. The automatic supervision function is designed to detect the unhealthy condition within the IED; the following concepts are taken into account:

- The operating performance of the protection system should not be distorted.
- Supervision should be carried out by itself without any failure whenever possible.
- The protection system should identify the fault instantly upon its occurrence.

Tips: The alarms can be blocked when **Off** is set for the switch [**A.M.F**]. The switch can be used to remove alarms during testing. See *Chapter User interface: Test sub-menu* for more information.

(i) Error levels

In the applications and the hardware, the number of items are supervised for detecting the operation failure; hence, the results of the supervision functions are grouped and they are classified into five error-levels to identify the error degree directly: warning (level 5=the minor error) to the serious error (level 1=the critical error). Incidentally, zero (level 0) can be identified as no error. Table 10.1-1 shows the errors grouped by the error degree. The grouping is provided, for setting the degree of error, the user can select an user-defined degree for each error occurs randomly. If a number of failures occur on several levels at same time, the automatic supervision function selects the critical error among them to represent the error inside the IED.

Table 10.1-1 Meanings and error degree in the supervision function

Levels	Degree of error	Example failures and errors
0	No error	No error exists
1‡	Serious	Fatal failures such as the memory errors within the IED
2†‡	Serious (Comm.)	Failures on tele-communication
3†‡	Minor	Failure on LAN (Ethernet) communication
4	Alarm	Minor errors such as invalid errors by the user using settings
5	Warning	Detection of warnings classified by the user using settings

†Note:Level 2 and level 3 are shown, but the difference between the level 2 and the level 3 not given; thus, we can take the both having the same degree.

‡Note: The IEC 61850quality value is also changed depending on the error level. For more information, see Chapter *Communication protocol: IEC 61850 communication: Quality signal*.

(ii) Error LED and LCD error message

The IED has LEDs and LCD screen† so that the automatic supervision function issues a result for the LEDs and the LCD screen. When the IED is linked with the SAS, it is possible to transfer the result for the LED and LCD screen using the communication system. Table 10.1-2 shows that which indicators are used for result generation in the function.

Table 10.1-2 Displays on LEDs, LCD, and SAS

Levels	"In service" LED	"Error" LED	Error message on LCD
0: No error	On	Off	(Not displayed)
1: Serious	Off	On	Displayed
2: Serious (Comm.)‡	On	On	Displayed
3: Minor	On (Off§)	On	Displayed
4: Alarm	On	Off	Displayed
5: Warning	On	Off	Displayed

†Note:For more information, see *Chapter User interface: Outline* and *Diagnostics*.

‡Note:It depends on the degree of the communication failure.

§Note:If the "In service" has to be turned off while a minor error (level:3) is occurring, set **On** for the setting [**ErrorLED_cond**].

The user can see a current error information in Monitoring sub-menu† on the LCD screen† (see Figure 10.1-1); Table 10.1-3 shows the six detail information, which the user can examine carefully using the hexadecimal number. When two or more errors occur at the same time, an error code is given by the summation of the error codes. That is, when X and Y errors (e.g., X-error-code '00000002' and Y-error-code '00000004') occur, the sum value '00000006' is screened.

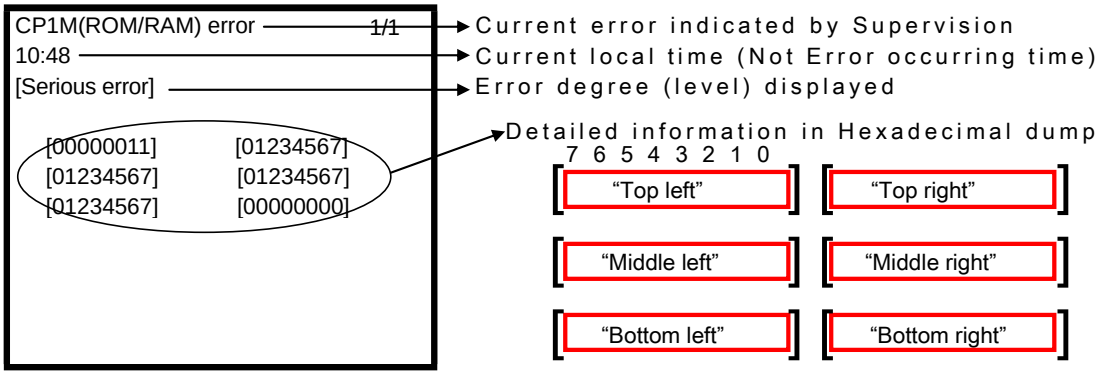


Figure 10.1-1 Example error codes and detailed information on Diagnostics sub-menu

†Note:See Chapter *User interface: Monitoring sub-menu: Diagnostics*. It will not be updated automatically. If new information is required, refresh LED screen again.

Table 10.1-3 Detailed information in Hexadecimal in the ROM and the RAM error (example)

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: ROM read error 00000002: ROM RAM mismatch	ROM address
Middle row	RAM address	ROM value
Bottom row	RAM value	(No information displayed)

(iii) Error outputs with contacts and binary output circuits

Automatic supervision function drives a contact of the power supply module (PWS)† when an error occurs without warning; additionally, binary output circuits (BOs‡) will be locked out to drive when serious error (Level 1=Critical error) is detected.

Table 10.1-4 FAIL contact, BO, LED outputs depending on levels

Error Levels	PWS† contact outputs				BO‡ locked out	Error LED
	FAIL1 terminal		FAIL2 terminal			
	Screw No. 1 (N/C)	Screw No. 3 (N/O)	Screw No. 7 (N/C)	Screw No. 9 (N/O)		
0: No error	Open	Closed	Open	Closed	Not locked out	Off
1:Serious	Closed	Open	Closed	Open	Locked out	On
2:Serious(Comm.)	Open	Closed	Open	Closed	Not locked out	On
3:Minor	Open	Closed	Open	Closed	Not locked out	On
4:Alarm	Open	Closed	Open	Closed	Not locked out	Off
5:Warning	Open	Closed	Open	Closed	Not locked out	Off

(iii)-1 Error output by PWS contact†

If serious error (Level1) is detected by Automatic supervision function, normally-closed-contact (N/C) on FAIL1 and FAIL2 terminals is closed. On the other hand, the N/O contact is open on the serious error, as shown in Table 10.1-4.

(iii)-2 Locking out of BO circuit operation‡

BO is locked out to operate, when serious error (Level1) occurs. Serious error stops trip signal generations to the BO circuit. When serious error is removed, the operation will be recovered.

†Note:See Chapter *Technical description: Power supply module*. FAIL1 (FAIL2) contact is in Form-C; terminal-screw No. 2 & 4 (8 &10) are provided with the common.

‡Note:BO is discussed in Chapter *Technical description: Binary output circuit*.

(iv) Affection of application operation by error levels

The error levels influence the operation of relay and control and monitoring application.

Table 10.1-5 Operation states in the IED applications affected by the error levels

Levels	Relay applications	Control and monitoring applications	Notes
0: No error	–	–	
1: Serious	Stopped	Stopped	
2: Serious (Comm.)	Not affected†	Not affected	
3: Minor	Not affected	Stopped	
4: Alarm	Not affected	Not affected	
5: Warning	Not affected	Not affected	

†Note: Serious (Comm.) can be related to communication of tele-protection applications.

10.2 Generic supervision tasks

Displaying errors regarding to common problems are summarized in Table 10.2-1; the error is cleared when recovered

Table 10.2-1 Supervision items and error levels for generic

Sec. No.	Supervision items(Screen message)	Detailed Info.	Error Lvl	Error LED
10.2.1	Mismatch between ROM and RAM (ROM/RAM error)	Displayed	1	On
10.2.2	Check-sum error (SUM error)	Displayed	1	On
10.2.3	Supervision of RAM (RAM error)	Displayed	1	On
10.2.4	Supervision of ECC on memory (ECC error)	Displayed	1	On
10.2.5	Supervision of MRAM (MRAM)	Displayed	1	On
10.2.6	Supervision of program codes (CPU error)	Displayed	1	On
10.2.7	Supervision of DPRAM on sub-CPU (DPRAM error)	Displayed	1	On
10.2.8	Supervision of DPRAM on external-CPU (DPRAM error)	Displayed	1	On
10.2.9	Detecting non-maskable interrupt (NMI error)	Displayed	1	On
10.2.10	Supervision of sampling period (SMP error)	Displayed	1	On
10.2.11	Detection of sub-CPU not operated (Stopped error)	Displayed	1	On
10.2.12	Detection of external-CPU not operated (Stopped error)	Displayed	1	On
10.2.13	Supervision of setting data (Setting error)	Displayed	1	On
10.2.14	Supervision of real-time clock (RTC error)	Displayed	3	On
10.2.15	Supervision of analog input data on VCTs (AI ACC error)	Displayed	1	On
10.2.16	Abnormal current flowing in CT (CT error)	N/A	3	On
10.2.17	Current transformer failure (CT fail)	Displayed	3	On
10.2.18	Supervision of current in zero-sequence (I0 error)	N/A	3	On
10.2.19	Supervision of voltage in negative-sequence (V2 error)	N/A	3	On
10.2.20	Supervision of voltage in zero-sequence (VZ error)	N/A	3	On
10.2.21	Supervision of binary IO module#1 (BIO#1 error)	Displayed	1	On
10.2.22	Supervision of binary IO module#2 (BIO#2 error)	Displayed	1	On
10.2.23	Supervision of binary IO module#3 (BIO#3 error)	Displayed	1	On
10.2.24	Supervision of binary IO module#4 (BIO#4 error)	Displayed	1	On
10.2.25	Supervision of binary IO module#5 (BIO#5 error)	Displayed	1	On
10.2.26	Supervision of binary IO module#6 (BIO#6 error)	Displayed	1	On
10.2.27	Supervision of binary IO module#7 (BIO#7 error)	Displayed	1	On
10.2.28	Supervision of binary IO module#8 (BIO#8 error)	Displayed	1	On
10.2.29	Supervision of human machine interface (HMI error)	Displayed	1	On
10.2.30	Supervision of power supply module (Power error)	Displayed	3	On

Sec. No.	Supervision items(Screen message)	Detailed Info.	Error Lvl	Error LED
10.2.31	Supervision of data in PLC function (PLC data error)	Displayed	3	On
10.2.32	Voltage transformer failure (VT fail)	N/A	3	On
10.2.33	Supervision of circuit breaker contacts (CB1/CB2 fail)	Displayed	3	On
10.2.34	Supervision of disconnector contacts (DS fail)	Displayed	3	On
10.2.35	Supervision of response for pinging (Ping error)	Displayed	3	On
10.2.36	Supervision of data in 61850 settings (Commslv error)	Displayed	3	On
10.2.37	Supervision of GOOSE publishing (LAN(GOOSE)error)	Displayed	3	On
10.2.38	Aux. contacts monitoring (DPSY faulty and undefined)	Displayed	3	On

10.2.1 Mismatch between ROM and RAM (ROM/RAM error)

The ROM and RAM on the CPU module are verified every two minutes; when the error is found, an error message is displayed by the supervision function.

(i) Error level

The error level has been set at level 1 (**Serious error**[1]) for the supervision, checking error on the RAM and the ROM is carried out periodically. If the error is detected, the IED restarts its operation automatically. The supervision function runs in respective CPU modules[1]; hence, the error detection is carried out in each CPU module.

[1]Note: The kinds of the CPU modules are discussed in Chapter *Technical description: Signal processing and communication module: Processing module.*

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-2 Error messages provided by the supervisor in CHK_ROMRAM

Message and level	Meaning of the information
CP*_ (ROM/RAM) error	Mismatch between the RAM and ROM detected on the following module instructed with "CP*_" as follows: CP1M: CPU1 module CP1S: CPM1 module CP2M: CPX1 module
Error level	Serious error (Level 1)

Table 10.2-3 Detailed information in CHK_ROMRAM

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: ROM read error 00000002: ROM RAM mismatch	ROM address
Middle row	RAM address	ROM value
Bottom row	RAM value	(No information displayed)

10.2.2 Check-sum error (SUM error)

The check sum in the memory on the CPU module is verified every four minutes; when the error is found the error message is displayed by the supervision function.

(i) Error level

The error level has been set at level 1 (**Serious error**[1]) for the supervision, the check-sum error on the memory is carried out periodically. If the error is detected, the IED restarts its operation automatically. The supervision function runs in the respective CPU modules[1]; hence, the error detection is carried out in each CPU module. Clearing the error message is made promptly when the error is cleared.

[1]Note: The kinds of the CPU modules are discussed in Chapter *Technical description: Signal processing and communication module: Processing module.*

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-4 Error messages provided by the supervisor in CHK_SUM

Message and level	Meaning of the information
CP*_ (SUM) error	Sum error in the memory detected on the following CPU module: CP1M: CPU1 module CP1S: CPM1 module CP2M: CPX1 module
Error level	Serious error (Level 1)

Table 10.2-5 Detailed information in Hexadecimal in CHK_SUM

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	Bit 0: ROM read error Bit 1: ROM RAM mismatch	Sum value calculated
Middle row	Sum value pre-programmed	Address information that read error occurs in the ROM
Bottom row	(No information displayed)	(No information displayed)

10.2.3 Supervision of RAM (RAM error)

The read-write operation on RAM circuit of the CPU module is verified at any time; when the error is found an error message is displayed by the supervision function.

(i) Error level

The error level has been set at level 1 (**Serious error**[1]) for the supervision; checking errors on the RAM is carried out at any time. If the error is detected, the IED restarts its operation automatically. The supervision function runs in respective CPU modules[1]; hence, the error detection is carried out in each CPU module. Clearing the error message is made promptly when the error is cleared.

[1]Note: The kinds of the CPU modules are discussed in Chapter *Technical description: Signal processing and communication module: Processing module.*

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-6 Error messages provided by the supervisor in CHK_RAM

Message and level	Meaning of the information
CPxx(RAM) error	Error detection in the RAM located on the following module instructed with "CP*_" as follows: 1M: CPU1 module (main CPU) 1S: CPM1 module (sub CPU) 2M: CPX1 module (another main CPU)
Error level	Serious error (Level 1)

Table 10.2-7 Detailed information in Hexadecimal in CHK_RAM

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	Read value	Write value
Middle row	Error address	(No information displayed)
Bottom row	(No information displayed)	(No information displayed)

10.2.4 Supervision of ECC on memory (ECC error)

The error detection on the error-correcting code memory (ECC memory) of the CPU module is verified at any time; when the error is found an error message is displayed by the supervision function.

(i) Error level

The error level has been set at level 1 (**Serious error**[1]) for the supervision; checking error on the ECC is carried out at any time. If the error is detected, the IED restarts its operation automatically. The supervision function runs in respective CPU modules[1]; hence, the error detection is carried out in each CPU module. Clearing the error message is made promptly when the error is cleared.

[1]Note: The kinds of the CPU modules are discussed in Chapter *Technical description: Signal processing and communication module: Processing module.*

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-8 Error messages provided by the supervisor in CHK_ECC

Message and level	Meaning of the information
CP*_ (ECC) error	Error in the ECC is detected on the following module instructed with "CP*_" as follows: CP1M: CPU1 module CP1S: CPM1 module CP2M: CPX1 module
Error level	Serious error (Level 1)

Table 10.2-9 Detailed information in Hexadecimal in CHK_ECC

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000080: err_cnt	LR register
Middle row	SRR0 register	ADDR
Bottom row	DATA (H)	DATA (L)

10.2.5 Supervision of MRAM (MRAM)

The error detection on the Magnetoresistive Random Access Memory (MRAM memory) of the CPU module is verified every 1 second; when the error is found, an error message is displayed by the supervision function.

(i) Error level

The error level has been set at level 1 (**Serious error**[1]) for the supervision; checking errors on the ECC is carried out at any time. If the error is detected, the IED restarts its operation automatically. The function supervise for the MRAM on the main CPU module[1]. Clearing the error message is made in 1 second when the error is cleared.

[1]Note: The kinds of the CPU modules are discussed in Chapter *Technical description: Signal processing and communication module: Processing module.*

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-10 Error messages provided by the supervisor in CHK_MRAM

Message and level	Meaning of the information
CP*_(MRAM) error	Error detection in the MRAM located on the following CPU module: 1M: CPU1 module (main CPU)
Error level	Serious error (Level 1)

Table 10.2-11 Detailed information in Hexadecimal in CHK_MRAM

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	Address at error occurs	00000000: Error detected with 0xaaaaaaaa 00000001: Error detected with 0x555555555
Middle row	(No information is displayed)	(No information is displayed)
Bottom row	(No information is displayed)	(No information is displayed)

10.2.6 Supervision of program codes (CPU error)

The program code in the ROM and RAM on the CPU module is verified every times; when the error is found an error message is displayed by the supervision function.

(i) Error level

The error level has been set at level 1 (**Serious error**[1]) for the supervision, detecting Program errors on the RAM and the ROM are carried out any time. If the error is detected, the IED restarts its operation automatically. The supervision function runs in respective CPU modules[1]; hence, the error detection is carried out in each CPU module. Clearing the error message is made promptly when the error is cleared.

[1]Note: The kinds of the CPU modules are discussed in Chapter *Technical description: Signal processing and communication module: Processing module.*

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-12 Error messages provided by the supervisor in CHK_PROGRAM

Message and level	Meaning of the information
CPxx(CPU) error	Error detection in the RAM and ROM located on the following CPU module: CP1M: CPU1 module CP1S: CPM1 module CP2M: CPX1 module
Error level	Serious error (Level 1)

Table 10.2-13 Detailed information in Hexadecimal in CHK_PROGRAM

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: Address 00000002: Sub 00000004: Mul 00000008: Div	(No information displayed)
Middle row	(No information displayed)	(No information displayed)
Bottom row	(No information displayed)	(No information displayed)

10.2.7 Supervision of DPRAM on sub-CPU (DPRAM error)

The state of the dual-ported RAM (DPRAM) is checked every 20 seconds when the erroneous state is found.

(i) Error level

The error level has been set at level 1 (**Serious error**[1]) for the supervision; the detection is carried out cyclically. If the error is detected, the IED does not restart its operation automatically. The function runs for the DPRAM on the main CPU of CPU1 module[1]. Clearing the error message is made in a second when the erroneous state is removed.

[1]Note: The kinds of the CPU modules are discussed in Chapter *Technical description: Signal processing and communication module: Processing module.*

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-14 Error messages provided by the supervisor in CHK_DPRAM

Message and level	Meaning of the information
CP*_ (DPRAM) error	Detection is performed o detected on the following module instructed with "CP*_" as follows: CP1M: CPU1 module
Error level	Serious error (Level 1)

Table 10.2-15 Detailed information expressed in Hexadecimal in CHK_DPRAM

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	Value of the counter to check the renewal not being occurred (=64H)	Checked data
Middle row	Inverted data retrieved from the opposite circuit module	(No information displayed)
Bottom row	(No information displayed)	(No information displayed)

10.2.8 Supervision of DPRAM on external-CPU (DPRAM error)

The state of the dual-ported RAM (DPRAM) is checked every 20 seconds when the erroneous state is found.

(i) Error level

The error level has been set at level 1 (**Serious error**[1]) for the supervision; the detection is carried out cyclically. If the error is detected, the IED does not restart its operation automatically. The function runs for the DPRAM on the CPU of CPX1 module[1]. Clearing the error message is made in a second when the erroneous state is removed.

[1]Note: The kinds of the CPU modules are discussed in Chapter *Technical description: Signal processing and communication module: Processing module.*

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-16 Error messages provided by the supervisor in CHK_EXDPRAM

Message and level	Meaning of the information
CP*_ (DPRAM) error	Detection is performed o detected on the following module instructed with "CP*_" as follows: CP2M: CPX1 module
Error level	Serious error (Level 1)

Table 10.2-17 Detailed information expressed in Hexadecimal in CHK_EXDPRAM

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	Value of the counter to check the renewal not being occurred (=64H)	Checked data
Middle row	Inverted data retrieved from the opposite circuit module	(No information displayed)
Bottom row	(No information displayed)	(No information displayed)

10.2.9 Detecting non-maskable interrupt (NMI error)

The occurrences of non-maskable-interruptions (NMIs) on the CPU module are examined every time; when the interruption is triggered, an interruption message is detected and displayed.

(i) Error level

The error level has been set at level 1 (**Serious error**[1]) for the supervision; detecting the interruption carried out at any time. If the interruption is detected, the IED restarts its operation automatically. The supervision function runs in the respective CPU modules[1]; hence, the detection is carried out in each CPU module. Clearing the error message is made promptly when the error is cleared.

[1]Note: The kinds of the CPU modules are discussed in Chapter *Technical description: Signal processing and communication module: Processing module.*

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-18 Error messages provided by the supervisor in CHK_NMI

Message and level	Meaning of the information
CPxx(NMI) error	Interruptions occurs on the following module instructed with "CP*_" as follows: CP1M: CPU1 module CP1S: CPM1 module CP2M: CPX1 module
Error level	Serious error (Level 1)

Table 10.2-19 Detailed information in Hexadecimal in NMI

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	NMI code	LR register
Middle row	SRR0 resister	SPP1 resister
Bottom row	Stack pointer	FRSCR register

10.2.10 Supervision of sampling period (SMP error)

The sampling error is verified at any time; when the error is found an error message is displayed by the supervision function.

(i) Error level

The error level has been set at level 1 (**Serious error**[1]) for the supervision; sampling errors are checked every seconds. If the error is detected, the IED restarts its operation automatically. The supervision function runs in respective CPU modules[1]; hence, the error detection is carried out in each CPU module. Clearing the error message is made in a second when the error is cleared.

[1]Note: The kinds of the CPU modules are discussed in Chapter *Technical description: Signal processing and communication module: Processing module.*

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-20 Error messages provided by the supervisor in CHK_SMP

Message and level	Meaning of the information
CP*_ (SMP) error	Sampling error detected on the following module instructed with "CP*_" as follows: CP1M: CPU1 module CP1S: CPM1 module CP2M: CPX1 module
Error level	Serious error (Level 1)

Table 10.2-21 Detailed information in Hexadecimal in CHK_SMP

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	1	Diff time
Middle row	Current timing	Pervious timing
Bottom row	(No information is displayed)	(No information is displayed)

10.2.11 Detection of sub-CPU not operated (Stopped error)

The operation on the sub CPU is monitored every five minutes; the error message is displayed when the sub CUP is stopped.

(i) Error level

The error level has been set at level 1 (**Serious error**[1]) for the supervision; the detection is carried out periodically. If the error is detected, the IED does not restart its operation automatically. The supervision function runs for respective sub CPU modules[1]; hence, the error detection is carried out in each sub CPU module. Clearing the error message is made in a second when the sub CPU runs again.

[1]Note: The kinds of the CPU modules are discussed in Chapter *Technical description: Signal processing and communication module: Processing module.*

(ii) Error message

When the function operates and detects errors, an error message can be shown at the LED and the LCD screen.

Table 10.2-22 Error messages provided by the supervisor in CHK_SUBCPU

Message and level	Meaning of the information
CP*_ stopped error	Stopping detected on the following module instructed with "CP*_" as follows: CP1M: CPM1 module
Error level	Serious error (Level 1)

Table 10.2-23 Detailed information expressed in Hexadecimal in CHK_SUBCPU

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: Failure existing	Value of the counter to check the renewal not being occurred
Middle row	Value of the counter when stopped	(No information displayed)
Bottom row	(No information displayed)	(No information displayed)

10.2.12 Detection of external-CPU not operated (Stopped error)

The operation on the external CPU is monitored every five minutes; the error message is displayed when the external CPU is stopped.

(i) Error level

The error level has been set at level 1 (**Serious error**[1]) for the supervision; the detection is carried out periodically. If the error is detected, the IED does not restart its operation automatically. The supervision function runs for respective CPU modules[1]; hence, the error detection is carried out in each CPU module. Clearing the error message is made in a second when the CPU runs again.

[1]Note: The kinds of the CPU modules are discussed in Chapter *Technical description: Signal processing and communication module: Processing module.*

(ii) Error message

When the function operates and detects errors, an error message can be shown at the LED and the LCD screen.

Table 10.2-24 Error messages provided by the supervisor in CHK_SUBCPU

Message and level	Meaning of the information
CP*_ stopped error	Stopping detected on the following module instructed with "CP*_" as follows: CP2M: CPX1 module
Error level	Serious error (Level 1)

Table 10.2-25 Detailed information expressed in Hexadecimal in CHK_SUBCPU

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: Failure existing	Value of the counter to check the renewal not being occurred
Middle row	Value of the counter when stopped	(No information displayed)
Bottom row	(No information displayed)	(No information displayed)

10.2.13 Supervision of setting data (Setting error)

The values of the Settings are checked every second; the error message is displayed when the erroneous value is found.

(i) Error level

The error level has been set at level 1 (**Serious error**[1]) for the supervision; the detection is carried out periodically. If the error is detected, the IED does not try to restart its operation automatically. The function runs for the saved settings in the main CPU module[1]. When the erroneous setting is removed, the error messages will be cleared in a second.

[1]Note: The kinds of the CPU modules are discussed in Chapter *Technical description: Signal processing and communication module: Processing module.*

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-26 Error messages provided by the supervisor in CHK_SETTING

Message and level	Meaning of the information
CP*_ (Setting) error	Setting error detected on the following module instructed with "CP*_" as follows: CP1M: CPU1 module
Error level	Serious error (Level 1)

Table 10.2-27 Detailed information expressed in Hexadecimal in CHK_SETTING

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: Failure exists in the common settings 00000002: Failure exists in the group setting 00000004: Error data found in the initial setting	Offset address corresponding to the failure in the common settings
Middle row	Offset address corresponding to the failure in the group setting	(No information is displayed)
Bottom row	00000001: Exec_tbl.cnf 00000002: Lcd_conf.cnf 00000004: g2minic.dat 00000008: guidance.dat	(No information is displayed)

10.2.14 Supervision of real-time clock (RTC error)

The state of the real time clock (RTC) is checked every five minutes; the error message is displayed when the clock stops.

(i) Error level

Generally, the default error level has been set at level 3 (**Minor error**), but the user can program the level using setting [**CHK_RTC:LVl**]; then, set **On** for the setting [**CHK_RTC:Sw**]. The manufacturer sets five (5) minutes is set to detect the failure; it is reset within five minutes when the clock starts to operate again.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-28 Error messages provided by the supervisor in CHK_RTC

Message and level	Meaning of the information
CP*_ (RTC) error	Error detection is performed on the RTC on the following CPU module: CP1M: CPU1 module (main CPU)
Error level	Minor error (Level 3)

Table 10.2-29 Detailed information expressed in Hexadecimal in CHK_RTC

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	"1" shows that the error exists in the RTC	Time in the second when the RTC stopped
Middle row	Time in the minute when the RTC stopped	(No information displayed)
Bottom row	(No information displayed)	(No information displayed)

10.2.15 Supervision of analog input data on VCTs (AI ACC error)

It is possible to detect the failure of the analog to digital conversion in the VCT module†.

†Note: For more information about the VCT, see Chapter *Technical description: Transformer module for AC analog input*. The function can operate for respective VCTs.

(i) Error level

Generally, the default error level has been set at level 1 (**Serious error**[1]). For example, the user can program the level using setting [**CHK_ACC1:LVI**] when the VCT module at the VCT#1[2] slot should be supervised. Set **On** for the settings [**CHK_ACC1:Sw**]. The manufacturer sets one (1) second to detect the failure; it is reset within a second when the failure is cleared.

[1]Note: When the error is detected, the entire operation of the IED is stopped forcibly.

[2]Note: The location of the VCT is discussed in Alpha-numerical references. See chapter *Technical description: IED case and module slot*.

(ii) Error message

When detecting an error, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-30 Error messages provided by the supervisor in CHK_ACC

Message and level	Meaning of the information
AI#x(ACC) error	Detection of the conversion deterioration at VCx slot
Error level	Serious error (Level 1)

Table 10.2-31 Detailed information in Hexadecimal in CHK_ACC

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: P error 00000002: N error 00000004: Neg error 00000010: P(H) error 00000020: N(H) error 00000040: Neg(H) error	Plus value / Minus value
Middle row	Plus rev value / (none)	Plus value / Minus value
Bottom row	Plus rev value	(No message displayed)

10.2.16 Abnormal current flowing in CT (CT error)

The CT supervision is to examine whether the three-phase currents are balanced and the current in zero-sequence is minimum. It secures the operation of the CT circuit. By monitoring of the currents flowing in the AC analog input circuit, it is also applied to detect the failure in the CT circuit. The failure is determined If Equation (10.2-1) is satisfied.

$$\mathrm{Max}(|I_a|, |I_b|, |I_c|) - 4 \times \mathrm{Min}(|I_a|, |I_b|, |I_c|) \geq k_0 \qquad (10.2\text{-}1)$$

where,

Max (|Ia|, |Ib|, |Ic|): The selection of maximum amplitude among Ia, Ib and Ic

Min (|Ia|, |Ib|, |Ic|): The selection of minimum amplitude among Ia, Ib and Ic

k0: Current multiplied a rated current by 20%

(i) Error level

Generally, the default error level has been set at level 3 (**Minor error**), but the user can program the level using setting [**CHK_CT:LVl**]; then, set **On** for the setting [**CHK_CT:Sw**]. The time for the detection can be set using [**CHK_CT:Timer**], which is set for 15 seconds as default. After the error is cleared, resetting will be performed after the elapse of setting time.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-32 Error messages provided by the supervisor in CHK_CT

Message and level	Meaning of the information
CT error	Detection of the extraordinary current flowing
Error level	Minor error (Level 3)

Table 10.2-33 Detailed information in Hexadecimal in CHK_CT

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.2.17 Current transformer failure (CT fail)

Detecting the failure in the CT is achieved by the operation of the CT failure detection function (CTF†). Thus, the failure signal in the CTF is transferred to the automatic supervision function and it is grouped into the error level together with other error signals.

†Note:For more information about the CTF function, see Chapter *Relay application: CT failure detection*.

(i) Error level

Generally, the default error level has been set at level 3 (**Minor error**), but the user can program the level using setting [**CHK_CTF:LVl**]; then, set **On** for the setting [**CHK_CTF:Sw**]. The manufacturer sets ten (10) seconds to detect the failure; it is reset instantly when the failure is cleared

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-34 Error messages provided by the supervisor in CHK_CTF

Message and level	Meaning of the information
CT fail	Detection of the failure in the CT
Error level	Minor error (Level 3)

Table 10.2-35 Detailed information in Hexadecimal in CHK_CTF

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.2.18 Supervision of current in zero-sequence (I0 error)

The zero-phase-sequence current entering to the input circuit is monitored; it is possible to provide a high sensitivity to detect the failure using the residual circuit current. Equation (10.2-2) is represented for the supervision:

$$\frac{|I_a + I_b + I_c - I_e|}{3} \geq 0.1 \times \mathrm{Max}(|I_a|, |I_b|, |I_c|) + k_0 \qquad (10.2\text{-}2)$$

where,

I_e	Residual current
$\mathrm{Max}(\|I_a\|, \|I_b\|, \|I_c\|)$	The largest amplitude among I_a, I_b and I_c
k_0:	5% of the rated current†

†Note: The rated current above the equation is defined with the setting of the VCT. For more information regarding the VCT, see Chapter *Technical description: Transformer module for AC analog input*.

(i) Error level

Generally, the default error level has been set at level 3 (**Minor error**), but the user can program the level using setting [**CHK_IZ:LVl**].; then, set **On** for the settings [**CHK_IZ:Sw**]. The time to detect can be set using [**CHK_IZ:Timer**], which is set for 15 seconds as default. If the error is cleared, resetting will be performed after the elapse of setting time.

(ii) Error message

When detecting an error, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-36 Error messages provided by the supervisor in CHK_IZ

Message and level	Meaning of the information
I0 error	Detection of flowing the zero-sequence current
Error level	Minor error (Level 3)

Table 10.2-37 Detailed information in Hexadecimal in CHK_IZ

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.2.19 Supervision of voltage in negative-sequence (V2 error)

Applying the voltage in negative-sequence is calculated regularly using three-phase voltages measured in the IED. If Equation (10.2-3) is satisfied over 10 seconds, the supervision function determines that a failure occurs in the input circuit.

The voltage in negative sequence can be used to detect a failure within the voltage input circuit in high sensitivity. It facilitates the detection of the incorrect phase sequence if cables are connected irregularly.

$$\frac{|V_a + a^2 V_b + aV_c|}{3} \geq 6.35 \ \text{(V)} \qquad (10.2\text{-}3)$$

where,

a = Phase shift operator of 120°

(i) Error level

Generally, the default error level has been set at level 3 (**Minor error**), but the user can program the level using setting [**CHK_V2:LVl**]; then, set **On** for the setting [**CHK_V2:Sw**]. The time for the detection can be set using [**CHK_V2:Timer**], which is set for 15 seconds as default. After the error is cleared, resetting will be performed after the elapse of setting time.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-38 Error messages provided by the supervisor in CHK_V2

Message and level	Meaning of the information
V2 error	Detection of the negative-sequence voltage
Error level	Minor error (Level 3)

Table 10.2-39 Detailed information in Hexadecimal in CHK_V2

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.2.20 Supervision of voltage in zero-sequence (VZ error)

Voltage in zero-sequence is automatically calculated using three-phase voltages measured in the relay. If Equation (10.2-4) is made up, the supervision function can determine that a voltage in zero-sequence is being applied erroneously.

$$\frac{|V_a + V_b + V_c|}{3} \geq 6.35 \ \text{(V)} \qquad (10.2\text{-}4)$$

(i) Error level

Generally, the default error level has been set at level 3 (**Minor error**), but the user can program the level using setting [**CHK_VZ:LVl**]; then, set **On** for the setting [**CHK_VZ:Sw**]. The time for the detection can be set using [**CHK_VZ:Timer**] , which is set for 15 seconds as default. After the error is cleared, it is reset in the time that is the same as the setting time to the detection.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-40 Error messages provided by the supervisor in CHK_VZ

Message and level	Meaning of the information
V0 error	Detection of the zero-sequence voltage
Error level	Minor error (Level 3)

Table 10.2-41 Detailed information in Hexadecimal in CHK_VZ

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.2.21 Supervision of binary IO module#1 (BIO#1 error)

A supervision function is provided to detect the operation failure in the first binary IO modules (BIO)†.

†Note:The function can operate for respective BIO modules mounted in the IED; the user should have settings in them, which are located at the IO slot identified with the number.

(i) Error level

Generally, the default error level has been set at level 1 (**Serious error**[1]). For example, the user can program the level using setting [**CHK_BIO1:LVl**] when the BIO module at the IO#1[2] slot should be supervised; then, set **On** for the setting [**CHK_BIO1:Sw**]. The manufacturer sets one (1) second to detect the failure; it is reset with in a second when the failure is cleared.

[1]Note: When the error is detected, the entire operation of the IED is stopped forcibly.

[2]Note: The location of the IO slot is discussed in Chapter *Technical description: IED case and module slot*.

(ii) Error message

When detecting an error, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-42 Error messages provided by the supervisor in CHK_BIO1

Message and level	Meaning of the information
BIO#1 error	Detection of the BIO failure at IO slot#1
Error level	Serious error (Level 1)

Table 10.2-43 Detailed information in Hexadecimal in CHK_BIO1

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: CRC error 00000002: Connection error 00000004: Read back error	Count number by the CRC error
Middle row	Count number by the connection error	Count number by the read-back error
Bottom row	(No message displayed)	(No message displayed)

10.2.22 Supervision of binary IO module#2 (BIO#2 error)

A supervision function is provided to detect the operation failure in the second binary IO modules (BIO)†.

†Note:The function can operate for respective BIO modules mounted in the IED; the user should have settings in them, which are located at the IO slot identified with the number.

(i) Error level

Generally, the default error level has been set at level 1 (**Serious error**[1]). For example, the user can program the level using setting [**CHK_BIO2:LVl**] when the BIO module at the IO#2[2] slot should be supervised; then, set **On** for the setting [**CHK_BIO2:Sw**]. The manufacturer sets one (1) second to detect the failure; it is reset within a second when the failure is cleared.

[1]Note: When the error is detected, the entire operation of the IED is stopped forcibly.

[2]Note: The location of the IO slot is discussed in Chapter *Technical description: IED case and module slot*.

(ii) Error message

When detecting an error, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-44 Error messages provided by the supervisor in CHK_BIO2

Message and level	Meaning of the information
BIO#2 error	Detection of the BIO failure at IO slot#2
Error level	Serious error (Level 1)

Table 10.2-45 Detailed information in Hexadecimal in CHK_BIO2

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: CRC error 00000002: Connection error 00000004: Read back error	Count number by the CRC error
Middle row	Count number by the connection error	Count number by the read-back error
Bottom row	(No message displayed)	(No message displayed)

10.2.23 Supervision of binary IO module#3 (BIO#3 error)

A supervision function is provided to detect the operation failure in the third binary IO modules (BIO)†.

†Note:The function can operate for respective BIO modules mounted in the IED; the user should have settings in them, which are located at the IO slot identified with the number.

(i) Error level

Generally, the default error level has been set at level 1 (**Serious error**[1]). For example, the user can program the level using setting [**CHK_BIO3:LVl**] when the BIO module at the IO#3[2] slot should be supervised; then, set **On** for the setting [**CHK_BIO3:Sw**]. The manufacturer sets one (1) second to detect the failure; it is reset with in a second when the failure is cleared.

[1]Note: when the error is detected the entire operation of the IED is stopped forcibly.

[2]Note: The location of the IO slot is discussed in Chapter *Technical description: IED case and module slot*.

(ii) Error message

When detecting an error, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-46 Error messages provided by the supervisor in CHK_BIO3

Message and level	Meaning of the information
BIO#3 error	Detection of the BIO failure at IO slot#3
Error level	Serious error (Level 1)

Table 10.2-47 Detailed information in Hexadecimal in CHK_BIO3

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: CRC error 00000002: Connection error 00000004: Read back error	Count number by the CRC error
Middle row	Count number by the connection error	Count number by the read-back error
Bottom row	(No message displayed)	(No message displayed)

10.2.24 Supervision of binary IO module#4 (BIO#4 error)

A supervision function is provided to detect the operation failure in the forth binary IO modules (BIO)†.

†Note:The function can operate for respective BIO modules mounted in the IED; the user should have settings in them, which are located at the IO slot identified with the number.

(i) Error level

Generally, the error level has been set at level 1 (**Serious error**[1]), as default. For example, the user can program the level using setting [**CHK_BIO4:LVl**] when the BIO module at the IO#4[2] slot should be supervised; then, set **On** for the setting [**CHK_BIO4:Sw**]. The manufacture sets one (1) second to detect the failure; it is reset in a second when the failure is cleared.

[1]Note: The entire operation of the IED is stopped forcibly when the error is detected.

[2]Note: The location of the IO slot is discussed in Chapter *Technical description: IED case and module slot*.

(ii) Error message

When detecting an error, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-48 Error messages provided by the supervisor in CHK_BIO4

Message and level	Meaning of the information
BIO#4 error	Detection of the BIO failure at IO slot#4
Error level	Serious error (Level 1)

Table 10.2-49 Detailed information in Hexadecimal in CHK_BIO4

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: CRC error 00000002: Connection error 00000004: Read back error	Count number by the CRC error
Middle row	Count number by the connection error	Count number by the read-back error
Bottom row	(No message displayed)	(No message displayed)

10.2.25 Supervision of binary IO module#5 (BIO#5 error)

A supervision function is provided to detect the operation failure in the fifth binary IO modules (BIO)†.

†Note:The function can operate for respective BIO modules mounted in the IED; the user should have settings in them, which are located at the IO slot identified with the number.

(i) Error level

Generally, the default error level has been set at level 1 (**Serious error**[1]). For example, the user can program the level using setting [**CHK_BIO5:LVl**] when the BIO module at the IO#5[2] slot should be supervised; then, set **On** for the setting [**CHK_BIO5:Sw**]. The manufacturer sets one (1) second to detect the failure; it is reset with in a second when the failure is cleared.

[1]Note: When the error is detected, the entire operation of the IED is stopped forcibly.

[2]Note: The location of the IO slot is discussed in Chapter *Technical description: IED case and module slot*.

(ii) Error message

When detecting an error, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-50 Error messages provided by the supervisor in CHK_BIO5

Message and level	Meaning of the information
BIO#5 error	Detection of the BIO failure at IO slot#5
Error level	Serious error (Level 1)

Table 10.2-51 Detailed information in Hexadecimal in CHK_BIO5

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: CRC error 00000002: Connection error 00000004: Read back error	Count number by the CRC error
Middle row	Count number by the connection error	Count number by the read-back error
Bottom row	(No message displayed)	(No message displayed)

10.2.26 Supervision of binary IO module#6 (BIO#6 error)

A supervision function is provided to detect the operation failure in the sixth binary IO modules (BIO)†.

†Note:The function can operate for respective BIO modules mounted in the IED; the user should have settings in them, which are located at the IO slot identified with the number.

(i) Error level

Generally, the default error level has been set at level 1 (**Serious error**[1]). For example, the user can program the level using setting [**CHK_BIO6:LVl**] when the BIO module at the IO#6[2] slot should be supervised; then, set **On** for the setting [**CHK_BIO6:Sw**]. The manufacturer sets one (1) second to detect the failure; it is reset with in a second when the failure is cleared.

[1]Note: when the error is detected the entire operation of the IED is stopped forcibly.

[2]Note: The location of the IO slot is discussed in Chapter *Technical description: IED case and module slot*.

(ii) Error message

When detecting an error, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-52 Error messages provided by the supervisor in CHK_BIO6

Message and level	Meaning of the information
BIO#6 error	Detection of the BIO failure at IO slot#6
Error level	Serious error (Level 1)

Table 10.2-53 Detailed information in Hexadecimal in CHK_BIO6

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: CRC error 00000002: Connection error 00000004: Read back error	Count number by the CRC error
Middle row	Count number by the connection error	Count number by the read-back error
Bottom row	(No message displayed)	(No message displayed)

10.2.27 Supervision of binary IO module#7 (BIO#7 error)

A supervision function is provided to detect the operation failure in the seventh binary IO modules (BIO)†.

†Note:The function can operate for respective BIO modules mounted in the IED; the user should have settings in them, which are located at the IO slot identified with the number.

(i) Error level

Generally, the default error level has been set at level 1 (**Serious error**[1]). For example, the user can program the level using setting [**CHK_BIO7:LVl**] when the BIO module at the IO#7[2] slot should be supervised; then, set **On** for the setting [**CHK_BIO7:Sw**]. The manufacturer sets one (1) second to detect the failure; it is reset with in a second when the failure is cleared.

[1]Note: When the error is detected, the entire operation of the IED is stopped forcibly.

[2]Note: The location of the IO slot is discussed in Chapter *Technical description: IED case and module slot*.

(ii) Error message

When detecting an error, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-54 Error messages provided by the supervisor in CHK_BIO7

Message and level	Meaning of the information
BIO#7 error	Detection of the BIO failure at IO slot#7
Error level	Serious error (Level 1)

Table 10.2-55 Detailed information in Hexadecimal in CHK_BIO7

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: CRC error 00000002: Connection error 00000004: Read back error	Count number by the CRC error
Middle row	Count number by the connection error	Count number by the read-back error
Bottom row	(No message displayed)	(No message displayed)

10.2.28 Supervision of binary IO module#8 (BIO#8 error)

A supervision function is provided, to detect the operation failure in the eighth binary IO modules (BIO)†.

†Note:The function can operate for respective BIO modules mounted in the IED; the user should have settings in them, which are located at the IO slot identified with the number.

(i) Error level

Generally, the default error level has been set at level 1 (**Serious error**[1]). For example, the user can program the level using setting [**CHK_BIO8:LVl**] when the BIO module at the IO#8[2] slot should be supervised; then, set **On** for the setting [**CHK_BIO8:Sw**]. The manufacturer sets one (1) second to detect the failure; it is reset with in a second when the failure is cleared.

[1]Note: When the error is detected, the entire operation of the IED is stopped forcibly.

[2]Note: The location of the IO slot is discussed in Chapter *Technical description: IED case and module slot*.

(ii) Error message

When detecting an error, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-56 Error messages provided by the supervisor in CHK_BIO8

Message and level	Meaning of the information
BIO#8 error	Detection of the BIO failure at IO slot#8
Error level	Serious error (Level 1)

Table 10.2-57 Detailed information in Hexadecimal in CHK_BIO8

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: CRC error 00000002: Connection error 00000004: Read back error	Count number by the CRC error
Middle row	Count number by the connection error	Count number by the read-back error
Bottom row	(No message displayed)	(No message displayed)

10.2.29 Supervision of human machine interface (HMI error)

Supervising the failure in the human machine interface (HMI) is provided.

(i) Error level

Generally, the default error level has been set at level 3 (**Minor error**[1]). However, the user can program the level using setting [**CHK_HMI:LVI**]; then, set **On** for the setting [**CHK_HMI:Sw**]. The manufacturer sets ten (10) seconds to detect the failure; it is reset within 10 seconds when the failure is cleared.

[2]Note: The functions of the HMI is discussed in Chapter *Technical description: Human machine interface*.

(ii) Error message

When detecting an error, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-58 Error messages provided by the supervisor in CHK_HMI

Message and level	Meaning of the information
HMI error	Detection of the HMI failure
Error level	Minor error (Level 3)

Table 10.2-59 Detailed information in Hexadecimal in CHK_HMI

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: Timeout of LCD communication 00000002: Format error in LCD communication 00000004: Communication error in MIMIC LCD	Culminated value for the timeout
Middle row	Counted value for the format error	Counter of the MIMIC communication
Bottom row	(No information is displayed)	(No information is displayed)

10.2.30 Supervision of power supply module (Power error)

A power error is issued when the DC voltage generated in the power supply module (PWS†) is less than a threshold. The user can select either 85V or 170V thresholds for issuing the power error; it is determined by inserting a shut connector (JP4) on the PWS.

†Note: For more information about the PWS, see Chapter *Technical description, Power supply module*. When the AC supply—however, the manufacture does not guarantee the operation in the AC power—is connected with the PWS module, the user shall set **Off** for the setting [**CHK_POWER:Sw**] (that is, the supervision function concerning to the PWS module are stopped). Remember that the state of the binary input circuit (BI) will be latched when the Power error occurs anytime.

(i) Error level

Generally, the default error level has been set at level 3 (**Minor error**), as default, but the user can program the level using setting [**CHK_POWER:LVl**]; then, set **On** for the setting [**CHK_POWER:Sw**]. The manufacturer sets one (1) second to detect the failure; it is reset with in a second when the failure is cleared.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-60 Error messages provided by the supervisor in CHK_POWER

Message and level	Meaning of the information
Power error	Detection of the failure in the PWS
Error level	Minor error (Level 3)

Table 10.2-61 Detailed information in Hexadecimal in CHK_POWER

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: PWS failure	(No information displayed)
Middle row	(No information displayed)	(No information displayed)
Bottom row	(No information displayed)	(No information displayed)

10.2.31 Supervision of data in PLC function (PLC data error)

The error of the PLC function is detected when the data coded by the PLC editor[1] has an error.

(i) Error level

Generally, the default error level has been set at level 3 (**Minor error**), but the user can program the level using setting [**CHK_PLC_DAT:LVI**]; then, set **On** for the setting [**CHK_PLC_DAT:Sw**]. The manufacturer sets one-hundred-twenty (120) second to detect the failure; it is reset within 60 seconds when the failure is cleared.

(ii) Error message

When detecting an error, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-62 Error messages provided by the supervisor in CHK_PLC_DAT

Message and level	Meaning of the information
PLC data error	Detection of the failure in the PLC function
Error level	Minor error (Level 3)

Table 10.2-63 Detailed information in Hexadecimal in CHK_ PLC_DAT

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	00000001: No PLC data exists in the IED. 00000002: Errors caused when Data is inputted in the IED[2] 00000004: Errors caused when Data is outputted in the IED[3] 00000008: Time over in the computation[4] 00000010: PLC stopped by the operation of the PLC editor[5]	(No information)
Middle row	(No information)	(No information)
Bottom row	(No information)	(No information)

[1]See Chapter *PLC editing in* PLC editor (6F2S1904) separately.

[2]It can be displayed when Data IDs are selected erroneously in DIN function.

[3]It can be displayed when Data IDs are selected erroneously in DOUT function.

[4]The kind of tasks (Main_1, Main_2, or Main_3) may be too large.

[5]The PLC stops manually by the PLC editor.

10.2.32 Voltage transformer failure (VT fail)

Detecting the failure in the VT is achieved by the operation of the VT failure detection function (VTF†). Thus, the failure signal in the VTF is transferred to the automatic supervision function and it is grouped into the error level together with other error signals.

†Note: For more information about the VTF function, see Chapter *Relay application: VT failure detection*.

(i) Error level

Generally, the default error level has been set at level 3 (**Minor error**), but the user can program the level using setting [**CHK_VTF:LVl**]; then, set **On** for the setting [**CHK_VTF:Sw**]. The manufacturer sets ten (10) seconds to detect the failure; it is reset instantly when the failure is cleared.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-64 Error messages provided by the supervisor in CHK_VTF

Message and level	Meaning of the information
VT fail	Detection of the failure in the VT
Error level	Minor error (Level 3)

Table 10.2-65 Detailed information in Hexadecimal in CHK_VTF

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.2.33 Supervision of circuit breaker contacts (CB1/CB2 fail)

Detecting the operation failure in the CB is achieved by the operation of the protection common function (PROT_COMM†). Thus, the failure signal in the PROT_COMM is transferred to the automatic supervision function and it is grouped into the error level together with other error signals.

†Note: For more information about the PROT_COMM function, see Chapter *Relay application: Protection common*. When the IED operates for the 1.5CB arrangements, the detection is carried out for two CBs.

(i) Error level

Generally, the default error level is set at level 3 (**Minor error**), as default, but the user can program the level using settings [**CHK_CB1:LVl**] and the others; then, set **On** for the settings [**CHK_CB1:Sw**] or whatever. The time for the detection can be set using [**TCBSV**], which is provided in the PROT_COMM function. It is reset instantly if the error is cleared,.

(ii) Error message

When the function operates and detects errors, an error message can be shown at the LED and the LCD screen.

Table 10.2-66 Error messages provided by the supervisor in CHK_CB

Message and level	Meaning of the information
CBx fail	Detection of the failure in the CBx
Error level	Minor error (Level 3)

Table 10.2-67 Detailed information in Hexadecimal in CHK_CB

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.2.34 Supervision of disconnector contacts (DS fail)

Detecting the operation failure in the disconnector (DS) is achieved by the operation of the protection common function (PROT_COMM†). Thus, the failure signal in the PROT_COMM is transferred to the automatic supervision function and it is grouped into the error level together with other error signals.

†Note: For more information about the PROT_COMM function, see Chapter *Relay application: Protection common*.

(i) Error level

Generally, the default error level has been set at level 3 (**Minor error**), but the user can program the level using settings [**CHK_DS:LVl**]; then, set **On** for the setting [**CHK_DS:Sw**]. The time for the detection can be set using [**TDSSV**], which is provided in the PROT_COMM function. It is reset instantly when the error is cleared.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.2-68 Error messages provided by the supervisor in CHK_DS

Message and level	Meaning of the information
DS fail	Detection of the failure in the DS
Error level	Minor error (Level 3)

Table 10.2-69 Detailed information in Hexadecimal in CHK_DS

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.2.35 Supervision of response for pinging (Ping error)

Communication error on the LAN† is detected by pinging for the addresses instructed.

†Note: For more information about the LAN, see Chapter *Communication Protocol: LAN communication*. For the information about the LAN hardware, see Chapter *Technical description: Signal processing and communication module*. When two network modules operates, the message is provided for the both.

(i) Error level

Generally, the default error level has been set at level 3 (**Minor error**), but the user can program the level using settings [**CHK_PING*:LVl**]; then, set **On** for the settings [**CHK_PING*:Sw**]. The manufacturer sets one-hundred (100) second to detect the failure; it is reset in 20 seconds when the failure is cleared.

(ii) Error message

When detecting errors, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-70 Error messages provided by the supervisor in CHK_PING

Message and level	Meaning of the information
LAN* (ping) error	Detection of the pinging failure instructed with "LAN*" as follows: LAN1 (ping): Communication module (COM#1 at C11) LAN2 (ping): Communication module (COM#2 at C12)
Error level	Minor error (Level 3)

Table 10.2-71 Detailed information in Hexadecimal in CHK_PING

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	Destination address for pinging	(No information is displayed)
Middle row	(No information is displayed)	(No information is displayed)
Bottom row	(No information is displayed)	(No information is displayed)

10.2.36 Supervision of data in 61850 settings (Commslv error)

The error† is detected when an inconsistency is found in the 61850 settings. Note that the information for the error may vary on the communication protocol.

(i) Error level

Generally, the default error level has been set at level 3 (**Minor error**), but the user can program the level using setting [**CHK_CMLV:LVl**]; then, set **On** for the setting [**CHK_CMLV:Sw**]. The error can be detected in two minutes after the IED is turned on.

(ii) Error message

When detecting errors, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-72 Error messages provided by the supervisor in CHK_CMLV

Message and level	Meaning of the information
Data(cmmslv) error	Detection of the failure in the settings
Error level	Minor error (Level 3)

Table 10.2-73 Detailed information in Hexadecimal in CHK_CMLV

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	Error reasons code	Displaying the Data ID relating to erroneous mapping
Middle row	Displaying the Data ID relating to erroneous mapping	Additional information
Bottom row	Additional information	Additional information

†Note:In the IEC 61850 communication protocol, LN, DO and DA names are displayed in ASCII characteristic codes, which instruct wrong mappings performed. In the below sample, for example, the user can get the error mapping of "GGIO2$STtVal" when ASCII codes are solved in eight-characters and four-characters.

Top row and left colum: [4747494F] Top row and right column: [32245354]

Middle row: [7456616C]

47 47 49 4F 32 24 53 54 74 56 61 6C = "GGIO2$STtVal"

Table 10.2-74 Error reasons detected by the supervisor in CHK_CMLV

Reasons of errors	
Function error found	Erroneous index being used in the data for the protocol stack designated
Failure occurred on going through the selection process with regard to the protocol	Time out
Failure occurred on the initialization in the protocol process	Going through the process
Failure for opening file	Found invalid arguments
Failure of access	Found the data type not being supported
No space left in the buffer	Failure of the acquisition of the authority right
No space left in the buffer provided for the SSP mapping	Failure occurred on the setting process
Failure of memory allocation in the memory dynamically	Failure of the event registration
Check sum errors	No event occurred
Not unfound about the searching object	Restarting
Failure of the defining of data type	Communication error

10.2.37 Supervision of GOOSE publishing (LAN(GOOSE)error)

Publishing error in the IEC 61850 communication† is detected when a GOOSE message is not received.

†Note:For more information about GOOSE, see Chapter *Communication protocol: IEC 61850 communication*.

(i) Error level

Generally, the default error level has been set at level 3 (**Minor error**), but the user can program the level using setting [**CHK_GOOSERCV:LVl**]; then, set **On** for the setting [**CHK_GOOSERCV:Sw**]. Detecting the error is expressed in five-minutes when the IED detects no reception of the GOOSE. When the GOOSE is started to receive, it is reset in one-minute.

(ii) Error message

When detecting errors, an error message can be shown on the LCD screen and an LED is lit.

Table 10.2-75 Error messages provided by the supervisor in CHK_GOOSERCV

Message and level	Meaning of the information
LAN(GOOSE) error	Detection of the failure in GOOSE
Error level	Minor error (Level 3)

Table 10.2-76 Detailed information in Hexadecimal in CHK_GOOSERCV

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	Receipt state regarding to the GOOSE subscribe information#1†	Receipt state regarding to the GOOSE subscribe information#2†
Middle row	Receipt state regarding to the GOOSE subscribe information#3†	Receipt state regarding to the GOOSE subscribe information#4†
Bottom row	Receipt state regarding to the GOOSE subscribe information#5†	Receipt state regarding to the GOOSE subscribe information#6†

†Note:"c000" is shown when no reception.

10.2.38 Aux. contacts monitoring (DPSY faulty and undefined)

When signals of an external device (i.e., a circuit breaker) are provided in a pair of auxiliary contacts[1], the signals may be grouped into four states: Open, Fault, Undefined, and Closed. This is because, two different kinds of N/C and N/O contacts operates in the other way around; hence, there is a possibility that the generated signal may have an incorrect condition (Faulty) or an intermediate condition (Undefined). When receiving the signal by the BI circuit[2] of the IED, a preliminary logic[3] starts to group the receiving signals into Open and the other states. Consequently, the control function is able to operate securely not being affected by improper signals (i.e., Fault, Undefined). In the supervision function, the received signals are sorted with the definition of the error levels programmed by the manufacture, but the user can program the sorting procedure arbitrarily using the settings in the check function (CHK_PALLET).

[1]Note: A pair of N/C and N/O contacts is called as "Pallet" in the manual.

[2]Note: The BI circuit is discussed in the Binary IO module. For more information, see Chapter *Technical description*.

[3]Note: The preliminary logic is designed to acquire a signal coming from the BI circuit and to sort the signal into the 'Open', 'Fault', 'Undefined', and 'Closed' states. The preliminary logic is furnished in every control functions. For example, we can find the logic in section "*Setup for BIO module*" in Chapter *Control and monitoring application: Double position controller with synchronizing-checking*.

(i) Correspondence between CHK_PALLETs and applications

There are a number of CHK_PALLETs operations in the automatic supervision function; hence the user is required so that the control application corresponds with the CHK_PALLET, as shown in the below table.

Table 10.2-77 Correspondence table for the control applications

Supervision functions		Controlling functions	
Function ID	Names	Function ID	Names
222201	CHK_PALLET1	511001	DPSY1 function
222202	CHK_PALLET2	511001	DPSY2 function

†Note: To detect the "Faulty" and "Undefined" states in the DPSY1 function, the user can adjust the time for supervision using settings [**DPSY01-FLTTIM**] and [**DPSY01-UDFTIM**], which are provided in the DPSY1 function. Then, set [**DPSY01-FLTEN**] **On** for the operation. Likewise, settings are available in the DPSY2 function.

(ii) Error level

For the operation, the user can set the error level when the function detects the error concerning the operation. Generally, the default error level has been set at level 3 (**Minor error**) and level 4 (**Alarm**) for the faulty state and the undefined state, respectively. However the user

can program them using settings. For example, when the user wishes to program the fault and undefined states in the DPSY1 function, use the settings [**CHK_PALLET1:FTxt**] and [**CHK_PALLET1:UTxt**], respectively; then, set **On** for the setting [**CHK_PALLET1:Sw**].

(iii) Error message

When the function operates and detects errors, an error message can be shown at the LED and the LCD screen.

Table 10.2-78 Error messages provided by the supervisor in CHK_PALLET

Message and level	Meaning of the information
DPSY* undefine	'Undefined" detected at * of the DPSY function
Error level	Minor error (Level 3) for 'Faulty'; Alarm (Level 4) for 'Undefined'

Table 10.2-79 Detailed information in Hexadecimal in CHK_PALLET

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	Detecting 'undefined' is represented with "1". Detecting 'faulty' is represented with "2".	(No information is displayed)
Middle row	(No information is displayed)	(No information is displayed)
Bottom row	(No information is displayed)	(No information is displayed)

10.2.39 Setting

Setting of CHK_SAMPLING (Function ID: 220701)

Setting item	Range	Contents	Default setting value	Notes
CHK_SPSYNC1:Sw	Off / On	Enable switch	On	
CHK_ SPSYNC1:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error(Comm)	
CHK_SPSYNC2:Sw	Off / On	Enable switch	On	
CHK_ SPSYNC2:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error(Comm)	

Setting of CHK_ACC (Function ID: 220E01 and 220E02)

Setting item	Range	Contents	Default setting value	Notes
CHK_ACC1:Sw	Off / On	Enable switch	On	
CHK_ ACC1:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error	
CHK_ACC2:Sw	Off / On	Enable switch	On	
CHK_ ACC2:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error	

Setting of CHK_BIO (Function ID: 221101 to 221108)

Setting item	Range	Contents	Default setting value	Notes
CHK_BIO1:Sw	Off / On	Enable switch for BIO#1	On	
CHK_ BIO 1:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level at BIO#1	Serious error	
…	…	…	…	
CHK_ BIO8:Sw	Off / On	Enable switch for BIO#8	On	
CHK_ BIO8:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level at BIO#1	Serious error	

Setting of CHK_HMI (Function ID: 221301)

Setting item	Range	Contents	Default setting value	Notes
CHK_HMI:Sw	Off / On	Enable switch	On	
CHK_ HMI:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Minor error	

Setting of CHK_RTC (Function ID: 221701)

Setting item	Range	Contents	Default setting value	Notes
CHK_RTC:Sw	Off / On	Enable switch	On	
CHK_RTC:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm / Warning	Error level	Minor error	

Setting of CHK_CT (Function ID: 221801)

Setting item	Range	Contents	Default setting value	Notes
CHK_CT:Sw	Off / On	Enable switch	On	
CHK_CT:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error	
CHK_CT:Timer	10 – 60 seconds	Checking timer	15 seconds	

Setting of CHK_IZ (Function ID: 221901)

Setting item	Range	Contents	Default setting value	Notes
CHK_IZ:Sw	Off / On	Enable switch	On	
CHK_IZ:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm / Warning	Error level	Minor error	
CHK_IZ:Timer	10s – 60s	Checking timer	15s	

Setting of CHK_V2 (Function ID: 221A01)

Setting item	Range	Contents	Default setting value	Notes
CHK_V2:Sw	Off / On	Enable switch	On	
CHK_V2:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm / Warning	Error level	Minor error	
CHK_V2:Timer	10s – 60s	Checking timer	15s	

Setting of CHK_VZ (Function ID: 221B01)

Setting item	Range	Contents	Default setting value	Notes
CHK_VZ:Sw	Off / On	Enable switch	On	
CHK_VZ:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm / Warning	Error level	Minor error	
CHK_VZ:Timer	10s – 60s	Checking timer	15s	

Setting of CHK_VTF (Function ID: 221C01)

Setting item	Range	Contents	Default setting value	Notes
CHK_VTF:Sw	Off / On	Enable switch	On	
CHK_ VTF:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Minor error	

Setting of CHK_POWER (Function ID: 222D01)

Setting item	Range	Contents	Default setting value	Notes
CHK_POWER:Sw	Off / On	Enable switch	On	

Setting of CHK_POWER (Function ID: 222D01)

Setting item	Range	Contents	Default setting value	Notes
CHK_POWER:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm / Warning	Error level	Minor error	

Setting of CHK_CTF (Function ID: 221E01)

Setting item	Range	Contents	Default setting value	Notes
CHK_CTF:Sw	Off / On	Enable switch	On	
CHK_ CTF:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Minor error	

Setting of CHK_CB (Function ID: 222001 and 222002)

Setting item	Range	Contents	Default setting value	Notes
CHK_CB1:Sw	Off / On	Enable switch	On	
CHK_ CB1 1:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Minor error	
CHK_ CB2:Sw	Off / On	Enable switch	On	
CHK_ CB2:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Minor error	

Setting of CHK_DS (Function ID: 221101)

Setting item	Range	Contents	Default setting value	Notes
CHK_DS:Sw	Off / On	Enable switch	On	
CHK_DS:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Minor error	

Setting of CHK_PLC_DAT (Function PLC_DAT: 223201)

Setting item	Range	Contents	Default setting value	Notes
CHK_PLC_DAT:Sw	Off / On	Enable switch	On	
CHK_PLC_DAT:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm / Warning	Error level	Minor error	

Setting of CHK_PING (Function ID: 223601)

Setting item	Range	Contents	Default setting value	Notes
CHK_PING1:Sw	Off / On	Enable switch	Off	

Setting of CHK_PING (Function ID: 223601)

Setting item	Range	Contents	Default setting value	Notes
CHK_PING1:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm / Warning	Error level	Minor error	
PING_IP_ADRS	0 - 255	Ping target IP address	192	
PING_IP_ADRS2	0 - 255		168	
PING_IP_ADRS3	0 - 255		1	
PING_IP_ADRS4	0 - 255		1	

Setting of CHK_CMLV (Function ID: 224001)

Setting item	Range	Contents	Default setting value	Notes
CHK_CMLV_DAT:Sw	Off / On	Enable switch	On	
CHK_CMLV_DAT:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Minor error	

Setting of CHK_GOOSERCV (Function ID: 223501)

Setting item	Range	Contents	Default setting value	Notes
CHK_GOOSERCV:Sw	Off / On	Enable switch	On	
CHK_GOOSERCV:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm / Warning	Error level	Minor error	

Setting of CHK_PALLET (Function ID: 222201 to 222202)

Setting item	Range	Contents	Default setting value	Notes
CHK_PALLET1:Sw	Off / On	Enable switch to supervising the DPSY1	On	
CHK_PALLET1:ULvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm / Warning	Error level for undefined error at DPSY1	Alarm	
CHK_PALLET1:FLvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm / Warning	Error level for faulty error at DPSY1	Minor error	
CHK_PALLET2:Sw	Off / On	Enable switch to supervising the DPSY2	On	
CHK_PALLET2:ULvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm / Warning	Error level for undefined error at DPSY2	Alarm	
CHK_PALLET2:FLvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm / Warning	Error level for faulty error at DPSY2	Minor error	

10.2.40 Signal (Data ID)

◆ **Signal monitoring point**

CHK_ROMRAM (Function ID: 220101)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	Executing counter
3210001001	RESULT	Check result
3210011001	RES_INST	Check result (instant)

◆ **Signal monitoring point**

CHK_SUM (Function ID: 220201)

Element ID	Name	Description
3210101001	CHECKSUM	
3210111001	CHECKSUMC	
32E0001001	CHK_POINT	
32FFFF1001	EXEC_CNT	Executing counter
3210201001	LOADERSUM	
3210121001	PROG_SIZE	
3210001001	RESULT	Check result
3210011001	RES_INST	Check result (instant)

◆ **Signal monitoring point**

CHK_PROGRAM (Function ID: 220301)

Element ID	Name	Description
30E0001001	CHKPOINT	test point1
30E0011001	CHKPOINT2	test point2
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_NMI (Function ID: 220401)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_RAM (Function ID: 220601)

Element ID	Name	Description
32E0001001	CHKPOINT	test point
3210021001	ECC_SECNT	ECC single error cnt
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result

◆ **Signal monitoring point**

CHK_RAM (Function ID: 220601)

Element ID	Name	Description
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_ECC (Function ID: 220602)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_ SAMPLING (Function ID: 220701)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_ ACC (Function ID: 220E01)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210021001	RES_FAST	check result(fast)
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_MRAM (Function ID: 220F01)

Element ID	Name	Description
32E0001001	CHKPOINT	test point
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_ BIO (Function ID: 221101 to 221108)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_ HMI (Function ID: 2201301)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_SETTING (Function ID: 221501)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_DPRAM and CHK_EXDPRAM (Function ID: 221601 and 221602)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	Executing counter
3210001001	RESULT	Check result
3210011001	RES_INST	Check result (instant)

◆ **Signal monitoring point**

CHK_RTC (Function ID: 221701)

Element ID	Name	Description
32E0001001	CHKPOINT	Test point
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_CT (Function ID: 221801)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_IZ (Function ID: 221901)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_V2 (Function ID: 221A01)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_VZ (Function ID: 221B01)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_ VTF (Function ID: 221C01)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_POWER (Function ID: 222D01)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_CTF (Function ID: 221E01)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_CB (Function ID: 222001)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_DS (Function ID: 221101)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_PLC_DAT (Function ID: 223201)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_PING (Function ID: 223601)

Element ID	Name	Description
EXEC_CNT	32FFFF1001	execute counter
RESULT	3210001001	check result
RES_INST	3210011001	check result(instant)

◆ **Signal monitoring point**

CHK_ CMLV (Function ID: 224001)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_PALLET (Function ID: 222201 and 222202)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	Executing counter
3210001001	RESULT	Check result
3210011001	RES_INST	Check result (instant)

10.3 Device-dependent supervision tasks

Displaying errors regarding to special problems are summarized in Table 10.2-1; the error is cleared when recovered

Table 10.3-1 Supervision items and error levels for device-dependent

Sec. No.	Supervision items(Screen message)	Detailed Info.	ERROR Lvl	ERROR LED
10.3.1	Error detection of differential current in DIF (Id)	N/A	3	On
10.3.2	Current transformer failure detected with DIF (DIF-CT)	N/A	3	On
10.3.3	Synchronizing and sampling error (Com sync fail)	N/A	2	On
10.3.4	Communication failure (Com fail)	N/A	2	On
10.3.5	Error signal level for sending (TX level)	N/A	3	On
10.3.6	Error signal level for receiving (RX level)	N/A	3	On
10.3.7	Propagation delay error (Com Td)	Displayed	3	On
10.3.8	Error terminal configuration (Term ID)	N/A	2	On
10.3.9	Monitoring ready state at the remote (Term rdy)	N/A	2	On
10.3.10	Transmission error (Com fail-R)	N/A	2	On
10.3.11	Master-slave monitoring (MSCHK)	N/A	2	On
10.3.12	Supervision of Relay ID (RYID)	Displayed	2	On

Note: The implementation of particular features is dependent upon the selection of hardware and the configuration of functions. Several IED models do not support certain features. To determine whether a particular feature has been implemented within an IED, identify the IED ordering number; and check the order number for the "G&T position" whilst referring to the comparison table below. For more information, see *Appendix: Ordering*.

Table 10.3-2 Comparative table in respective ordering numbers

Sec.	Feature	Ordering No. at "G&T"				
		10	11	13	19	22
–	Device dependent supervision tasks	✓	✓	✓	✓	✓

✓: Applicable NA: Not applicable

10.3.1 Error detection of differential current in DIF (Id)

Operations are monitored by the operation of DIFL-SV element† in the current differential function (DIF). The automatic supervision function can alarm its erroneous operation by the notification from the DIF function.

†Note:The DIF function has a supervision feature; and, the user can set it using settings [**DIFL-IdSV**] and [**TDIFL-IdSV**]; then set **On** for the scheme switch [**DIFL-IdSV-EN**]. For more information about the DIF supervision, see Chapter *Relay application: Current differential protection for the line: Differential current monitor*.

(i) Error level

The default error level is set at 3 (**Minor error**), but the user can change it using setting [**CHK_ID:LVl**]; then, set **On** for the setting [**CHK_ID:Sw**]. The manufacture sets 10 seconds for the detection using the [**TDIFL-IdSV**]. It is reset instantly when the error is cleared.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.3-3 Error messages provided by the supervisor in CHK_ID

Message and level	Meaning of the information
Id error	Detection of the erroneous differential current
Error level	Minor error (Level 3)

Table 10.3-4 Detailed information in Hexadecimal in CHK_ID

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.3.2 Current transformer failure detected with DIF (DIF-CT)

The CT failure can be monitored by the operation of DIFL-CTF element† in the current differential function (DIF); the automatic supervision function can alarm its erroneous operation by the notification from the DIF function.

†Note: The DIF function has the supervision feature itself; hence, the user can program the criteria for the supervision using setting [**DIFL-CTF**]; then set **On** for the scheme switch [**CTFL-EN**]. For more information about the DIF supervision, see Chapter *Relay application: Current differential protection for the line: Differential current monitor*.

(i) Error level

Generally, the default error level is set at level 3 (**Minor error**), but the user can program the level using setting [**CHK_DIF_CTF:LVl**]; then, set **On** for the setting [**CHK_DIF_CTF:Sw**]. The manufacturer sets the time for the detection for 10 seconds. The function resets instantly after the error is cleared.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.3-5 Error messages provided by the supervisor in CHK_DIF_CTF

Message and level	Meaning of the information
DIF-CT fail	Failure detection on the CT
Error level	Minor error (Level 3)

Table 10.3-6 Detailed information in Hexadecimal in CHK_DIF_CTF

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.3.3 Synchronizing and sampling error (Com sync fail)

In the dual communication mode† (i.e., either **2Term-Dual**, **2Term–4Term** is set for setting [**TERM_TOPOLGY**]), synchronization between two IEDs is monitored. If the error is detected for ten seconds, the synchronizing error is issued.

†Note:See chapter *Relay application: Transmission control function*.

(i) Error level

Generally, the default error level is set at level 2 (**Serious error (Comm)**), as default, but the user can program the level using settings [**CHK_SPSYNC1:LVL**] and [**CHK_SPSYNC2:LVL**]; then, set **On** for the settings [**CHK_SPSYNC1:Sw**] and [**CHK_SPSYNC2:Sw**]. The manufacturer sets ten (10) seconds to detect the failure; it is reset with in one second when the failure is cleared.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.3-7 Error messages provided by the supervisor in CHK_SPSYNC

Message and level	Meaning of the information
ComX sync fail	Detection of an error located at X
Error level	Serious error (Level 2)

Table 10.3-8 Detailed information in CHK_SPSYNC

Code No.	Meaning of the detailed information
N/A	(No information is displayed)

10.3.4 Communication failure (Com fail)

The transmission between two IEDs is also monitored. If the error is detected for ten seconds, the communication failure is issued.

(i) Error level

Generally, the default error level is set at level 2 (**Serious error (Comm)**), but the user can program the level using settings [**CHK_CM_FAIL1:Lvl**] and [**CHK_CM_FAIL2:Lvl**]; then, set **On** for the setting [**CHK_CM_FAIL1:Sw**] and [**CHK_CM_FAIL2:Sw**]. The manufacture sets ten (10) seconds to detect the failure; it is reset in 12 ssp (i.e., 12×48×Power_system_frequency (Hz)) when the failure is cleared.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.3-9 Error messages provided by the supervisor in CHK_CM_FAIL

Message and level	Meaning of the information
ComX fail	Detection of an error located at X†
Error level	Serious error (Level 2) †

†Note:Level 2 is set as default, but the user can change the error level above using the settings [**CHK_CM_FAIL*:Lvl**].

Table 10.3-10 Detailed information in CHK_CM_FAIL

Code No.	Meaning of the detailed information
N/A	(No information is displayed)

10.3.5 Error signal level for sending (TX level)

When the communication module operates for the medium or long distance, the signal level for sending can be monitored when **On** is set for the setting. The error signal is issued when the erroneous signal is sensed for ten seconds. Note that this monitoring is not available for the communication module for the short distance.

(i) Error level

Generally, the default error level is set at level 3 (**Minor error**), as default, but the user can program the level using settings [**CHK_TX_LVL1:Lvl**] and [**CHK_TX_LVL2:Lvl**]; then, set **On** for the settings [**CHK_TX_LVL1:Sw**] and [**CHK_TX_LVL:Sw**]. The manufacturer sets ten (10) seconds set to detect the failure; it is reset in a second when the failure is cleared.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.3-11 Error messages provided by the supervisor in CHK_TX_LVL

Message and level	Meaning of the information
TXx level error	Detection for sending level improperly at x module
Error level	Minor error (Level 3)

Table 10.3-12 Detailed information in Hexadecimal in CHK_TX_LVL

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.3.6 Error signal level for receiving (RX level)

Similarly, the signal level for receiving can be monitored when **On** is set for the setting. The error signal is issued when the erroneous signal is sensed for ten seconds. Note that this monitoring is not available for the communication module for the short distance.

(i) Error level

Generally, the default error level is set at level 3 (**Minor error**), but the user can program the level using settings [**CHK_RX_LVL1:Lvl**] and [**CHK_RX_LVL2:Lvl**]; then, set **On** for the setting [**CHK_RX_LVL1:Sw**] and [**CHK_RX_LVL:Sw**]. The manufacturer sets ten (10) seconds to detect the failure; it is reset with in a second when the failure is cleared.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.3-13 Error messages provided by the supervisor in CHK_RX_LVL

Message and level	Meaning of the information
RXx level error	Detection for receiving level improperly at x module
Error level	Minor error (Level 3)

Table 10.3-14 Detailed information in Hexadecimal in CHK_RX_LVL

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.3.7 Propagation delay error (Com Td)

Propagation delay on the communication can be monitored; it can be detected when the propagation delay is examined beyond the setting. The delay error is issued when the delay is detected for ten seconds.

(i) Error level

Generally, the default error level is set at level 3 (**Minor error**) when the delay is 6000 micro seconds larger. However, the user can program the criterion time using settings [**CHK_TD_OVER1:Td**] and [**CHK_TD_OVER2:Td**] in micro seconds; then, set **On** for the settings [**CHK_TD_OVER1:Sw**] and [**CHK_TD_OVER2:Sw**] after set preferred error levels of the settings [**CHK_TD_OVER1:Lvl**] and [**CHK_TD_OVER2: Lvl**]. The manufacturer sets ten (10) seconds to detect the failure; it is reset with in a second when the failure is cleared.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.3-15 Error messages provided by the supervisor in CHK_TD_OVER

Message and level	Meaning of the information
ComX Td over	Detection for delay time being over at X module
Error level	Minor error (Level 3)

Table 10.3-16 Detailed information in Hexadecimal in CHK_TD_OVER

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	Delay time expressed in the hexadecimal	Setting time expressed in the hexadecimal
Middle row	(No information is displayed)	(No information is displayed)
Bottom row	(No information is displayed)	(No information is displayed)

10.3.8 Error terminal configuration (Term ID)

The user can monitor the network configuration between terminals. The error signal is issued when the erroneous configuration is observed for ten seconds. For monitoring, the user should set **Off** for the settings [**MSCHK-EN**] and set **On** for the [**CHK_TERM_CNF:Sw**]. For more information about the master-slave relationship, see chapter *Relay application: Communication application*.

(i) Error level

Generally, the default error level is set at level 2 (**Serious error (Comm)**), but the user can program the level using setting [**CHK_TERM_CNF:Lvl**]; then, set **On** for the setting [**CHK_TERM_CNF:Sw**]. The manufacturer sets ten (10) seconds to detect the failure; it is reset with in a second when the failure is cleared.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.3-17 Error messages provided by the supervisor in CHK_TERM_CNF

Message and level	Meaning of the information
Term ID error	Detection for error ID in the network configuration
Error level	Serious error (Level 2)

Table 10.3-18 Detailed information in Hexadecimal in CHK_TERM_CNF

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.3.9 Monitoring ready state at the remote (Term rdy)

Monitor of the ready state at the remote IED is performed when the user sets **On** for the setting. If the IED at the remote cannot stay in the ready state for ten seconds, an error signal is issued.

(i) Error level

Generally, the default error level is set at level 2 (**Serious error (Comm)**), but the user can program the level using settings [**CHK_READY1:Lvl**] and [**CHK_READY2:Lvl**]; then, set **On** for the settings [**CHK_READY1:Sw**] and [**CHK_READY2:Sw**]. The manufacture sets ten (10) seconds to detect the failure; it is reset with in a second when the failure is cleared.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.3-19 Error messages provided by the supervisor in CHK_READY

Message and level	Meaning of the information
Term rdy error	Detection for remote terminal not being ready
Error level	Serious error (Level 2)

Table 10.3-20 Detailed information in Hexadecimal in CHK_READY

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.3.10 Transmission error (Com fail-R)

An error occurred at the remote can be detected when the user sets **On** for the setting [**CHK_CMRFAIL1:Sw**]. The error signal is issued when the remote IED cannot sense the signal coming from the opposite IED for ten seconds.

(i) Error level

Generally, the default error level is set at level 2 (**Serious error (Comm)**), as default, but the user can program the level using settings [**CHK_CMRFAIL1:Lvl**] and [**CHK_CMRFAIL2:Lvl**]; then, set **On** for the settings [**CHK_CMRFAIL1:Sw**] and [**CHK_CMRFAIL2:Sw**]. The manufacture sets ten (10) seconds to detect the failure; it is reset with in a second when the failure is cleared.

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.3-21 Error messages provided by the supervisor in CHK_CMRFAIL

Message and level	Meaning of the information
ComX fail-R	Detection for communication failure at remote terminal
Error level	Serious error (Level 2)

Table 10.3-22 Detailed information in Hexadecimal in CHK_CMRFAIL

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.3.11 Master-slave monitoring (MSCHK)

The user can monitor the relationship between the master and the slave terminals when the IEDs operate in the master-slave configuration. The error signal will be issued instantly when the erroneous configuration is observed. For monitoring, the user set **On** for the settings [**MSCHK-EN**] and [**CHK_CM_MS:Sw**]. For more information about the master-slave relationship, see chapter *Relay application: Communication application*.

(i) Error level

Generally, the default error level is set at level 2 (**Serious error (Comm)**), but the user can program the level using settings [**CHK_CM_MS1:Lvl**] and [**CHK_CM_MS2:Lvl**]; then, set **On** for the settings [**CHK_CM_MS1:Sw**] and [**CHK_CM_MS2:Sw**].

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.3-23 Error messages provided by the supervisor in CHK_CM_MS

Message and level	Meaning of the information
MSCHKx error	Detection for master/slave failure at X module
Error level	Serious error (Level 2)

Table 10.3-24 Detailed information in Hexadecimal in CHK_CM_MS

Display area	Meaning of the detailed information
N/A	(No information is displayed)

10.3.12 Supervision of Relay ID (RYID)

When the IED is designated with relay addresses (relay ID), the relay ID can be monitored by the communication application when the user set **On** for the settings [**CHK_RYID:Sw**]. For more information with regard to the relay address, see chapter *Relay application: Communication application*.

(i) Error level

Generally, the default error level is set at level 2 (**Serious error (Comm)**), but the user can program the level using settings [**CHK_RYID1:Lvl**] and [**CHK_RYID2:Lvl**]; then, set **On** for the settings [**CHK_RYID1:Sw**] and [**CHK_RYID 2:Sw**].

(ii) Error message

When the function operates and detects error, an error message can be shown at the LED and the LCD screen.

Table 10.3-25 Error messages provided by the supervisor in CHK_RYID

Message and level	Meaning of the information
RYIDx error	Detection for erroneous Relay ID at x module
Error level	Serious error (Level 2)

Table 10.3-26 Detailed information in Hexadecimal in CHK_RYID

Display area	Meaning of the detailed information	
	Left column	Right column
Top row	Relay ID expecting	Relay ID received in practice
Middle row	(No information is displayed)	(No information is displayed)
Bottom row	(No information is displayed)	(No information is displayed)

10.3.13 Setting

Setting of CHK_ID (Function ID: 221401)

Setting item	Range	Contents	Default setting value	Notes
CHK_ID:Sw	Off / On	Enable switch	On	
CHK_ID:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Minor error	

Setting of CHK_DIF_CTF (Function ID: 221F01)

Setting item	Range	Contents	Default setting value	Notes
CHK_DIF_CTF:Sw	Off / On	Enable switch	On	
CHK_DIF_CTF:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Minor error	

Setting of CHK_SPSYNC (Function ID: 2205001)

Setting item	Range	Contents	Default setting value	Notes
CHK_SPSYNC1:Sw	Off / On	Enable switch	On	
CHK_ SPSYNC1:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error(Comm)	
CHK_SPSYNC2:Sw	Off / On	Enable switch	On	
CHK_ SPSYNC2:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error(Comm)	

Setting of CHK_CM_FAIL (Function ID: 225101 and 225102)

Setting item	Range	Contents	Default setting value	Notes
CHK_CM_FAIL1:Sw	Off / On	Enable switch	On	
CHK_ CM_FAIL1:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error(Comm)	
CHK_CM_FAIL2:Sw	Off / On	Enable switch	On	
CHK_ CM_FAIL2:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error(Comm)	

Setting of CHK_TX_LVL (Function ID: 225401 and 225402)

Setting item	Range	Contents	Default setting value	Notes
CHK_TX_LVL1:Sw	Off / On	Enable switch	On	
CHK_TX_LVL1:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Minor error	
CHK_TX_LVL2:Sw	Off / On	Enable switch	On	
CHK_TX_LVL2:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Minor error	

Setting of CHK_RX_LVL (Function ID: 225501 and 225502)

Setting item	Range	Contents	Default setting value	Notes
CHK_RX_LVL1:Sw	Off / On	Enable switch	On	
CHK_RX_LVL1:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Minor error	
CHK_RX_LVL2:Sw	Off / On	Enable switch	On	
CHK_RX_LVL2:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Minor error	

Setting of CHK_TD_OVER1 and 2 (Function ID: 225601 and 225602)

Setting item	Range	Units	Contents	Default setting value	Notes
CHK_TD_OVER1:Sw	Off / On	—	Enable switch	On	
CHK_TD_OVER1:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	—	Error level	Minor error	
CHK_TD_OVER1:Td	100 - 16000	Micro sec	telecomm delay time	6000	
CHK_TD_OVER2:Sw	Off / On	—	Enable switch	On	
CHK_TD_OVER2:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	—	Error level	Minor error	
CHK_TD_OVER2:Td	100 - 16000	Micro sec	telecomm delay time	6000	

Setting of CHK_TERM_CNF (Function ID: 225701)

Setting item	Range	Contents	Default setting value	Notes
CHK_TERM_CNF:Sw	Off / On	Enable switch	On	
CHK_TERM_CNF:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error(Comm)	

Setting of CHK_READY (Function ID: 225801 and 225802)

Setting item	Range	Contents	Default setting value	Notes
CHK_READY1:Sw	Off / On	Enable switch	On	
CHK_READY1:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error (Comm)	
CHK_READY2:Sw	Off / On	Enable switch	On	
CHK_READY2:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error (Comm)	

Setting of CHK_CMRFAIL (Function ID: 225901 and 225902)

Setting item	Range	Contents	Default setting value	Notes
CHK_CMRFAIL1:Sw	Off / On	Enable switch	On	
CHK_CMRFAIL1:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error (Comm)	
CHK_CMRFAIL2:Sw	Off / On	Enable switch	On	

Setting of CHK_CMRFAIL (Function ID: 225901 and 225902)

Setting item	Range	Contents	Default setting value	Notes
CHK_CMRFAIL2:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error (Comm)	

Setting of CHK_CM_MS (Function ID: 225A01 and 225A02)

Setting item	Range	Contents	Default setting value	Notes
CHK_CM_MS1:Sw	Off / On	Enable switch	On	
CHK_CM_MS1:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error (Comm)	
CHK_CM_MS2:Sw	Off / On	Enable switch	On	
CHK_CM_MS2:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error (Comm)	

Setting of CHK_RYID (Function ID: 222901 and 222902)

Setting item	Range	Contents	Default setting value	Notes
CHK_RYID1:Sw	Off / On	Enable switch	On	
CHK_RYID1:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error (Comm)	
CHK_RYID2:Sw	Off / On	Enable switch	On	
CHK_RYID2:Lvl	--- / Serious error / Serious error(Comm) / Minor error / Alarm/ Warning	Error level	Serious error (Comm)	

10.3.14 Signal (Data ID)

◆ **Signal monitoring point**

CHK_ID (Function ID: 221401)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_DIF_CTF (Function ID: 221F01)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_ SPSYNC (Function ID: 225001 – 225002)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_CM_FAIL (Function ID: 225101 – 225102)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_TX_LVL1 and 2 (Function ID: 225401 and 225402)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_RX_LVL1 and 2 (Function ID: 225501 and 225502)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter

◆ **Signal monitoring point**

CHK_RX_LVL1 and 2 (Function ID: 225501 and 225502)

Element ID	Name	Description
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_TD_OVER1 and 2 (Function ID: 225601 and 225602)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_TERM_CNF (Function ID: 225701)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_READY1 and 2 (Function ID: 225801 and 225802)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_CMRFAIL1 and 2 (Function ID: 225901 and 225902)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ **Signal monitoring point**

CHK_CM_MS1 and 2 (Function ID: 225A01 and 225A02)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

◆ Signal monitoring point

CHK_RYID1 and 2 (Function ID: 222901 and 222902)

Element ID	Name	Description
32FFFF1001	EXEC_CNT	executing counter
3210001001	RESULT	check result
3210011001	RES_INST	check result(instant)

11 Communication protocol

11.1 LAN communication

When LAN module(s) are provided in the IED, the IED can operate with LAN communications using the "Transmission Control Protocol/Internet Protocol (TCP/IP)". Thus, the user should set IP addresses and other information in accordance with the requirements of TCP/IP. Two communication features are provided within TCP/IP: Hot-standby communication and LAN monitoring. The two features are discussed later.

11.1.1 Setup

(i) How to set the local IP address

Table 11.1-1 shows a summary of the setting items provided in the communication module for Network. The user can set an IP address, subnet mask and gateway addresses in the IED†.

Table 11.1-1 TCP/IP setting of LAN module

Setting items	Range	Setting meaning	Default value
IPADDRESS1‡	0.0.0.0–255.255.255.255	IP address	192.168.1.11
SUBNETMASK1‡	0.0.0.0–255.255.255.255	Subnet mask	255.255.255.0
GATEWAY1‡	0.0.0.0–255.255.255.255	Default gateway	192.168.1.1

When the wishing to change addresses, the user can use this setting menu. Figure 11.1-1 shows the setting menu provided to change the addresses‡.

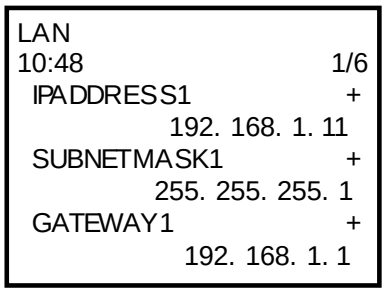


Figure 11.1-1 Local LAN setting menu (on IED screen)

†Note: For more information with regard to the communication modules, see Chapter *Technical description: Signal processing and communication module*.

‡Note: Although the IED can support either one or two LAN modules, the user should assign a single IP address for the IED. (Just for the record, subscript '1' of "IPADDRESS1, SUBNETMASK1, and GATEWAY1" is not relevant in this case.)

‡Note: Chapter *User interface: Setting sub-menu* describes how to set the address on the IED screen.

(ii) How to set Hot-standby communication

Redundant communication (i.e. "Hot-standby") is designed to provide additional security if a communications failure should occur on the LAN network. The "Hot-standby (HOTST)" function is implemented using two LAN modules in the IED.

For the Hot-standby communication, the first communication module for Network is used as the primary port, (i.e. LAN#1) while a second communication module for Network, (i.e. LAN#2) is used as the secondary port; the IED will communicate using the LAN#1 for normal operation. If a communications failure occurs at the LAN#1, the IED can automatically switch communication from the LAN#1 to the LAN#2.

When the IED detects the occurrence of a communications failure, for which the LAN module is unable to respond to the IED (i.e. a communications link is down), the IED starts a timer. When the timer exceeds a setting [**DownTime**], the IED will switch ports. Thus, LAN#2 is then used for communications. (Note that LAN#1 can be determined to be the secondary port on the occurrence of the failure. If LAN#2 is unable to continue to operate, then LAN#1 will be re-switched to run after a predetermined setting [**UpTime**]. Then, LAN#2 will be discriminated as the secondary port.)

(ii)-1 Setting for redundant mode

The Hot-standby function runs when the user sets **Hot_Standby** for scheme switch [**RedundantMode**]. If the user does not wish to run the Hot-standby function, set **Fixed** for the scheme switch [**RedundantMode**]. In this case, LAN#2 will not function even though dual LAN ports are provided by the IED.

(ii)-2 Selection of any one of ports as the primary port

The user can select any one of the ports to be the primary port although the LAN#1 is normally used as the primary port. For example, provided that both the LAN#1 and the LAN#2 are physically connected to the LAN, when the user wishes to use LAN#2 as the primary port, the user should set **Port2** for scheme switch [**PrimaryPort**]. If the user wishes not to select the primary port, set **None** for scheme switch [**PrimaryPort**].

(ii)-3 Setting of link-down timer

As mentioned earlier, the occurrence of a communication failure is determined when the timer exceeds the setting [**DownTime**]. Thus, the user should set a time setting for this decision.

(ii)-4 Setting of link-up timer

Another timer is provided in the Hot-standby function. Let us assume that the communication on LAN#1 is changed to LAN#2. If the failure of LAN#1 is removed after changing to LAN#2,

the IED will try to re-start using LAN#1 as the primary port. In this case, the user can define a time to revert to the original port and re-start communication on the original port by applying a re-start time for setting [**UpTime**].

Table 11.1-2 Summary of Hot-standby communication setting

Setting Items	Range	Meaning	Default
RedundantMode	Fixed / Hot_Standby	Fixed: LAN#2 not used. Hot_Standby: Hot-standby activated.	Fixed
DownTime	0–10000ms	A timer starts upon the occurrence of the communication failure (link down). The standby port commences communication in the DownTime.	5ms
PrimaryPort	None / Port1 / Port2	Selection of priority port None: No selection for the priority port. Port1: LAN#1 selected as the priority port. Port2: LAN#2 selected as the priority port.	None
UpTime	0–10000ms	A timer starts when the primary port is ready to commence communication after switching port.	5ms

The user should be aware of the following three facts prior to the Hot-standby operation:

1 The IED uses the IP/MAC address of LAN#1 for the Hot-standby operation. The IP/MAC address of LAN#2 is not used even if communication is carried out on LAN#2.

2 The user should ensure that an optical fiber is correctly connected when a 100Base-FX module is used in the IED, otherwise a repeat communication failure (link-down) will be experienced continuously. If the period for which the link-down is shorter than the setting [**DownTime**], another LAN port cannot be switched as the primary port. Thus, the user should determine the setting to be applied for [**DownTime**] on the basis of the system requirement. It is allowable for the user to apply a setting of zero for [**DownTime**] so that the switching of the ports will be performed immediately; conversely, the user can set any value less than 3000ms in order that the system would negate chattering failures if the optic fiber were not connected securely. Switching between the primary and the secondary ports is not performed when the user is keying a value for the setting [**DownTime**]. The user should consider the setting approach for [**UpTime**] in the same manner as when setting [**DownTime**].

3 The auto-negotiation function is executed when the 100Base-TX modules establish communication over the communications network. The auto-negotiation function selects a mode for communication; the auto-negotiation function adjusts the communication speed. In the case of a link-down condition, the auto-negotiation function will run again immediately. The link-down condition continues until auto-negotiation has been completed (it may continue for 1 or 2 seconds). The user can apply a setting for [**DownTime**] for any value of time less than that required by the

auto-negotiation function in response to the system requirement (i.e. the user can set [**DownTime**] to be zero milliseconds). In this case, switching between the primary and secondary ports is performed immediately i.e. prior to the auto-negotiation function running. If switching between ports is not required before the completion of the auto-negotiation function, the user can set the setting [**DownTime**] longer than the time required by the auto-negotiation function. The user can consider the setting for [**UpTime**] in the same manner as when setting [**DownTime**].

(ii)-5 Switching using PLC signals

Compulsory signals may be used to switch the ports. For example, if a compulsory signal is issued via PLC connection point "CH1_CH_CHG", communication is switched from the LAN#1 to the LAN#2. On the other hand, changing from the LAN#2 to the LAN#1 can be executed upon the reception of a signal via PLC signal "CH2_CH_CHG".

(iii) Network monitoring during Hot-standby operation

The Hot-standby (HOTST) function can send PING packets to remote devices thus enabling the Hot-standby function to monitor the state of the network. The Hot-standby function checks for a response signal from the remote device. If the Hot-standby function does not receive a response signal, the Hot-standby function will switch to the other port. The operation is performed when the user sets the scheme switches [**RedundantMode**] **Hot_Standby** and [**NetMonitor_EN**] **On**.

Settings [**Ping_IP1**] to [**Ping_IP12**] are provided in the Hot-standby function for the monitoring of remote devices on the network. When the user sets plural remote IP addresses for the settings [**Ping_IP***], and if the Hot-standby function does not receive a response from any one of these remote devices, the Hot-standby function determines that a communication failure has occurred. Table 11.1-3 shows the network monitoring settings for Hot-standby operation.

Table 11.1-3 Settings network monitoring on Hot-standby

Setting items	Range	Meaning	Default
NetMonitor_EN	Off/On	Enabling switch for monitoring	Off
Ping_IP1 to Ping_IP12	0.0.0.0 to 255.255.255.255	The user can set twelve IP addresses at 12 remote terminals. Value "0.0.0.0" should be set respectively when the remote IP addresses are not provided.	0.0.0.0
Ping_Wait	1–10 (sec)	Waiting time to PING response; if any one of the responses is not received, after the setting time has elapsed, the function will determine that there has been no-response.	1
Ping_Interval	1–120 (sec)	Interval of PING send; a PING packet is sent sequentially in accordance with this setting.	5
Chk_Count	1–10	Number of PING packets for checking; the "no-response "condition is determined when the IED is unable to obtain a number of responses from the same IP address. The user can set the number of responses required to determine the "no-response" condition using the setting [**Chk_Count**].	3

The user should note that the use of network monitoring could increase the burden on the network. This is because a number of PING packets are repeatedly transmitted over the network. Thus, the user should choose the setting values carefully in accordance with the network capacity, the burden, and the required time. Examples 1 and 2 below show the respective results using the network monitoring function with for different settings.

(iii)-1 Example operation 1

There is a remote device on the network with the address Ping_IP1. The Hot-standby function sends ping packets to the remote device every five seconds; then the Hot-standby function waits for one second until the Hot-standby function receives a response signal from the remote device. The Hot-standby function will determine that a communication failure has occurred if two sequential response signals are not received from the remote device. Subsequently, the Hot-Standby function will switch from one port to the other port (See Figure 11.1-2). The following settings are required in this example 1:

- The IP address of the remote device1 is set for setting [**Ping_IP1**]. (the setting of IP addresses in the other remote devices is not required.)
- One second is set for setting [**Ping_Wait**].
- Number "5" is set for [**Ping_Interval**].
- Number "2" is set for [**Check_Count**].

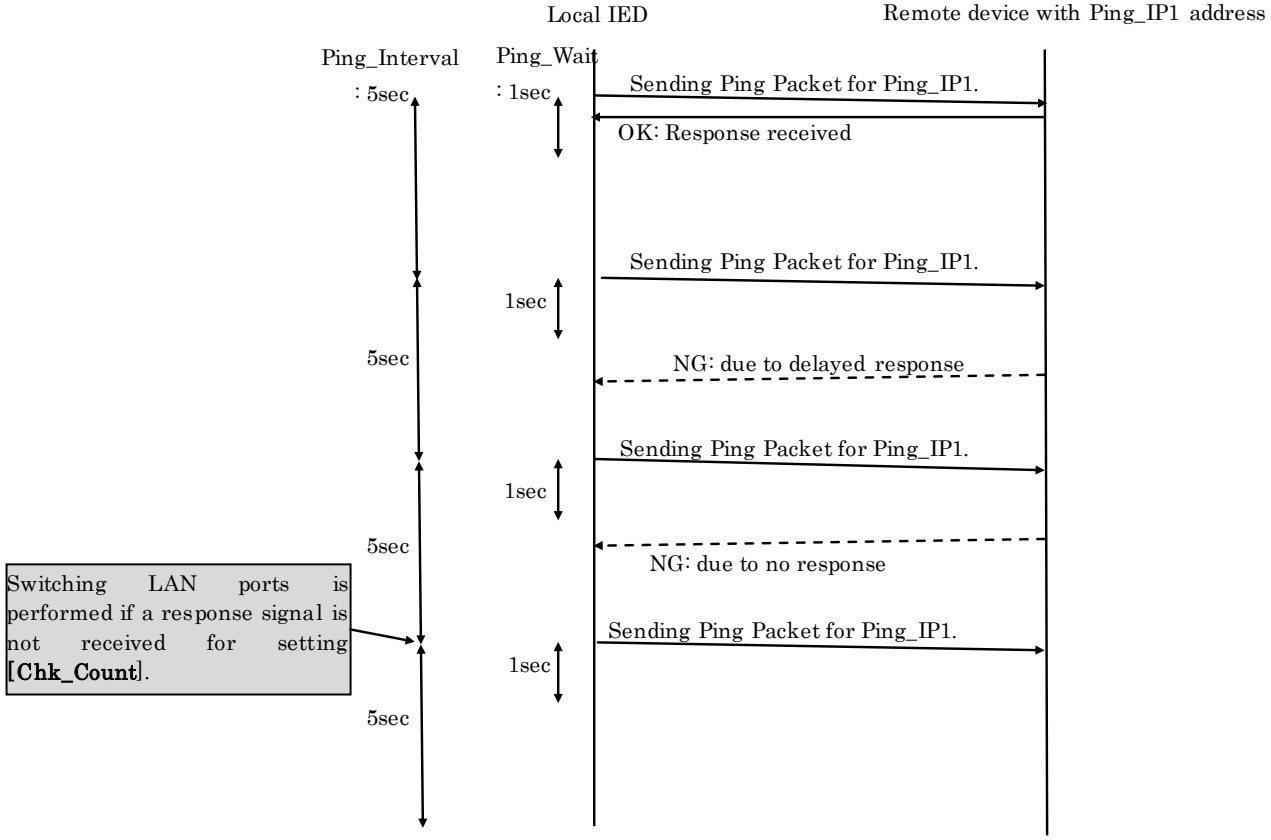


Figure 11.1-2 Time chart for Example 1

(iii)-2 Example operation 2

In Example 2 it is assumed that there are three remote devices on the network: Ping_IP1, Ping_IP2, and Ping_IP3. The Hot-standby function sends a Ping packet to each of the respective remote devices alternately every 10 seconds (i.e., the IED sends ping packets to the same remote device every 30 seconds). Since "1" is set for [**Check_Count**], the Hot-standby function will determine that a communication failure has occurred after 30 seconds if any one of the remote devices is unable to send a response. Figure 11.1-3 shows the operation of the Hot-standby function for Example 2; first switching of the ports is not executed as shown in the figure. This is because a response has not been confirmed from one of the remote addresses. In other words, switching of the ports is only applicable when all responses from all remote devices are not confirmed.

- The IP addresses of the remote devices are set for [**Ping_IP1**] to [**Ping_IP3**]. (Setting IP addresses for other remote devices is not required.)
- 10seconds is set for [**Ping_Wait**].
- Number "5" is set for [**Ping_Interval**].
- Number "1" is set for [**Check_Count**].

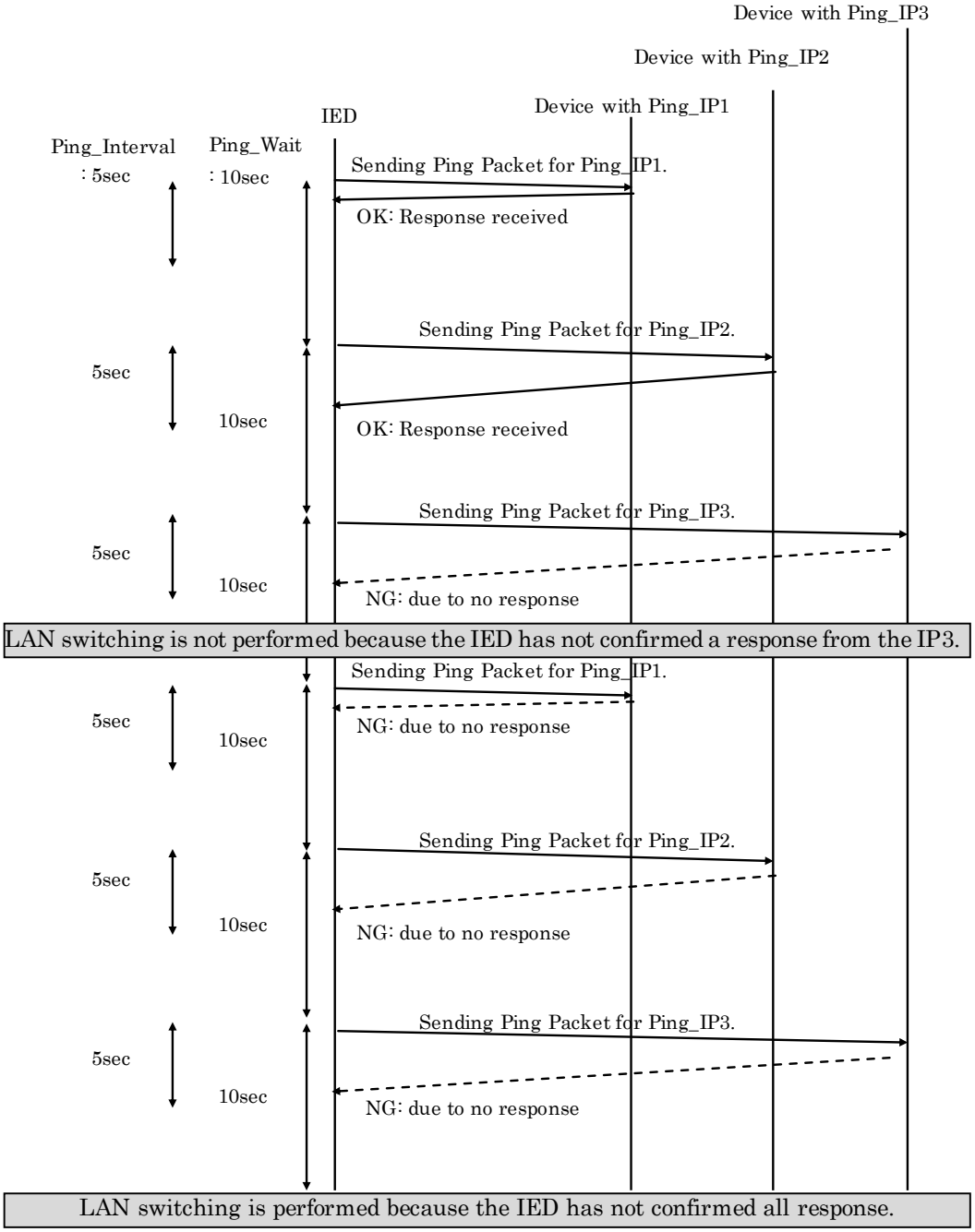


Figure 11.1-3 Time chart for Example 2

11.1.2 Auto reset function

To set the communication protocols† in the IED, the user can write the settings in the IED by transferring the setting-file generated in GR-TIEMS. After the transfer, the IED is required to start up again, but the user can allow the IED restart automatically with Auto reset function, shown in Table 11.1-4. Figure 11.1-4 shows the setting 'Common' under 'Main Menu-Setting-Communication' screens.

Table 11.1-4 Autoreset setting

Setting item	Switch	Feature	Default setting
AUTORESET	None / Cold	Restart function	None

†Note:GOOSE Subscribe, IEC 61850-CID File, IEC61850-Mapping Data, IEC 61870-103, DNP3, Modbus are applied.

None: is used when the user wishes to reset the IED by the hand. For example, the communication settings are written in the IED using the GR-TIEMS, the user should make restart the IED by oneself.

Cold: can allow the IED restart automatically when settings have been written in the IED with the GR-TIEMS. After that, the settings can be applied in the IED. Note that the protection operations are disqualified during the restart.

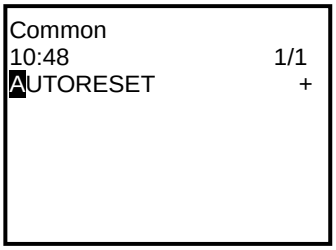


Figure 11.1-4 Setting screen for AUTORESET

11.1.3 Monitoring LAN communication

(i) LCD screen

The user can examine the statuses about the communion modules by the monitoring function.

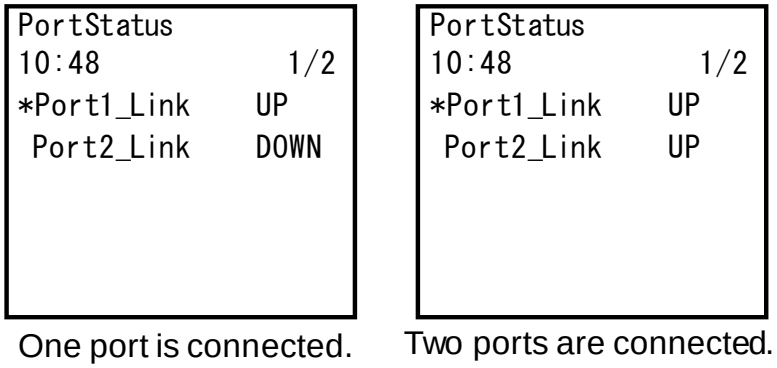


Figure 11.1-5 shows the port status about the modules; terms 'Up' and 'Down' mean running and stopping, respectively. For menus operations, see Chapter *User interface: Monitoring sub-menu*.

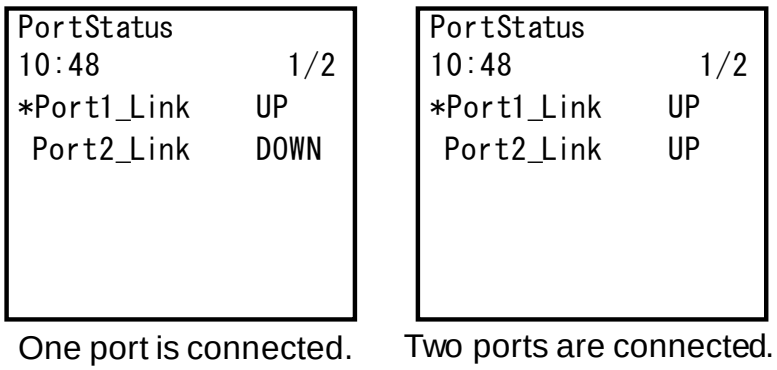


Figure 11.1-5 Communication status

(ii) Status signals for Port1 and Port2

The user can also examine the LAN status using PLC signal monitoring points 'Port1_Link (3100061001)' and 'Port2_Link (3100061001)' of the HOTST function. For example, when the user wishes to monitor the status of the Prot1_Link, use the 'Port1_Link'. Consequently, the user can get the physical information about the port1: the value '1' is issued when the communication is made (Linkup), whereas value '0' is issued when the communication is not made (Linkdown).

When the **Hot_Standby** is set for the setting [**RedundantMode**], the user can find a running port using the PLC signal monitoring point 'Using_CH (3100081001)' of the HOTST function. Value '1' is provided when the Port1 is running, whereas value '2' is provided when the Port2 is running.

11.1.4 Settings

Setting of TCP/IP (Function ID: 230201)

Setting item			Range	Units	Contents	Default setting value	Notes
	IP	IPADDRESS1	0 – 255	–	First decimal in IP at local IED	192	
		IP1_2	0 – 255	–	Second decimal in IP at local IED	168	
		IP1_3	0 – 255	–	Third decimal in IP at local IED	1	
		IP1_4	0 – 255	–	Forth decimal in IP at local IED	11	
	SUB NET	SUBNETMASK1	0 – 255	–	First decimal in subnet mask	255	
		SM1_2	0 – 255	–	Second decimal in subnet mask	255	
		SM1_3	0 – 255	–	Third decimal in subnet mask	255	
		SM1_4	0 – 255	–	Fourth decimal in subnet mask	1	
	GATE WAY	GATEWAY1	0 – 255	–	First decimal in gateway	192	
		GW1_2	0 – 255	–	Second decimal in gateway	168	
		GW1_3	0 – 255	–	Third decimal in gateway	1	
		GW1_4	0 – 255	–	Fourth decimal in gateway	1	

Setting of Net_MONITOR(Function ID: 351001)

Setting item			Range	Units	Contents	Default setting value	Notes
		NetMonitor_EN	Off / On	–	Enable switch for net monitoring	Off	
	IP1	Ping_IP1	0 – 255	–	First decimal address in IP1	0	
		Ping_IP1_2	0 – 255	–	Second decimal address in IP1	0	
		Ping_IP1_3	0 – 255	–	Third decimal address in IP1	0	
		Ping_IP1_4	0 – 255	–	Fourth decimal address in IP1	0	
	IP2	Ping_IP2	0 – 255	–	First decimal address in IP2	0	
		Ping_IP2_2	0 – 255	–	Second decimal address in IP2	0	
		Ping_IP2_3	0 – 255	–	Third decimal address in IP2	0	
		Ping_IP2_4	0 – 255	–	Fourth decimal address in IP2	0	
	IP3	Ping_IP3	0 – 255	–	First decimal address in IP3	0	
		Ping_IP3_2	0 – 255	–	Second decimal address in IP3	0	
		Ping_IP3_3	0 – 255	–	Third decimal address in IP3	0	
		Ping_IP3_4	0 – 255	–	Fourth decimal address in IP3	0	
	IP4	Ping_IP4	0 – 255	–	First decimal address in IP4	0	
		Ping_IP4_2	0 – 255	–	Second decimal address in IP4	0	
		Ping_IP4_3	0 – 255	–	Third decimal address in IP4	0	
		Ping_IP4_4	0 – 255	–	Fourth decimal address in IP4	0	
	IP5	Ping_IP5	0 – 255	–	First decimal address in IP5	0	
		Ping_IP5_2	0 – 255	–	Second decimal address in IP5	0	
		Ping_IP5_3	0 – 255	–	Third decimal address in IP5	0	
		Ping_IP5_4	0 – 255	–	Fourth decimal address in IP5	0	
	IP6	Ping_IP6	0 – 255	–	First decimal address in IP6	0	
		Ping_IP6_2	0 – 255	–	Second decimal address in IP6	0	
		Ping_IP6_3	0 – 255	–	Third decimal address in IP6	0	
		Ping_IP6_4	0 – 255	–	Fourth decimal address in IP6	0	
	IP7	Ping_IP7	0 – 255	–	First decimal address in IP7	0	
		Ping_IP7_2	0 – 255	–	Second decimal address in IP7	0	
		Ping_IP7_3	0 – 255	–	Third decimal address in IP7	0	
		Ping_IP7_4	0 – 255	–	Fourth decimal address in IP7	0	
		Ping_IP8	0 – 255	–	First decimal address in IP8	0	

Setting of Net_MONITOR(Function ID: 351001)

Setting item			Range	Units	Contents	Default setting value	Notes
	IP8	Ping_IP8_2	0 – 255	–	Second decimal address in IP8	0	
		Ping_IP8_3	0 – 255	–	Third decimal address in IP8	0	
		Ping_IP8_4	0 – 255	–	Fourth decimal address in IP8	0	
	IP9	Ping_IP9	0 – 255	–	First decimal address in IP9	0	
		Ping_IP9_2	0 – 255	–	Second decimal address in IP9	0	
		Ping_IP9_3	0 – 255	–	Third decimal address in IP9	0	
		Ping_IP9_4	0 – 255	–	Fourth decimal address in IP9	0	
	IP10	Ping_IP10	0 – 255	–	First decimal address in IP10	0	
		Ping_IP10_2	0 – 255	–	Second decimal address in IP10	0	
		Ping_IP10_3	0 – 255	–	Third decimal address in IP10	0	
		Ping_IP10_4	0 – 255	–	Fourth decimal address in IP10	0	
	IP11	Ping_IP11	0 – 255	–	First decimal address in IP11	0	
		Ping_IP11_2	0 – 255	–	Second decimal address in IP11	0	
		Ping_IP11_3	0 – 255	–	Third decimal address in IP11	0	
		Ping_IP11_4	0 – 255	–	Fourth decimal address in IP11	0	
	IP12	Ping_IP12	0 – 255	–	First decimal address in IP12	0	
		Ping_IP12_2	0 – 255	–	Second decimal address in IP12	0	
		Ping_IP12_3	0 – 255	–	Third decimal address in IP12	0	
		Ping_IP12_4	0 – 255	–	Fourth decimal address in IP12	0	
	Ping	Ping_Wait	1 – 10	sec	Ping packet waiting time	1	
		Ping_Interval	1 – 120	sec	Ping packet interval time	5	
		Chk_Count	1 – 10	sec	Number of ping check count	3	

Setting of REDLAN(Function ID: 340001)

Setting item		Range	Units	Contents	Default setting value	Notes
	RedundantMode	Fixed / Hot_Standby	–	Selection of Hot-standby	Fixed	

Setting of HOTST(Function ID: 341001)

Setting item		Range	Units	Contents	Default setting value	Notes
	PrimaryPort	None / Port1 /Port2	–	Selection of any one of the actual ports as the primary port	None	
	DownTime	0 – 10000	ms	Determination time for link-down	5	
	UpTime	0 – 10000	ms	Determination time for link-up	5	

Setting of TOOL_COM (Function ID: 201501)

Setting item	Range	Units	Contents	Default setting value	Notes
AUTORESET	None / Cold	–	Auto Restart function	None	

11.1.5 Data ID

◆ Signal monitoring points

TCPIP_DRV (Function ID: 230201)

Element ID	Name	Description
3030021150	GATEWAY1_1	Default gateway octet1
3030021151	GATEWAY1_2	Default gateway octet2
3030021152	GATEWAY1_3	Default gateway octet3
3030021153	GATEWAY1_4	Default gateway octet4
3030001150	IP ADDR1_1	IP address octet1
3030001151	IP ADDR1_2	IP address octet2
3030001152	IP ADDR1_3	IP address octet3
3030001153	IP ADDR1_4	IP address octet4
3010001150	MAC1_OCT1	MAC1 address octet 1
3010001151	MAC1_OCT2	MAC1 address octet 2
3010001152	MAC1_OCT3	MAC1 address octet 3
3010001153	MAC1_OCT4	MAC1 address octet 4
3010001154	MAC1_OCT5	MAC1 address octet 5
3010001155	MAC1_OCT6	MAC1 address octet 6
3011001150	MAC2_OCT1	MAC2 address octet 1
3011001151	MAC2_OCT2	MAC2 address octet 2
3011001152	MAC2_OCT3	MAC2 address octet 3
3011001153	MAC2_OCT4	MAC2 address octet 4
3011001154	MAC2_OCT5	MAC2 address octet 5
3011001155	MAC2_OCT6	MAC2 address octet 6
0012001001	NIC_R_SIG	NIC refreshed signal
0012011001	NIC_R_SIG1H	NIC refreshed signal (1 hour timer)
3110111001	RX1ER_CNT	receive error counter
3110101001	RX1_CNT	receive packet counter
3111111001	RX2ER_CNT	
3111101001	RX2_CNT	
3030011150	SUBNET1_1	Subnetmask octet1
3030011151	SUBNET1_2	Subnetmask octet2
3030011152	SUBNET1_3	Subnetmask octet3
3030011153	SUBNET1_4	Subnetmask octet4
3110211001	TX1ER_CNT	send error counter
3110201001	TX1_CNT	send packet counter
3111211001	TX2ER_CNT	
3111201001	TX2_CNT	

◆ Signal monitoring points

NET_MONITOR (Function ID: 351001)

Element ID	Name	Description
3121001001	NETMONITOR	Change to Network monitoring function
3120001460	Ping_IP1	Decision output of PING1 response w.r.t IP1 address
3120011460	Ping_IP2	Decision output of PING2 response w.r.t IP2 address
3120021460	Ping_IP3	Decision output of PING3 response w.r.t IP3 address
3120031460	Ping_IP4	Decision output of PING4 response w.r.t IP4 address
3120041460	Ping_IP5	Decision output of PING5 response w.r.t IP5 address
3120051460	Ping_IP6	Decision output of PING6 response w.r.t IP6 address
3120061460	Ping_IP7	Decision output of PING7 response w.r.t IP7 address
3120071460	Ping_IP8	Decision output of PING8 response w.r.t IP8 address
3120081460	Ping_IP9	Decision output of PING9 response w.r.t IP9 address
3120091460	Ping_IP10	Decision output of PING10 response w.r.t IP10 address
31200A1460	Ping_IP11	Decision output of PING11 response w.r.t IP11 address
31200B1460	Ping_IP12	Decision output of PING12 response w.r.t IP12 address

◆ Signal monitoring points

HOTST (Function ID: 341001)

Element ID	Name	Description
3100061001	Port1_Link	Port1 Link Status
3100071001	Port2_Link	Port2 Link Status
3100081001	Using_CH	Using channel information

◆ Connection point on PLC logic

HOTST (Function ID: 341001)

Element ID	Name	Description
310000E001	CH1_CH_CHG	Change to CH1 from CH2
310001E001	CH2_CH_CHG	Change to CH2 from CH1

11.2 IEC 61850 communication

Figure 11.2-1 shows a substation automation system (SAS) and a number of IEDs connected via a Ring LAN (100BASE-FX). The IEDs can have communication with other devices using the international standard protocol (IEC 61850 standard‡); additionally, the ring network topology is used to achieve network redundancy in the system. The user should use the GR-TIEMS to configure the protocol in the IEC 61850 standard. That is, the functions for the protection, the measurement, monitoring at local and remote, controlling and logging the data are required to program in the IEC 61850 standard.

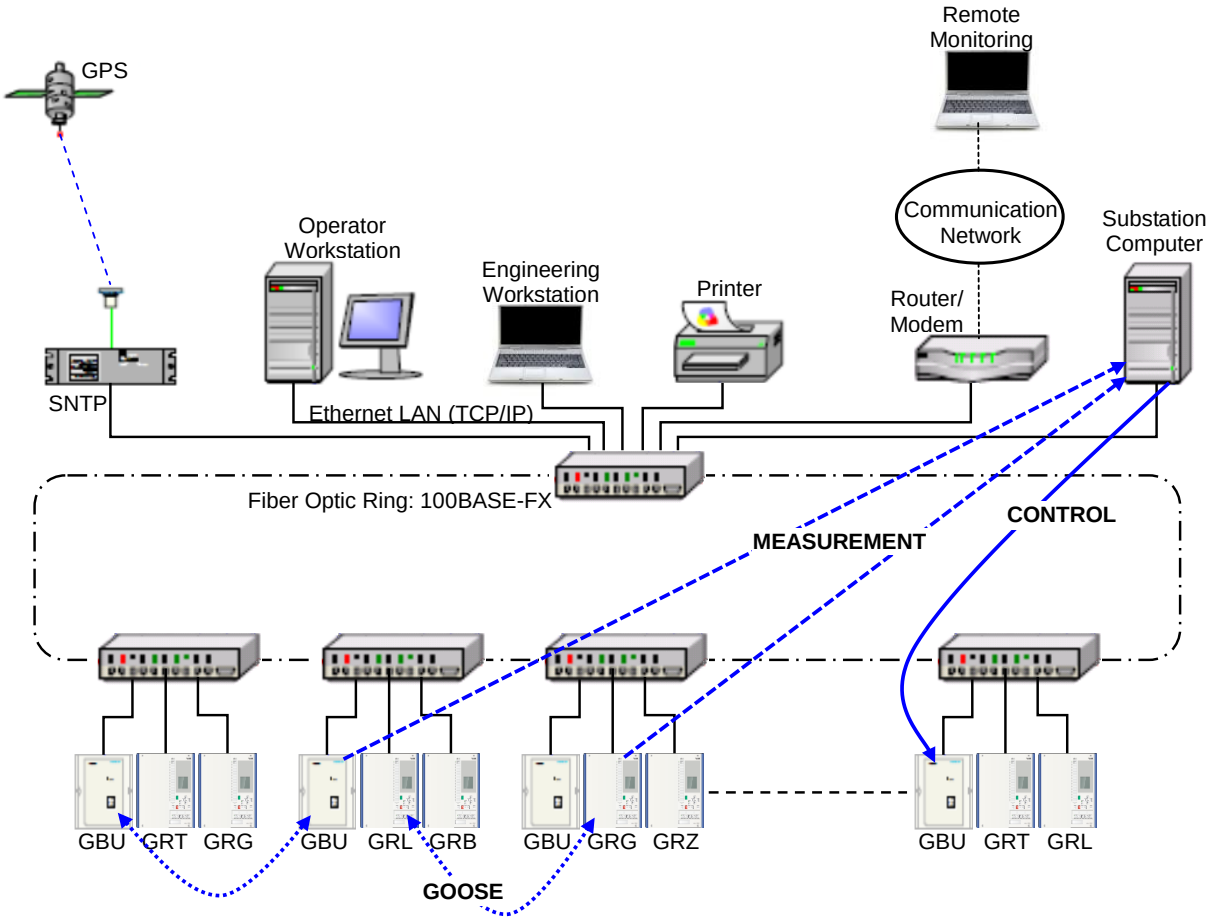


Figure 11.2-1 SAS network using IEC 61850 protocol

†Note: When applying IEC 61850 communications, the user should map application signals with the required logical-nodes (LNs) within the IED. In this manual, we show the application signals as Data IDs; hence, the user is able to connect the Data IDs with the required LNs using the engineering tool (GR-TIEMS) provided by Toshiba. For the GR-TIEMS, see Chapter *Engineering tool*.

‡Note: Before using the IEC 61850 communications feature provided within the IED, the user should verify its IEC 61850 capability by reviewing both the protocol-implementation-conformance-statement (PICS) and the model-implementation-

conformance-statement (MICS). The MICS provides the user with information for the LNs provided within the IED; the PICS provides the user with information to enable the IED to communicate with both SAS and other devices. See *Appendix:IEC61850 MICS, PICS, PIXIT and TICS*. It explains how the user can obtain this information.

When TCP/IP operates, the IEDs can communicate with SAS computer, operator workstation (OWS), engineering workstation (EWS), remote monitoring system, SNTP server. In the SAS, the communication is served with the method of data transfer:

- Report method of sending event messages like measurement, status, alarm and so on
- GOOSE (Generic Object Oriented Substation Event) method of communication between IEDs like interlock
- Control method like controlling the circuit breaker (CB), the disconnector (DS), the selector device (43), the transformer tap (TAP) and so on

11.2.1 About protocol

The IED dynamically generates Logical Nodes, Data sets and control blocks defined in CID file upon boot-up. We shall discuss the configuration procedure to set the data in CID files later.

For the IEC 61850 communication, the IED consists of multiple logical devices and logical nodes. The user should configure the 61850 Data Model to perform a required function for the protection and control.

Modular approach achieves data transfer between devices in the IEC 61850 standard. All function in the IEC 61850 network are grouped into smaller objects called Logical Nodes (LNs), which contains process objects related data and attributes of a logical device protection and control function. Logical Node Zero (LLN0) represents specific information of the logical device. Logical Node Physical Device (LPHD) represents specific information of a physical device. A generic device is called Physical device (PD). The LPHD contains the properties of the PD. A specific function in the IED is represented as domain specific LN. The domain specific LN contains the essential function for target devices in the IEC 61850 network.

LN data model defines the abstract syntax and semantics of the information exchanged between PDs. The relation between data object classes, data types, data attributes and abstract data objects are provided in the LN data model. The LN data model is mapped to Manufacturing Message Specification (MMS) and Generic Object Oriented Substation Event (GOOSE) functions. Table 11.2-1shows the description of LNs.

Table 11.2-1 LN descripion

LN	Description	Actual device corresponding to LN
LLNO	Logical node zero represents logical device specific information	Operation state of BCU State of 43 switch
LPHD	Logical node physical device represents physical device specific information	BCU,BCPU
Domain specific LN	Domain specific LN represents protection relay specific function	XCBR,CSWI
GGIO	Generic input output logical node is used if essential signals are not defined in the extended logical nodes.	Based on client requirements

All LN classes (LLN0 and domain specific LN) receive the mandatory data of the common LN except LPHD. Table 11.2-2 exemplifies Function, Logical node and Communication service used in the IEC 61850 communication.

Table 11.2-2 Function groups in 61850

Functions grouped in 61850	Examples of IED applications to provide protection/control functions for the power system	Logical node defined in 61850	Communication methods serviced in 61850
Monitor	Overvoltage relay (OV)	PTOV	Buffered Report
	Overcurrent relay (OC)	PTOC	Buffered Report
	Trip circuit (TRC)	XCBR	GOOSE
	Generic functions	SIMG	GOOSE
Control	SPOS etc.	CSWI	Enhanced-security Control
Measurement	Measurement	MMXU	Unbuffered Report
	Harmonics	MHAI	Unbuffered Report
Time Synchronization	Simple Network Time Protocol	NA	SNTP

Figure 11.2-2 shows Physical Model, which is equivalent to the IEC 61850 Model. The Physical Model illustrates that both the IED and its functions are communicating with the SAS using the Ethernet. The equivalent IEC 61850 Model represents communication at LNs in both the PD using different Communication services, which we shall discuss in section 11.2.2.

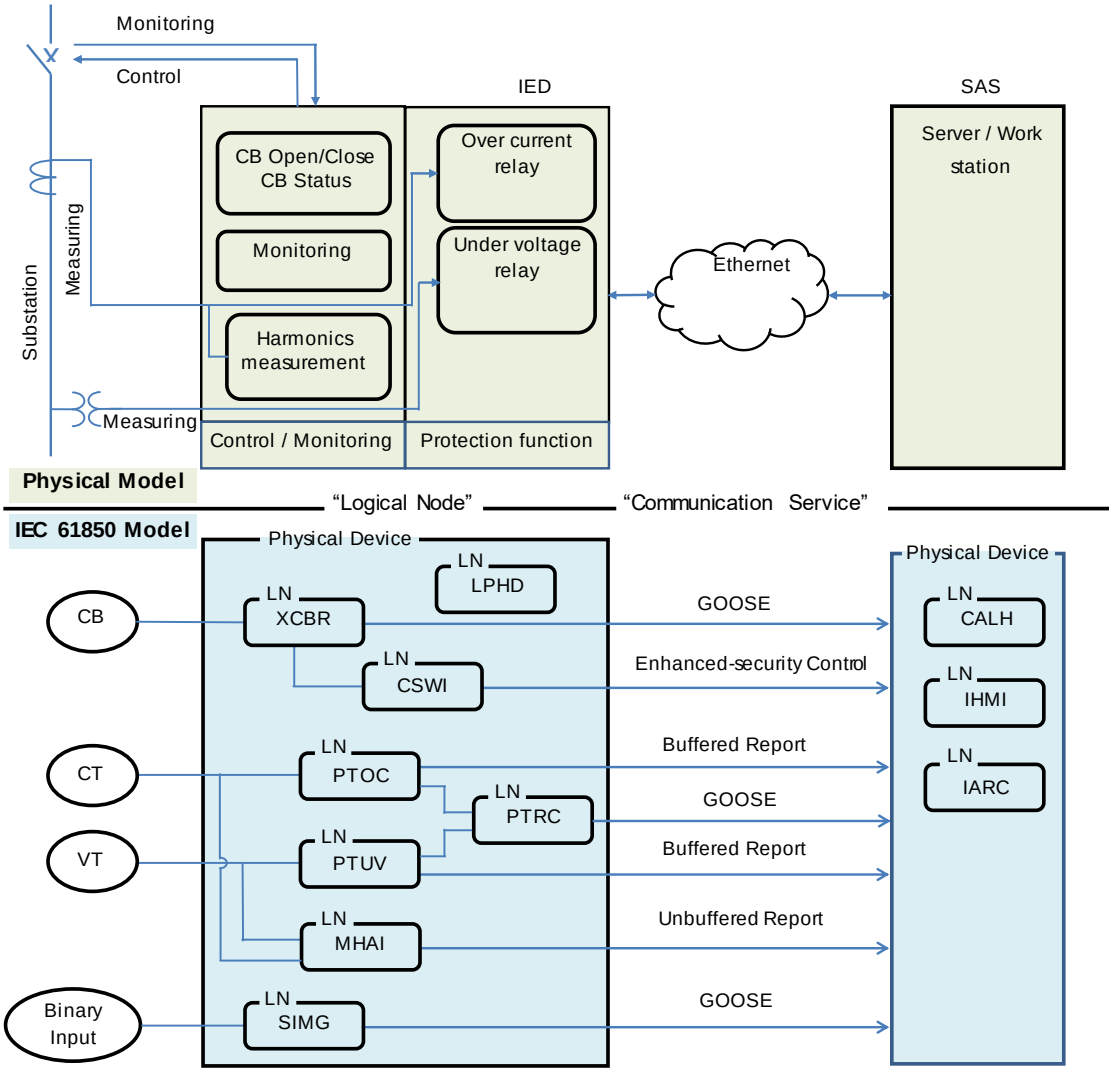


Figure 11.2-2 Example of Physical model and its equivalent IEC 61850 model

11.2.2 Communication service

.

All essential data transmission methods are summarized in Abstract communication service interface (ACSI); the IED application from communication stack is separated by the ACSI. The user can map an interface to a communication stack using Specific communication service mapping (SCSM).

The LN contains data list with their attributes based on their functionality in SAS. A data has a well-defined structure and information of SAS. The data and attributes of the LN in a logical device are exchanged by the communication services according to IEC 61850 protocol. The communication services are implemented by SCSM using Ethernet TCP/IP protocol.

(i) Report for SAS

In the IED, 'report' is a method of sending status data, alarm data, measurement data and so on. Using server-client communication, 'Report' is a 'data set' transferred from the IED to the SAS. The 'reports' generated by the predefined 'triggers' are issued regularly in interval; the 'reports' are also generated upon a change in the event. The 'reports' are grouped into two types: (1) Buffered-report-control-block and (2) Unbuffered-report-control-block. Note that the system achieved by the unbuffered-report-service cannot start an event recover function during the communication failure.

(ii) GOOSE for peer-to-peer communication

'Generic Object Oriented Substation Event (GOOSE) ' is a faster method to transfer the data in 'Generic substation event (GSE)' between IEDs. In all IEDs, multicast GOOSE message is published from the 'GOOSE_control_block (GCB)'. The GOOSE communication methods are grouped into two: (1) GOOSE publish and (2) GOOSE subscribe.

The data structures of the GOOSE are illustrated in Table 11.2-3; they are grouped for the system (say, SAS) and other logical devices (say, a relay); they are used in the applications in the SAS and the IED.

Table 11.2-3 Data structures in the GOOSE

Logical Device		
Category	"System"	Other Logical device (e.g., "Relay")
Data Model	System DataSet "GOOSEDS" GGIO1 Ind1..16 LLN0 GoCB The DataSet "GOOSEDS" is fixed LPHD1 GGIO	Relay LLN0 GoCB LPHD1 PTRC ….
Data set	Fixed (Not configurable)	Configurable
Performance	GOOSE data sent communication time is < 3msec	GOOSE data sent, communication time is around 10msec

(iii) System

The data model in the LN named "System" is not allowed to modify (that is, a data model is fixed; other LN data models are configurable to meet the system requirement). Mapping signals to the GGIO1 is required when the GOOSE should send data faster.

(iv) Control mode using GOOSE

In the IED, signals generated on the binary output circuit (BO) can be controlled by the SAS, if the user makes the link between a reviving control message and a control function block that changes the state of the output element. Four control modes are provided:

DOes: Direct control with normal security (direct-operate)
SBOns: SBO control with normal security (operate-once or operate-many)
DOes: Direct control with enhanced security (direct-operate)
SBOes: SBO control with enhanced security (operate-once or operate-many)

(v) Time synchronization using IEC 61850 protocol / SNTP

SNTP (Simple network time protocol) is used to synchronize clocks of all IEDs in SAS. Time synchronization is required to maintain common time across all IEDs in the network. This makes it easier to analyze the Time stamped event data generated by the IEDs in chronological order. In the system, IEDs are synchronized with the device having precision time source (for example, GPS).

(vi) File transfer (COMTRADE)

To send data of the disturbance records, file transfer service is used, which is the operated in COMTRADE format.

(vii) Manufacturing Message Specification (MMS)

MMS is an application layer protocol that provides data transmission between IEDs, which performs monitoring and controlling; it can provide reliability for the data transmission. The MMS operates in the international standardized messaging system that are made of TCP/IP and Ethernet.

(viii) Generic Substation Events (GSE)

GSE is a control model defined in the IEC 61850 standard; it provides a fast and reliable method for transferring the event data over the SAS. The GSE provides facility to transfer the same event message to multiple physical devices using multicast or broadcast service.

11.2.3 How to manage engineering work

An IED can have multiple logical devices, which represents protection and control functions. Each logical device has Logical Nodes (LN), Datasets, Report Control Block (RCB), GOOSE Control Block (GCB), GOOSE Publish and GOOSE Subscribe function. Figure 11.2-3 illustrates the data structure in the IED.

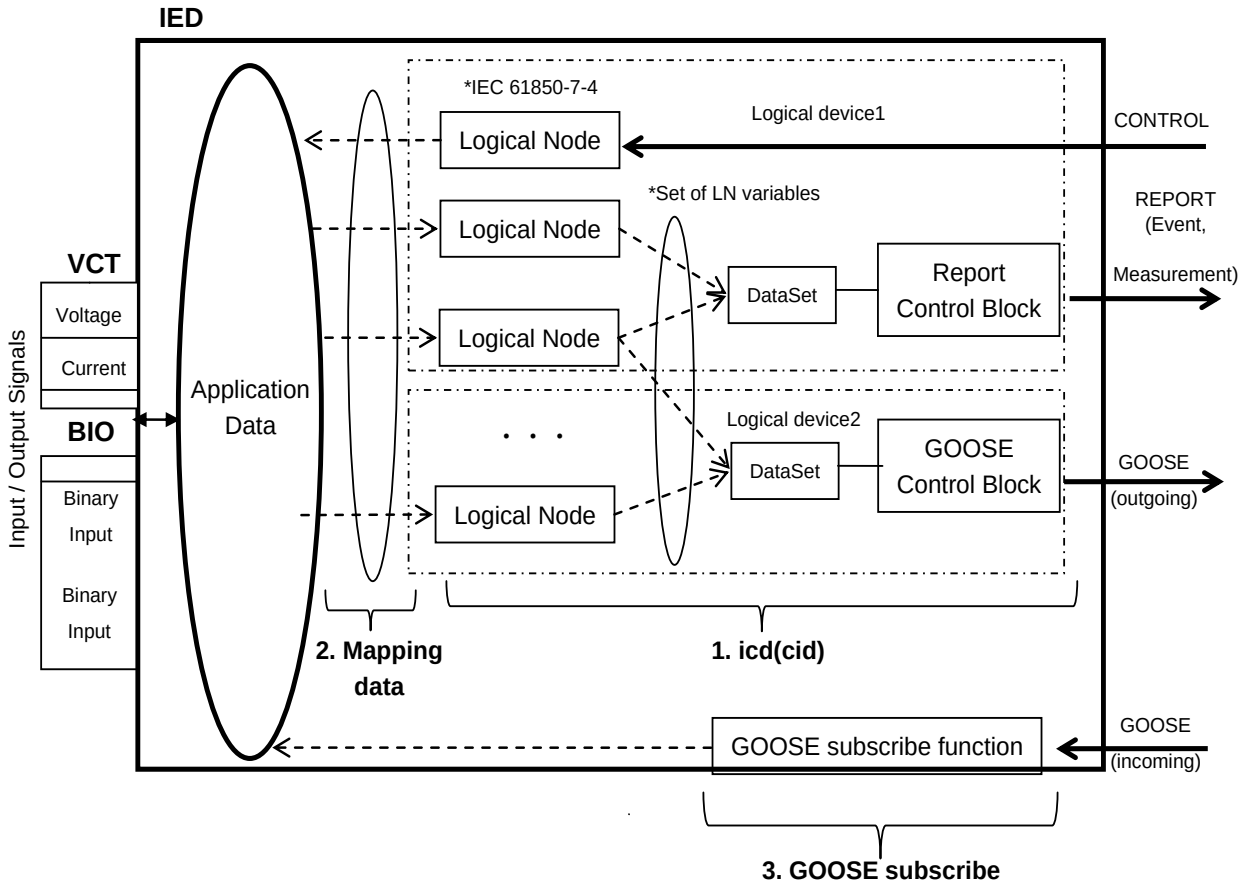


Figure 11.2-3 IED Data Structure

To configure the data structure of an IED, the user needs to edit the following items using the GR-TIEMS. Figure 11.2-4 shows the flow diagram for IEC 61850 configuration using GR-TIEMS.

- Edit Signal mapping
- Edit Logical Node
- Edit DataSet
- Edit Report Control Block
- Edit GOOSE Control Block
- Edit GOOSE Publish
- Edit GOOSE Subscribe
- Edit Control function

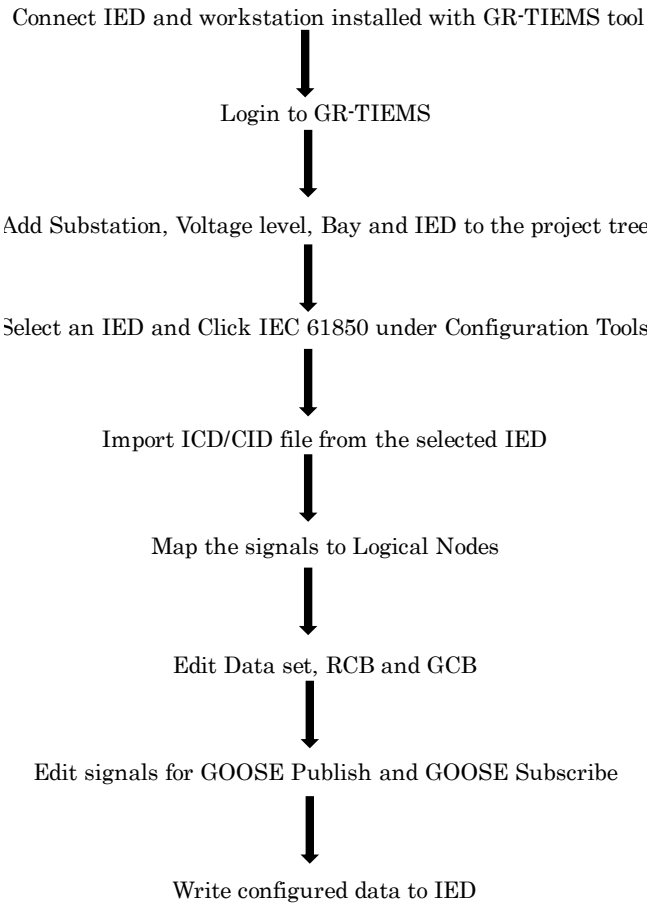


Figure 11.2-4 Flow diagram

(i) Creating and opening project

In the operation of the GR-TIEMS, the user can find an existing project or create a new project. Figure 11.2-5 shows the 'File Menu', where the user can open an existing project or create a new project.

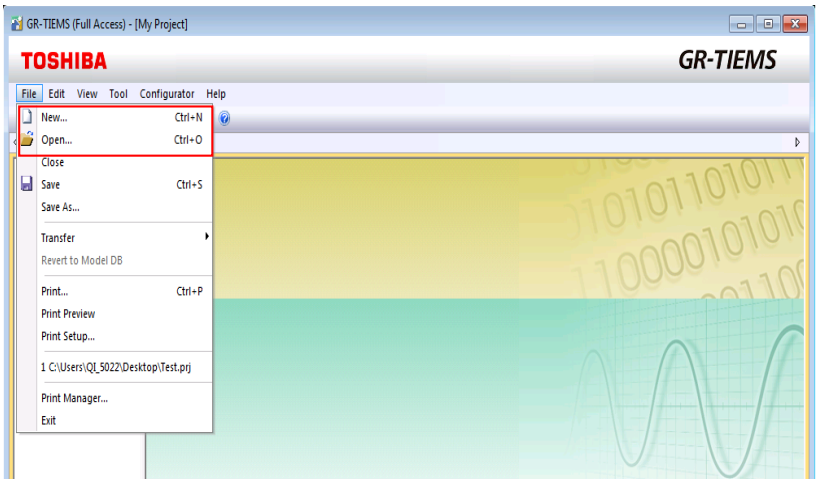


Figure 11.2-5 File menu

Once the project is created, the user can add IEDs in the project tree structure as shown in Figure 11.2-6.

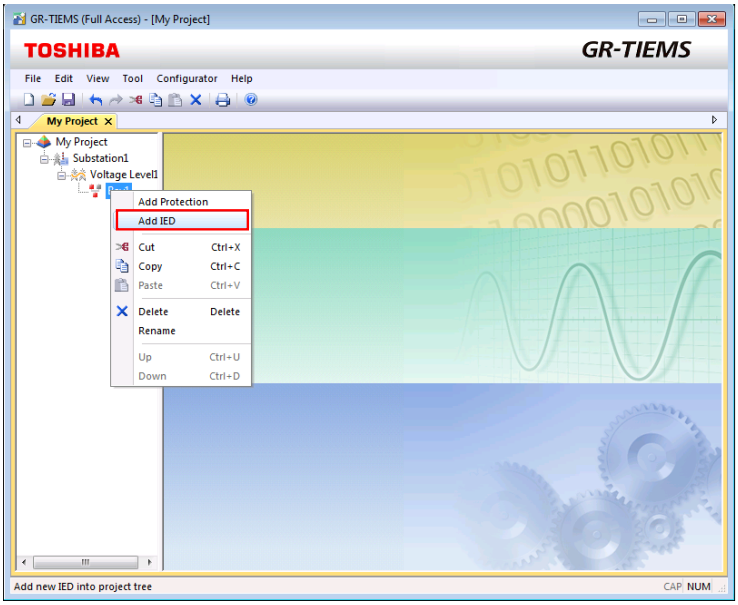


Figure 11.2-6 Adding IED

Select the IED in the project tree structure and **Click** IEC 61850 under Configuration Tools as shown in Figure 11.2-7.

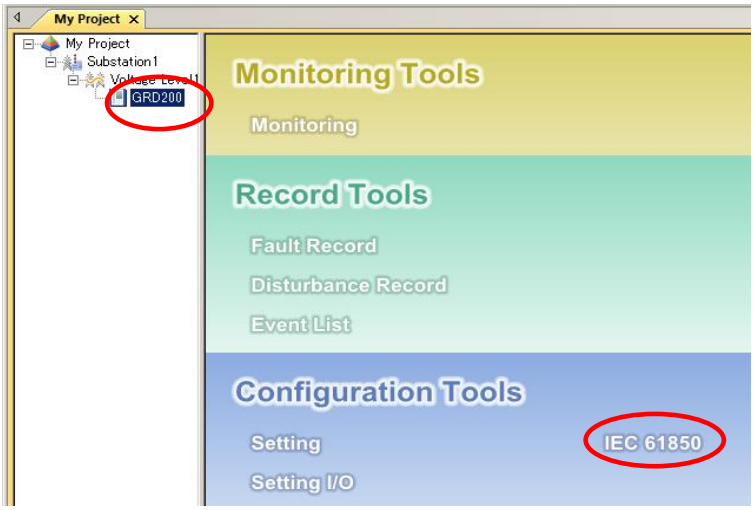


Figure 11.2-7 GR-TIEMS main screen

Click 'IEC 61850', then check to see that four engineering screens are appeared:

- Logical Node Screen
- Signal List Screen
- GOOSE Publish Screen
- GOOSE Subscribe Screen

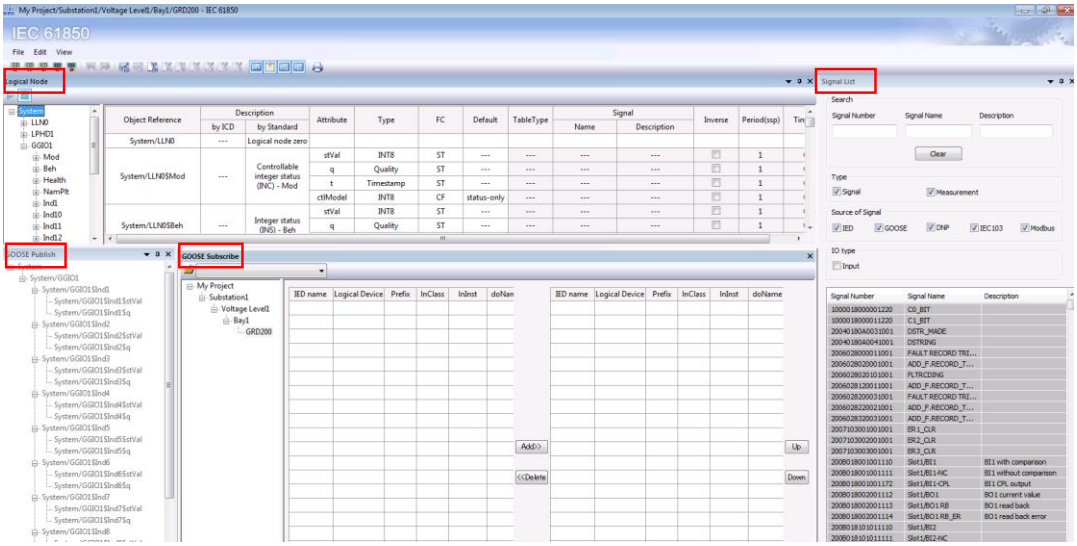


Figure 11.2-8 IEC 61850 Main screen

(ii) IEC 61850 configuration files

Substation configuration language (SCL) files are generated by the configuration in the IEC 61850 protocol. The SCL files are used to exchange the configuration data in different manufacture tools. Two types of files are used for exchanging data in Table 11.2-4.

Table 11.2-4 Types of SCL files

SCL file	Description
.ICD IED Capability Description	This file describes the capabilities of an IED. It contains the communication data and function of LN in an IED.
.CID Configured IED Description	Every device configured for IEC 61850 in the GR-TIEMS tool generates a CID file. This file is then written to the IED. This file contains configuration information of the IED to which it is connected.

(ii)-1 Exporting and Importing CID/ICD file

The user can export or / import a CID/ICD file as a CSV file. The user can edit the exported CSV file using the MS-EXCEL®; the user can import the edited CSV file back to the GR-TIEMS. Figure 11.2-9 shows the options available to import/export CID/ICD file. The user can either click the icons on the menu bar or select the required option form the File menu drop down list.

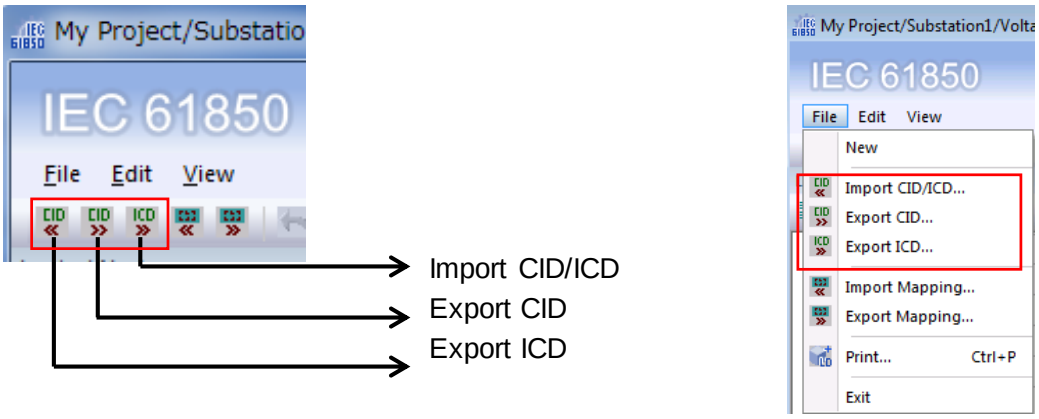


Figure 11.2-9 Export / Import of CID / ICD file

(ii)-2 Manage third party CID file

The GR-TIEMS can have third party CID file. In the project tree of the GR-TIEMS, the user can use the device information for creating a third Party IED. To configure dataset, RCB, GCB, GOOSE publish and GOOSE subscribe settings and so on, the data attributes are used after the creation of the data.

(ii)-3 Mapping application data in IEC 61850

For any IED, the IEC61850 configuration* is available by default. The user

should check whether the required signals are mapped in the default configuration.

*Note: There is no default configuration for GOOSE subscription. If GOOSE subscribe function is required, then a new configuration has to be done.

To verify the signals configured for the IEC 61850 protocol, the user should check the mapped data, Dataset or Report Control list. If they have existed, the signals in the signal list should be matched with the attributes of LNs.

Figure 11.2-10 shows an example to check if the signals are mapped in default configuration. For example, to check for mapping of the primary element signal in earth fault protection (EF1), follow the steps below:

1. To check if the EF1 signal is already mapped in the LN, key 'EF1' under Signal Name in the Signal List screen.

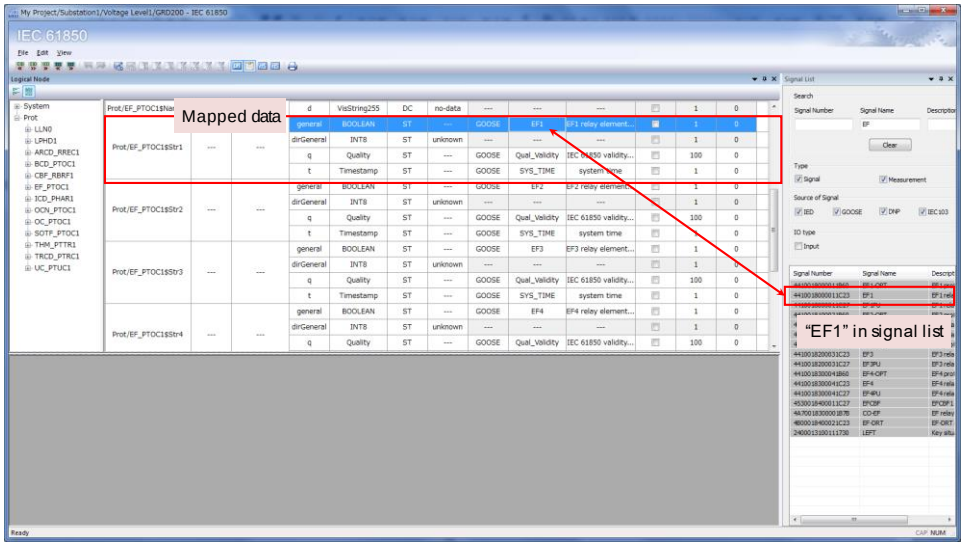


Figure 11.2-10 Signal mapping

As shown in the above figure, the "EF1" signal is already mapped to LN attribute Prot/EF_PTOC1$Str1, general.

2. To check if "Prot/EF_PTOC1$Str1, general" is already added in Dataset. **Right click** on "LLN0" and select Edit DataSet, then DataSet List screen appears as shown in Figure 11.2-11.

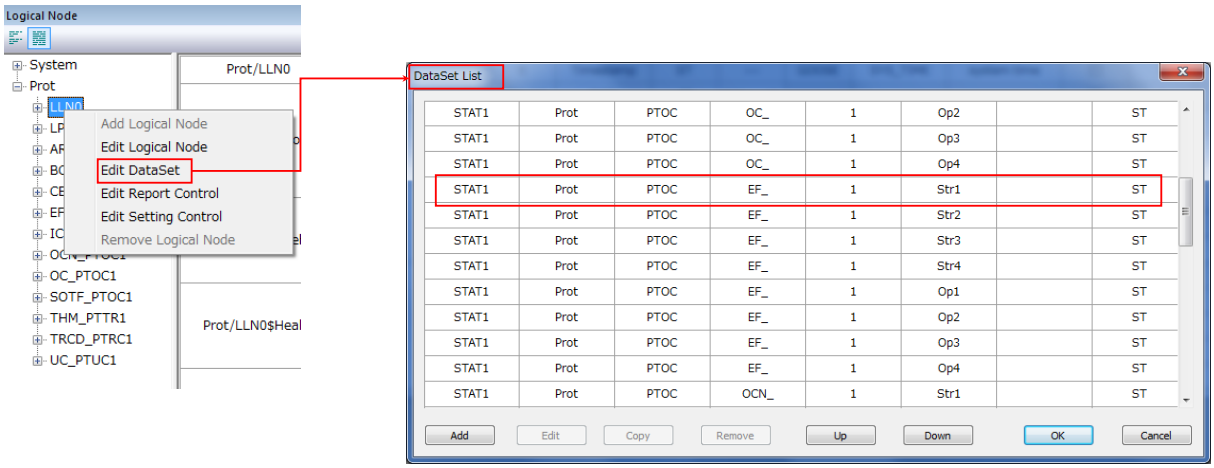


Figure 11.2-11 DataSet list

As shown in the above figure, "Prot/EF_PTOC1$Str1, general" is already mapped in the Dataset "STAT1".

3. To check, if the DataSet is already assigned to RCB, **Right click** on "LLN0" and select Edit Report Control, then Report Control List screen appears as shown in Figure 11.2-12.

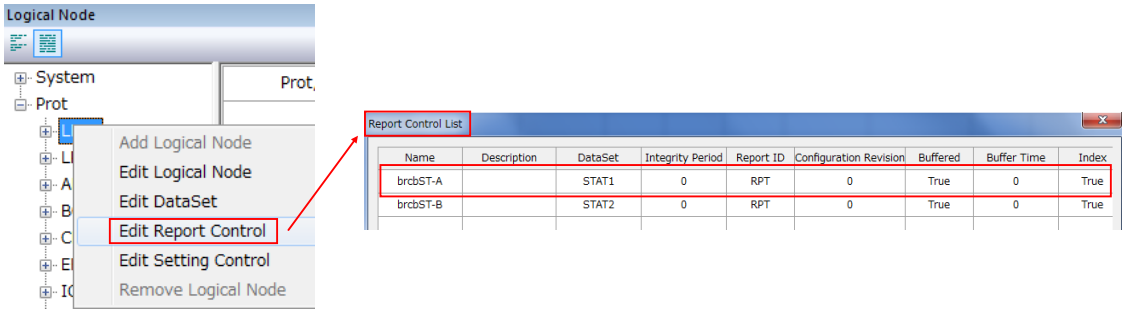


Figure 11.2-12 Report Control List

As shown in the above figure, the DataSet "STAT1" is already assigned to RCB "brcbST-A".

(iii) Mapping signals in signal list to Logical Nodes

The user can add or modify signal mapping to the LN variable. The following section describes how to modify the mapped data if the user wants to add signals, which are sent using Report or GOOSE.

(iii)-1 Edit Mapping Data

1. Search the signal to be sent from the Signal List window as shown in Figure 11.2-13.
2. Drag and Drop the selected signal to the logical node variable.

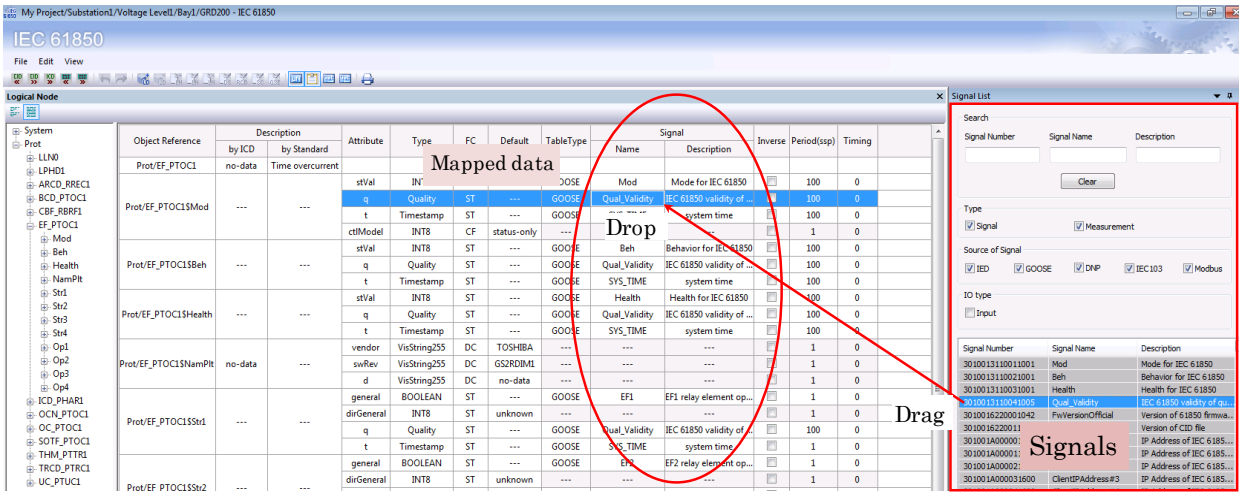


Figure 11.2-13 Signal mapping

Note: To optimize the performance of the IED, "Period" should be 100 if the signal is not required to be sent immediately.

"301001 3110041005 (Qual_Validity)" should be mapped to "q" with Period=100.

"200301 9010001006 (SYS_TIME)" should be mapped to "t".

(iii)-2 Export / Import Mapping Data

The user can export mapped data in the CSV file; the user can edit the exported CSV file by the MS-Excel® and import back into the GR-TIEMS. Figure 11.2-14 shows the export / import options.

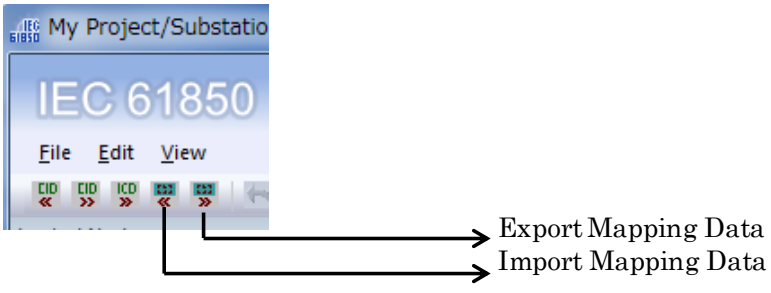


Figure 11.2-14 Export / Import mapping data

(iii)-3 Edit Logical Node

If the required LN or variable is not available in the IED, the user should follow the steps below to add or modify the Logical Node:

1. To add new LN or to edit the variable of an existing LN, **Right click** Prot and select Add Logical Node or select Edit Logical Node.
2. In the Edit Logical Node screen, select LN Class, Prefix and LN Instance and check the required variable check boxes as shown in Figure 11.2-15 below.

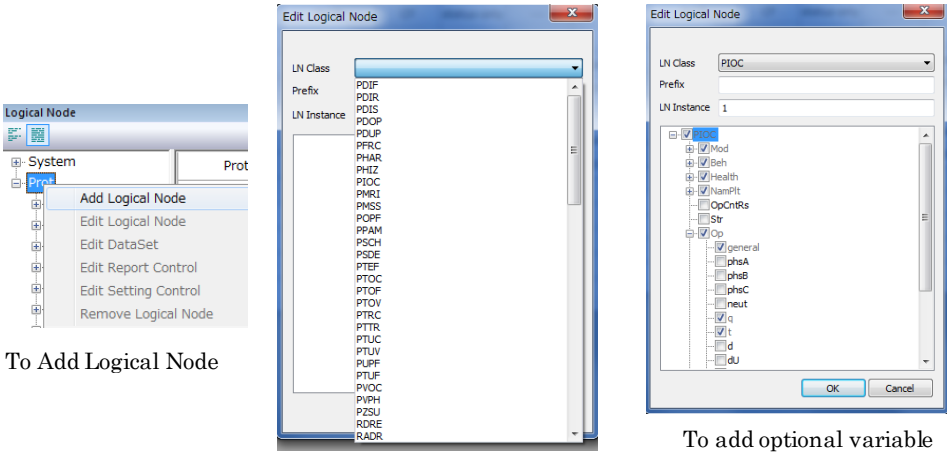


Figure 11.2-15 Add or Edit Logical Node

*Note: Refer to IEC 61850-7-4 to choose a proper Logical Node.

(iii)-4 Edit DataSet

Dataset can be edited or a new dataset can be added for the LNs as shown in Figure 11.2-16. For editing the DataSet, follow the steps below:

1. Right **click** LLNO and select Edit DataSet, DataSet List window appears as shown in Figure 11.2-16.
2. Choose the variables to be added to the DataSet and **click** OK.

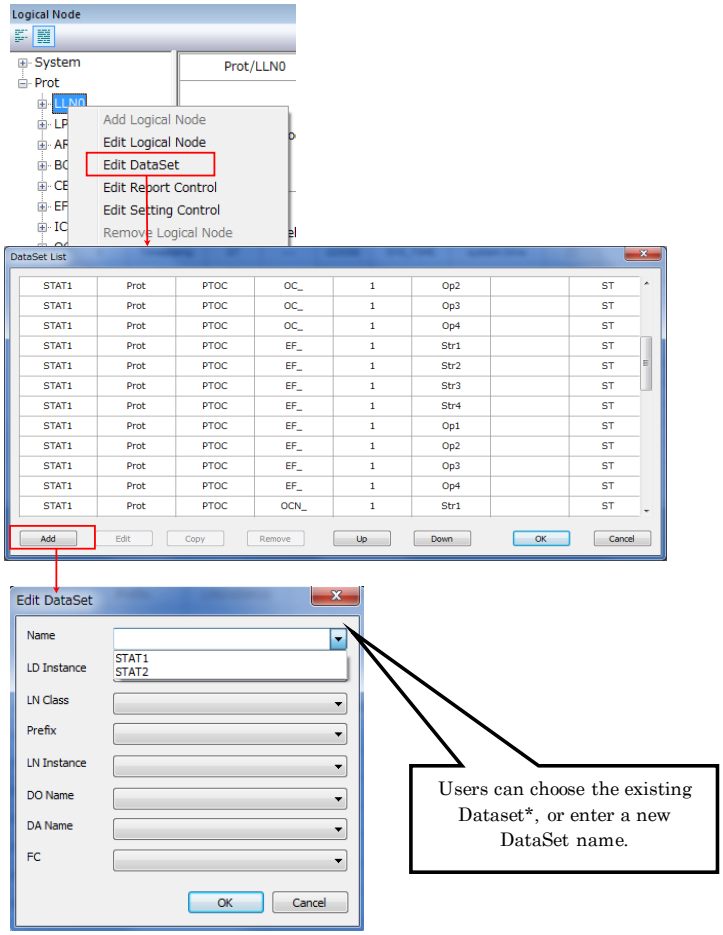


Figure 11.2-16 Edit DataSet screen

*Note: 100 DataSets can be added in the DataSet List and each DataSet can have maximum of 32 elements.

(iii)-5 Edit Report Control Block (RCB)

Report Control Block (RCB) is used to send report from IEDs to client. If the user wishes to assign the DataSet to Report Control Block, follow the steps below:

1. Under the LN tree structure, select Prot, **Right click** LLN0 and select Edit Report Control. Report Control List screen appears as shown in Figure 11.2-17.
2. **Click** Add or Edit to add a new dataset or to edit the existing dataset in the Report Control List window as shown in Figure 11.2-17.

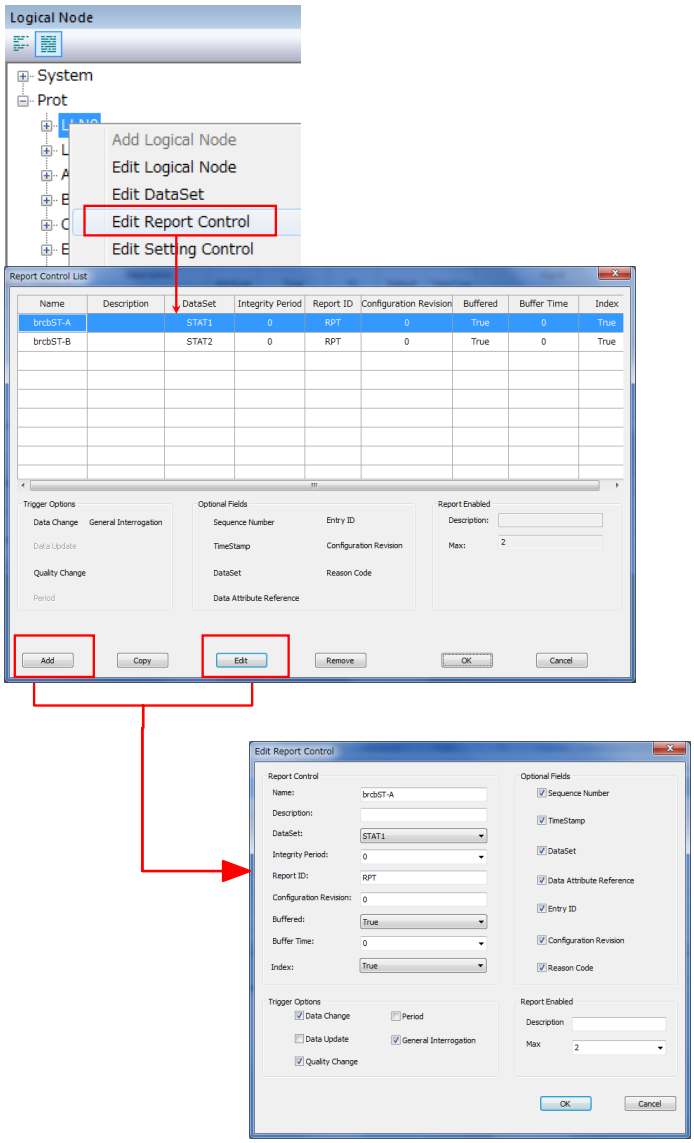


Figure 11.2-17 Edit Report Control screen

(iii)-6 Edit GOOSE Control Block

GOOSE control block is used to exchange information between IEDs. GOOSE messages are used for interlock operation between IEDs in order to protect the electrical system. GGIO1 is used for sending high-speed GOOSE messages. The DataID assigned to GGIO1 is sent within 3ms.

If the user wishes to assign the DataID for GOOSE operation, follow the steps below:

1. **Click** GGIO1 and select Ind1 as shown in Figure 11.2-18.
2. **Drag** and **Drop** the required signals to be sent by GOOSE.

Note: The user can assign any signal to GGIO1->Ind1~16 for high-speed GOOSE, as required.

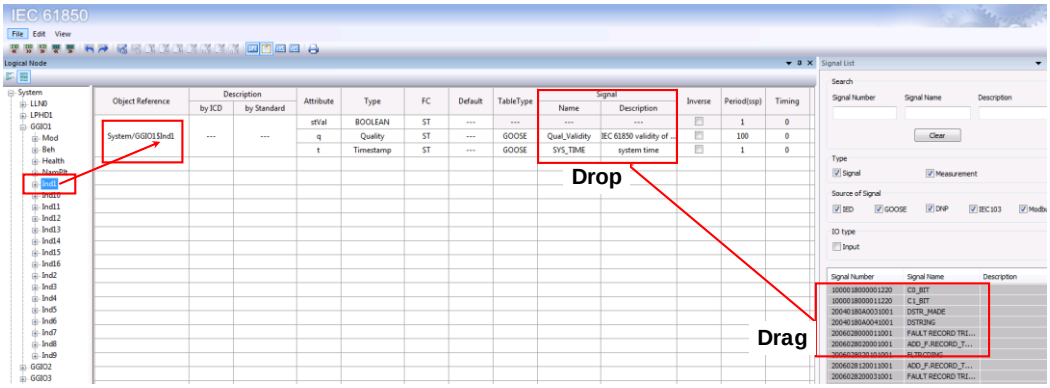


Figure 11.2-18 Signal mapping for high speed GOOSE

As shown in the above figure, signals are assigned to "System/GGIO1$Ind1". The user can assign signals to other GGIOs (for example, GGIO2, GGIO3 and so on) which are not meant for high-speed GOOSE operation.

(iii)-7 Edit GOOSE Publish

The signals assigned to GGIO1 variables are published automatically by default. The GGIO1 data set is fixed and is pre-configured in GOOSE Publish screen. If the user assign signals to other GGIO variables (for example, GGIO2, GGIO3) for GOOSE publish operation, then the user needs to add those variables in the GOOSE Publish screen.

Figure 11.2-19 shows the GOOSE Publish screen, where "System" is fixed and is not configurable for GGIO1, whereas "Ctrl" (Control) and "Prot" (Protection) are configurable. The user can add new variables from the "Logical Node" screen to the GOOSE Publish screen using drag & drop* method. Figure 11.2-19 shows an example for GOOSE Publish, where "System/GGIO2$Ind1$stVal" is added to the GOOSE Publish screen.

*Note: Only "stVal" and "q" variables can be added to GOOSE Publish screen.

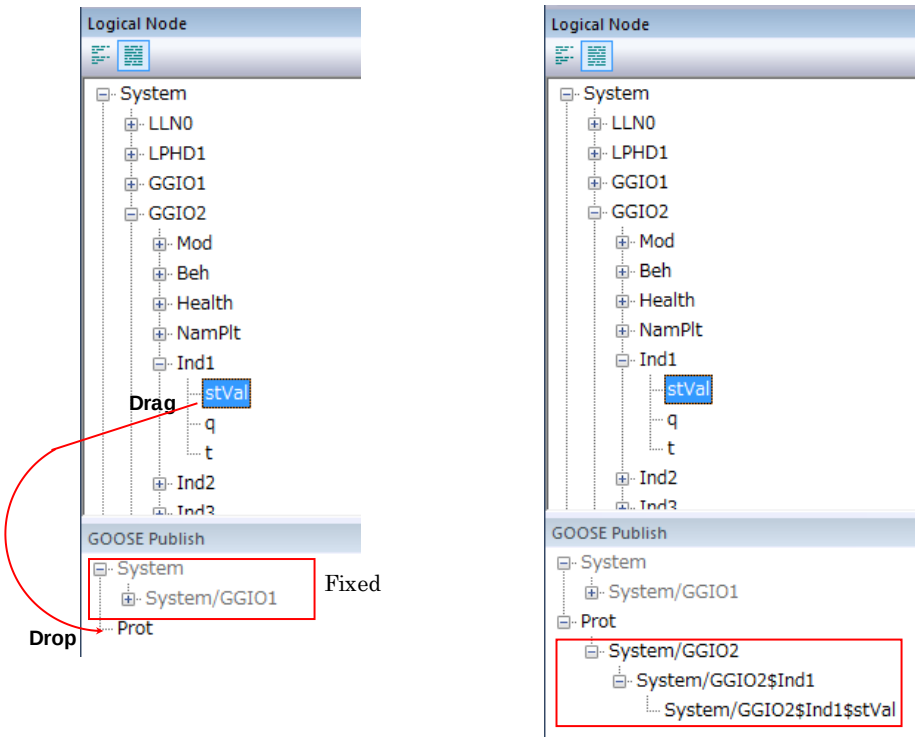


Figure 11.2-19 GOOSE Publish

(iii)-8 Edit GOOSE subscribe

GOOSE subscribe function is configured to receive GOOSE messages published by other IEDs. Figure 11.2-20 exemplifies the GOOSE Subscribe screen; the user can select the necessary signals to be added. For example, "Bay1 GBU200" is the current IED; "Bay2 GRZ200" is the other IED. "List 1" is GOOSE publisher of GRZ200; "List 2" is GOOSE subscriber for GBU200. The user can select the GOOSE publisher from GRZ200 and add to the GOOSE subscriber of GBU200.

In the example shown below, select the required variable and **click** Add. Similarly, the user can delete the variables.

When the user adds a signal to the GOOSE subscribe list from the other IED, then the same signal is automatically added in the Signal List of the current IED.

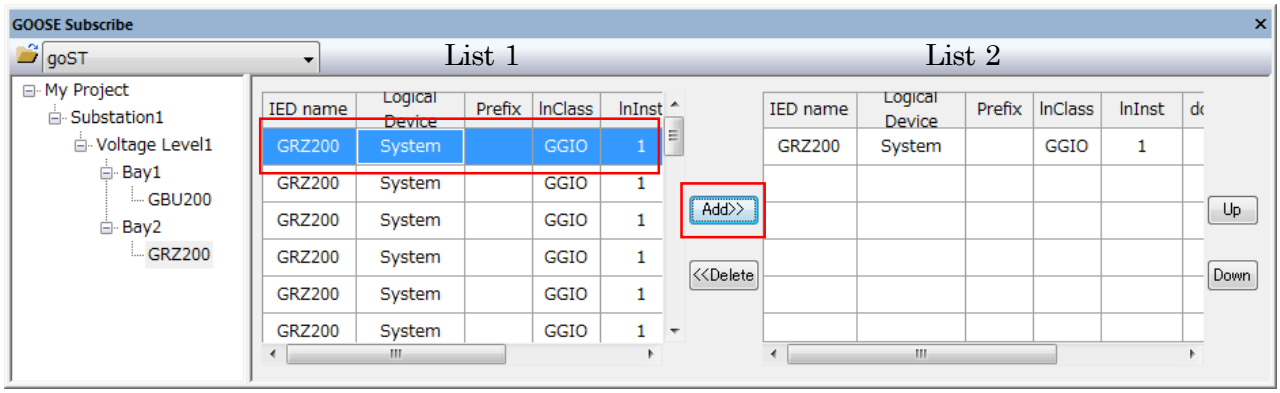


Figure 11.2-20 GOOSE Subscribe

Note: The user can monitor about the GOOSE message on the LCD screen. See sec. 11.2.7.

(iii)-9 Edit Control function

The Data IDs (i.e., Signal Number) starting with "5" is used for control function when the IED has the control function by default. The user should check whether the required signals are mapped in the default configuration. The user can edit and add the control signals to the LN as described in section 11.2.3(iii).

In an IED, usually an output Data ID of a protection function is assigned to LN variable. However, for the control application, the IED is capable of receiving command from the SAS server. To control a device (such as a circuit breaker), the input point* (Data ID) in the control application should be configured to receive commands from the SAS sever (that is, selecting, operating or cancel command).

For example, to let a device execute “Select”, “Operate” and “Cancel” commands from the sever through “CSWI4” and transmit the information to an IED, the user should map an input point (Data ID) to several variables of “CSWI4” (See Figure 11.2-21). Mapping period for Control shall be 100.

*Note: For more information of the input points, see chapter *General control function or Control and monitoring application*, if available.

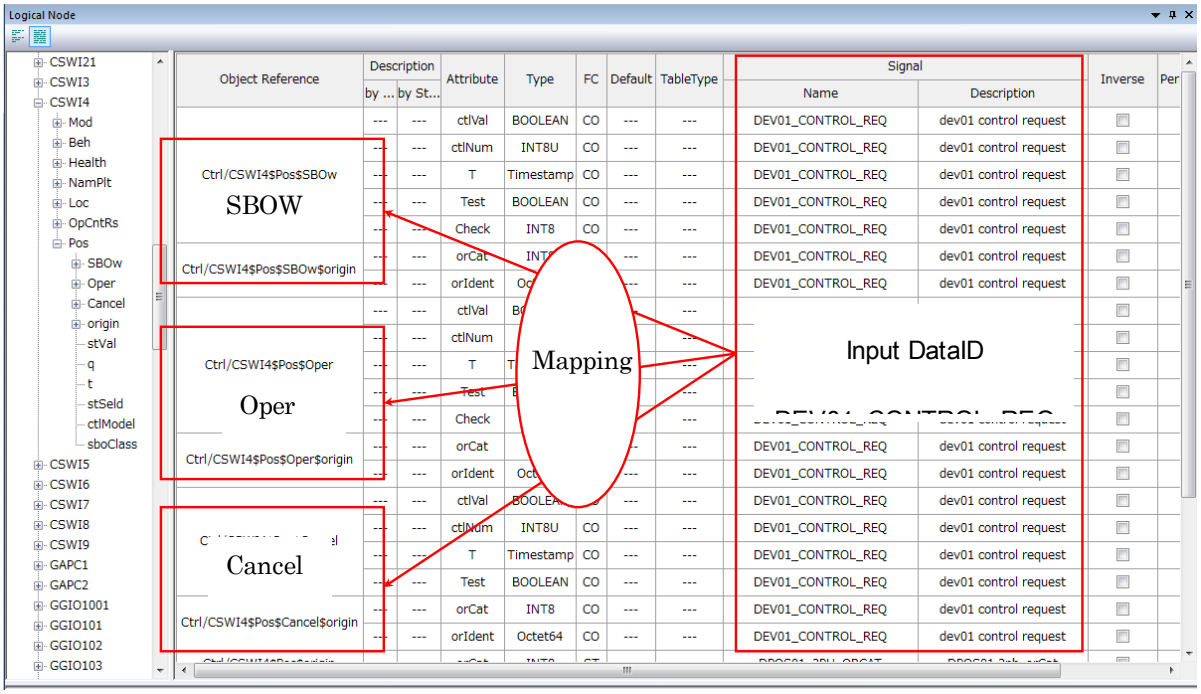


Figure 11.2-21 Control function mapping

To complete the setting for control function, after mapping data, the user needs to set BI, BO† in the GR-TIEMS ->Setting.

†Note:For more information for the BI, BO, see Chapter *Technical description: Binary IO module*.

(iv) Writing the configuration file to IED

After completing the IEC 61850 configuration, follow the steps below to download the CID file for the IED.

1. Save the project.
2. Right click on the required IED and select Write to IED.
3. Configure the parameters in the Connection Method window to connect the IED (If needed).
4. Select the writing items (IEC 61850-CID File and IEC 61850-Mapping Data) to be written into the IED and click Write to download the IEC 61850 configuration. If GOOSE subscribe operation is required, then select writing items Signal List and GOOSE Subscribe before clicking Write.

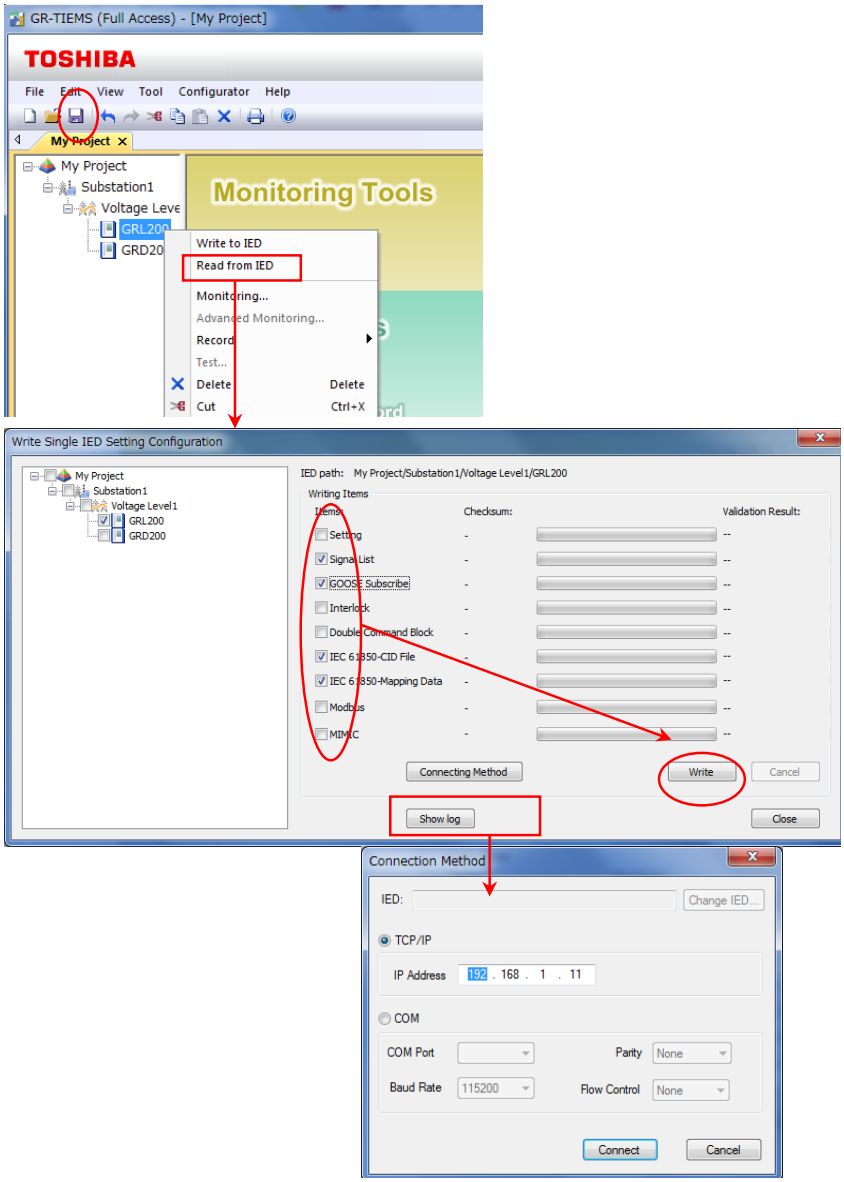


Figure 11.2-22 Write to IED

11.2.4 Setting for IED

(i) Setting time for re-sending GOOSE subscribe information

The user can configure the maximum duration time for the case when the IED fails to re-send GOOSE subscribe information. Set the time in seconds using setting [**GOINT**].

(ii) Setting for 61850 authentication

When the IED is to be authenticated for starting the IEC 61850 communications, the user should set scheme switch [**850AUT**] **On**.

(iii) Blocking 61850 communication

If the user does not want the IED to start the IEC 61850 communications, the user should set scheme switch [**850BLK**] **On**.

(iv) Setting 'keep-alive' time for TCP

When applying IEC 61850 communications with TCP/IP, the user should set a time for the 'keep-alive' signal. The user should set the time in seconds using the setting [**850KEEPALIVE**].

(v) Setting 'CommTerm'

If the user wishes to receive a 'CommTerm' signal carrying an actual operation time from a device outside the IED, the user should set scheme switch [**TCMD**] **On**. Note that the 'CommTerm' signal† will not conform to the IEC 61850 standard when the user turns on this function. That is, this function can be availed on the server communication provided by TOSHIBA.

†Note: For example, Figure 11.2-23 shows the signal flow between a substation computer (SC), an IED and a target device (e.g. CB). If the requirement is to close the CB on request of the SC, the SC will send the operation command "Operate" to the IED; the time information (T) is also sent along with the operation command. When receiving the operation command and observing that the CB has closed, the IED will send a response signal "CommTerm" to the SC along with the time information. However, this time information is not the actual operation time of the CB, but the same time information originally sent with the operation command. The IEC 61850 standard defines this rule; hence, general operations in the IEC 61850 standard are subject to this rule. However, the server communication provided by Toshiba is able to accept the actual operation time; hence, the setting 'CommTerm' is required in the Toshiba communication. The user should also note that **Off** is set for the scheme switch [**TCMD**] as the default setting.

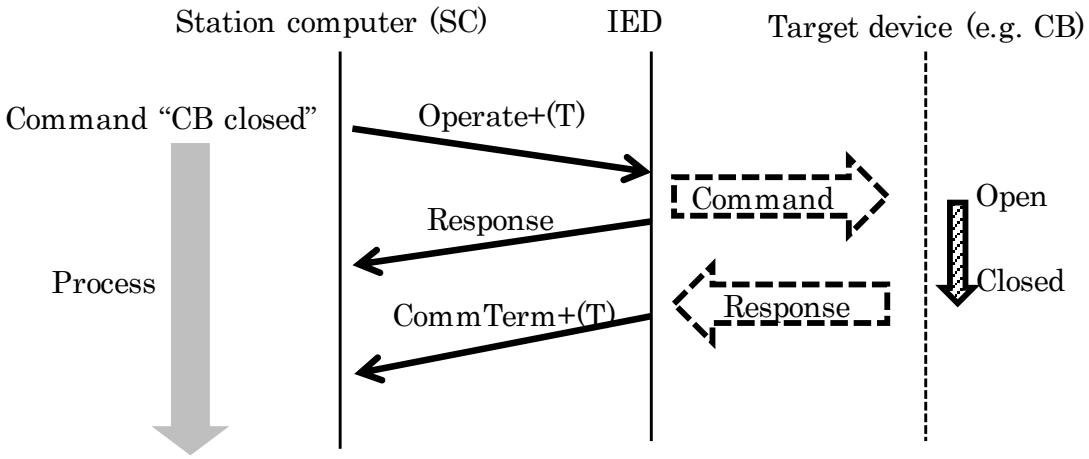


Figure 11.2-23 Example of CB operation flow

(vi) Setting test mode

With regard to the reception test for GOOSE subscribe information, the user can simulate a bad condition passively by using both GOSNDBLK and GOSUBBLK functions†.

(vi)-1 GOOSE sending block (GOSNDBLK)

For the test using the GOOSE sending block function (GOSNDBLK), the user can disable the IED so that it does not send the GOOSE message. The GOSNDBLK function is useful when there is a conflict in the communication with another active IED on sending a GOOSE signal. To block the sending of the GOOSE message, the user should set **On** for scheme switch [**GOSNDBLK**].

(vi)-2 GOOSE receive block (GOSUBBLK)

Suppose the user wishes to simulate a bad reception condition with regard to the GOOSE signal, the user can apply a setting that will prevent an IED from receiving the GOOSE message from another IED using this test. The user can perform this test using the test setting **On** for scheme switch [**GOSUBBLK**]. Consequently, the IED rejects the GOOSE messages from other IEDs. The GOOSE receive block function (GOSUBBLK) is also useful for the validation of switchgear interlocking determination.

†Note: The user may wish to perform bad reception tests from a remote terminal using the GOSNDBLK function. However, carrying out the GOSNDBLK function at a remote terminal may influence the overall operation of other IEDs, because communication packets will not be received from the remote terminal. In order to avoid the influence, we recommend the user to test bad receptions for a particular IED using the GOSUBBLK function. As a result, testing will only affect the particular IED under test i.e. all other terminals will not be influenced by the

tests.

11.2.5 How to supervise in 61850 communications

The IED can monitor the status of the IEC 61850 communications. Discussions on IEC 61850 communications status monitoring are provided separately. (See Chapter *Automatic supervision*)

11.2.6 Quality signal in 61850 communication

The IED can send the quality signal of the IEC 61850 communications. Table 11.2-5 shows the structure of the quality signal; a value is set for the 'Validity' bits in accordance with 'Error level' in the IED†. 'Test mode' bit is set when the IED is set for the test operation‡.

Table 11.2-5 Quality signal in the IEC 61850-7-3

Bit(s)	Definitions in the IEC 61850 7-3		Value	Definitions in the IED
	Attribute Name	Attribute Value		
0-1	Validity	Good	00	No error(Level0)†
		Invalid	01	Serious Error, Serious Error(Comm.) (Level1 and Level2)†
		Reserved	10	Not applicable
		questionable	11	Minor Error, Alarm, Warning (Level3, Level4, Level5)†
2	Overflow	–	–	*Not applicable (Default '0' setting)*
3	OutofRange	–	–	*Not applicable (Default '0' setting)*
4	BadReference	–	–	*Not applicable (Default '0' setting)*
5	Oscillatory	–	–	*Not applicable (Default '0' setting)*
6	Failure	–	–	*Not applicable (Default '0' setting)*
7	Olddata	–	–	*Not applicable (Default '0' setting)*
8	Inconsistent	–	–	*Not applicable (Default '0' setting)*
9	Inaccurate	–	–	*Not applicable (Default '0' setting)*
10	Source	Process	0	*'0' setting, unconditionally*
		Substituted	1	*Not used*
11	Test	–	0	Operation in 'Test mode'
			1	Normal operation
12	OperatorBlocked	–	0	*'0' setting, unconditionally*

†Note: For more information about the meanings about the error levels, see Chapter *Automatic supervision: Outline of automatic supervision*.

‡Note: The user can change the IED the test mode by the screen operation. See Chapter *User interface: Test sub-menu* and Chapter *Commissioning and Maintenance*.

11.2.7 Goose monitoring status in 61850 communication

IEDs are able to monitor the communication using GOOSE packets, which other IEDs have sent their information via the network. If the IED can receive the GOOSE packets, the IED can display them on the information list. Figure 11.2-24 illustrates an example of the GOOSE monitoring list; it shows all IEDs have reported good status (OK) message, except one IED.

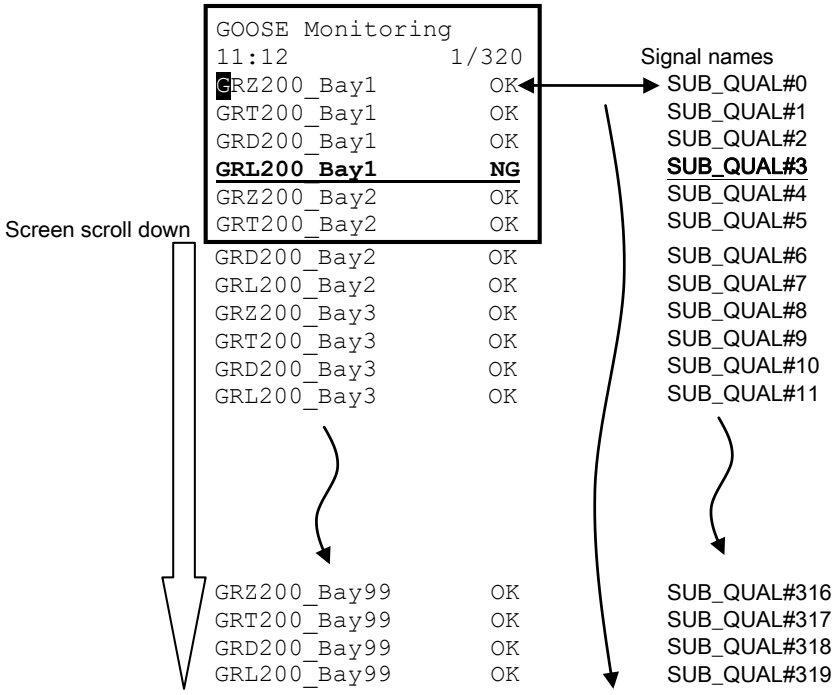


Figure 11.2-24 Screen example of GOOSE Monitoring

Note: The IED shall be managed with own subscription information to receive the GOOSE packets regarding the other IEDs. Thus, the user should edit the subscription contents (see Figure 11.2-20). The LCD displays the statuses based on that the user has edited the list of the subscription contents.

Note: Jump to *Monitoring sub-menu* (see Chapter *User interface*) to display the GOOSE mentoring screen. The user can also find the GOOSE information on the test screen on GR-TIEMS.

On the LCD screen, the user can find either OK or NG message regarding other IEDs. The OK/NG message is generated with the information of the GOOSE packet received. Table 11.2-6 illustrates the messages displayed on LCD screen and GR-TIEMS screen.

Table 11.2-6 GOOSE statutes and signal outputs

Signal values	LCD screen messages	GR-TIEMS screen messages
0x0000	OK	GOOD
0xC000	NG	QUESTIONABLE
0xC010	NG	QUESTIONABLE | TEST
0xC040	NG	QUESTIONABLE | INACCURATE
0xC080	NG	QUESTIONABLE | INCONSISTENT

When the user wishes to see GOOSE outputs†, the user can see them by user's PLC logic, but the user should build its logic using the PLC function. Table 11.2-7 shows the GOOSE signals, which the user can select. For example, in order to get the GRL200_Bay1_4 information, the user should take the GOOSE content using SUB_QUAL#3 output.

Table 11.2-7 GOOSE output signals

Data ID	Signal names	Descriptions
301101 3100001001	SUB_QUAL#0	GOOSE subscription quality status
301101 3100011001	SUB_QUAL#1	GOOSE subscription quality status
301101 3100021001	SUB_QUAL#2	GOOSE subscription quality status
301101 3100031001	SUB_QUAL#3	GOOSE subscription quality status
301101 3100041001	SUB_QUAL#4	GOOSE subscription quality status
~~	~~~	~~~
301101 31013E1001	SUB_QUAL#318	GOOSE subscription quality status
301101 31013F1001	SUB_QUAL#319	GOOSE subscription quality status

†Note: The user cannot view GOOSEs signal lists on the GR-TIMES engineering.

11.2.8 Setting

Setting of 61850(Function ID: 301001)

Setting item			Range	Unit s	Contents	Default setting value	Notes
		GOINT	1 to 120	sec.	Maximum GOOSE resend interval	2	
		850BLK	Off/On		IEC 61850 enable/disable	Off	
		850AUT	Off/On		Authentication of IEC 61850 association	Off	
		850KEEPALIVE	1 to 120	sec.	TCP 'KeepAlive' time for IEC 61850	20	
		GOSNDBLK	Off/On		GOOSE publishing block	Off	
		GOSUBBLK	Off/On		GOOSE subscription block	Off	
		TCMD	Off/On		Set 'T' in 'CommTerm' as actual Time	Off	

11.2.9 Data ID

◆ Monitoring point

61850 (Function ID: 301001)

Element ID	Name	Description
0010001001	61850STAT	Status of IEC 61850(T:Running, F:Stop)
3100001440	INCOMINGPKT#0	Incoming packet number from IEC 61850 client#0
3100011440	INCOMINGPKT#1	Incoming packet number from IEC 61850 client#1
3100021440	INCOMINGPKT#2	Incoming packet number from IEC 61850 client#2
3100031440	INCOMINGPKT#3	Incoming packet number from IEC 61850 client#3
3100041440	INCOMINGPKT#4	Incoming packet number from IEC 61850 client#4
3100051440	INCOMINGPKT#5	Incoming packet number from IEC 61850 client#5
3100001441	OUTGOINGPKT#0	Outgoing packet number to IEC 61850 client#0
3100011441	OUTGOINGPKT#1	Outgoing packet number to IEC 61850 client#1
3100021441	OUTGOINGPKT#2	Outgoing packet number to IEC 61850 client#2
3100031441	OUTGOINGPKT#3	Outgoing packet number to IEC 61850 client#3
3100041441	OUTGOINGPKT#4	Outgoing packet number to IEC 61850 client#4
3100051441	OUTGOINGPKT#5	Outgoing packet number to IEC 61850 client#5
3100001001	REMOTEPORTNUM#0	Port number of IEC 61850 client #0
3100011001	REMOTEPORTNUM#1	Port number of IEC 61850 client #1
3100021001	REMOTEPORTNUM#2	Port number of IEC 61850 client #2
3100031001	REMOTEPORTNUM#3	Port number of IEC 61850 client #3
3100041001	REMOTEPORTNUM#4	Port number of IEC 61850 client #4
3100051001	REMOTEPORTNUM#5	Port number of IEC 61850 client #5
3110041005	Qual_Validity	IEC 61850 validity of quality

◆ Monitoring point

GOOSE (Function ID: 301101)

Element ID	Name	Description
3110001001	GOOSESUB_STATUS	0 if all GOOSE being subscribed are not subscribed.
3100001001	SUB_QUAL#0	GOOSE subscription quality for record #0
3100011001	SUB_QUAL#1	GOOSE subscription quality for record #1
3100021001	SUB_QUAL#2	GOOSE subscription quality for record #2
3100031001	SUB_QUAL#3	GOOSE subscription quality for record #3

◆ Monitoring point

GOOSE (Function ID: 301101)

Element ID	Name	Description
3100041001	SUB_QUAL#4	GOOSE subscription quality for record #4
3100051001	SUB_QUAL#5	GOOSE subscription quality for record #5
3100061001	SUB_QUAL#6	GOOSE subscription quality for record #6
3100071001	SUB_QUAL#7	GOOSE subscription quality for record #7
3100081001	SUB_QUAL#8	GOOSE subscription quality for record #8
3100091001	SUB_QUAL#9	GOOSE subscription quality for record #9
31000A1001	SUB_QUAL#10	GOOSE subscription quality for record #10
31000B1001	SUB_QUAL#11	GOOSE subscription quality for record #11
31000C1001	SUB_QUAL#12	GOOSE subscription quality for record #12
31000D1001	SUB_QUAL#13	GOOSE subscription quality for record #13
31000E1001	SUB_QUAL#14	GOOSE subscription quality for record #14
31000F1001	SUB_QUAL#15	GOOSE subscription quality for record #15
3100101001	SUB_QUAL#16	GOOSE subscription quality for record #16
3100111001	SUB_QUAL#17	GOOSE subscription quality for record #17
3100121001	SUB_QUAL#18	GOOSE subscription quality for record #18
3100131001	SUB_QUAL#19	GOOSE subscription quality for record #19
3100141001	SUB_QUAL#20	GOOSE subscription quality for record #20
3100151001	SUB_QUAL#21	GOOSE subscription quality for record #21
3100161001	SUB_QUAL#22	GOOSE subscription quality for record #22
3100171001	SUB_QUAL#23	GOOSE subscription quality for record #23
3100181001	SUB_QUAL#24	GOOSE subscription quality for record #24
3100191001	SUB_QUAL#25	GOOSE subscription quality for record #25
31001A1001	SUB_QUAL#26	GOOSE subscription quality for record #26
31001B1001	SUB_QUAL#27	GOOSE subscription quality for record #27
31001C1001	SUB_QUAL#28	GOOSE subscription quality for record #28
31001D1001	SUB_QUAL#29	GOOSE subscription quality for record #29
31001E1001	SUB_QUAL#30	GOOSE subscription quality for record #30
31001F1001	SUB_QUAL#31	GOOSE subscription quality for record #31
3100201001	SUB_QUAL#32	GOOSE subscription quality for record #32
3100211001	SUB_QUAL#33	GOOSE subscription quality for record #33
3100221001	SUB_QUAL#34	GOOSE subscription quality for record #34
3100231001	SUB_QUAL#35	GOOSE subscription quality for record #35
3100241001	SUB_QUAL#36	GOOSE subscription quality for record #36
3100251001	SUB_QUAL#37	GOOSE subscription quality for record #37
3100261001	SUB_QUAL#38	GOOSE subscription quality for record #38
3100271001	SUB_QUAL#39	GOOSE subscription quality for record #39
3100281001	SUB_QUAL#40	GOOSE subscription quality for record #40
3100291001	SUB_QUAL#41	GOOSE subscription quality for record #41
31002A1001	SUB_QUAL#42	GOOSE subscription quality for record #42
31002B1001	SUB_QUAL#43	GOOSE subscription quality for record #43
31002C1001	SUB_QUAL#44	GOOSE subscription quality for record #44
31002D1001	SUB_QUAL#45	GOOSE subscription quality for record #45

◆ Monitoring point

GOOSE (Function ID: 301101)

Element ID	Name	Description
31002E1001	SUB_QUAL#46	GOOSE subscription quality for record #46
31002F1001	SUB_QUAL#47	GOOSE subscription quality for record #47
3100301001	SUB_QUAL#48	GOOSE subscription quality for record #48
3100311001	SUB_QUAL#49	GOOSE subscription quality for record #49
3100321001	SUB_QUAL#50	GOOSE subscription quality for record #50
3100331001	SUB_QUAL#51	GOOSE subscription quality for record #51
3100341001	SUB_QUAL#52	GOOSE subscription quality for record #52
3100351001	SUB_QUAL#53	GOOSE subscription quality for record #53
3100361001	SUB_QUAL#54	GOOSE subscription quality for record #54
3100371001	SUB_QUAL#55	GOOSE subscription quality for record #55
3100381001	SUB_QUAL#56	GOOSE subscription quality for record #56
3100391001	SUB_QUAL#57	GOOSE subscription quality for record #57
31003A1001	SUB_QUAL#58	GOOSE subscription quality for record #58
31003B1001	SUB_QUAL#59	GOOSE subscription quality for record #59
31003C1001	SUB_QUAL#60	GOOSE subscription quality for record #60
31003D1001	SUB_QUAL#61	GOOSE subscription quality for record #61
31003E1001	SUB_QUAL#62	GOOSE subscription quality for record #62
31003F1001	SUB_QUAL#63	GOOSE subscription quality for record #63
3100401001	SUB_QUAL#64	GOOSE subscription quality for record #64
3100411001	SUB_QUAL#65	GOOSE subscription quality for record #65
3100421001	SUB_QUAL#66	GOOSE subscription quality for record #66
3100431001	SUB_QUAL#67	GOOSE subscription quality for record #67
3100441001	SUB_QUAL#68	GOOSE subscription quality for record #68
3100451001	SUB_QUAL#69	GOOSE subscription quality for record #69
3100461001	SUB_QUAL#70	GOOSE subscription quality for record #70
3100471001	SUB_QUAL#71	GOOSE subscription quality for record #71
3100481001	SUB_QUAL#72	GOOSE subscription quality for record #72
3100491001	SUB_QUAL#73	GOOSE subscription quality for record #73
31004A1001	SUB_QUAL#74	GOOSE subscription quality for record #74
31004B1001	SUB_QUAL#75	GOOSE subscription quality for record #75
31004C1001	SUB_QUAL#76	GOOSE subscription quality for record #76
31004D1001	SUB_QUAL#77	GOOSE subscription quality for record #77
31004E1001	SUB_QUAL#78	GOOSE subscription quality for record #78
31004F1001	SUB_QUAL#79	GOOSE subscription quality for record #79
3100501001	SUB_QUAL#80	GOOSE subscription quality for record #80
3100511001	SUB_QUAL#81	GOOSE subscription quality for record #81
3100521001	SUB_QUAL#82	GOOSE subscription quality for record #82
3100531001	SUB_QUAL#83	GOOSE subscription quality for record #83
3100541001	SUB_QUAL#84	GOOSE subscription quality for record #84
3100551001	SUB_QUAL#85	GOOSE subscription quality for record #85
3100561001	SUB_QUAL#86	GOOSE subscription quality for record #86
3100571001	SUB_QUAL#87	GOOSE subscription quality for record #87

◆ Monitoring point

GOOSE (Function ID: 301101)

Element ID	Name	Description
3100581001	SUB_QUAL#88	GOOSE subscription quality for record #88
3100591001	SUB_QUAL#89	GOOSE subscription quality for record #89
31005A1001	SUB_QUAL#90	GOOSE subscription quality for record #90
31005B1001	SUB_QUAL#91	GOOSE subscription quality for record #91
31005C1001	SUB_QUAL#92	GOOSE subscription quality for record #92
31005D1001	SUB_QUAL#93	GOOSE subscription quality for record #93
31005E1001	SUB_QUAL#94	GOOSE subscription quality for record #94
31005F1001	SUB_QUAL#95	GOOSE subscription quality for record #95
3100601001	SUB_QUAL#96	GOOSE subscription quality for record #96
3100611001	SUB_QUAL#97	GOOSE subscription quality for record #97
3100621001	SUB_QUAL#98	GOOSE subscription quality for record #98
3100631001	SUB_QUAL#99	GOOSE subscription quality for record #99
3100641001	SUB_QUAL#100	GOOSE subscription quality for record #100
3100651001	SUB_QUAL#101	GOOSE subscription quality for record #101
3100661001	SUB_QUAL#102	GOOSE subscription quality for record #102
3100671001	SUB_QUAL#103	GOOSE subscription quality for record #103
3100681001	SUB_QUAL#104	GOOSE subscription quality for record #104
3100691001	SUB_QUAL#105	GOOSE subscription quality for record #105
31006A1001	SUB_QUAL#106	GOOSE subscription quality for record #106
31006B1001	SUB_QUAL#107	GOOSE subscription quality for record #107
31006C1001	SUB_QUAL#108	GOOSE subscription quality for record #108
31006D1001	SUB_QUAL#109	GOOSE subscription quality for record #109
31006E1001	SUB_QUAL#110	GOOSE subscription quality for record #110
31006F1001	SUB_QUAL#111	GOOSE subscription quality for record #111
3100701001	SUB_QUAL#112	GOOSE subscription quality for record #112
3100711001	SUB_QUAL#113	GOOSE subscription quality for record #113
3100721001	SUB_QUAL#114	GOOSE subscription quality for record #114
3100731001	SUB_QUAL#115	GOOSE subscription quality for record #115
3100741001	SUB_QUAL#116	GOOSE subscription quality for record #116
3100751001	SUB_QUAL#117	GOOSE subscription quality for record #117
3100761001	SUB_QUAL#118	GOOSE subscription quality for record #118
3100771001	SUB_QUAL#119	GOOSE subscription quality for record #119
3100781001	SUB_QUAL#120	GOOSE subscription quality for record #120
3100791001	SUB_QUAL#121	GOOSE subscription quality for record #121
31007A1001	SUB_QUAL#122	GOOSE subscription quality for record #122
31007B1001	SUB_QUAL#123	GOOSE subscription quality for record #123
31007C1001	SUB_QUAL#124	GOOSE subscription quality for record #124
31007D1001	SUB_QUAL#125	GOOSE subscription quality for record #125
31007E1001	SUB_QUAL#126	GOOSE subscription quality for record #126
31007F1001	SUB_QUAL#127	GOOSE subscription quality for record #127
3100801001	SUB_QUAL#128	GOOSE subscription quality for record #128
3100811001	SUB_QUAL#129	GOOSE subscription quality for record #129

◆ Monitoring point

GOOSE (Function ID: 301101)

Element ID	Name	Description
3100821001	SUB_QUAL#130	GOOSE subscription quality for record #130
3100831001	SUB_QUAL#131	GOOSE subscription quality for record #131
3100841001	SUB_QUAL#132	GOOSE subscription quality for record #132
3100851001	SUB_QUAL#133	GOOSE subscription quality for record #133
3100861001	SUB_QUAL#134	GOOSE subscription quality for record #134
3100871001	SUB_QUAL#135	GOOSE subscription quality for record #135
3100881001	SUB_QUAL#136	GOOSE subscription quality for record #136
3100891001	SUB_QUAL#137	GOOSE subscription quality for record #137
31008A1001	SUB_QUAL#138	GOOSE subscription quality for record #138
31008B1001	SUB_QUAL#139	GOOSE subscription quality for record #139
31008C1001	SUB_QUAL#140	GOOSE subscription quality for record #140
31008D1001	SUB_QUAL#141	GOOSE subscription quality for record #141
31008E1001	SUB_QUAL#142	GOOSE subscription quality for record #142
31008F1001	SUB_QUAL#143	GOOSE subscription quality for record #143
3100901001	SUB_QUAL#144	GOOSE subscription quality for record #144
3100911001	SUB_QUAL#145	GOOSE subscription quality for record #145
3100921001	SUB_QUAL#146	GOOSE subscription quality for record #146
3100931001	SUB_QUAL#147	GOOSE subscription quality for record #147
3100941001	SUB_QUAL#148	GOOSE subscription quality for record #148
3100951001	SUB_QUAL#149	GOOSE subscription quality for record #149
3100961001	SUB_QUAL#150	GOOSE subscription quality for record #150
3100971001	SUB_QUAL#151	GOOSE subscription quality for record #151
3100981001	SUB_QUAL#152	GOOSE subscription quality for record #152
3100991001	SUB_QUAL#153	GOOSE subscription quality for record #153
31009A1001	SUB_QUAL#154	GOOSE subscription quality for record #154
31009B1001	SUB_QUAL#155	GOOSE subscription quality for record #155
31009C1001	SUB_QUAL#156	GOOSE subscription quality for record #156
31009D1001	SUB_QUAL#157	GOOSE subscription quality for record #157
31009E1001	SUB_QUAL#158	GOOSE subscription quality for record #158
31009F1001	SUB_QUAL#159	GOOSE subscription quality for record #159
3100A01001	SUB_QUAL#160	GOOSE subscription quality for record #160
3100A11001	SUB_QUAL#161	GOOSE subscription quality for record #161
3100A21001	SUB_QUAL#162	GOOSE subscription quality for record #162
3100A31001	SUB_QUAL#163	GOOSE subscription quality for record #163
3100A41001	SUB_QUAL#164	GOOSE subscription quality for record #164
3100A51001	SUB_QUAL#165	GOOSE subscription quality for record #165
3100A61001	SUB_QUAL#166	GOOSE subscription quality for record #166
3100A71001	SUB_QUAL#167	GOOSE subscription quality for record #167
3100A81001	SUB_QUAL#168	GOOSE subscription quality for record #168
3100A91001	SUB_QUAL#169	GOOSE subscription quality for record #169
3100AA1001	SUB_QUAL#170	GOOSE subscription quality for record #170
3100AB1001	SUB_QUAL#171	GOOSE subscription quality for record #171

◆ Monitoring point

GOOSE (Function ID: 301101)

Element ID	Name	Description
3100AC1001	SUB_QUAL#172	GOOSE subscription quality for record #172
3100AD1001	SUB_QUAL#173	GOOSE subscription quality for record #173
3100AE1001	SUB_QUAL#174	GOOSE subscription quality for record #174
3100AF1001	SUB_QUAL#175	GOOSE subscription quality for record #175
3100B01001	SUB_QUAL#176	GOOSE subscription quality for record #176
3100B11001	SUB_QUAL#177	GOOSE subscription quality for record #177
3100B21001	SUB_QUAL#178	GOOSE subscription quality for record #178
3100B31001	SUB_QUAL#179	GOOSE subscription quality for record #179
3100B41001	SUB_QUAL#180	GOOSE subscription quality for record #180
3100B51001	SUB_QUAL#181	GOOSE subscription quality for record #181
3100B61001	SUB_QUAL#182	GOOSE subscription quality for record #182
3100B71001	SUB_QUAL#183	GOOSE subscription quality for record #183
3100B81001	SUB_QUAL#184	GOOSE subscription quality for record #184
3100B91001	SUB_QUAL#185	GOOSE subscription quality for record #185
3100BA1001	SUB_QUAL#186	GOOSE subscription quality for record #186
3100BB1001	SUB_QUAL#187	GOOSE subscription quality for record #187
3100BC1001	SUB_QUAL#188	GOOSE subscription quality for record #188
3100BD1001	SUB_QUAL#189	GOOSE subscription quality for record #189
3100BE1001	SUB_QUAL#190	GOOSE subscription quality for record #190
3100BF1001	SUB_QUAL#191	GOOSE subscription quality for record #191
3100C01001	SUB_QUAL#192	GOOSE subscription quality for record #192
3100C11001	SUB_QUAL#193	GOOSE subscription quality for record #193
3100C21001	SUB_QUAL#194	GOOSE subscription quality for record #194
3100C31001	SUB_QUAL#195	GOOSE subscription quality for record #195
3100C41001	SUB_QUAL#196	GOOSE subscription quality for record #196
3100C51001	SUB_QUAL#197	GOOSE subscription quality for record #197
3100C61001	SUB_QUAL#198	GOOSE subscription quality for record #198
3100C71001	SUB_QUAL#199	GOOSE subscription quality for record #199
3100C81001	SUB_QUAL#200	GOOSE subscription quality for record #200
3100C91001	SUB_QUAL#201	GOOSE subscription quality for record #201
3100CA1001	SUB_QUAL#202	GOOSE subscription quality for record #202
3100CB1001	SUB_QUAL#203	GOOSE subscription quality for record #203
3100CC1001	SUB_QUAL#204	GOOSE subscription quality for record #204
3100CD1001	SUB_QUAL#205	GOOSE subscription quality for record #205
3100CE1001	SUB_QUAL#206	GOOSE subscription quality for record #206
3100CF1001	SUB_QUAL#207	GOOSE subscription quality for record #207
3100D01001	SUB_QUAL#208	GOOSE subscription quality for record #208
3100D11001	SUB_QUAL#209	GOOSE subscription quality for record #209
3100D21001	SUB_QUAL#210	GOOSE subscription quality for record #210
3100D31001	SUB_QUAL#211	GOOSE subscription quality for record #211
3100D41001	SUB_QUAL#212	GOOSE subscription quality for record #212
3100D51001	SUB_QUAL#213	GOOSE subscription quality for record #213

◆ Monitoring point

GOOSE (Function ID: 301101)

Element ID	Name	Description
3100D61001	SUB_QUAL#214	GOOSE subscription quality for record #214
3100D71001	SUB_QUAL#215	GOOSE subscription quality for record #215
3100D81001	SUB_QUAL#216	GOOSE subscription quality for record #216
3100D91001	SUB_QUAL#217	GOOSE subscription quality for record #217
3100DA1001	SUB_QUAL#218	GOOSE subscription quality for record #218
3100DB1001	SUB_QUAL#219	GOOSE subscription quality for record #219
3100DC1001	SUB_QUAL#220	GOOSE subscription quality for record #220
3100DD1001	SUB_QUAL#221	GOOSE subscription quality for record #221
3100DE1001	SUB_QUAL#222	GOOSE subscription quality for record #222
3100DF1001	SUB_QUAL#223	GOOSE subscription quality for record #223
3100E01001	SUB_QUAL#224	GOOSE subscription quality for record #224
3100E11001	SUB_QUAL#225	GOOSE subscription quality for record #225
3100E21001	SUB_QUAL#226	GOOSE subscription quality for record #226
3100E31001	SUB_QUAL#227	GOOSE subscription quality for record #227
3100E41001	SUB_QUAL#228	GOOSE subscription quality for record #228
3100E51001	SUB_QUAL#229	GOOSE subscription quality for record #229
3100E61001	SUB_QUAL#230	GOOSE subscription quality for record #230
3100E71001	SUB_QUAL#231	GOOSE subscription quality for record #231
3100E81001	SUB_QUAL#232	GOOSE subscription quality for record #232
3100E91001	SUB_QUAL#233	GOOSE subscription quality for record #233
3100EA1001	SUB_QUAL#234	GOOSE subscription quality for record #234
3100EB1001	SUB_QUAL#235	GOOSE subscription quality for record #235
3100EC1001	SUB_QUAL#236	GOOSE subscription quality for record #236
3100ED1001	SUB_QUAL#237	GOOSE subscription quality for record #237
3100EE1001	SUB_QUAL#238	GOOSE subscription quality for record #238
3100EF1001	SUB_QUAL#239	GOOSE subscription quality for record #239
3100F01001	SUB_QUAL#240	GOOSE subscription quality for record #240
3100F11001	SUB_QUAL#241	GOOSE subscription quality for record #241
3100F21001	SUB_QUAL#242	GOOSE subscription quality for record #242
3100F31001	SUB_QUAL#243	GOOSE subscription quality for record #243
3100F41001	SUB_QUAL#244	GOOSE subscription quality for record #244
3100F51001	SUB_QUAL#245	GOOSE subscription quality for record #245
3100F61001	SUB_QUAL#246	GOOSE subscription quality for record #246
3100F71001	SUB_QUAL#247	GOOSE subscription quality for record #247
3100F81001	SUB_QUAL#248	GOOSE subscription quality for record #248
3100F91001	SUB_QUAL#249	GOOSE subscription quality for record #249
3100FA1001	SUB_QUAL#250	GOOSE subscription quality for record #250
3100FB1001	SUB_QUAL#251	GOOSE subscription quality for record #251
3100FC1001	SUB_QUAL#252	GOOSE subscription quality for record #252
3100FD1001	SUB_QUAL#253	GOOSE subscription quality for record #253
3100FE1001	SUB_QUAL#254	GOOSE subscription quality for record #254
3100FF1001	SUB_QUAL#255	GOOSE subscription quality for record #255

◆ Monitoring point

GOOSE (Function ID: 301101)

Element ID	Name	Description
3101001001	SUB_QUAL#256	GOOSE subscription quality for record #256
3101011001	SUB_QUAL#257	GOOSE subscription quality for record #257
3101021001	SUB_QUAL#258	GOOSE subscription quality for record #258
3101031001	SUB_QUAL#259	GOOSE subscription quality for record #259
3101041001	SUB_QUAL#260	GOOSE subscription quality for record #260
3101051001	SUB_QUAL#261	GOOSE subscription quality for record #261
3101061001	SUB_QUAL#262	GOOSE subscription quality for record #262
3101071001	SUB_QUAL#263	GOOSE subscription quality for record #263
3101081001	SUB_QUAL#264	GOOSE subscription quality for record #264
3101091001	SUB_QUAL#265	GOOSE subscription quality for record #265
31010A1001	SUB_QUAL#266	GOOSE subscription quality for record #266
31010B1001	SUB_QUAL#267	GOOSE subscription quality for record #267
31010C1001	SUB_QUAL#268	GOOSE subscription quality for record #268
31010D1001	SUB_QUAL#269	GOOSE subscription quality for record #269
31010E1001	SUB_QUAL#270	GOOSE subscription quality for record #270
31010F1001	SUB_QUAL#271	GOOSE subscription quality for record #271
3101101001	SUB_QUAL#272	GOOSE subscription quality for record #272
3101111001	SUB_QUAL#273	GOOSE subscription quality for record #273
3101121001	SUB_QUAL#274	GOOSE subscription quality for record #274
3101131001	SUB_QUAL#275	GOOSE subscription quality for record #275
3101141001	SUB_QUAL#276	GOOSE subscription quality for record #276
3101151001	SUB_QUAL#277	GOOSE subscription quality for record #277
3101161001	SUB_QUAL#278	GOOSE subscription quality for record #278
3101171001	SUB_QUAL#279	GOOSE subscription quality for record #279
3101181001	SUB_QUAL#280	GOOSE subscription quality for record #280
3101191001	SUB_QUAL#281	GOOSE subscription quality for record #281
31011A1001	SUB_QUAL#282	GOOSE subscription quality for record #282
31011B1001	SUB_QUAL#283	GOOSE subscription quality for record #283
31011C1001	SUB_QUAL#284	GOOSE subscription quality for record #284
31011D1001	SUB_QUAL#285	GOOSE subscription quality for record #285
31011E1001	SUB_QUAL#286	GOOSE subscription quality for record #286
31011F1001	SUB_QUAL#287	GOOSE subscription quality for record #287
3101201001	SUB_QUAL#288	GOOSE subscription quality for record #288
3101211001	SUB_QUAL#289	GOOSE subscription quality for record #289
3101221001	SUB_QUAL#290	GOOSE subscription quality for record #290
3101231001	SUB_QUAL#291	GOOSE subscription quality for record #291
3101241001	SUB_QUAL#292	GOOSE subscription quality for record #292
3101251001	SUB_QUAL#293	GOOSE subscription quality for record #293
3101261001	SUB_QUAL#294	GOOSE subscription quality for record #294
3101271001	SUB_QUAL#295	GOOSE subscription quality for record #295
3101281001	SUB_QUAL#296	GOOSE subscription quality for record #296
3101291001	SUB_QUAL#297	GOOSE subscription quality for record #297

◆ Monitoring point

GOOSE (Function ID: 301101)

Element ID	Name	Description
31012A1001	SUB_QUAL#298	GOOSE subscription quality for record #298
31012B1001	SUB_QUAL#299	GOOSE subscription quality for record #299
31012C1001	SUB_QUAL#300	GOOSE subscription quality for record #300
31012D1001	SUB_QUAL#301	GOOSE subscription quality for record #301
31012E1001	SUB_QUAL#302	GOOSE subscription quality for record #302
31012F1001	SUB_QUAL#303	GOOSE subscription quality for record #303
3101301001	SUB_QUAL#304	GOOSE subscription quality for record #304
3101311001	SUB_QUAL#305	GOOSE subscription quality for record #305
3101321001	SUB_QUAL#306	GOOSE subscription quality for record #306
3101331001	SUB_QUAL#307	GOOSE subscription quality for record #307
3101341001	SUB_QUAL#308	GOOSE subscription quality for record #308
3101351001	SUB_QUAL#309	GOOSE subscription quality for record #309
3101361001	SUB_QUAL#310	GOOSE subscription quality for record #310
3101371001	SUB_QUAL#311	GOOSE subscription quality for record #311
3101381001	SUB_QUAL#312	GOOSE subscription quality for record #312
3101391001	SUB_QUAL#313	GOOSE subscription quality for record #313
31013A1001	SUB_QUAL#314	GOOSE subscription quality for record #314
31013B1001	SUB_QUAL#315	GOOSE subscription quality for record #315
31013C1001	SUB_QUAL#316	GOOSE subscription quality for record #316
31013D1001	SUB_QUAL#317	GOOSE subscription quality for record #317
31013E1001	SUB_QUAL#318	GOOSE subscription quality for record #318
31013F1001	SUB_QUAL#319	GOOSE subscription quality for record #319

11.3 IEC 60870-5-103 communication

The IEC 60870-5-103 standard† is one of the communication protocols when measuring data is required to communicate between the control system and the IED; the communication is carried out with the RS485 or the Fiber optic interface‡. The following data are transferred by the IEC 60870-5-103 communication; the user is required create the configuration using the GR-TIEMS, as cited in the previous section:

- Measured data: current, voltage, active power, reactive power, frequency
- Status data: events, fault indications, etc.

†Note: The selection of the IEC 60870-5-103 communication is dependent on the ordering code in the communication protocols. For the selection, see *Appendix: Ordering*.

‡Note: The selection concerning to the communication module (interface) is dependent on the ordering in the hardware selection. We shall see the description with regard to the communication specification in Chapter *Technical description: Signal processing and communication module*.

11.3.1 Overview

For the communication in the IEC 60870-5-103 standard, the user should create the data with regard the protocol, which is grouped into a slave and a master. The user can edit the slave Data or the master Data using the GR-TIEMS.

(i) Management

As cited earlier, the IEC 60870-5-103 standard is grouped into the slave and the master. In an IED the user should select either the master mode or the slave mode; the user should edit either the master data or the slave Data. The both modes can provide the same functions equally. The GR-TIEMS can provide the user the management means for the following data.

(i)-1 Data management

Import data are provided in the CSV file. The data are categorized as “adding items”, “editing items”, “deleting items”, and “arranging items”.

(i)-2 Process management

Creation of the new data

Registration, clear, and change name of a slave IED

Registration and clear of signals

Edition of the dialog prototype

External Interfaces

Logging and Access Security

(i)-3 Manage IEC 60870-5-103 display

Tree view style

List view style

(ii) Configuration†

Table 11.3-1 and Table 11.3-2 show that the items should be programmed using the GR-TIEMS. We shall see how to set and edit data of the IEC 60870-5-103 configuration in section 11.3.5

†Note:Configuration for the master Data is not available in the GR200-serises.

Table 11.3-1 Configuration items in IEC 60870-5-103

Items	Contents
Time-tagged message	Type ID(1/2), INF, FUN, Transmission condition(Data ID), COT
Time-tagged measurands	INF, FUN, Transmission condition(Data ID), COT, Type of measurands quantities
General command	INF, FUN, Control condition(Data ID)
Measurands	Type ID(3/9), INF, FUN, Number of measurands, Type of measurands quantities

Table 11.3-2 Common settings in IEC 60870-5-103

Items	Notice
Transmission cycle of Measurands frame	To perform to write the settings in the IED effectively, the user should turn off the DC supplying to the IED; then turn on the DC again.
FUN of System function	
Test mode	

11.3.2 Requirements in the Master station

In the master station of the IEC 60870-5-103 standard, the following specifications should be followed in the respective IEDs:

1) Polling cycle: 150ms or longer
2) Timeout time (time to re-sending the request frame to the IED): 100ms

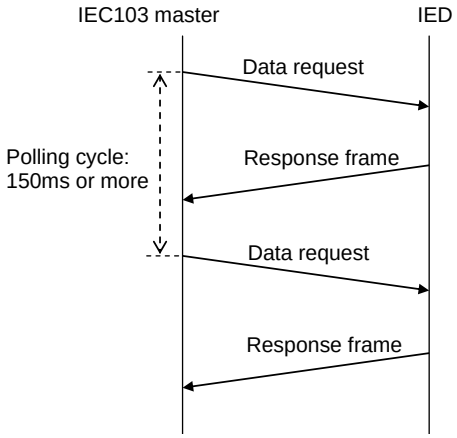


Figure 11.3-1 Ping cycles between the master station and the IED

11.3.3 Interoperability

The IEC 60870-5-103 protocol provides a physical layer and an application layer for the communication to secure the interoperability.

(i) Physical layer

Either an electrical or an optical interface† is defined in the IEC 60870-5-103 standard.

(i)-1 Electrical interface in the RS-485

A maximum number of 32 relays is possible in the IEC 60870-5-103 standard.

(i)-2 Optic interface

Several optic communication modules are available

†Note: Either interface is provided with a communication module in the IED; the specification is discussed separately. See chapter *Technical description: Signal processing and communication module*.

(ii) Application Layer

The following layers are provided on the application layer:

COMMON ADDRESS of ASDU

One COMMON ADDRESS OF ASDU (identical with station address)

11.3.4 Communication interface in the IEC 60870-5-103 standard

(i) Spontaneous events

When events are generated in the IED, they are transferred to the master station. The event transferred is grouped into the Function-type (FUN) and the Information numbers (INF).

(ii) General interrogation[1]

"GI request" is used when it is required to read the IED status, the Function-types (FUNs), and the Information numbers (INFs). The status and others are reported during the GI cycle.

(iii) Cyclic measurements

Measured values are cyclically generated using Type ID=3 or 9; they are read in the IED using a Class 2 poll. The generating rate of new measured values is possible to program.

(iv) Commands[2]

The user can customize the supported commands. The IED can replay for unsupported commands using the cause of transmission (COT) negative acknowledgement of a command.

(v) Test mode[3]

For the process in the control system, both spontaneous messages and polled measured values are designated by the means in the 'test mode' of "CAUSE OF TRANSMISSION". The means denoted the 'test mode' of "CAUSE OF TRANSMISSION = 7" is normally used for the messages transmitted with COT=1 (spontaneous) or COT=2 (cyclic).

(vi) Blocking of monitor direction[4]

If blocking the monitor direction is activated in the protection equipment, all indications and measurands are never transmitted.

[1]Note: With regard to the GI list, see *Appendix IEC 60870-5-103 interoperability*. When the user wishes to understand the details, refer to the section 7.4.3 of the IEC 60870-5-103 standard.

[2]Note: For details, refer to the section 7.4.4 of the IEC 60870-5-103 standard.

[3]Note: For details, refer to the section 7.4.5 of the IEC 60870-5-103 standard.

[4]Note: For details, refer to the section 7.4.6 of the IEC 60870-5-103 standard.

11.3.5 Editing data of the configuration

(i) Common setting

When the "Common setting" item is selected on the start screen of the IEC 60870-5-103 configuration, the "Common setting" setting screen is displayed. Settings common to each frame can be performed in this screen.

(i)-1 Setting file remark

The remark of the setting file is used for managing the version of the configuration data file. A comment with the maximum of 12 characters can be entered in the box. The comment can be viewed on the IED screen.

(i)-2 Remote operation valid time

When "Time-tagged message" or "Time-tagged measured" occurs during the period from the receiving any command (which is provided by "General command" setting) to the setting time of "Remote Operation valid time", its COT is set to COT=12 (Remote operation). This setting for the event is enabled when the COT=12 and COT=1 or 11 are checked in "Time-tagged message" or "Time-tagged measurand" setting. The setting range of "Remote Operation valid time" is 0 to 60000ms. The default setting is 4000ms. In the following case, the "Time-tagged measurand" with COT=12 occurs.

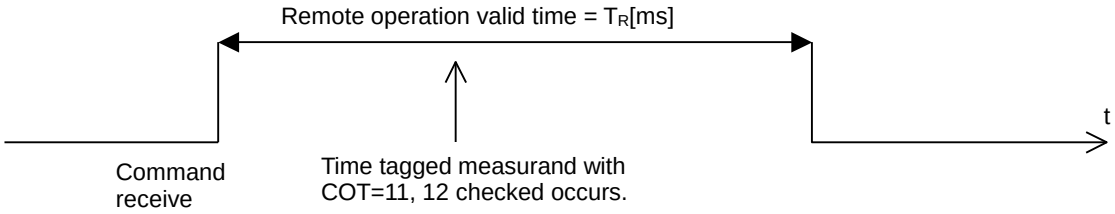


Figure 11.3-2 Time setting for the remote operation

(i)-3 Local operation valid time

When "Time-tagged message" or "Time-tagged measurand" occurs during the period from the start of local operation (described in 11.3.5(ii)-7) to the setting time of "Local Operation valid time", its COT is set to COT=11 (Local operation). This setting for the event is enabled when the COT=11 and COT=1 or 12 are checked in "Time-tagged message" or "Time-tagged measurand" setting. The setting range of "Remote Operation valid time" is 0 to 60000ms. The default setting is 4000ms. In the following case, the "Time-tagged message" with COT=11 occurs.

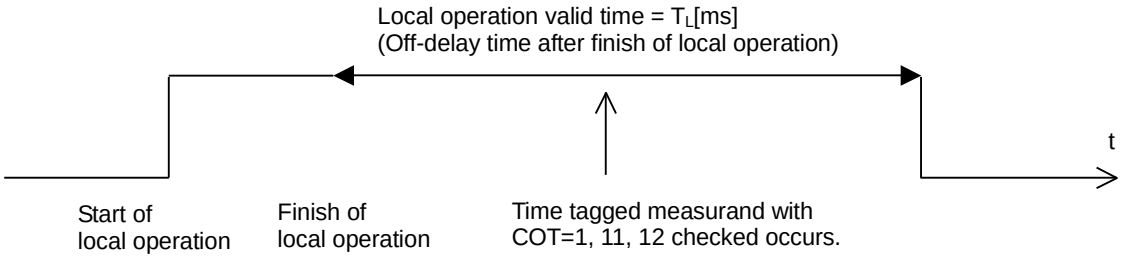


Figure 11.3-3 Time setting for the local operation

(i)-4 Measurand period

This setting is used to set the transmission cycle (s) of Measurand frame. The setting range is 0 to 60s. If no Measurand frame is provided by measurand setting, this setting is disabled.

(i)-5 Function type of system functions

This setting is used to set Function type (FUN) of System functions† (INF=0 to 5). The FUN can be set individually per the frame provided. When clicking the **"Change all FUNs"**, confirmation dialog box appears. When clicking **"OK"**, FUNs of all frames are changed to these setting values.

†Note: We mean the following frames: end of general interrogation, time synchronization, reset FCB, reset CU, start/restart, power on.

(i)-6 Signal No. of test mode

This setting is used to set a Data ID in the test mode. The relevant Data ID should be selected from the signal list, which can be found in Chapters *"Relay" or "Control and monitoring"* applications. Usually, the default setting is not changed.

The test mode in the IEC 60870-5-103 standard is enabled by the operation on the IED screen or the GR-TIEMS. When the set signal changes "ON" and Time-tagged message or Time-tagged measured of spontaneous cause (COT=1) or measurand frame or cyclic transmission (Type ID=3 or 9) occurs, its COT shifts COT=7 (Test mode).

(i)-7 Signal No. for relative time and fault number

This setting is used to set the trigger signal which is attached the frame of Type ID=2 or 4. The trigger signal is selected from the signal list. (This setting is not related to the frame of Type ID=1.)

The time (ms), which is from the establishment of a set signal to the detection of a status change, is added the set frame as RET value. FAN (Fault number), attached the frame of Type ID=2 or 4, has the same number during the set signal ON. (Whenever the set signal is ON, the FAN increases.) When setting to "0", RET value is always "0" (RET=0). The default setting is set to the OR signal of elements operation. When Type ID=2 frame is provided with OC trip as send condition, for example, the time from OC element operation to OC tripping is attached to the frame as RET. Though, the RET of GI frame is always "0" in spite of this setting.

In the following case, T1[ms] is attached to [i] as RET, T2[ms] is attached to [ii], and T3[ms] is attached to [iii], as shown in Figure 11.3-4.

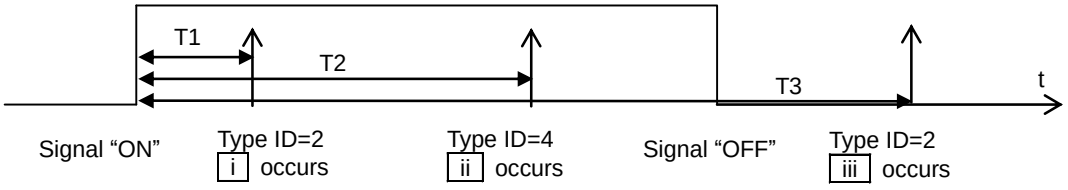


Figure 11.3-4 Occurrences after the signal "ON"

(ii) Setting of time-tagged messages

In Time-tagged message frame in the IEC 60870-5-103 standard, event information and status information are responded for Class 1 request from the upper system (station). The GR-series relay can provide event information and status information by Time-tagged message frame about the signal assigned to a Data ID of the signal list.

When the "Time-tagged message" tab is selected, the "Time-tagged message" setting screen is displayed on the start screen.

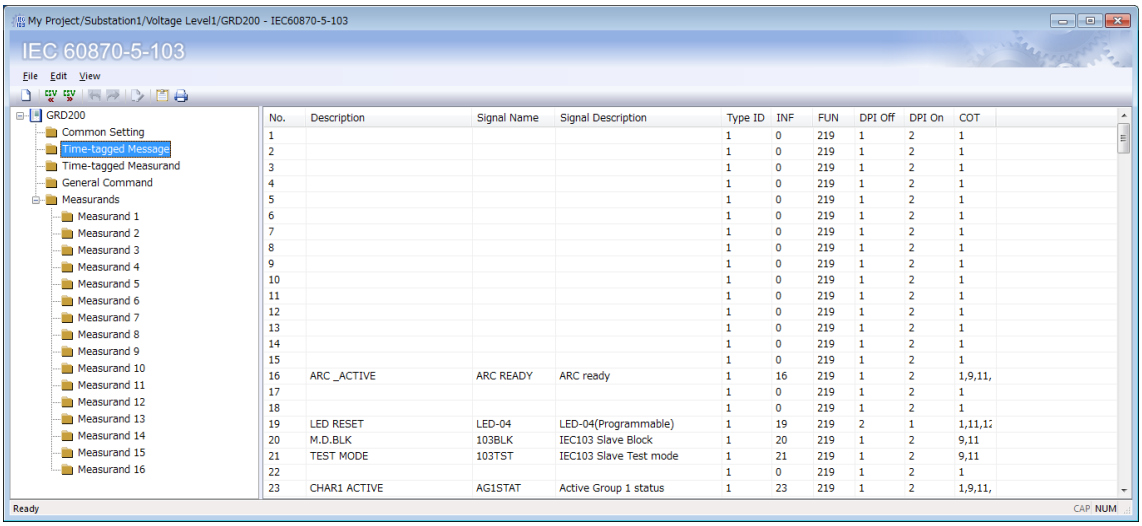


Figure 11.3-5 Time-tagged message in the GR-TIEMS

Type ID=1 (Time-tagged message) or Type ID=2 (Time-tagged message with relative time) can be set in this screen. In one frame of Time-tagged message, the Type ID, INF, FUN, DPI and COT must be set and the maximum 256 frames of Time-tagged message can be set. The information number of the frame is determined by the INF setting. The most left item "No." is only serial number and can be skipped.

Common address is linked with the address setting† in the IEC 60870-5-103 standard.

†Note:For more information, see *Appendix: IEC 60870-5-103 interoperability*.

In the transmission format of Type ID=1 (Time-tagged message) and Type ID=2 (Time-tagged message with relative time), customized items are shown in Table 11.3-3 and Table 11.3-4.

Table 11.3-3 Time-tagged message (Type ID=1)

Oct.	Item	Value	Remarks
1	Start	68H	
2	Length	14	
3	Length	14	
4	Start	68H	
5	Control field	08H+ACD+DFC	
6	Address	1-254	Setting from the relay
7	Type identification (Type ID)	1	Customized by GR-TIEMS
8	Variable structure qualifier	81H	
9	Cause of transmission (COT)	1/9/11/12	Customized by GR-TIEMS

Oct.	Item	Value	Remarks
10	Common address of ASDU	1-254	Linked with Address setting
11	Function type (FUN)	0-255	Customized by GR-TIEMS
12	Information number (INF)	0-255	Customized by GR-TIEMS
13	Double point information (DPI)	-/(0)/1/2/(3)/DP	Customized by GR-TIEMS
14	Millisecond (low)	0-59999	
15	Millisecond (high)		
16	Minutes + Invalid flag (MSB)	0-59+80H	
17	Hours + Summer time flag (MSB)	0-23+80H	
18	Supplementary information (SIN)	0-255	
19	Checksum		
20	End	16H	

Table 11.3-4 Time-tagged message with relative time (Type ID=2)

Oct.	Item	Value	Remarks
1	Start	68H	
2	Length	18	
3	Length	18	
4	Start	68H	
5	Control field	08H+ACD+DFC	
6	Address	1-254	Setting from the relay
7	Type identification (Type ID)	2	Customized by GR-TIEMS
8	Variable structure qualifier	81H	
9	Cause of transmission (COT)	1/9/11/12	Customized by GR-TIEMS
10	Common address of ASDU	1-254	Linked with Address setting
11	Function type (FUN)	0-255	Customized by GR-TIEMS
12	Information number (INF)	0-255	Customized by GR-TIEMS
13	Double point information (DPI)	-/(0)/1/2/(3)/DP	Customized by GR-TIEMS
14	Relative time (RET)	0-65535	Trigger condition to calculate RET is customized by GR-TIEMS.
16	Fault number (FAN)	0-65535	Trigger condition of FAN increment is customized by GR-TIEMS.
18	Millisecond	0-59999	
20	Minutes + Invalid flag (MSB)	0-59+80H	
21	Hours + Summer time flag (MSB)	0-23+80H	
22	Supplementary information (SIN)	0-255	
23	Checksum		
24	End	16H	

(ii)-1 Description

Any comment with maximum 16 characters can be entered. This setting does not affect the function of IEC 60870-5-103 communication.

(ii)-2 Signal name / signal description

The Data ID† (Sig. No.) showing the status of the frame is set from the signal list of the

relay. If the setting value (signal No.) is "0", all setting items related events are disable and the frame is not provided.

†Note: A relevant Data ID is required to select; the description is obtained automatically.

(ii)-3 Type ID

Type ID=1 (Time-tagged message) or Type ID=2 (Time-tagged message with relative time) is selected to set the frame type. It is recommended that the frame related to status is set to Type ID=1 and the frame related to faults is set to Type ID=2. In Type ID=2, the trigger signal for the relative time should be set. For the setting, see Section 11.3.5(i).

(ii)-4 INF

Information number (INF) of the frame is set. The INF can be set to 0 to 255. When the standard frame is provided, the INF according to the Appendix† is recommended. If the frame out of standard is provided, the INF should be set referring Table 11.3-5 and the Appendix†.

Table 11.3-5 INF category of Monitor direction

INF	Category
0 to 15	system functions
16 to 31	Status
32 to 47	Supervision
48 to 63	earth fault
64 to 127	short circuit
128 to 143	auto-reclosure
144 to 159	Measurands
160 to 239	not used
240 to 255	generic functions

†Note: See *Appendix: IEC 60870-5-103 interoperability: Semantics of Information number.*

(ii)-5 FUN

Function type (FUN) is set referring to Table 11.3-6. The FUN can be set to 0 to 255. When clicking the **"Change all FUNs"** on the Common setting screen, all FUNs are changed to the setting values at Common setting.

Table 11.3-6 Semantics of Function type

0 - 127	private range
128	distance protection
129	not used
144	not used
145	not used
160	overcurrent protection
161	not used
176	transformer differential protection
177	not used
192	Line differential protection

193	not used
208	not used
209	not used
224	not used
225	not used
240	not used
241	not used
254	Generic function type
255	Global function type

(ii)-6 DPI/Off, DPI/On

Double-point information (DPI) is set using the menu as follows:

DPI/Off: The frame is transmitted when the DPI/Sig.No. signal is OFF.
DPI/On: The frame is transmitted when the DPI/Sig.No. signal is ON.

Note: If selecting "-"(=don't care), the frame is not transmitted even though the DPI/Sig.No. signal set change to the set status. In general, the frames related to tripping such as "Time-tagged message" and Time-tagged measurand", etc., which are not an object of GI (General Interrogation), are not transmitted when the DPI changes "On" to "Off". In this case, set the "DPI/Off" to "-"(=don't care).

Note: When selecting "DP" for both "DPI/Off" and "DPI/On", the DPI number is transmitted as the number (=0/1/2/3) using the same information number (INF). Regarding the frame related to a device control, the "undefined/failed" status may be required in addition to the "close/open" status for the extension. When selecting "DP", "undefined(00)/close(01)/open(10)/failed(11)" status is applied in the same information number (INF).

(ii)-7 COT

Cause of Transmission (COT) of the frame is set. Not only one COT but also two or more COT can be selected each No. (frame). COT setting pattern and COT supplemented the frame are as follows:

(1) If two or all of COT=1, 11 and 12 are checked per No., each frame of the No. become the following conditions.

Table 11.3-7 COT

COT	Conditions
COT=12 (remote operation)	T_R[ms] after receiving any command of the IEC 60870-5-103[1]
COT=11 (local operation)	T_L[ms] after Key operation on the relay front panel[1]
COT=1 (spontaneous)	Conditions except above COT=11 and 12 The relay is in test mode[2], the COT=1(Spontaneous) is shifted to 7(Test mode)

[1]Note: TR and TL are set in Common setting.
[2]Note: Settings of the test mode is described later.

(2) If one of COT is specified per No., the frame is always supplemented with the

specified COT regardless of cause of transmission.

(3) If COT=9 is specified, the frame become the object of GI and is sent back when the GI request frame is received. Time-tagged message is sent back in order of No. instead of order of INF.

Table 11.3-8 shows the summary of (1), (2) and (3) above.

Table 11.3-8 COT setting pattern and COT supplemented frame

COT setting pattern				COT supplemented frame when status changes	GI
1	9	11	12		
✓				Always “1”	No
	✓			Events don’t occur.	Yes
		✓		Always “11”	No
			✓	Always “12”	No
✓	✓			Always “1”	Yes
✓		✓		“11” (cause at local) or “1” (other causes)	No
✓			✓	“12” (cause at remote) or “1” (other causes)	No
	✓	✓		Always “11”	Yes
	✓		✓	Always “12”	Yes
		✓	✓	“11” (cause at local) or “12” (cause at remote) or “1” (other causes)	No
✓	✓	✓		“11” (cause at local) or “1” (other causes)	Yes
✓	✓		✓	“12” (cause at remote) or “1” (other causes)	Yes
✓		✓	✓	“11” (cause at local) or “12” (cause at remote) or “1” (other causes)	No
	✓	✓	✓	“11” (cause at local) or “12” (cause at remote) or “1” (other causes)	Yes
✓	✓	✓	✓	“11” (cause at local) or “12” (cause at remote) or “1” (other causes)	Yes
				Always “1” in spite of cause of event occurrence	No

Note: When being in the test mode, the COT=1(Spontaneous) is shifted to 7(Test mode)

(iii) Setting for time-tagged measurands

For Time-tagged measurand frame in the IEC 60870-5-103 standard, event information supplemented with numerical information are responded for Class 1 request from upper system (station). The GR200-series relay can provide event information, which is converted the numerical information in metering table according to user setting weight, by using Time-tagged measurand frame about the signal assigned (i.e., the Data ID).

When the "Time-tagged measurand" item is selected on the GR-TIEMS, the setting screen is displayed.

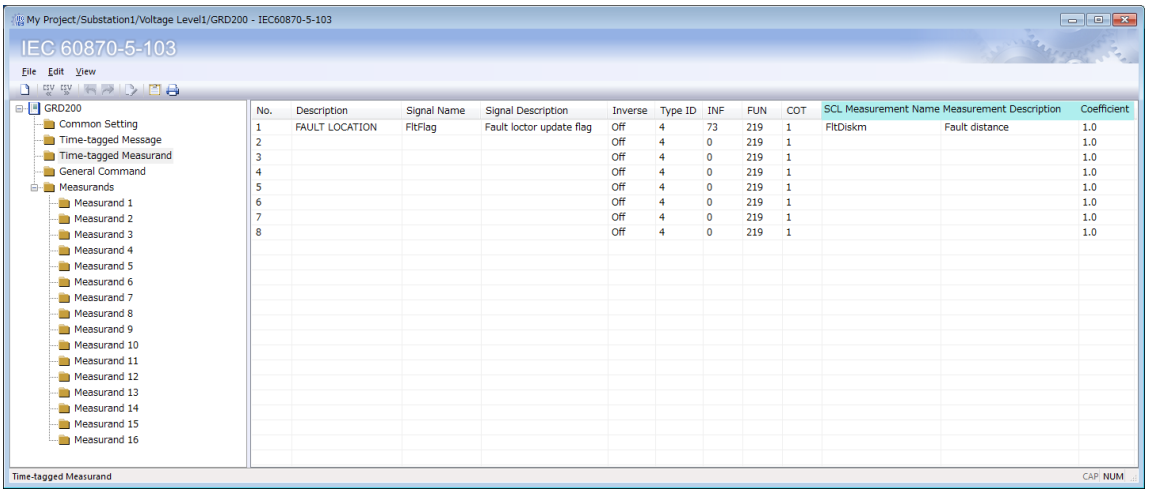


Figure 11.3-6 Time-tagged measurands

Type ID=4 (Time-tagged measurand with relative time) can be set in this screen. In one frame of Time-tagged measurand, the INF, FUN, Sig No., Rev, COT and SCL must be set and the maximum eight frames of Time-tagged measurand can be set. The information number of the frame is determined by the INF setting. The most left item "No." is only serial number and can be skipped.

Common address is linked with the address setting† of the relay.

†For more information, see *Appendix: IEC 60870-5-103 interoperability*.

In the transmission format of Type ID=4 (Time-tagged measurand with relative time), customized items are shown in Table 11.3-9.

Table 11.3-9 Time-tagged measurand with relative time (Type ID=4)

Oct.	Item	Value	Remarks
1	Start	68H	
2	Length	20	
3	Length	20	
4	Start	68H	
5	Control field	08H+ACD+DFC	
6	Address	1-254	Setting from the relay
7	Type identification (Type ID)	4	
8	Variable structure qualifier	81H	
9	Cause of transmission (COT)	1/7/11/12	Customized by GR-TIEMS
10	Common address of ASDU	1-254	Linked with Address setting

Oct.	Item	Value	Remarks
11	Function type (FUN)	0-255	Customized by GR-TIEMS
12	Information number (INF)	0-255	Customized by GR-TIEMS
13	Short-circuit location (SCL)		Customized by GR-TIEMS
17	Relative time (RET)	0-65535	Trigger condition to calculate RET is customized by GR-TIEMS.
19	Fault number (FAN)	0-65535	Trigger condition of FAN increment is customized by GR-TIEMS.
21	Millisecond	0-59999	
23	Minutes + Invalid flag (MSB)	0-59+80H	
24	Hours + Summer time flag (MSB)	0-23+80H	
25	Checksum		
26	End	16H	

(iii)-1 Description

Any comment with maximum 16 characters can be entered. This setting does not affect the function in the IEC 60870-5-103 communication.

(iii)-2 Signal name / signal description

The Data ID† (Sig. No.) showing the trigger of the frame is set from the signal list. If the setting value (signal No.) is "0", all setting items related the "Time-tagged measurand" are disable and the frame is not provided.

The frame cannot be set to the object of GI and cannot be transmitted even though the status of set signal changes from ON to OFF. If the metering values at the newest fault record are transmitted as the status change frame, select the Data ID of "F.Record_DONE" or "FAULT RECORD DONE" in the signal list of the relay.

†Note: A relevant Data ID is required to select in the signal list. The description of the Data ID is obtained automatically on the setting.

(iii)-3 Inverse

This setting is used to invert the logic of the signal assigned to the Data ID above. If the frame is transmitted when the signal assigned to the Data ID is ON, leave the Inverse check box blank. If the frame is transmitted when the signal is OFF, click the inverse check box to be marked with "✓".

(iii)-4 Type ID

Type ID=4 (Time-tagged measurand with Relative time) is fixed. In Type ID=4, the trigger signal for the relative time should be set. For the setting, see Section 11.3.5(i).

(iii)-5 INF

Information number (INF) of the frame is set. The INF can be set to 0 to 255. When the standard frame is provided†, the INF according to the standard is recommended. If the fame out of the standard is provided, the INF should be set referring Table 11.3-3 and the Appendix†.

†Note: For more information, see *Appendix: IEC 60870-5-103 interoperability*.

(iii)-6 FUN

Function type (FUN) is set referring to the Table 11.3-4. The FUN can be set to 0 to 255. When clicking the "**Change all FUNs"** on the Common setting screen, all FUNs are changed to the setting values at Common setting.

(iii)-7 COT

Cause of Transmission (COT) of the frame is set. Not only one COT but two or more COT can be selected each No. (frame). COT setting pattern and COT supplemented the frame are according to Table 11.3-6. Though, the COT=9 (General Interrogation) cannot be selected.

(iii)-8 SCL Measurement Name/Measurement Description

The Data ID corresponding to a measurand is required to select.

(iii)-9 Coefficient

Set the conversion coefficient, multiplied the power system quantities by, using floating-point number. The SCL is a value which the power system quantity specified as above is multiplied by this setting value.

(iv) Setting for General commands

Using General command frame in the IEC 60870-5-103 standard, relay applications can be performed by the remote control. For the GR200-series relay, a Data ID in the signal list is controlled when receiving general command frame.

When the "General command" item is selected on the GR-TIEMS, the setting screen is displayed.

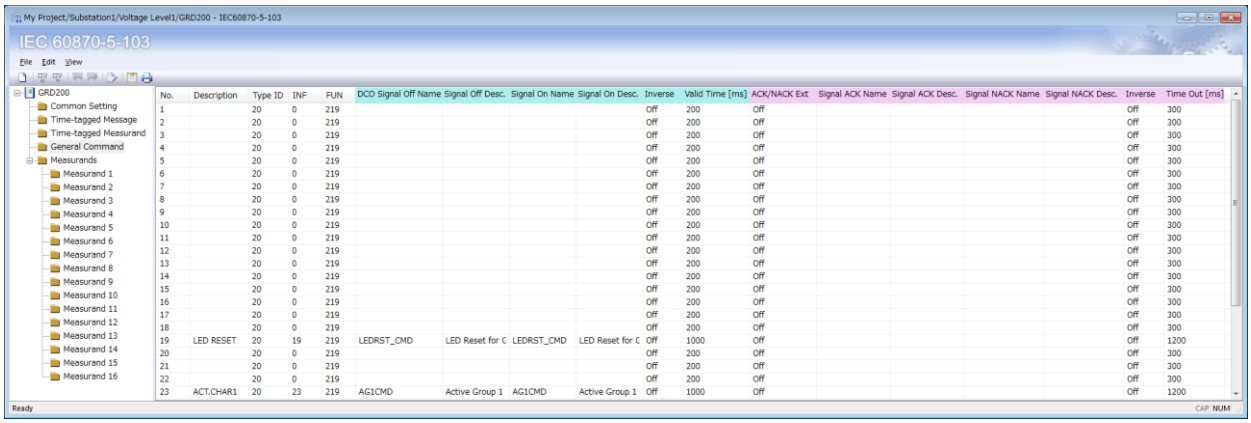


Figure 11.3-7 "General command" setting screen

The frame of Type ID=20 (General command) and Command ACK/NACK can be set in this screen. In one command of General command, the INF, FUN and DCO must be set. The Command ACK/NACK is for detail setting and must not be set usually. (If do not check the Ext check box, the setting of Command ACK/NACK is disabled and the Command ACK and Command NACK respond according to the default response.)

The maximum 32 frames of General command and Command ACK/NACK can be set. The information number of the frame is determined by the INF setting. The most left item "No." is only serial number and can be skipped.

Common address is linked with the address setting† of the relay.

†For more information, see *Appendix: IEC 60870-5-103 interoperability*.

In this setting screen, if a Data ID except "0" is set to "Sig Off" and "Sig On", the command at INF setting value is provided and Command ACK or Command NACK is sent back when receiving the command from upper station. If both "Sig Off" and "Sig On" have "0", the fixed length NACK is always sent back then and the command is not provided.

Though the command is provided, however, Command NACK is always sent back and no control is performed in the following cases:

(1): When receiving any General command from the upper station before Command ACK/NACK is sending back from the relay.

(2): Under Monitor direction block condition ("IECBLK" setting is "blocked".) when receiving General command.

(3): When receiving an incorrect value of DCO of General command, that is DCO is neither "1" nor "2".

General command receiving sequence is as follows:

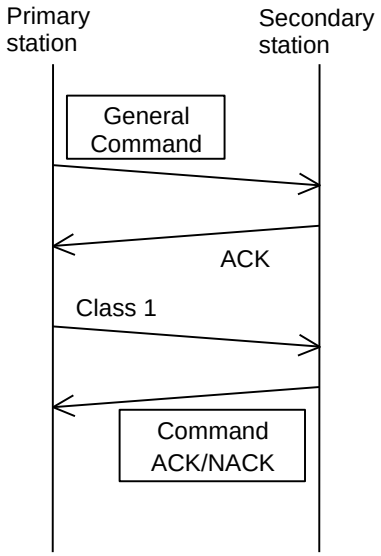


Figure 11.3-8 Command receiving sequence

In the transmission format of General command (Type ID=20), customized items are shown in Table 11.3-10.

Table 11.3-10 General command (Type ID=20)

Oct.	Item	Value	Remarks
1	Start	68H	
2	Length	10	
3	Length	10	
4	Start	68H	
5	Control field	73H/53H	
6	Address	1-254	Setting from the relay
7	Type identification (Type ID)	20	
8	Variable structure qualifier	81H	
9	Cause of transmission (COT)	20	
10	Common address of ASDU	1-254	Linked with Address setting
11	Function type (FUN)	0-255	
12	Information number (INF)	0-255	Customized by the GR-TIEMS
13	Double command (DCO)	1/2	
14	Return Information identifier (RII)	0-65535	
15	Checksum		
16	End	16H	

In the transmission format of Command ACK/NACK (Type ID=1), customized items are shown in Table 11.3-11. The frame type of Command ACK/NACK is Time-tagged message.

Table 11.3-11 Time-tagged message (Type ID=1)

Oct.	Item	Value	Remarks
1	Start	68H	
2	Length	14	
3	Length	14	

Oct.	Item	Value	Remarks
4	Start	68H	
5	Control field	08H+ACD+ DFC	
6	Address	1-254	Setting from the relay
7	Type identification (Type ID)	1	Customized by GR-TIEMS
8	Variable structure qualifier	81H	
9	Cause of transmission (COT)	20/21	Customized by GR-TIEMS
10	Common address of ASDU	1-254	Linked with Address setting
11	Function type (FUN)	0-255	Customized by GR-TIEMS
12	Information number (INF)	0-255	Customized by GR-TIEMS. Answer back of receiving command INF
13	Double point information (DPI)	1/2	Answer back of receiving command DCO
14	Millisecond (low)	0-59999	
15	Millisecond (high)		
16	Minutes + Invalid flag (MSB)	0-59+80H	
17	Hours + Summer time flag (MSB)	0-23+80H	
18	Supplementary information (SIN)	0-255	Answer back of receiving command RII
19	Checksum		
20	End	16H	

Any comment with maximum 16 characters can be entered. This setting does not affect the function in the IEC 60870-5-103 communication.

(iv)-1 Description

Any comment with maximum 16 characters can be entered. This setting does not affect the function in the IEC 60870-5-103 communication.

(iv)-2 Type ID

Type ID=20 (General command) is fixed.

(iv)-3 INF

Information number (INF) of the frame is set. The INF can be set to 0 to 255. When the standard frame is provided†, the INF according to the standard is recommended. If the frame out of standard is provided, the INF should be set referring Table 11.3-12 and the appendix†.

Table 11.3-12 INF category of Monitor direction

INF	Category
0 to 15	system functions
16 to 31	status
32 to 239	not used
240 to 255	generic functions

†Note:For more information, see *Appendix: IEC 60870-5-103 interoperability*.

(iv)-4 FUN

Function type (FUN) applied to a command response frame is set referring to Table 11.3-13. The FUN can be set to 0 to 255. When clicking the "**Change all FUNs"** on the Common setting screen, all FUNs are changed to the setting values at Common setting.

(iv)-5 DCO/Sig Off Name, Signal Off Desc., DCO Signal On Name, Signal On Desc., Inverse

"Sig off" and "Sig On" are used to set the Data ID of control object in General command. (Hereafter, these are described as "command output signal".) "Inverse" is used to reverse the logic when controlling the command output signal.

When the command output signal is treated as two signals (Sig Off ≠ Sig On), the control scheme is shown as the following table by the combination of the receiving command DCO and Inverse setting.

For example, when the DCO=Off command is received under "Inverse" no-checked, the command output signal of "Sig Off" is controlled to "1". "Sig On" is not controlled.

Table 11.3-13 Control Scheme of Command Output Signal (Sig Off ≠ Sig On)

"Inverse" checked / Control object / Receiving command DCO	Checked		No-checked	
	Signal specified to Sig.off	Signal specified to Sig.on	Signal specified to Sig.off	Signal specified to Sig.on
Off	Controlled to "1"	Not controlled	Controlled to "0"	Not controlled
On	Not controlled	Controlled to "1"	Not controlled	Controlled to "0"

When the command output signal is treated as one signal (Sig Off = Sig On), the control scheme is shown in Table 11.3-14. For example, when the DCO=On command is received under "Inverse" checked, the command output signals of "Sig On" and "Sig Off" are controlled to "0". "Sig On" is not controlled.

Table 11.3-14 Control Scheme of Command Output Signal (Sig Off = Sig On)

"Inverse" checked / Control object / Receiving command DCO	Checked		No-checked	
	Signal specified to Sig.off	Signal specified to Sig.on	Signal specified to Sig.off	Signal specified to Sig.on
Off	Controlled to "0"		Controlled to "1"	
On	Controlled to "1"		Controlled to "0"	

When setting the "Sig Off", "Sig On" and "Inverse", check the specifications of the command output signals of communication and others, and then set them.

(iv)-6 Valid time

Valid time is used to set the time (ms) to control the command output signal. The command output signal is controlled based on the control scheme described in section 11.3.5(iv)-5 for the setting time after receiving General command, and is reset by communication side after the set time. However, if the time is set to "0", the control is not reset and is continued. Set the time with a margin for interface of other applications.

(iv)-7 ACK/NACK / Ext

This setting is used to enable the extension setting of Command ACK/NACK response scheme or not. If "Ext" is not specified (Ext check box is not checked.), Command NACK (in cases of (1)–(3) of the section 11.3.5(iii) and Command ACK (in case of others) respond according to the default response. If "Ext" is specified, the setting of Command ACK/NACK described later is enabled and the response scheme can be customized. When required the stricter handshake by using Command ACK/NACK, it is better to specify the "Ext". This setting is not influenced by the control scheme of the command output signal.

(iv)-8 Signal ACK Name/Signal ACK Desc./Signal NACK Name/Signal NACK Desc./Inverse

"ACK Sig" and "NACK Sig" are used to set the Data ID for judgment of command response. (Hereafter, these are described as "command response signal".) "Inverse" is used to reverse the logic of the command response signal, and "Timeout" is used to set the timeout time for judgment of command response. Under specified "Ext" (Ext check box is checked.), Command ACK or Command NACK responds based on the logic of command response signal against General command.

When the command response signal is treated as two signals (ACK Sig ≠ NACK Sig), the judgment scheme is shown as the following table by the combination of the receiving command DCO and Inverse setting. The judgment timing is when (1), (2), (3) or (4) in Table 11.3-15 is established. If the neither (1), (2), (3) nor (4) is established (that is ACK sig = NACK Sig = 1 or ACK sig = NACK Sig = 0) for the period from the command receiving to the timeout setting time, Command NACK responds at that time.

For example, when the DCO=On command is received under "Inverse" no-checked, Command ACK responds in case of "ACK Sig = 0" and NACK Sig = 1".

Table 11.3-15 Judgment Scheme of Command Response (ACK Sig ≠ NACK Sig)

"Inverse" checked / Command response signal / Receiving command DCO	No-checked		Checked	
	(1)NACK Sig=1 ACK Sig=0	(2)NACK Sig=0 ACK Sig=1	(3)NACK Sig=1 ACK Sig=0	(4) NACK Sig=0 ACK Sig=1
Off	Command NACK responds.	Command ACK responds.	Command ACK responds.	Command NACK responds.
On	Command NACK responds.	Command ACK responds.	Command ACK responds.	Command NACK responds.

When the command response signal is treated as one signal (ACK Sig = NACK Sig), the judgment scheme is shown as the following table by the combination of the receiving command DCO and Inverse setting. The judgment timing is after the timeout setting time

from the command receiving.

For example, when the DCO=On command is received under "Inverse" checked, Command ACK responds in case of "ACK Sig = NACK Sig = 1" after the timeout setting time.

Table 11.3-16 Judgment Scheme of Command Response (ACK Sig = NACK Sig)

"Inverse" checked / Command response signal / Receiving command DCO	No-checked		Checked	
	(1)NACK Sig= ACK Sig = 0	(2)NACK Sig = ACK Sig = 1	(3) NACK Sig = ACK Sig = 0	(4) NACK Sig = ACK Sig = 1
Off	Command ACK responds.	Command NACK responds.	Command NACK responds.	Command ACK responds.
On	Command NACK responds.	Command ACK responds.	Command ACK responds.	Command NACK responds.

(v) Setting of Measurands

In Measurand frame of the IEC 60870-5-103 standard, numerical information such as power system quantities are responded for Class 2 cyclic request from upper system (station). The GR200-series relay can provide numerical information, which is converted the numerical information in metering table according to user setting weight.

When the "Measurands" item is selected on the start screen of the GR-TIEMS, the setting screen is displayed.

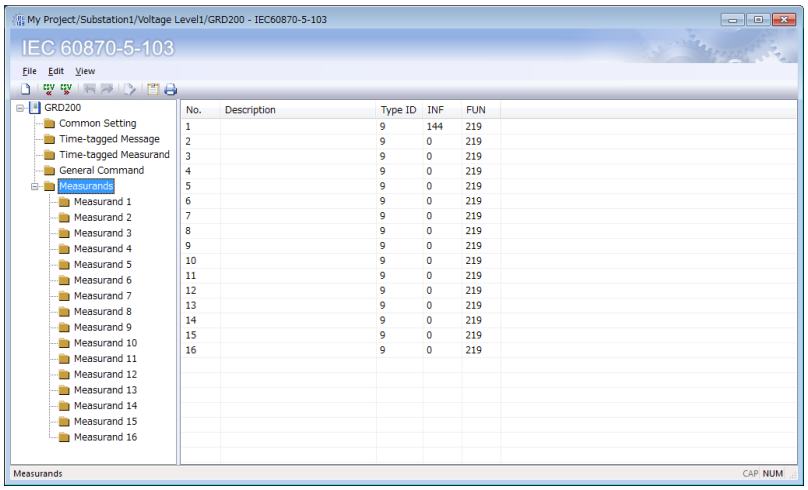


Figure 11.3-9 "Measurands" setting screen

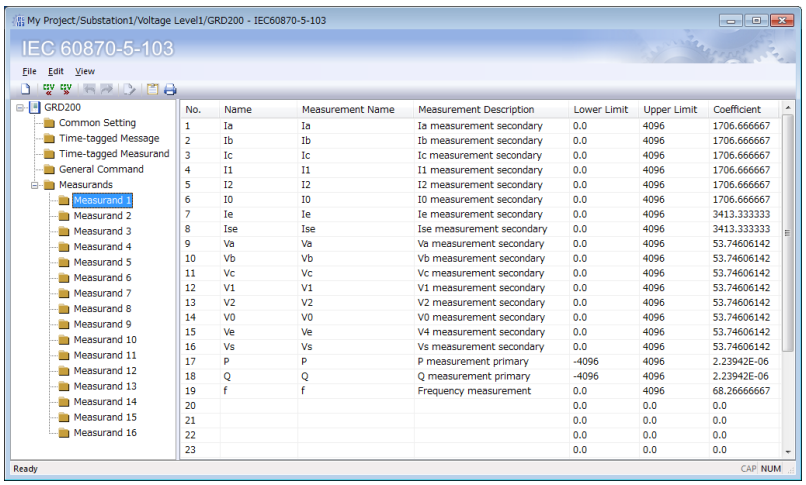


Figure 11.3-10 "Measurand1" setting screen

In one frame of Measurand, the Type ID, INF, FUN settings, and its position setting (Measurement Name/Measurement Description/Lower Limit/Upper Limit/Coefficient) must be set. "No." shows the position of power system quantity. (For details, describe later.) The maximum 16 items of Measurands and the maximum 32 power system quantities per one frame can be set.

Common address is linked with the address setting† of the relay.

†For more information, see *Appendix: IEC 60870-5-103 interoperability*.

In the transmission format of Measurand I (Type ID=3) and Measurand II (Type ID=9), customized items are shown in Table 11.3-17.

Table 11.3-17 Measurand I／Measurand II (Type ID=3／9)

Oct.	Item	Value	Remarks
1	Start	68H	
2	Length	8+2N	
3	Length	8+2N	
4	Start	68H	
5	Control field	08H+ACD+ DFC	
6	Address	1-254	Setting from the relay
7	Type identification(Type ID)	3/9	Customized by GR-TIEMS
8	Variable structure qualifier	81H	
9	Cause of transmission(COT)	2/7	
10	Common address of ASDU	1-254	Linked with Address setting
11	Function type(FUN)	0-255	Customized by GR-TIEMS
12	Information number(INF)	0-255	Customized by GR-TIEMS
13+2(N-1)	Measurand with quality descriptor(MEA) + IV + OV		Customized by GR-TIEMS
15+2(N-1)	Checksum		
16+2(N-1)	End	16H	

(v)-1 Description

Any comment with maximum 16 characters can be entered. This setting does not affect the function of the IEC 60870-5-103 communication.

(v)-2 Type ID

Type ID=3 (Measurands I) or Type ID=9 (Measurands II) can be selected to set the frame type of Measurand frame. In general, the maximum MEA number of Type ID=3 uses 1 or 2 or 4 and that of Type ID=9 uses 9. (However, the maximum MEA number of both types can extend up to 32 in the GR-TIEMS. In this case, there are no difference between the transmission format of Type ID=3 and that of Type ID=9.)

(v)-3 INF

Information number (INF) of the Measurand frame is set. The INF can be set to 0 to 255. When the standard frame† is provided, the INF according to the standard is recommended.

If the fame out of standard is provided, the INF should be set referring Table 11.3-3 and the appendix†.

†Note:For more information, see *Appendix: IEC 60870-5-103 interoperability*.

(v)-4 FUN

Function type (FUN) of the Measurand frame is set referring to the Table 11.3-4. The FUN can be set to 0 to 255. If click the **"Change all FUNs"** on the Common setting screen, all FUNs are changed to the setting values at Common setting.

(v)-5 Name

Any comment with maximum eight characters can be entered. This setting does not affect the function in the IEC 60870-5-103 communication.

(v)-6 Measurement Name/Measurement Description

The Data ID corresponding to a measurand is required to select.

(v)-7 Lower Limit/Upper Limit

The established condition of IV flag is set per MEA. IV flag is established when MEA value exceeds a Lower limit or an Upper limit. If Lower limit = Upper limit =0 is set, The IV flag is always established and it becomes MEA=0.

Table 11.3-18 MEA Bit Arrangement

High Octet								Low Octet							
Sign	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	RES	IV	OV

If MEA value exceeds the full scale (if the value expressed as B1 to B12 is less than –4096 or more than 4095), the MEA is clamped at –4096 or 4095 and OV flag is established. However, if IV flag is established, OV flag is not established.

(v)-8 Coefficient

Set the conversion coefficient, multiplied the power system quantities by, using floating-point number. The MEA is a value which the power system quantity specified as above is multiplied by this setting value.

11.3.6 Protocol selection

As shown in the setting menu for the Communication (Figure 11.3-11), the user should set **IEC103** for the [**Slave Protocol**] so that the communication in the IEC60870-5-103 standard is carried out in the IED. Note that the restarting the IED (i.e., resetting the IED power) is required after the user turns to the IEC60870-5-103 protocol.

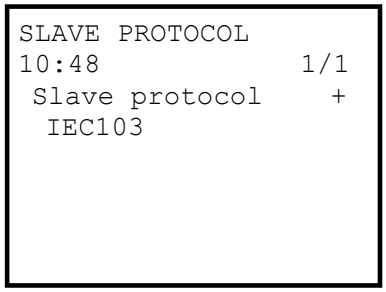


Figure 11.3-11 Slave protection for the IEC103 protocol (on IED setting menu)

Note: The menu is just screened when a couple of communication protocols are embedded in the IED.

11.3.7 Tips for settings

During the GR-TIEMS operation, we recommend the user to choose an appropriate file-name for the setting-file. That is, for example, when the user creates the setting file for an IED at the first time, the user is required to make it with the name "**IED#1-model_01**.map". Likewise, the user can create the other setting file with the name "**IED#2-model_01**.map" for the other IED. If the user is required to modify the "**IED#1-model_01**.map", the user should replace the name by new name "**IED#1-model_02**.map". Consequently, the user can easily discriminate the setting files in the IED model2 (i.e., **IED#1-model** or **IED#2-model**) and the revision number (i.e., **01** or **02**).

Figure 11.3-12 shows the editing screen of the GR-TIEMS; the screen has a remark field concerning to the IEC 60870-5-103 communication. Note the available length of the remark field is up to 12 in the one-byte character. The remark field is utilized for the control of the setting data.

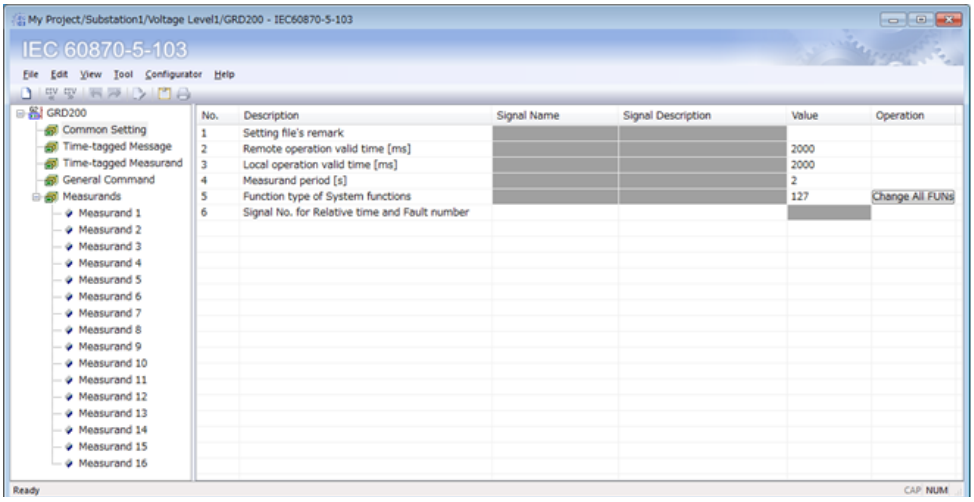


Figure 11.3-12 Common setting screen in the GR-TIEMS

Note: We recommend to make the backup file of the setting data.

11.3.8 Setting

Setting of 103_SLAVE (Function ID: 304001)

Setting item		Range	Units	Contents	Default setting value	Notes
	103ADDR	0 to 254		Slave address	2	
	103TST	Off/On	–	IEC 60780-5-103 test mode	Off	
	103BLK	Off/On	–	IEC 60780-5-103 slave block	Off	

11.4 USB communication

The IED has an USB port in B-type connector; the user PC can be connected with the IED through that. The USB port places on the IED front panel. The communication operates in the serial transmission; its speed is fixed at 115.2kbps.

12 User interface

12.1 Outline

Users can perform maintenance on the IED from the front panel. Monitoring is also possible locally by using a PC connected through the USB cable. This section discusses the configuration of the front panel and the basic configuration of the screen-menu hierarchy of the Human Machine Interface (HMI).

(i) Front Panel

As shown in Figure 12.1-1, the front panel is provided with a screen (LCD Screen), 26 light emitting diodes (LEDs), 11 operation keys, seven function keys (in the later section the function keys are referred to as F1 to F7.), monitoring jacks and a USB receptacle.

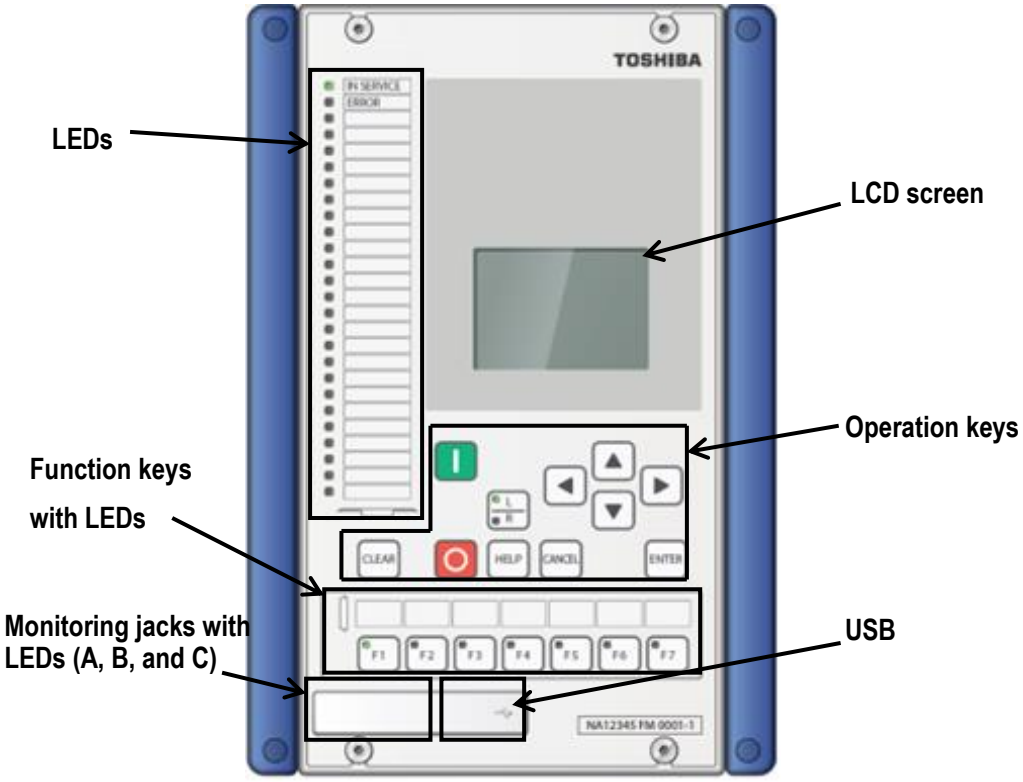


Figure 12.1-1 Front Panel

(ii) LCD screen

The LCD screen provides the user with detailed internal information provided by the IED such as records, monitoring and settings. Normally, the LCD screen appears blank unless an operation key is pressed, by pressing any of the operation keys, the LCD screen will display the top menu.

If the top menu is shown on the LCD screen, the user can turn off the screen backlight by pressing the operation key ◀. When operation is idle for some time, the screen backlight turns off. By pressing any key except the CLEAR key, the backlight turns on, and the previous menu will be displayed on the LCD screen.

(iii) LEDs

As shown inTable 12.1-1, 26 LEDs, each having signal labels and colors, are defined:

Table 12.1-1 LED labels and their color

LED No.	Label	Color	User configurable setting[2]	Remarks
1	IN SERVICE	Green	N/A	Lit up when the IED is in service.
2	ERROR	Red	N/A	Lit up when an error is occurred.
3[1]	N/A	N/A	✔	
4[1]	TRIP	Red	✔	Default
5[1]	N/A	N/A	✔	
6[1]	TEST	Yellow	✔	Default
7[1]	N/A	N/A	✔	
.	N/A	N/A	✔	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
26[1]	N/A	N/A	✔	

[1]Note: LED #3 to LED #26 is user-configurable LEDs. User can assign a signal with or without latch function.

[2]Note: For setting LEDs, see section **12.6(iv)**.

(iv) Monitoring jacks

There are three monitoring jacks on the front panel; the three monitoring jacks have LEDs, A, B, and C respectively. For example, if the user wishes to undertake test work[1], two monitoring-jacks (A and B) are available for use. By selecting the Data ID of an object signal from the Data ID list, and by keying this Data ID into the IED, the object signal can be displayed on the selected LEDs (A and B). The user can also observe this object signal at the output of the monitoring jacks (A and B) on an oscilloscope.

(v) Function keys

The IED provides seven function keys (F1 to F7) with the following two features; a LED is attached on each function key. Table 12.1-2 shows the features for these keys.

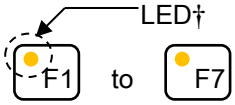
- Skip to a specific screen directly, set by the user.

Used for skipping to a set page by pressing the function keys. Press again to return to the previous page. Set by pressing the function key for 2 seconds on the selected page. (See section 12.5(v)-1)

- Control the signal setting easily.

A convenient method that can be used for operating binary signals. Set by assigning the signal in the settings menu. (See section 12.5(v)-2)

Table 12.1-2 Features of Function keys (F1 to F7)

Labels on Keys	Feature and Remark
	Skip to a specific screen directly. Control for the operation of pre-assigned binary signals.

†Note: Like in the LEDs of Table 12.1-1, the user can set to light the above LEDs by itself. Setting the above LEDs are similar to the ones of the Table 12.1-1 (For setting, see section 12.6(iv)). Note the manufacture programs to light the respective LEDs in default prior to shipping.

(vi) Operation keys

By using the operation keys, the user can display records, relay status etc. Input of setting values is performed using these keys. The operation keys are tabulated in Table 12.1-3.

Table 12.1-3 Features of operation keys

Label	Functions and Remarks
▲	Move the cursor up / Scroll up / Count up[1]
▼	Move the cursor down / Scroll down / Count down[1]
◀	Previous page / Move to the left digit.
▶	Next page / Move to the right digit
ENTER	Enter edit mode, if item is active / Executive operation / Accept alarm message.
CANCEL	Exit edit mode / Cancel operation.
CLEAR	Clear all latched LEDs (Except [In service] and [Error] LEDs).
HELP	Display the help message, for cases where the active item has a help function.
L / R	Switch between Local mode and Remote mode.
I	Control key. (Close)
O	Control key. (Open)
MENU / MIMIC	Switch for using MIMIC[2] mode or for returning back to the menu screen. This key is not provided for standard LCD screen[2].

[1]Note: To scroll up or scroll down quickly, press keys ▲ or ▼ respectively along with key ▶.

[2]Note: The MIMIC key is only available when a large LCD screen is mounted on the front panel. The pixel resolution (dot) is 240(W) × 320(H). Note that this mode is only provided when the user programmed the feature using the engineering tool. See chapter *Engineering tool: MIMIC configuration tool*.

12.2 HMI operation

By using the LCD screen, the operation keys and the function keys, the user can access functions such as recording, monitoring, relay setting and testing.

Note: The operation of the LCD screen is more or less common in all IED models. However, the contents of the LCD screen depend upon the IED model.

(i) Screen and LEDs during normal HMI operation

When the IED is operating normally, the green "IN SERVICE" LED is lit. Press any key except the key **CLEAR**; and then the backlight of the LCD screen is turned on[1]. If the IED detects a fault, the fault message will appear in a pop-up screen. At the same time, the "TRIP"[2] LED is lit.

[1]Note: If another fault occurs during the period of time for which the previous fault pop-up screen, is displayed, the previous fault information will be overwritten by the new fault on the pop-up screen. Press the key **CANCEL** to remove the pop-up screen for "Latest Fault" to return to the previous screen.

[2]Note: Press the key **CLEAR** to turn off the LED.

(ii) Main-menu and Sub-menu

- Main-menu

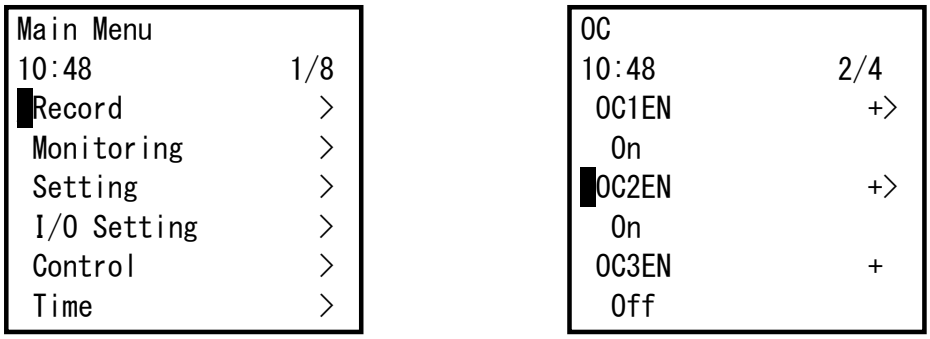
  If LCD screen is turned off, press any key, except the key **CLEAR**. "Main-Menu" will appear on the LCD screen (see the left of Figure 12.2-1). To go to the next level of hierarchy, press the key ▶.

- Sub-menu

  An example of setting the sub-menu screen is shown in the right of Figure 12.2-1. By using the key ▼ and the key ▲, the user can move the cursor downward or upward to view all of the items. By using the keys ◀ ▶, the user can return to a previous level of hierarchy or go to the next level of hierarchy.

- Screen structure

  The screen is composed of a title area and a data area. The title area is fixed on the top two lines. The first line displays the screen title. The second line on the left-hand side displays local time, whereas the right-hand side displays either the current line number, cursor position number and the maximum page number, or the item number. For example, the display "2/4" means the current cursor position, which is at the second item of a maximum of four items.



a. Main Menu b. Sub Menu

Figure 12.2-1 LCD screen for Main-Menu and Sub-menu

Figure 12.2-2 shows the menu hierarchy. The menu consists of a Main-Menu and several Sub-menus. Table 12.2-1 shows the configuration of Main-Menu.

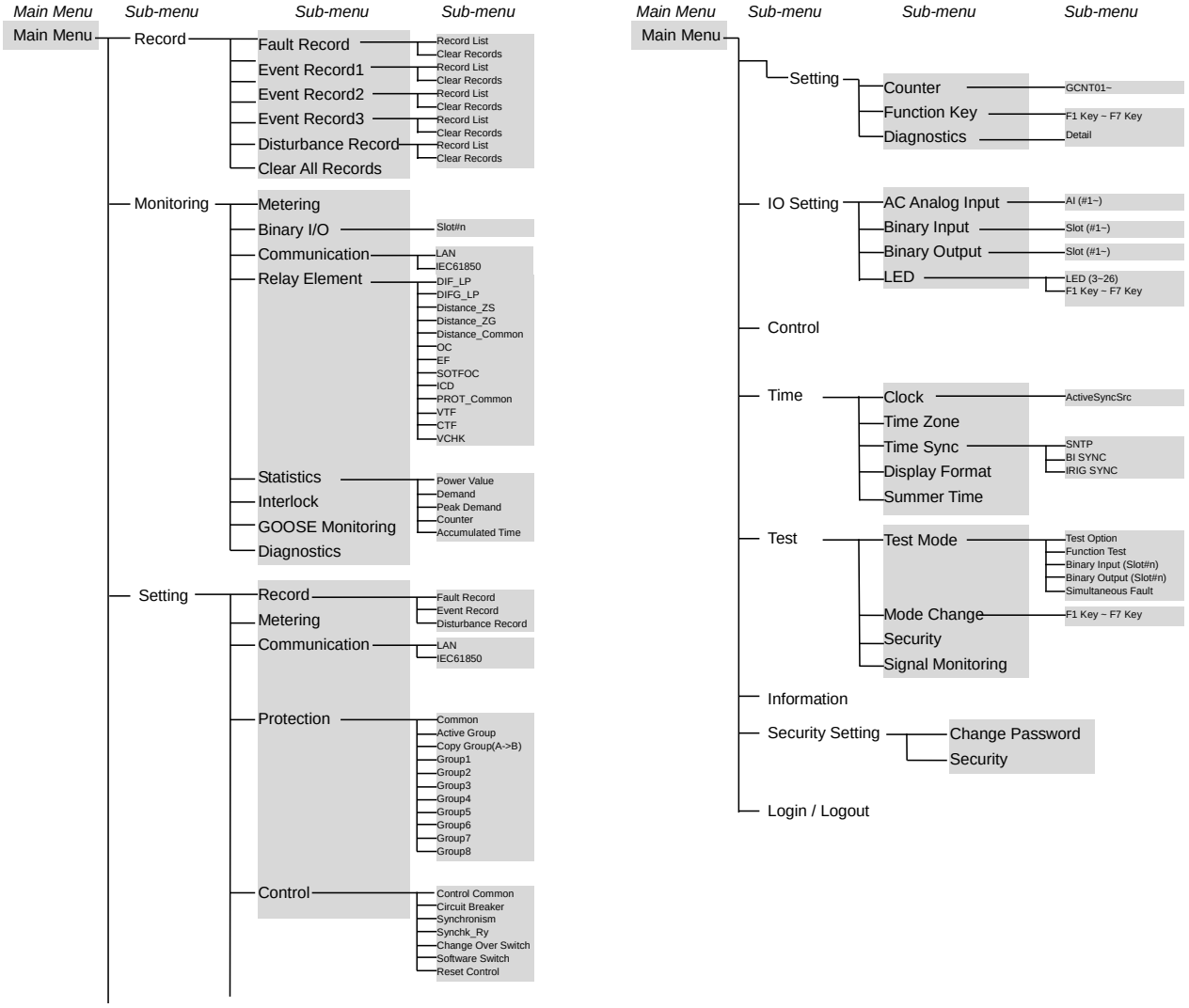


Figure 12.2-2 Menu hierarchy

Table 12.2-1 Outline of Main-menu and their purposes

Sub-menu	Purpose and functions
Record	The "Record" sub-menu provides fault record, event record and disturbance record. The user can erase each record individually or can clear all records at the same time. The user can assign event records to three distributed “Event Record” sub-menus as required.
Monitoring	The "Monitoring" sub-menu displays all of the status values for the IED, such as Metering, Binary I/O, Communication, Relay Element, Statistics, Interlock, GOOSE Monitoring, and Diagnostics.
Setting	The "Setting" sub-menu is used to view or change the settings: Record, Metering, Communication and Protection.
I/O Setting	The "I/O Setting" sub-menu is used to view or change the settings for inputs, configurable binary inputs, configurable binary outputs, and configurable LEDs.
Control	The “Control” sub-menu is used to manipulate an external gear such as circuit breaker (CB), isolator, etc. manipulated control applications.
Time	The "Time" sub-menu provides settings for calendar clock, time zone, the source of time synchronization and the display format of the calendar clock.
Test	The "Test" sub-menu is used to set and to test the following: a trip circuit, forcible operation of binary outputs from the IED, time measurement of variable timers, and observation of the binary signals in logic circuits.
Information	The "Information" sub-menu displays information about the IED such as hardware, software, communication, etc.
Security Setting	The "Security Setting" sub-menu is used to change the password and access level, providing high levels of security by assigning users different levels of access.
Login/Logout	When the "Security Setting” sub-menu is ON, the “Login/Logout” sub-menu is displayed.

12.3 Record sub-menu

The Record sub-menu is composed of several sub-menus: fault record, event record, disturbance record, and clearance of all records. In each sub-menu, the user can clear records separately.

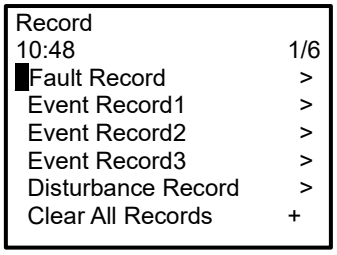


Figure 12.3-1 Display of Record

Table 12.3-1 Operation and display in Record sub-menu

Display	Operation key	Remark
[>]	▶	Press the key ▶ to go to the sub-menu
[+]	ENTER	Press the key **ENTER** for executing "Clear all records". Confirmation dialog screen will be displayed.

(i) Fault Record

The "Fault Record" sub-menu displays the date and time of fault occurrence, fault phase, tripping mode, and the power system quantities, as shown in Figure 12.3-2.

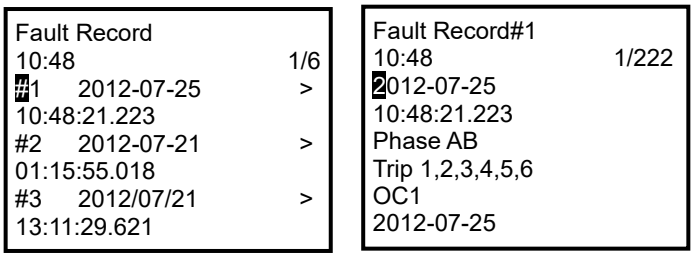
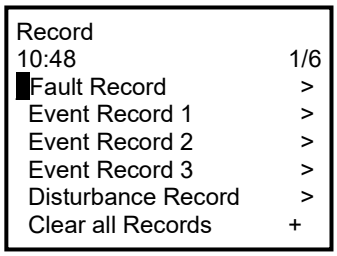


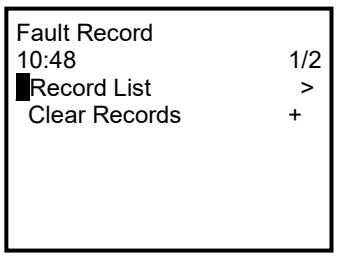
Figure 12.3-2 Display of Fault Record

(i)-1 Display fault record

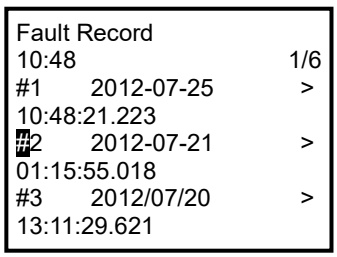
Figure 12.3-3 shows how to see the screen of fault record list and the details.



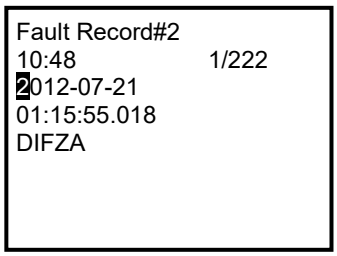
1). Move cursor to the Fault Record menu and press ▶.



2). Fault Record screen is displayed. Press ▶ at the Record List sub menu.



3). Fault record list in the Fault Record screen is displayed. Move cursor to a desired item by ▲ or ▼ and press ▶.

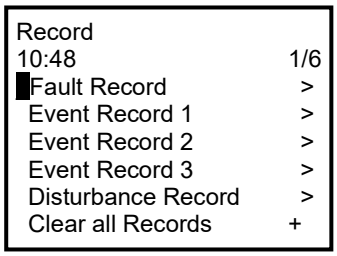


4). Press ▲ or ▼ to move display items.

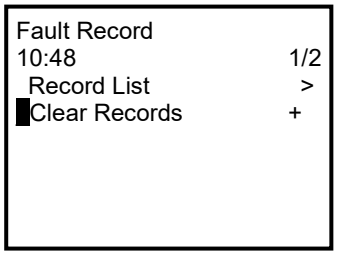
Figure 12.3-3 Fault Record

(i)-2 Clear fault record

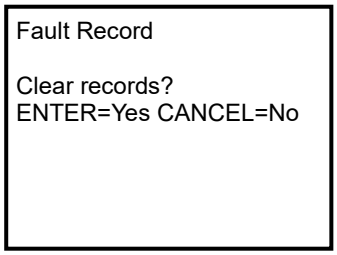
Figure 12.3-4 shows the steps to clear the fault record list.



1). Move cursor to the Fault Record menu and press ▶.



2). Move cursor to Clear Records and press ENTER.

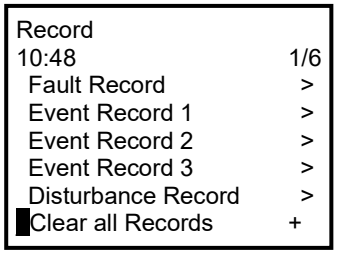


3). Clear records if ENTER is pressed. Back to display of "Fault Record" directly if CANCEL is pressed.

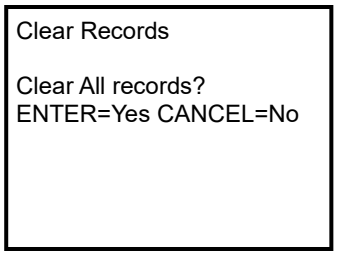
Figure 12.3-4 Clear Record

(i)-3 Clear all information in Fault Record

Figure 12.3-5 shows the steps to clear all the records.



1). Move cursor to the Clear all Records sub menu and press ENTER.



2). Clear all records if ENTER is pressed. Back to display of "Record" directly if CANCEL is pressed.

Figure 12.3-5 All clear

(ii) Event Record

The "Event Record" sub-menu provides three parts namely, "Event Record1", "Event Record2" and "Event Record3". In each Event Record sub-menu, the data and time, device name, and the operation of the device are displayed as shown in the example below.

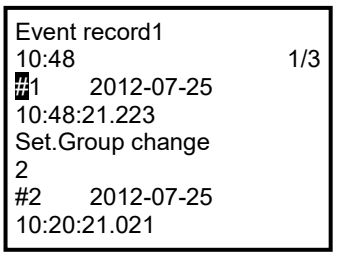
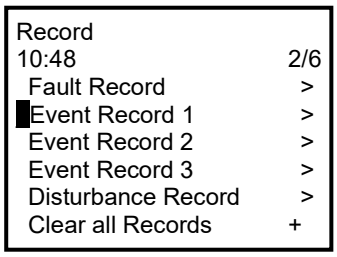


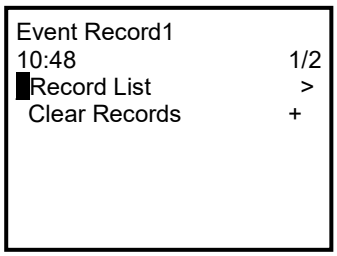
Figure 12.3-6 Display of Event Record

(ii)-1 Display of Event Record

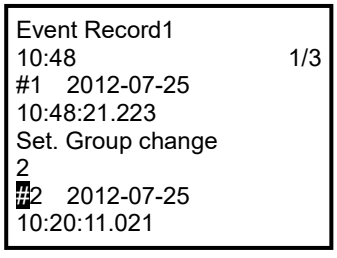
Figure 12.3-7 shows the steps to display and erase event records. To clear all records, refer to section (i)-3.



1). Move cursor to Event Record 1, 2, or 3 sub menu and press ▶.



2). Event Record screen is displayed. Press ▶ at the Record List sub menu.

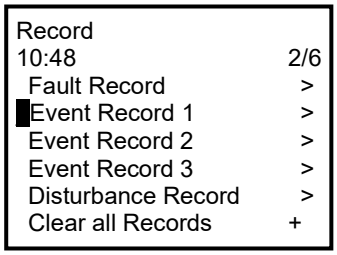


3). Press ▲ or ▼ to move display items.

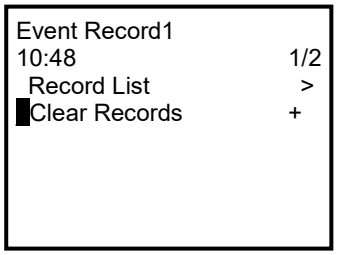
Figure 12.3-7 Display events

(ii)-2 Clear of Event Records

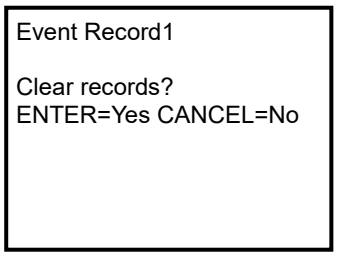
Figure 12.3-8 shows the steps to display and erase event records. To clear all records, refer to section (i)-3.



1). Move cursor to Event Record 1, 2, or 3 sub menu and press ▶.



2). Event Record screen is displayed. Press ENTER at the Clear Records sub menu.



3). Clear all Event records if ENTER is pressed. Back to display of Event Record directly if CANCEL is pressed.

Figure 12.3-8 Clear Event

(iii) Disturbance Record

Disturbance Records can be displayed graphically on the PC screen by using GR-TIEMS. The IED screen displays only the recorded date and times, which are stored in the IED as the entire disturbance data, as shown in the following example:

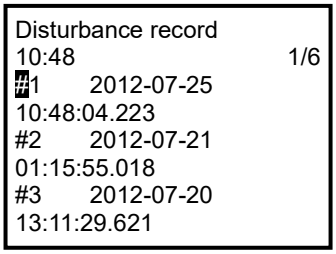
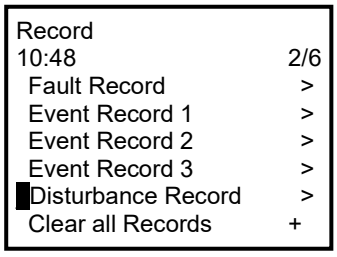


Figure 12.3-9 Display of Disturbance Record

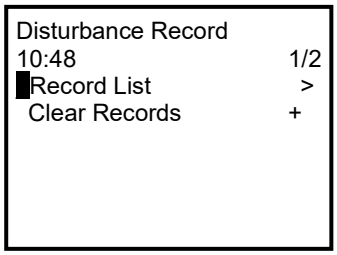
The following shows the steps to display and erase disturbance records.

(iii)-1 Display of disturbance Record

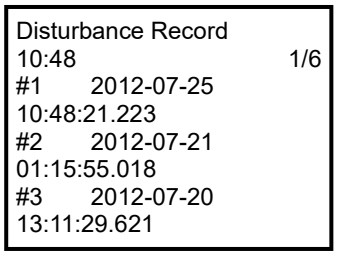
Figure 12.3-10 shows the steps to display and erase event records. To clear all records, refer to section (i)-3.



1). Move cursor to Disturbance Record sub menu and press ►.



2). Disturbance Record screen is displayed. Press ► at the Record List sub menu.

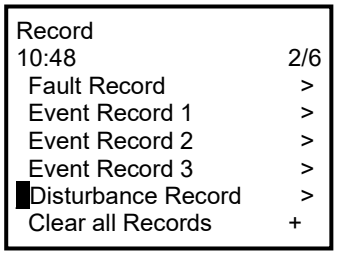


3). Press ▲ or ▼ to move display items.

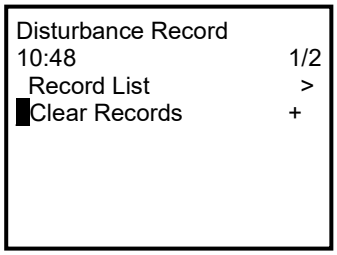
Figure 12.3-10 Disturbance

(iii)-2 Clear of Disturbance Records

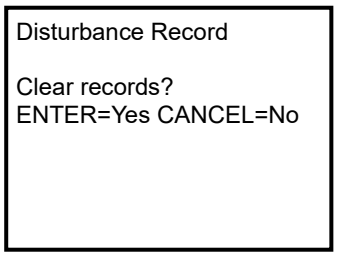
Figure 12.3-11 shows the steps to display and erase disturbance records. To clear all records, refer to section (i)-3.



1). Move cursor to Disturbance Record sub menu and press ▶.



2). Disturbance Record screen is displayed. Press ENTER at the Clear Records sub menu.



3). Clear all Disturbance records if ENTER is pressed. Back to display of "Disturbance Record" directly if CANCEL is pressed.

Figure 12.3-11 Clear records

12.4 Monitoring sub-menu

"Monitoring" sub-menu is used to display the current status of the IED. The data is updated every second on the LCD screen. The user can view the following functions from the Monitoring sub-menu:

i. Metering sub-menu
ii. Binary I/O sub-menu
iii. Communication sub-menu
iv. Relay Elements sub-menu
v. Statistics sub-menu
vi. GOOSE Monitoring sub-menu
vii. Diagnostics sub-menu

(i) Metering

The value and direction of current, voltage etc. can be displayed. The user can change the units as required by using the appropriate setting. Figure 12.4-1 shows an example of the Metering sub-menu.

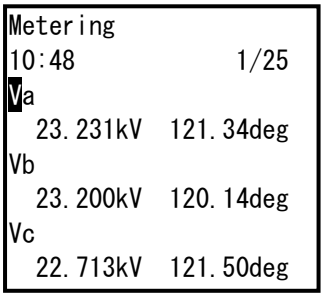


Figure 12.4-1 Display for Metering

(ii) Binary I/O

"Binary I/O" sub-menu can be used to display the respective status of the binary IO module circuits. The LCD displays the binary input or output signal number, the signal name[1] assigned to the circuits of the binary IO modules and their status in a line. The status for the binary output circuit is shown by a logic level ("1" or "0"). Figure 12.4-2 provides an example for binary IO module at IO#1 (Slot#1).

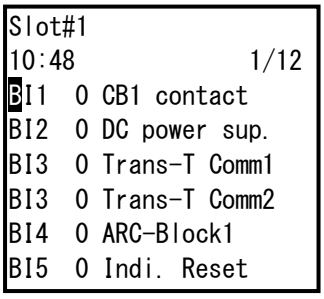


Figure 12.4-2 Display of Binary I/O status

[1]Note: The user can set the names of binary signals with GR-TIEMS.

Figure 12.4-3 shows the steps required to display the status of the binary inputs and outputs.

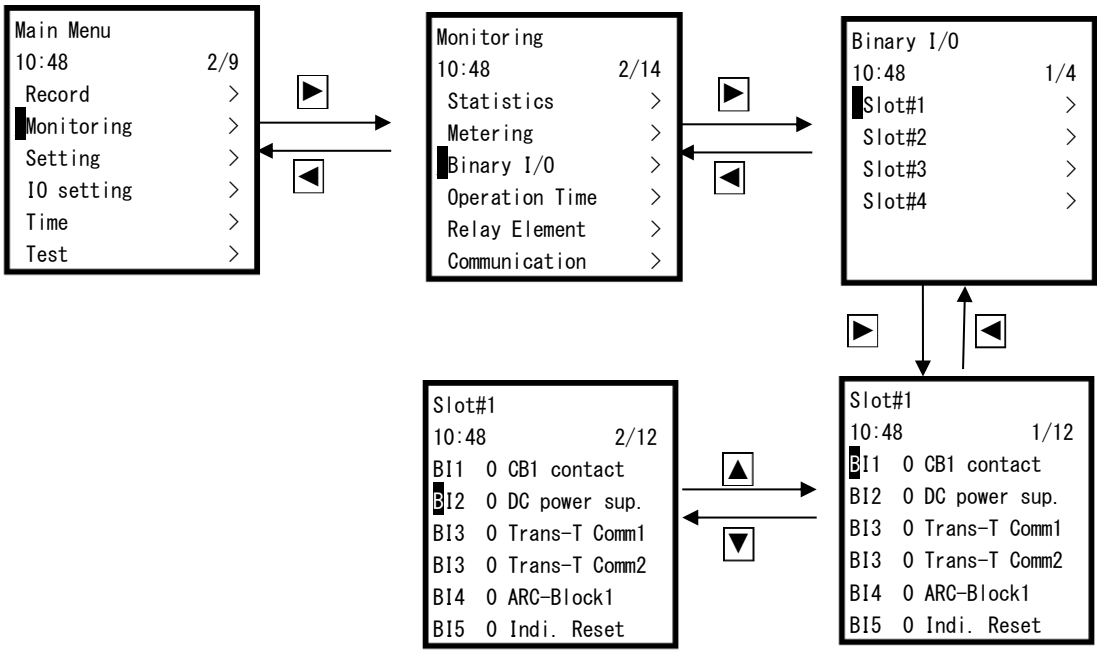


Figure 12.4-3 Steps to display Binary I/O status

(iii) Communication

The "Communication" sub-menu provides several sub-menus as shown in Figure 12.4-4.

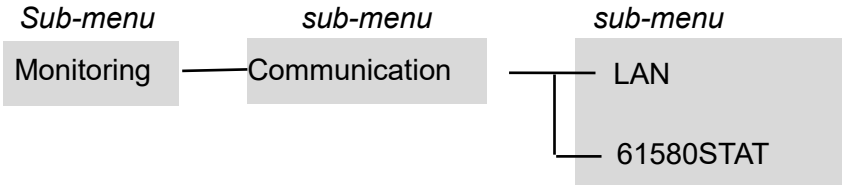


Figure 12.4-4 Menu hierarchy for Communication sub-menu

The display structure for each sub-menu is explained in the following sections:

(iii)-1 **LAN sub-menu**: the communication port name and status are shown in a line. When the IED has single communication module, or when the IED has communication modules but a communication module is allowed to operate in the IED, an operation status of the communication ports is shown, as shown in Figure 12.4-5.

"LAN" sub-menu can display "PortStatus" and "NetMonitor status". If "NetMonitor" is running (active), the LCD screen will display a ">"mark.

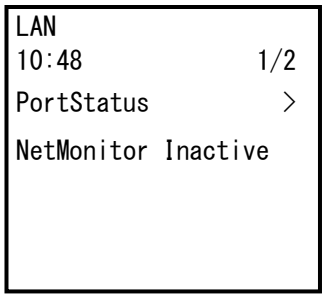
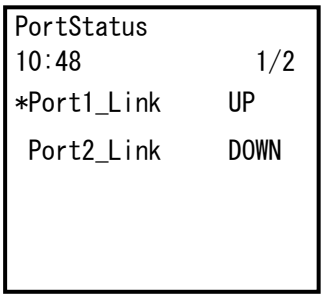


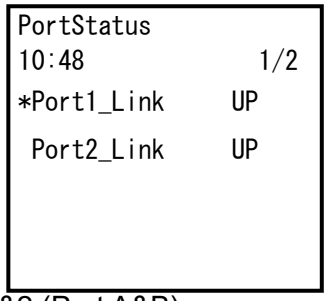
Figure 12.4-5 Display for LAN

If the status of a port is "UP", it means that the communication link is working; if the status of a port is "DOWN, it means that the LAN cable is not connected to the port.

The following two sub-menus are displayed to show the communication status when the IED has dual LAN communication modules.



Port 1(Port A) is connected.
Port 2(Port B) is not connected.



Port 1&2 (Port A&B) are connected.

Figure 12.4-6 Communication status

(iii)-2 **IEC61850 sub-menu**: IP addresses of the devices connecting in IEC61850 are shown in a straight line. Configurations of those IP addresses are available with GR-TIEMS.

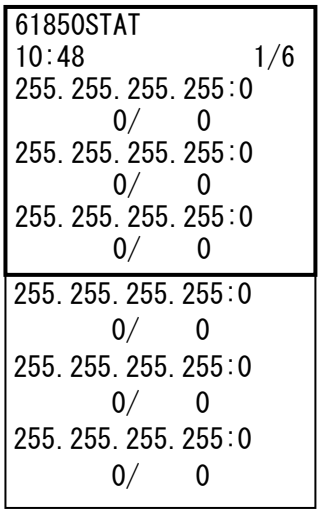


Figure 12.4-7 Display of IEC61850

(iv) Relay Elements

The names of relay elements and statuses of the operation are shown in respective columns. To view all of the relay elements, the user has to press keys ▲ and ▼.

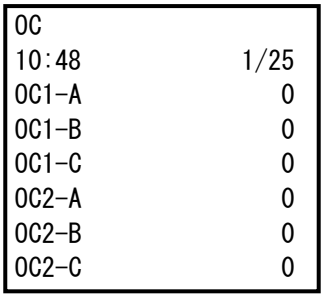


Figure 12.4-8 Displaying Relay Elements

Figure 12.4-9 shows the steps necessary to display the status of the measuring elements.

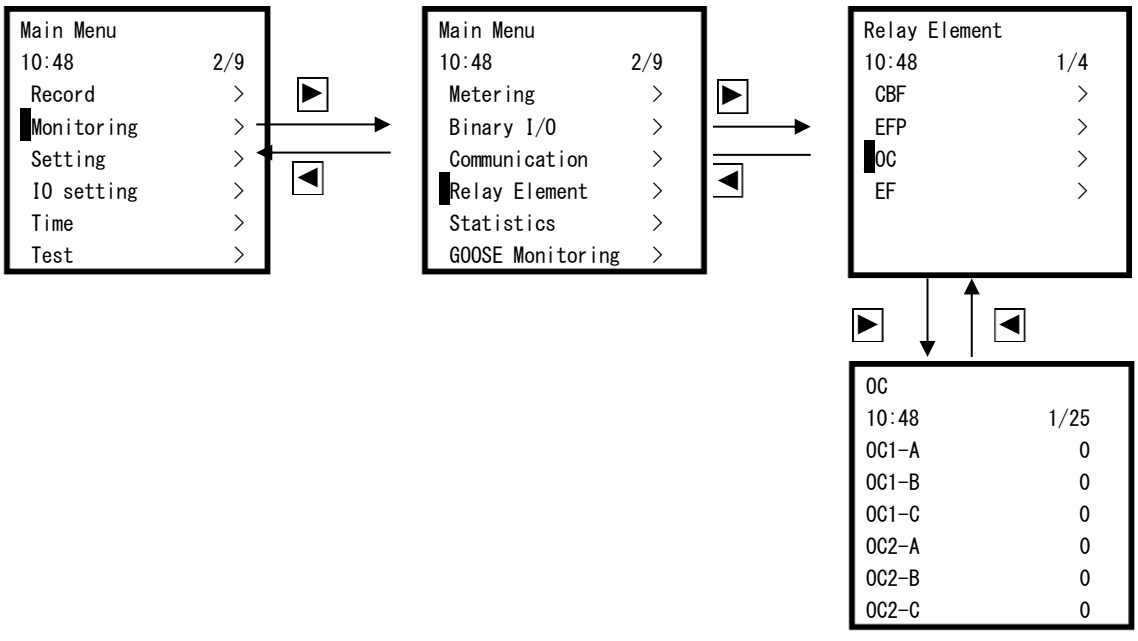


Figure 12.4-9 Steps to display the status of measuring elements

(v) Statistics

"Statistics" sub-menu has several sub-menus.

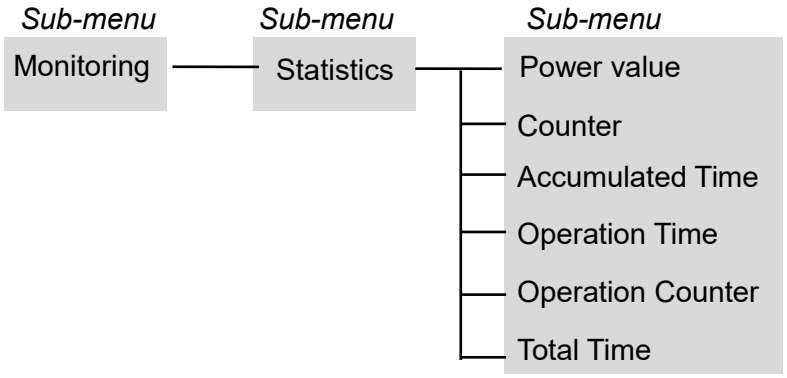


Figure 12.4-10 Menu hierarchy for Statistics

For each statistical item, with the exception of displaying their status, the data can be reset or revised.

(v)-1 **Power Value sub-menu**: With regard to statistics item, the name and its value are shown below. The user can also change the unit of each value by the setting[1]. It is allowed to reset or revise the statistics value[2].

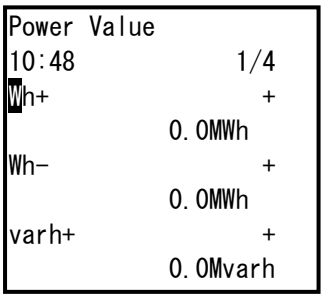


Figure 12.4-11 Display of Power Value

Table 12.4-1 Operation means for data reset or data revise

Step	Display	Operation key	Remark
1	[>]	▶	Press ▶ key to go to the sub-menu
2	[+]	ENTER	Press ENTER key to execute reset or revise. After executing, a confirmation dialog screen displays.

[1]**Note:** In order to secure the reliability, the reset and revision items are controlled by the vendor.

[2]**Note**: The number of digits for the power value can be reduced based on the units kW, MW and kvar+. For instance, when the power is measured as "123,456kW" then it is displayed as "123MW". If this value has to be changed then the user can key in a new compensated value. For example, if "78MW" should be displayed on the IED screen even though the measured value is "123,456kW" then the user should key in the new value of "78MW". Note that the compensated value "78MW" is "78,000kW",

and it is not "78,456kW" or "123,456kW". Note that the compensated value will be affected when there is a change in CT ratio setting. That is, when the user key in a value of "78MW" for the CT ratio of "2000:1" and later when the CT ratio is changed from "2000:1" to "4000:1", then the value is displayed as "156MW" on the IED screen. Therefore when the CT ratio setting is changed, the user should key in the value of "78MW" again to display the compensated value.

(v)-2 **Counter sub-menu**: the name and number of statistical items are shown in two lines. When an item is revised, a [+] mark is shown at the end of the first line.

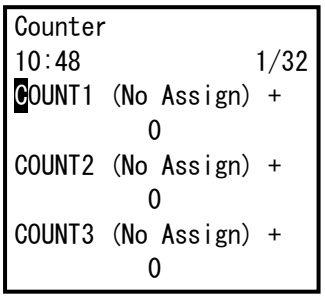


Figure 12.4-12 Display for Counter sub-menu

To change the counter number, follow the steps as shown in Figure 12.4-13.

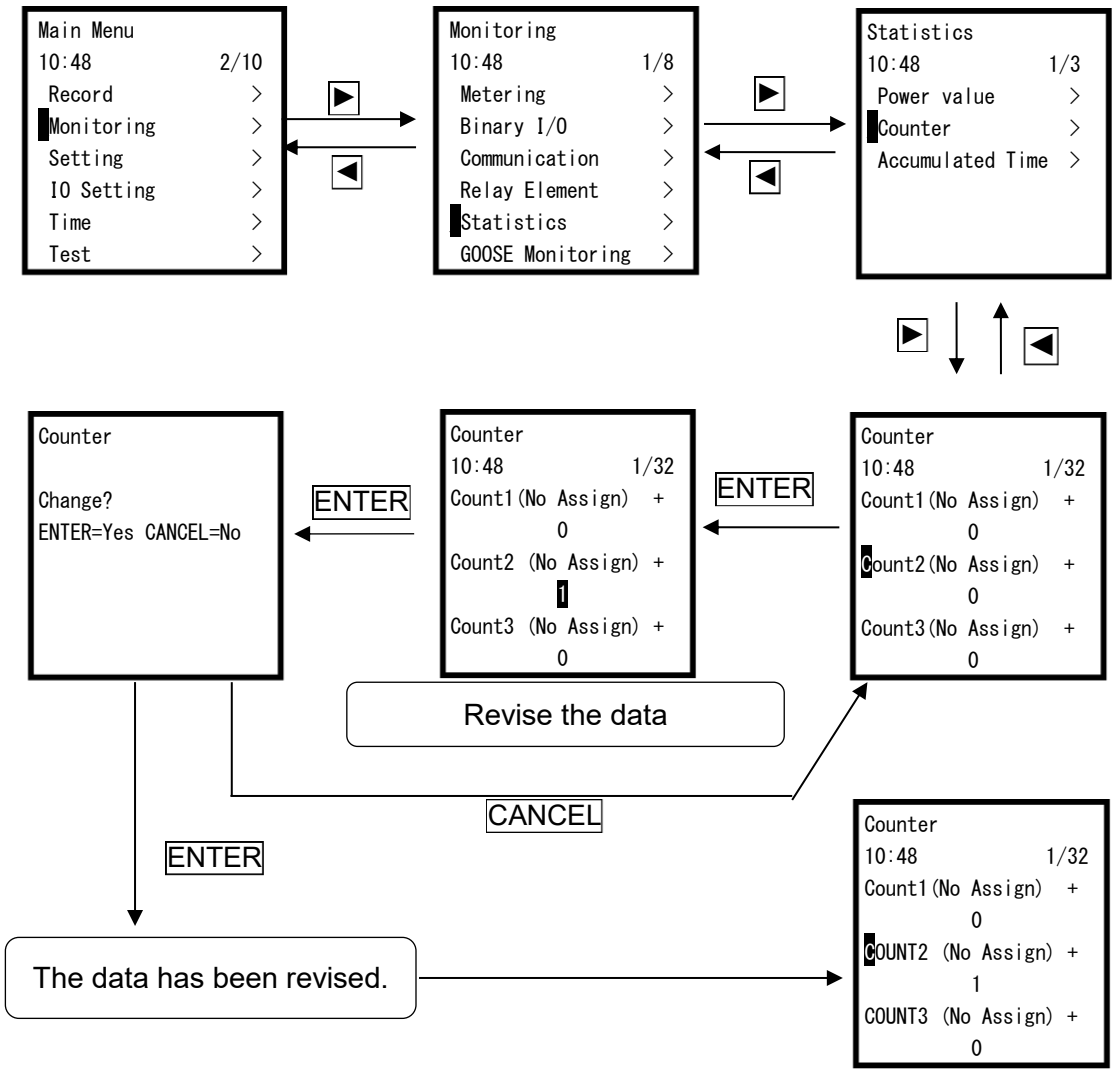


Figure 12.4-13 Steps for changing the counter number

(v)-3 **Accumulated Time sub-menu**: Total time for which the IED has been running is shown in "d (date) h (hour) m (minute)" format. The user can clear the total time value by clear operation (reset), which is shown in Figure 12.4-14.

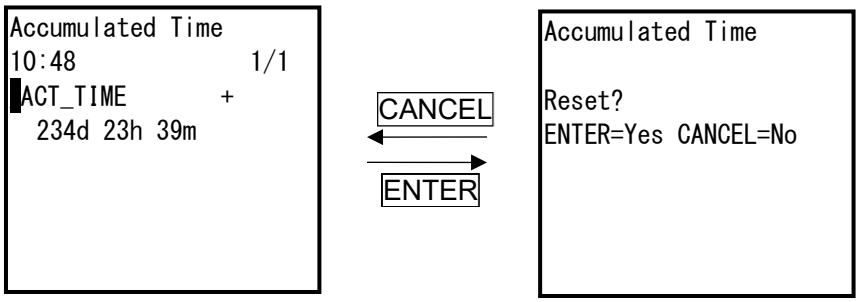


Figure 12.4-14 Display for Accumulated Time

(vi) GOOSE monitoring

The status of the GOOSE subscription information is shown for each record-unit, as shown in Figure 11.2-24. Each IED name (for example, "GRx200-11-603") has been defined in the

GOOSE subscription information.

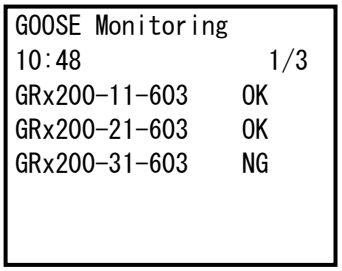


Figure 12.4-15 Display for GOOSE Monitoring

(vii) Diagnostics

Error message will be published in Automatic supervision. If there are no errors, an error message is not displayed.

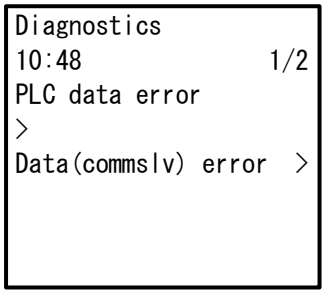


Figure 12.4-16 Display of Supervision items

12.5 Setting sub-menu

"Setting" sub-menu is used to view and change settings for the following functions: Recording, Metering, Communication interface, Relay application, and Monitoring. In this section, we show the "Setting method for elements, switches, and list selection", "Protection setting", and others. Furthermore, this section describes the confirmation of setting, and the "On/Off" function that is used to hide some unnecessary settings.

Note: The meaning of settings and their setting process are beyond the scope of this section. The figures in this chapter are examples only. The user should confirm setting values after their values are changed.

(i) Setting method

In "Setting" sub-menu, four setting modes are provided as follows:

1. Element Setting Mode
2. Switch Setting Mode
3. List Selection Mode (items selection)
4. Signal Selection Mode (signal selection)

(i)-1 **Element Setting Mode**: The "Element Setting Mode" is used for setting numerical values. For each setting, the setting name, setting value and the unit are displayed in two lines. Figure 12.5-1 provides an example of the element setting mode.

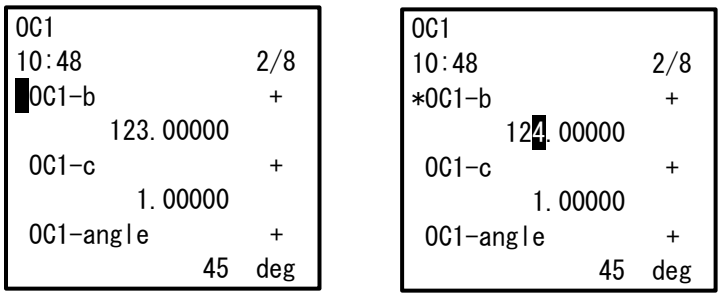


Figure 12.5-1 Example of Element Setting Mode

To begin the setting process, press the key **ENTER**. Once the setting has been changed, the [*] mark will appear alongside the name of the setting. Once the change is canceled or confirmed, the [*] mark will disappear automatically. For the setting of a value, follow the steps as shown in Figure 12.5-2[1]:

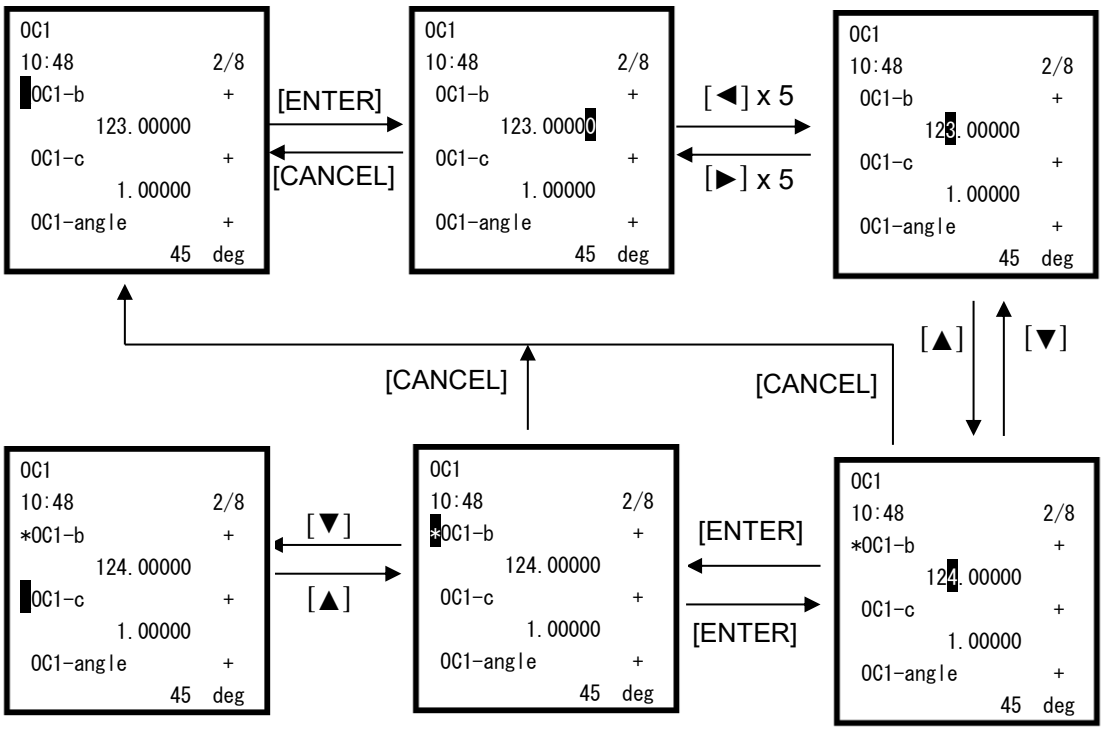


Figure 12.5-2 Steps for setting the value

[1]Note: The meaning of settings and their setting process are beyond the scope of this section. The figure above is provided by way of example. The user should confirm the setting values after making any changes to their values. For verification, refer to "Confirmation of Setting" discussed later.

[2]Note: The operation keys have several features enabling the user to key values for setting items. Table 12.5-1 shows values that have been changed before and after the user presses the operation keys.

Table 12.5-1 Operation example when the operation keys are pressed.

Before	Key	After
1 2 6 7 9	[▲] [▼]	1 2 6 8 0
9 1 7		1 0 1 7
9 1 7		1 0 9 1 7
9 . 1		1 0 9 . 1
6 7 5	[◄] [►]	6 7 5
1 . 7 5		1 . 7 5
2 1 : 2 3		2 1 : 2 3

(i)-2 **Switch Setting Mode**: The "Switch Setting Mode" is a setting used for the selection of two modes. Figure 12.5-3 provides an example of the switch setting mode. For each setting, the setting name and the selected item are

displayed on two lines.

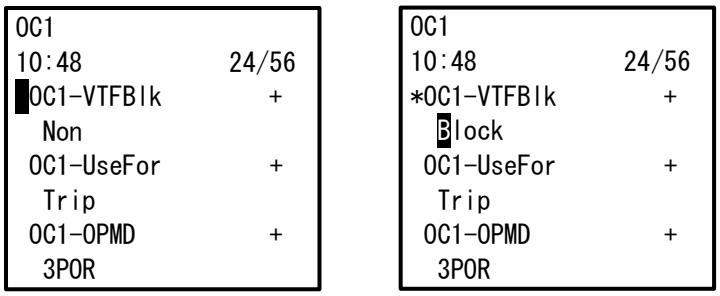


Figure 12.5-3 Display Example of Switch Setting Mode

To begin the setting process, press the key **ENTER**. Once the setting is changed, the [*] mark will appear alongside the name of the setting. When the change is canceled or confirmed, the [*] mark will disappear automatically. Figure 12.5-4 shows the operation of the switch setting mode.

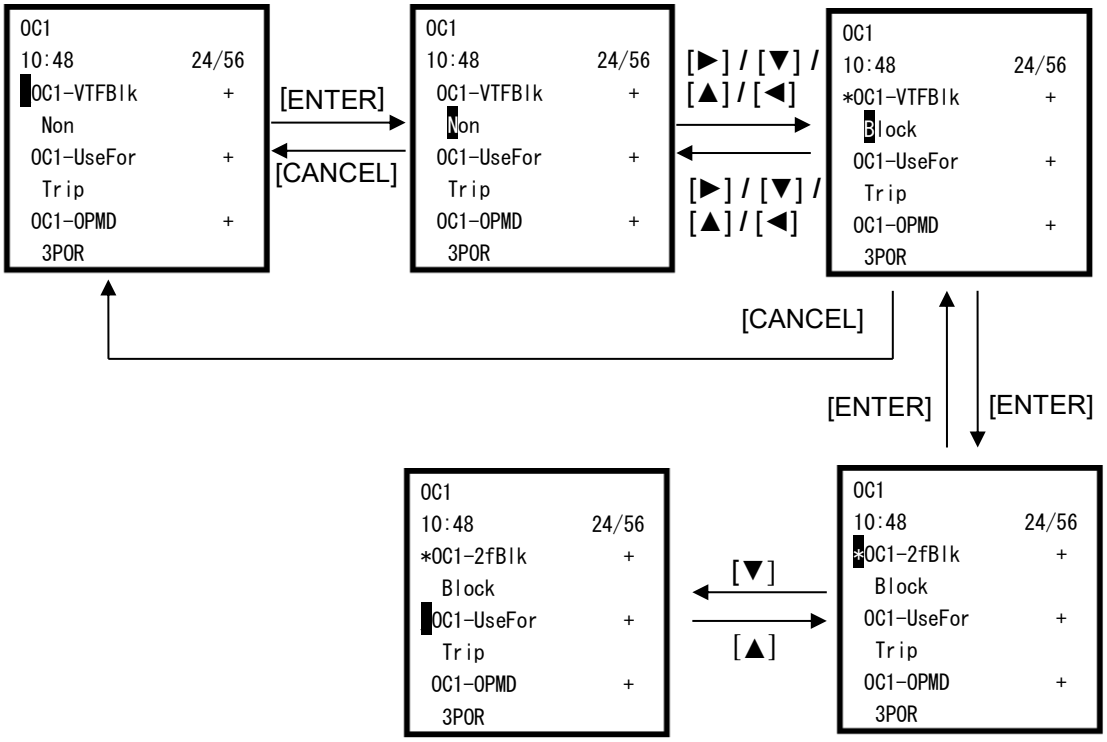


Figure 12.5-4 Operation of Switch Setting Mode

Note: The meaning of settings and their setting process are beyond the scope of this section. The above figure is provided by way of example. The user should confirm setting values after making any changes to their values. For verification, refer to "Confirmation of Setting" discussed later.

(i)-3 **List Selection Mode**: The "List Selection Mode" is composed of main-setting-screens and selection-list-screens as shown in Figure 12.5-5. In the main-

setting-screen, the setting name and the selected item are displayed. Press the key **ENTER** to begin the setting process; the screen for selection list will appear. Once a setting has been changed, the [*] mark will appear alongside the name of the setting. When the change is canceled or confirmed, the [*] mark will disappear automatically.

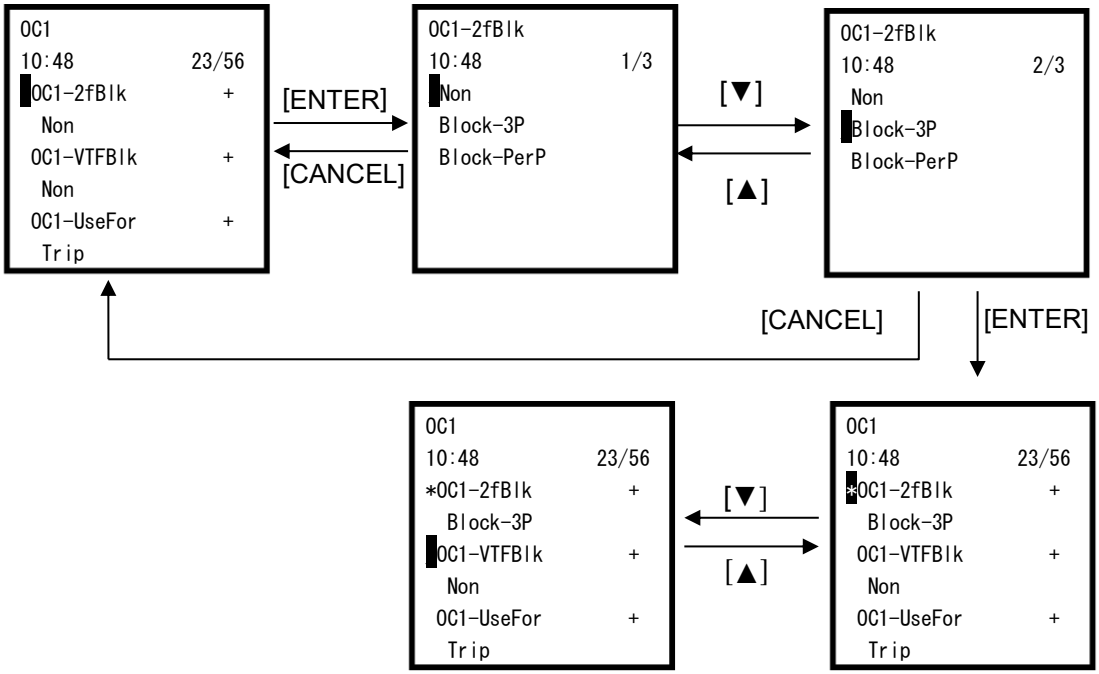


Figure 12.5-5 Operation of List Selection Mode

(i)-4 **Signal Selection Mode**: Figure 12.5-6 shows the steps to select a signal.

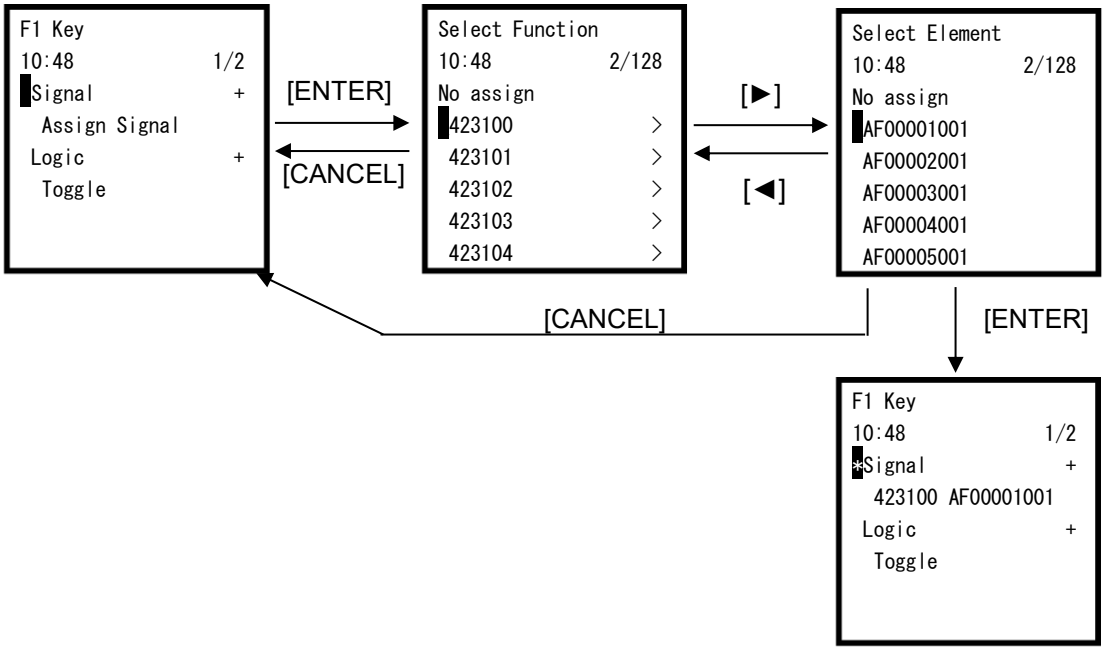


Figure 12.5-6 Operation of signal selection

(ii) Confirmation dialog in each sub-menu

In "Setting" menu, a confirmation dialog #1 and #2 appears in the sub-menu and lower-level menu, as shown in Figure 12.5-7

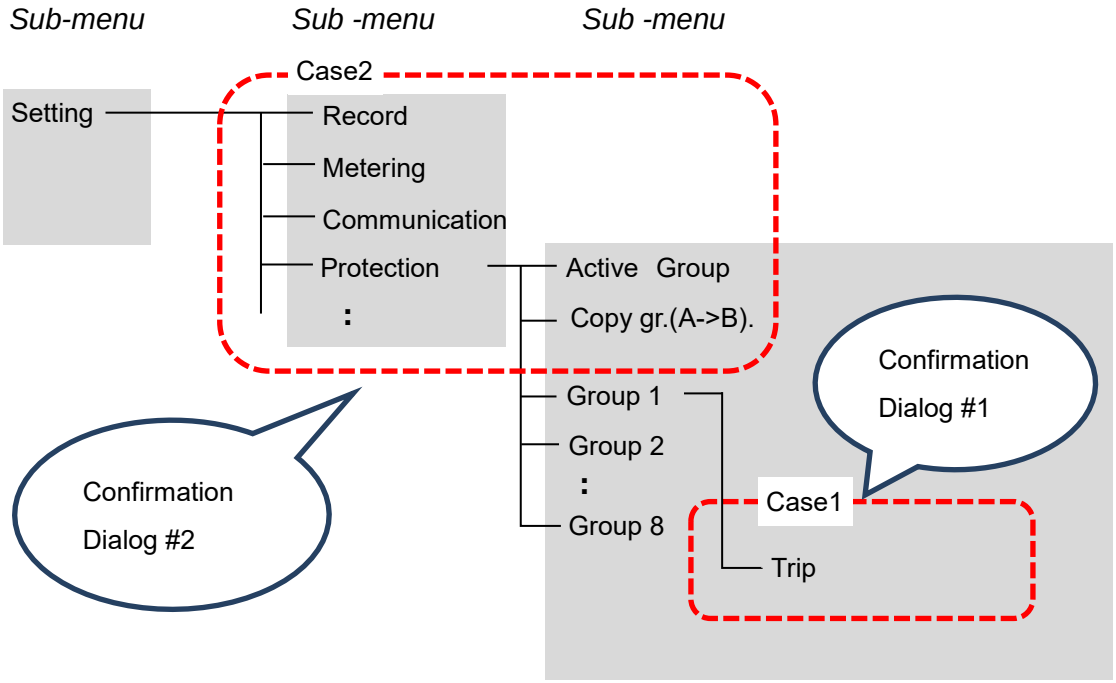


Figure 12.5-7 Confirmation dialog setting

- Case1: Confirmation dialog #1

  Suppose the setting of each group is changed; the confirmation dialog will appear when returning to the screen of the "Protection" sub-menu, as shown in Figure 12.5-8.

- Case2: Confirmation dialog #2

  Suppose a setting is changed; the confirmation dialog will appear when returning to the "Upper Menu", as shown in Figure 12.5-9.

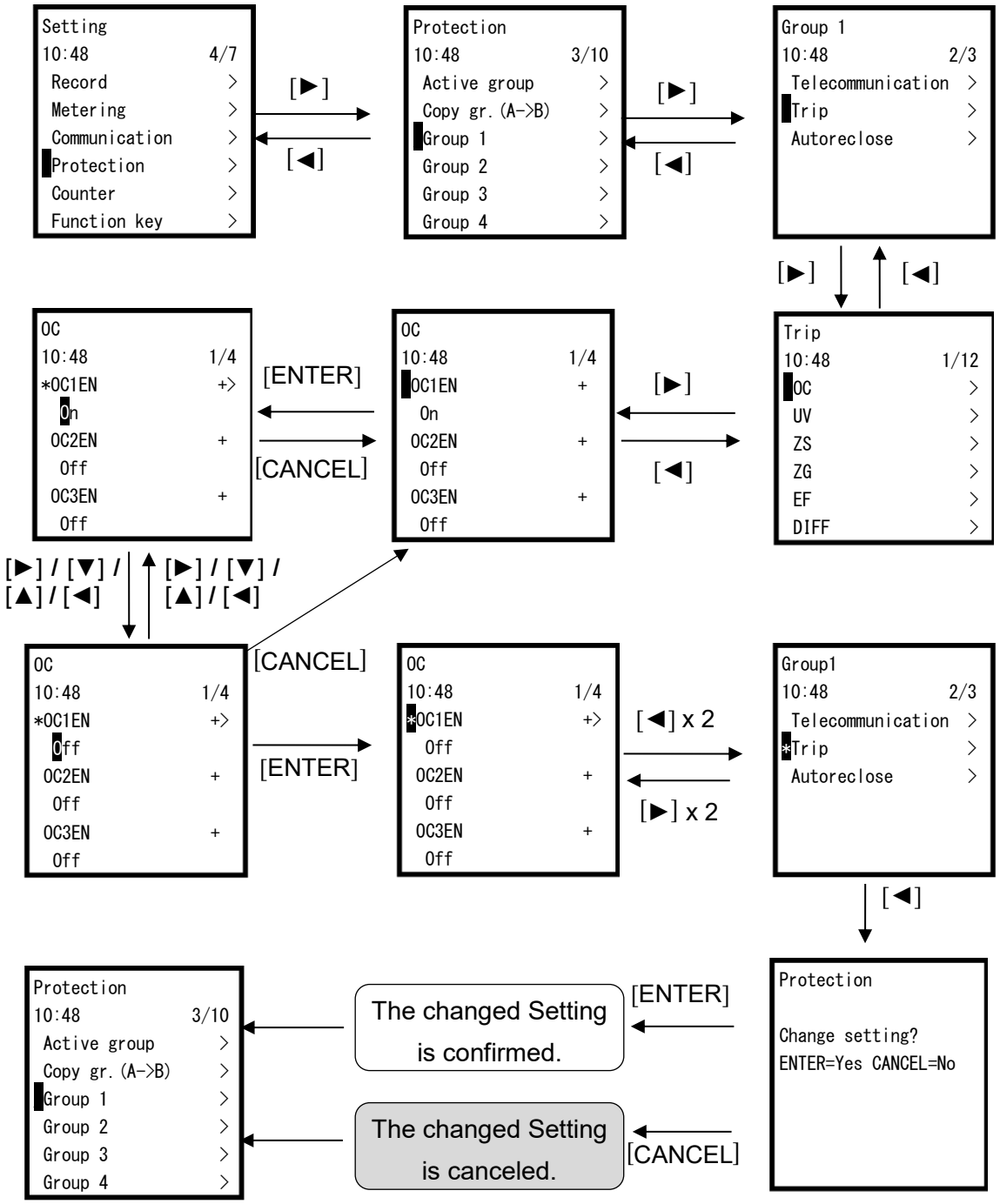


Figure 12.5-8 Setting example in case #1

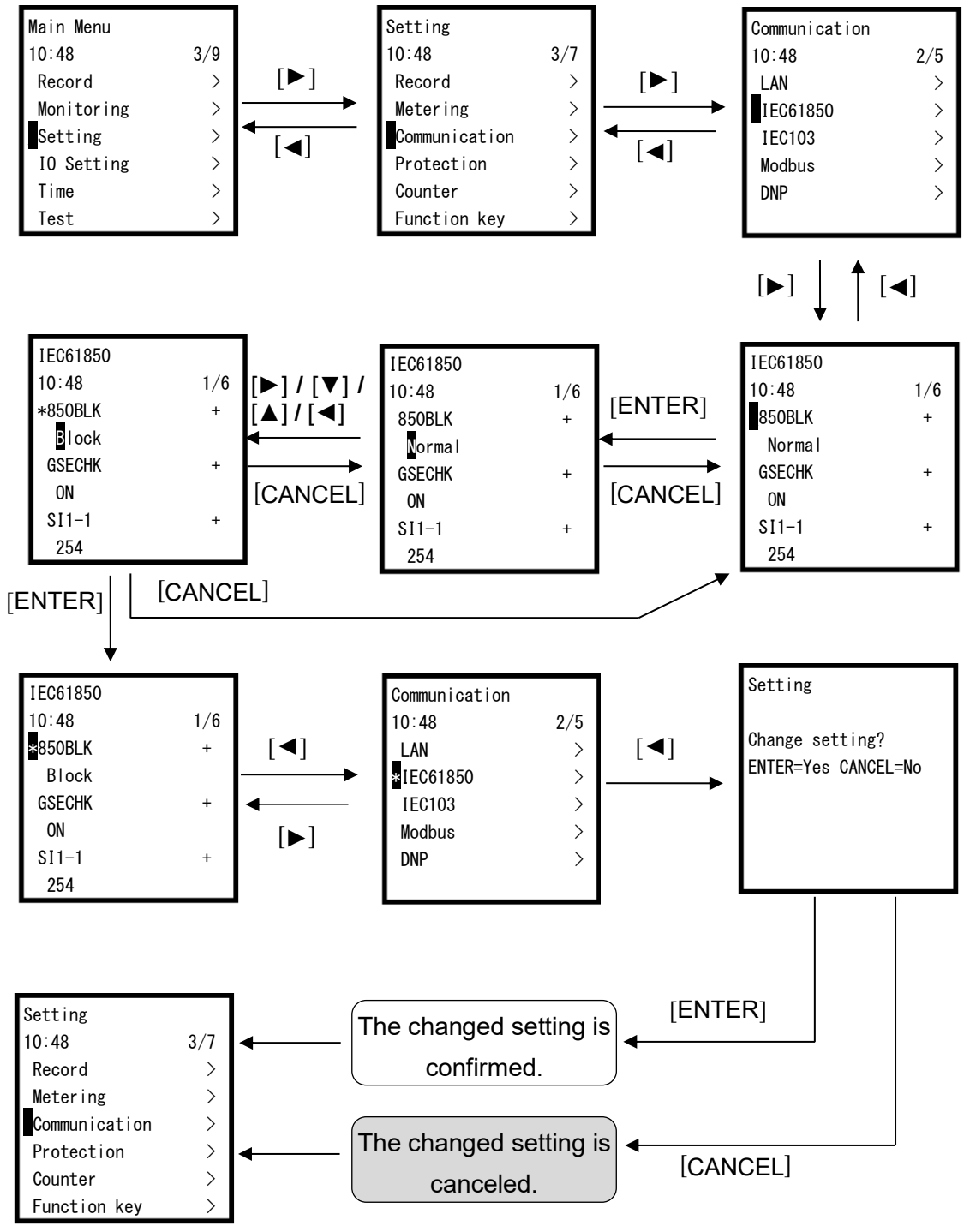


Figure 12.5-9 Setting example in case #2

(iii) On/Off function

When the "Setting->Protection->Group (1 to 8)" sub-menu is displayed, the "On/OFF function" is used to hide some unnecessary settings.

"On" indicates that the setting is enabled; the mark [>] will appear. More detail of the settings provided within the hierarchy are described later.

"Off" indicates that the setting is disabled; the detailed settings are hidden, the mark [>] is not indicated. The following figure shows the usage of On/Off function.

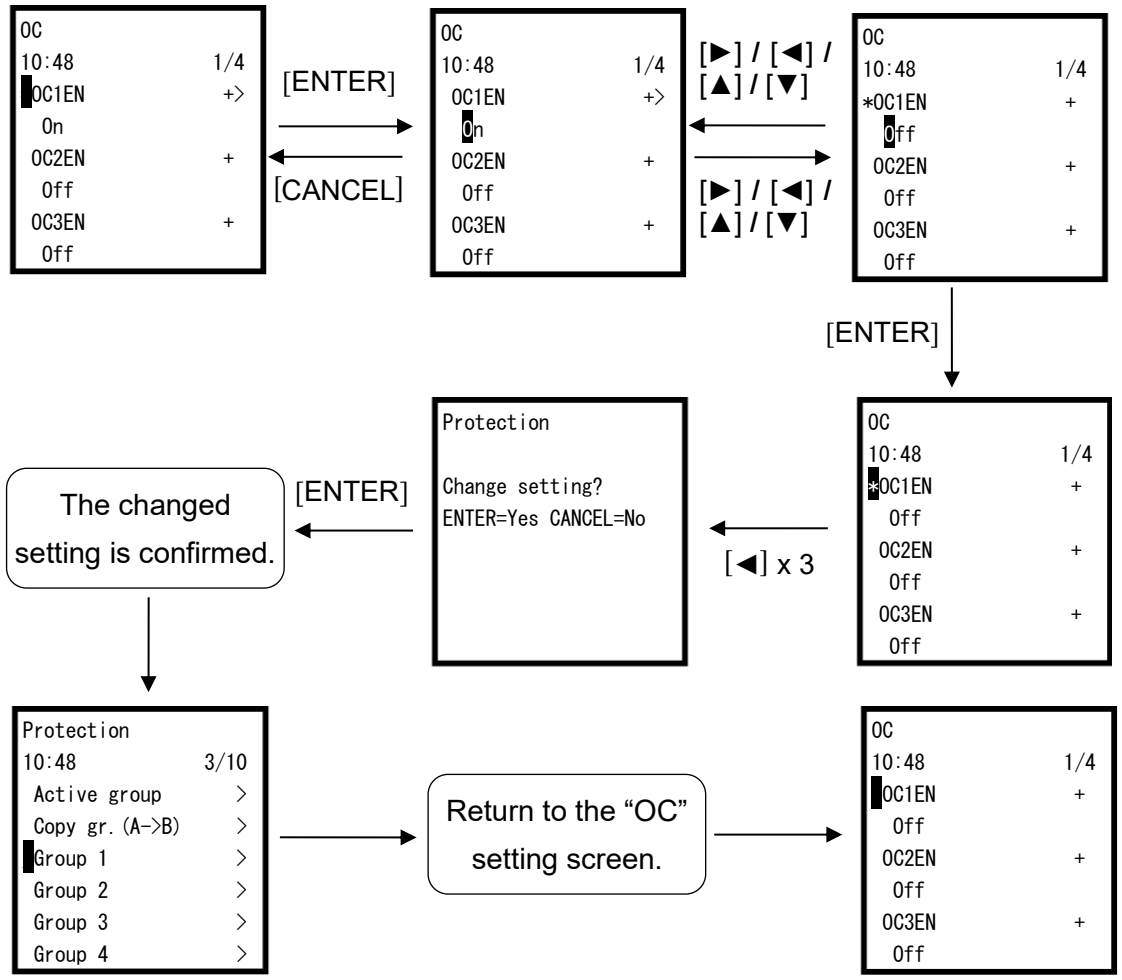


Figure 12.5-10 Operation of On/Off function

Table 12.5-2 Explanation of [+>] mark in On/Off function

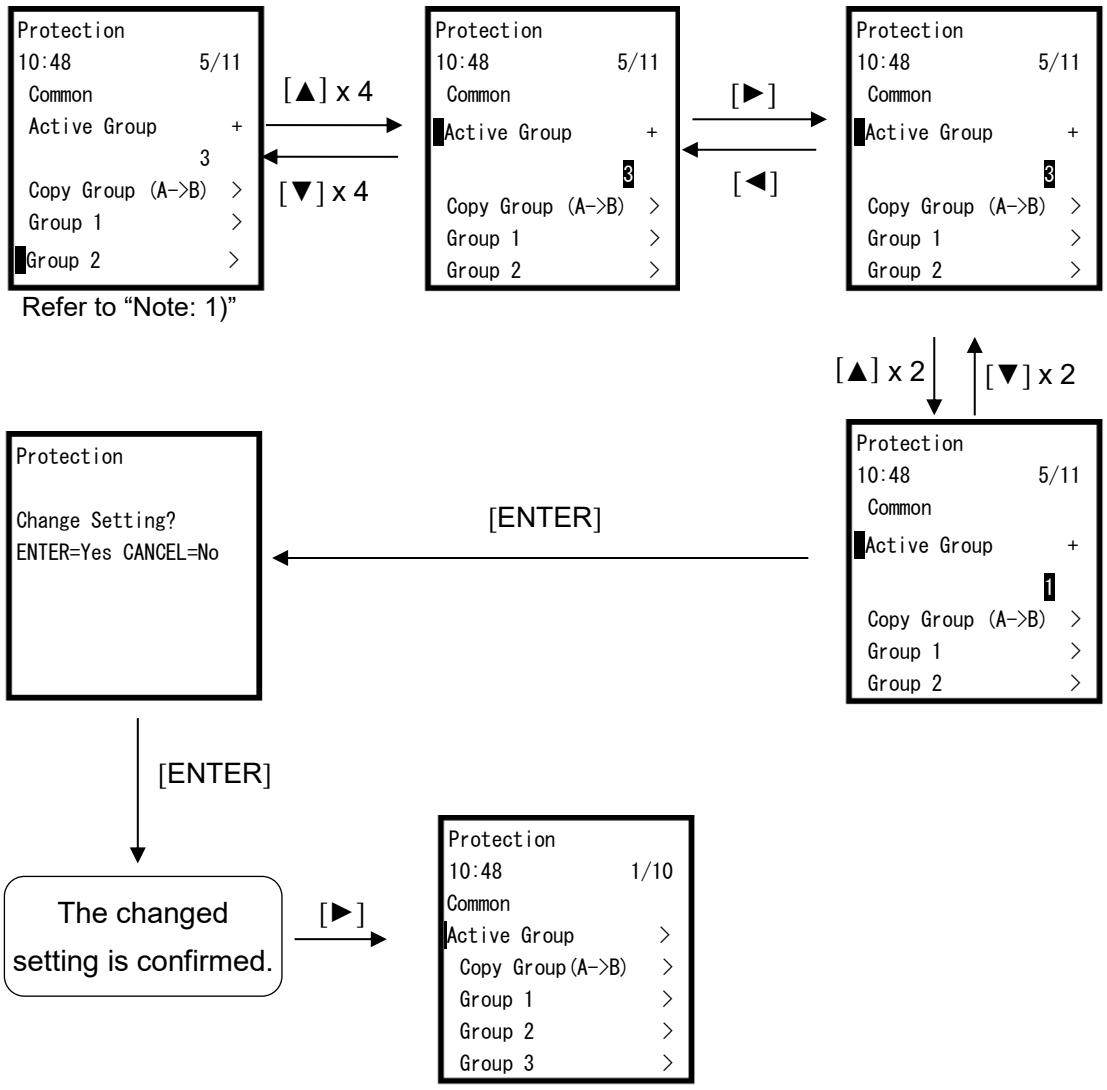
Display	Operation	Remark
[+>]	▶	Go to the sub-menu
	ENTER	Change setting.

(iv) Protection group setting

The IED provides eight setting groups for the protection of the power system; the user can choose an alternative setting group from one of the eight groups in response to a change in the

operation of the power system. In the "Protection" sub-menu, the user can change the active group and can copy the group settings. Jump to the "Element Setting Menu" if a relay setting is required.

(iv)-1 Change active group: An example for changing the active group is shown in the following figure.



†Note: When the screen moves to the "Protection" sub-menu from the "Setting" sub-menu, the cursor will appear alongside the current active group.

Figure 12.5-11 Operation of changing active group

(iv)-2 **Copy group setting:** The user can copy an active setting from one group to another group. As an example, in the following figure "Group3" will be copied to "Group2", as shown in Figure 12.5-12.

Note: In the "Copy Group (A->B)" screen, the number displayed at A is the current active group number.

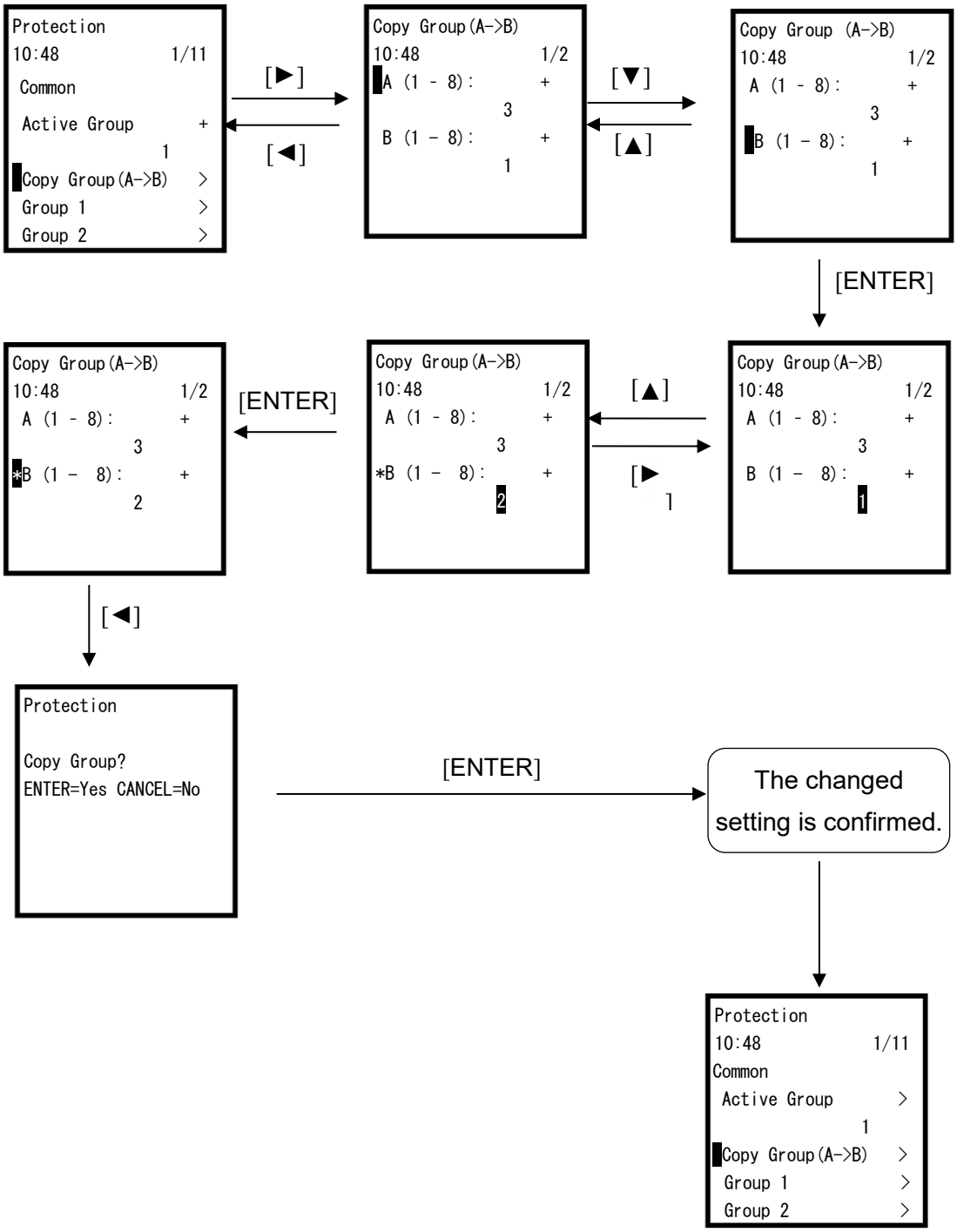


Figure 12.5-12 Copy group setting

(iv)-3 **Change group settings**: Upon shipment from the factory, the default settings are set. Therefore, in each group, the user can change the settings of the protection functions and other features. To change the settings in each group, refer to the setting method discussed in section 12.5(i).

(v) Configuration of Function keys

Function keys (F1 to F7) on the IED front panel provide a feature to navigate to a specific screen, which is configurable by the user. These keys have their own LED, which can be

programmed using settings. Six screens are configured for six of the function keys (F1 to F6), respectively, as the default settings shown in Table 5.6-3.

Table 12.5-3 Function keys which are configured to navigate a menu

Function Key configured	Menus
F1	Metering
F2	Fault Record
F3	Event Record1
F4	Event Record2
F5	Event Record3
F6	Diagnostics

(v)-1 Screen jump function: To configure the screen jump function, follow the steps as shown in the figure below.

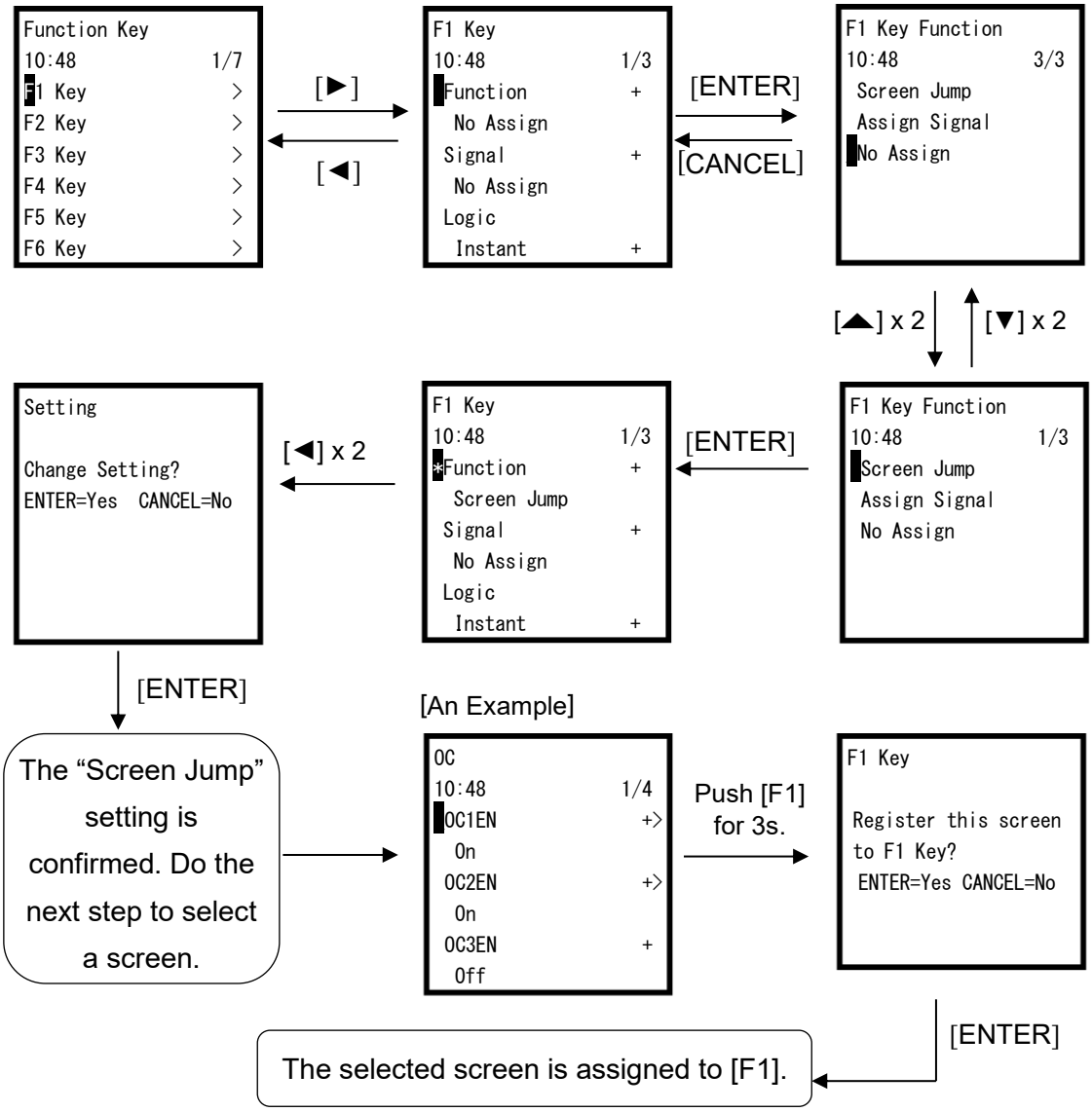


Figure 12.5-13 Operation of screen jump setting

On any screen, press the screen-jump function key to display a screen, refer to the following figure:

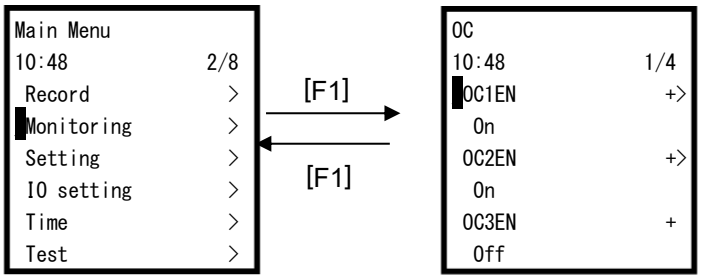


Figure 12.5-14 Operation of screen jump function

To cancel the screen-jump function, follow the procedure provided in Figure 12.5-15.

Note: 1) Once a screen is configured to a function key, it will not be deleted until a new screen is configured for the same function key.

2) If a configured screen is disabled by "On/Off Function" setting (refer to section 12.5(iii)), the screen jump function is also disabled for the function key.

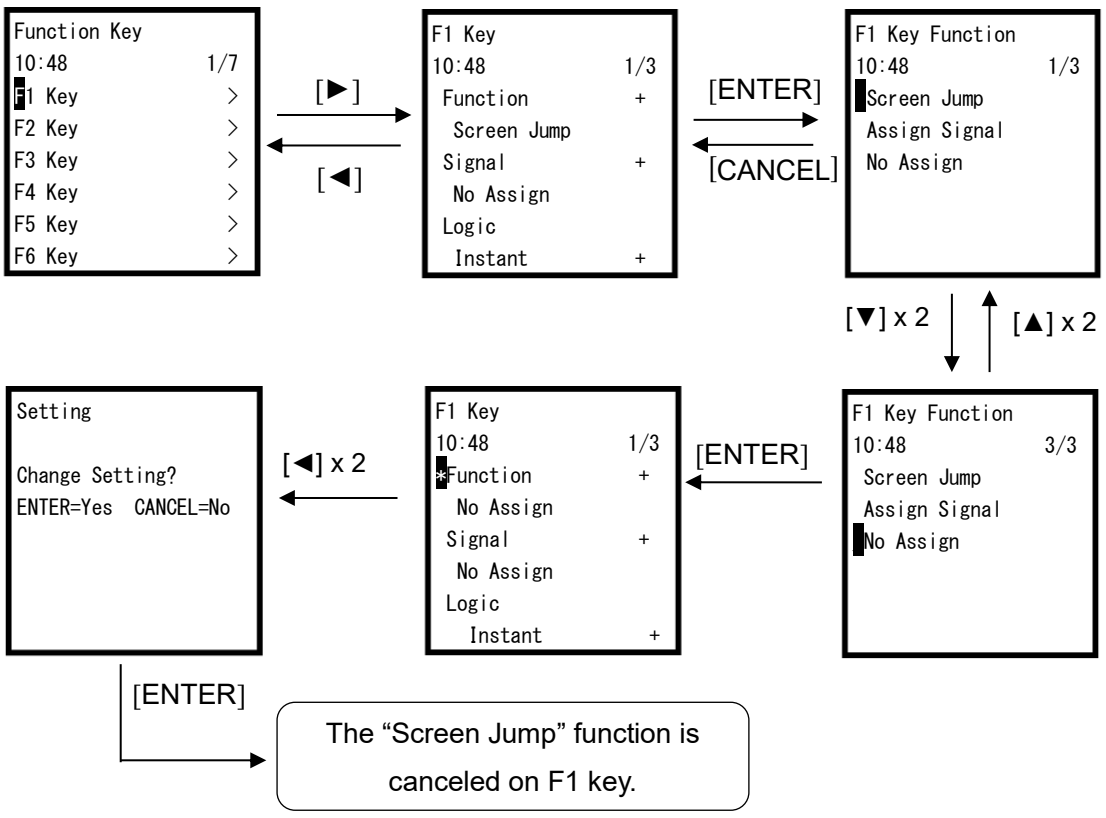


Figure 12.5-15 Cancelling screen jump function

(v)-2 **Signal control function:** To assign a test signal to a function key, follow the steps as shown in Figure 12.5-16.

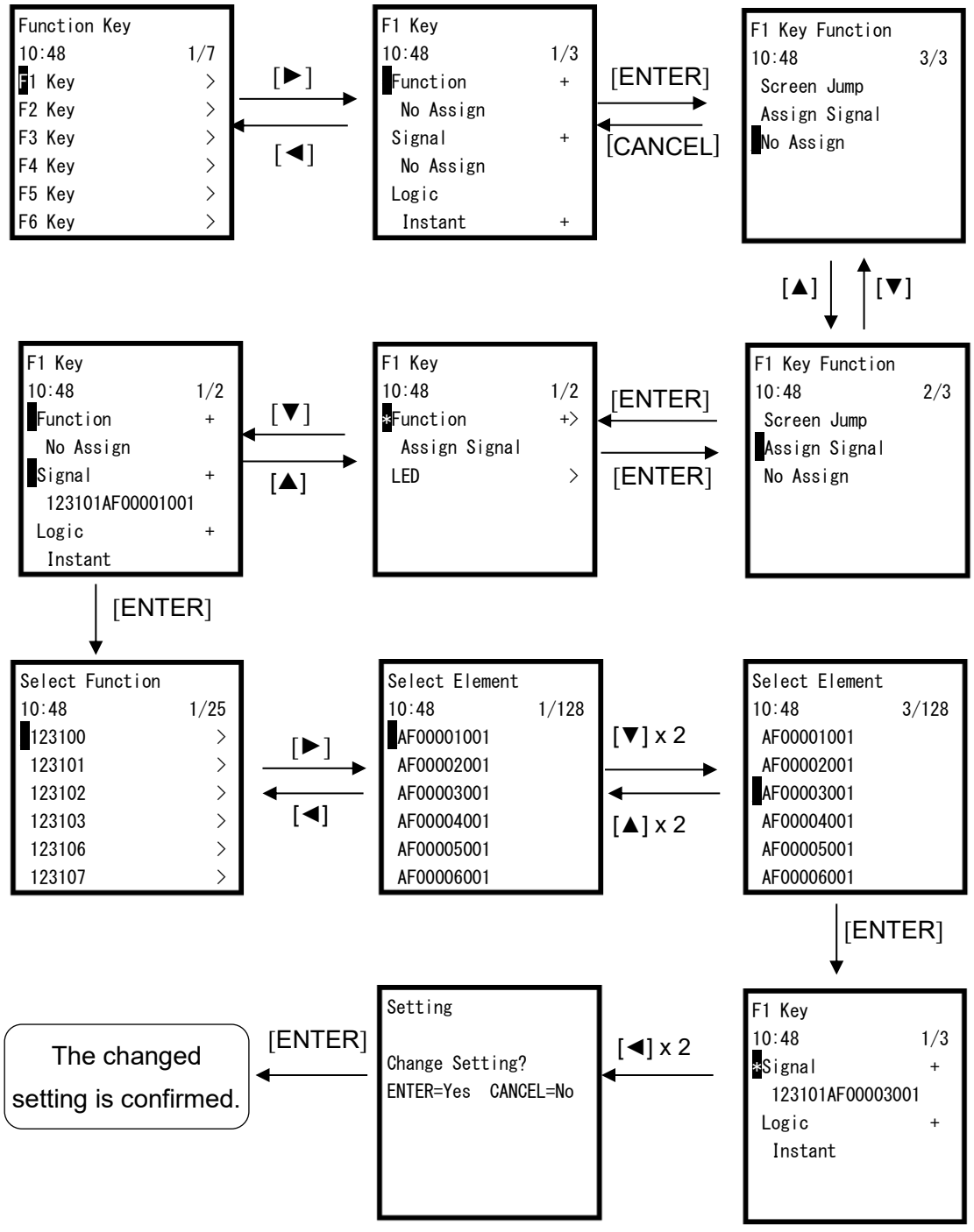


Figure 12.5-16 Assigning a signal to the function key

12.6 I/O setting sub-menu

The "I/O Setting" sub-menu is used to set or change settings for the following items:

(i) AC Analog Input

(ii) Binary Input

(iii) Binary Output

(iv) LED

This section explains the details of the setting method.

(i) AC analog input

For the AC analog inputs in the VCT module, the user can configure a ratio for each AC analog channel. With regard to the ratio, the user can key the value of the ratio from the sub-menu.

(i)-1 **Selection of ratio**: For example, Figure 5.2-1 shows how the channel selection is made for the AC analog input on a VCT module (AI#1 = VCT#1). Move the cursor by pressing keys ▲ and ▼. Then, press key ► to go to the next level in the hierarchy.

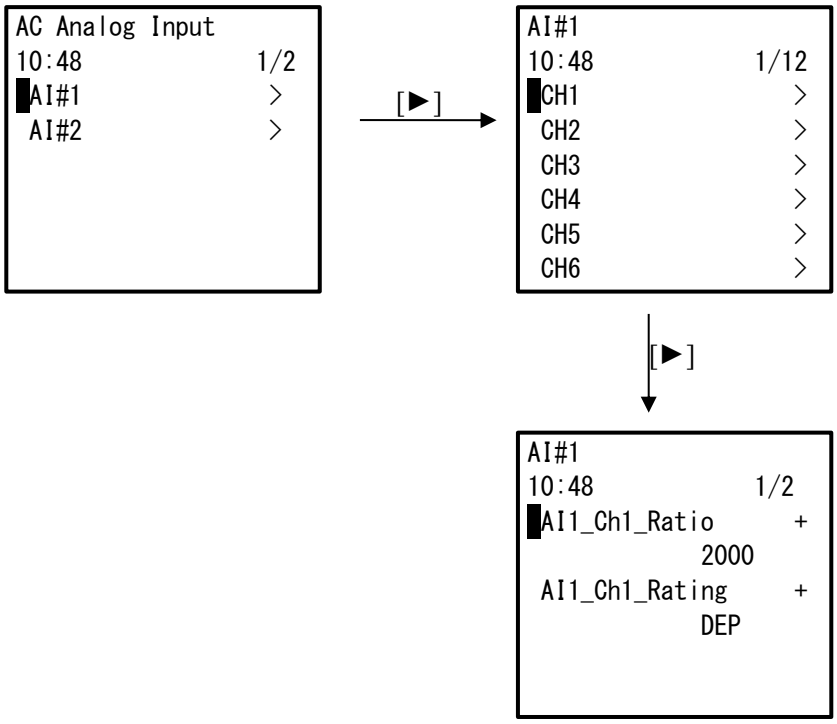


Figure 12.6-1 AC analog input screen

Note: This screen is a sample. The AI numbers displayed are dependent upon the configuration of VCT modules in each IED.

(i)-2 **Check of rating**: Figure 12.6-2 is an example of rating in channel#1. From this screen, the user can find a rating defined for each channel.

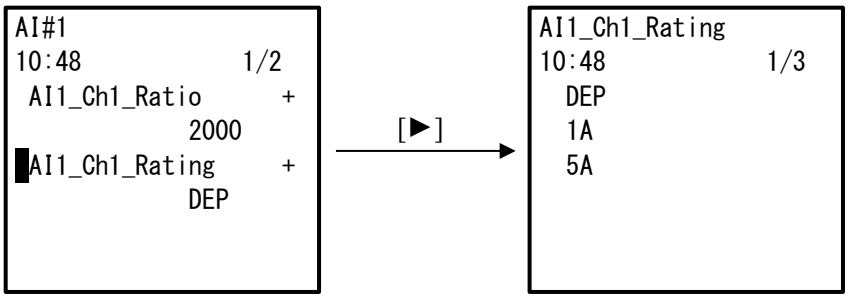


Figure 12.6-2 Check of rating

Note: Term "DEP" means that a rating value follows the default setting at the manufacture when it is carried out customer's ordering. For more information of ordering, see *Appendix: Ordering*.

(ii) Binary input

All binary input circuits provided in the IED are user-configurable; the user can set common programmable logic (CPL) for each binary input circuit. (For more information of CPL, see Chapter *Technical description: Binary IO module: Binary input circuit*)

The user can activate or turn off the above timers and switches using the setting function. To configure the binary input circuits, the user should follow the procedure in steps ((ii)-1 and (ii)-2)

(ii)-1 **Selection of binary input circuit**: For example, Figure 12.6-3 illustrates the selection of a binary input circuit on a binary IO module. Move the cursor by pressing keys [▲] and [▼]. Then, press key [►] to go to the next hierarchy.

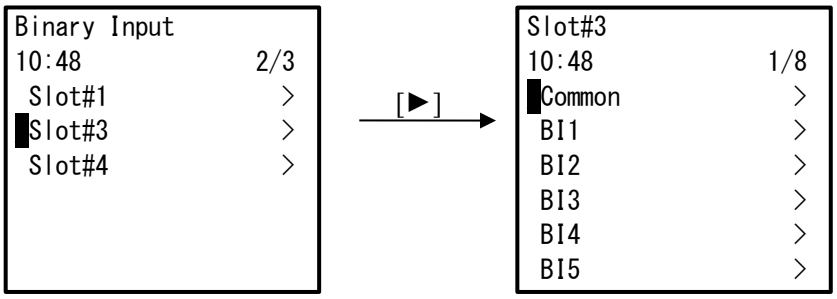


Figure 12.6-3 Selection of slot and binary input circuit

Note: This screen is a sample. The slot numbers displayed depend upon the configuration of the binary IO module in each IED.

(ii)-2 **CPL setting**: Figure 12.6-4 is an example of a "Common" setting. From this screen, the user can set a threshold level and the number of comparisons feature for contact chatter for all binary input circuits.

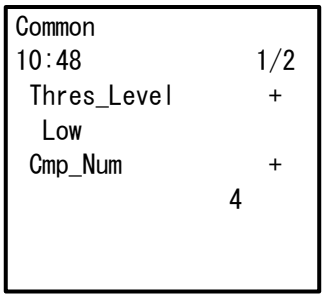


Figure 12.6-4 Common screen

For example, Figure 12.6-5 shows the CPL setting for binary input circuit (BI1). The timer and the inverse switch can be activated when **On** or **Off** is set for setting [**BI1_CPL**]. Press key **ENTER** to commence the setting of a switch or parameter.

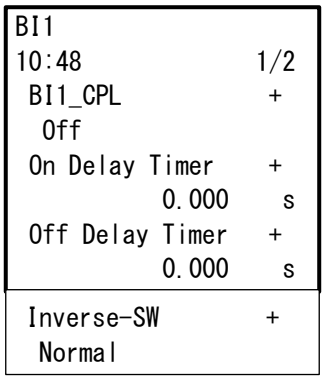


Figure 12.6-5 CPL setting

Note: Setting items "On Delay timer and others" are displayed when the user sets [**BI*_CPL**] **On**.

(iii) Binary output

All binary output circuits provided in the IED are also user-configurable; the user can configure timers and switches using CPL settings. (For more information of CPL, see Chapter *Technical description: Binary IO module: Binary output circuit*)

(iii)-1 **Selection of binary output circuit**: For example, Figure 12.6-6 illustrates the selection of a binary output circuit on a binary IO module. Move the cursor by pressing keys ▲ and ▼. Press key ▶ to go to the next level in the hierarchy.

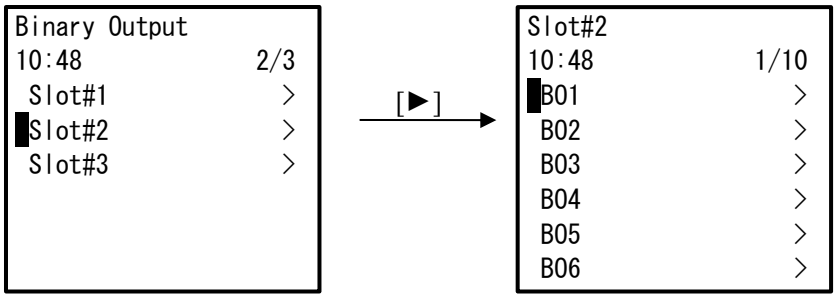


Figure 12.6-6 Selection of slot and binary output circuit

Note: This screen is a sample. The slot numbers displayed are dependent upon the configuration of the binary IO module in each IED case.

(iii)-2 **CPL Setting**: For example, Figure 12.6-7 illustrates the setting of a binary output circuit (BO1). Using setting [**BI1_CPL**] **On**, the CPL logic in BO1 is available. Similarly, assigned signals, timers and switches can be set in this menu. Note that detailed setting items are shown when **On** is keyed into setting [**BI*_CPL**].

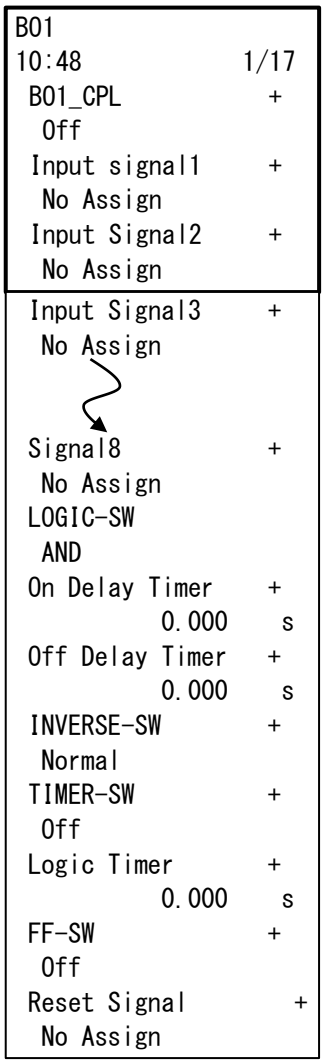


Figure 12.6-7 Binary output setting

Figure 12.6-8 shows how to assign a signal:

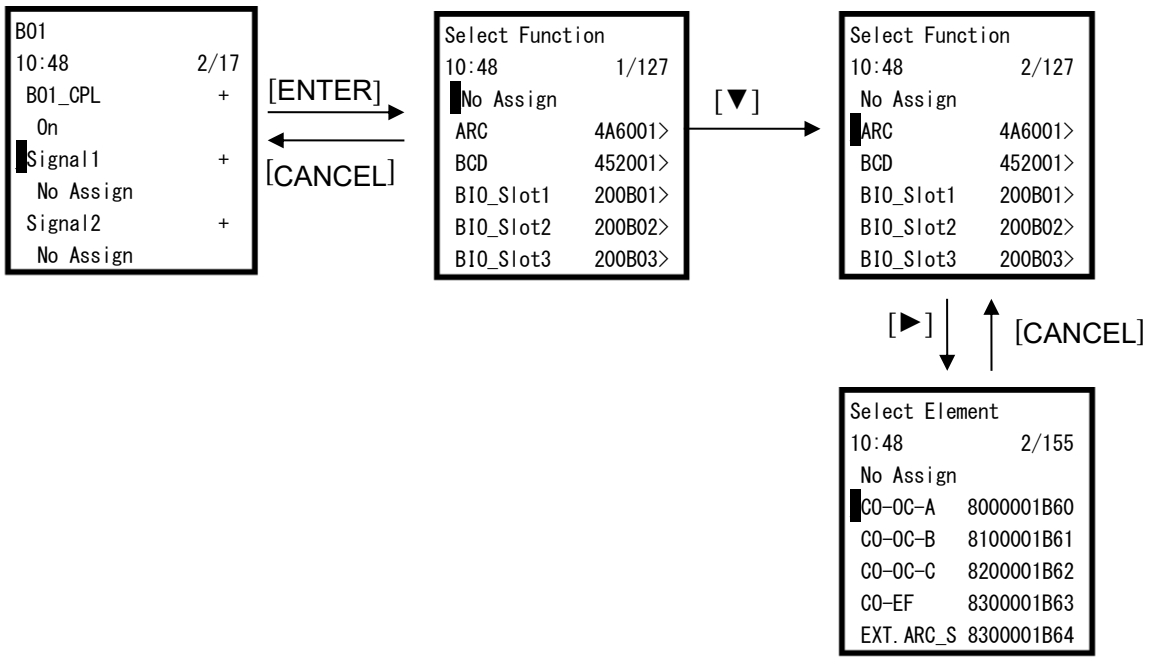


Figure 12.6-8 Assigning a signal

Note: "No Assign" is always displayed on the first line, even when the page is changed.

(iv) Selection and setting of LED

As shown in Figure 12.1-1, the IED provides 26 LEDs and 7 function-keys. The user can configure LEDs ("LED#3" to "LED#26") and the function key LEDs (F1 to F7; each has a LED). Each LED is driven via a logic gate which can be programed to be an AND gate, OR gate or XOR gate operation. Furthermore, each LED has a programmable reset characteristic, settable for instantaneous drop-off, or for latching operation. One or up to eight signals can be assigned to a single LED with selectable LED color.

(iv)-1 **Selection of LED**: Figure 12.6-9 shows the LED selection screen; the user can select a setting item by pressing keys ▲ and ▼. Press key ► to go to the next level in the hierarchy.

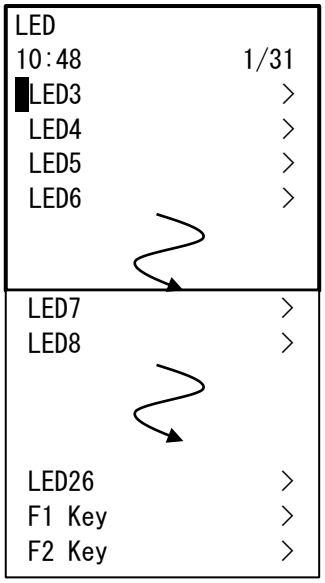


Figure 12.6-9 LED selecting screen

(iv)-2 **LED Setting**: As shown in Figure 12.6-10, the user can set the logical gate, timer, color of LED and assign signals in this screen.

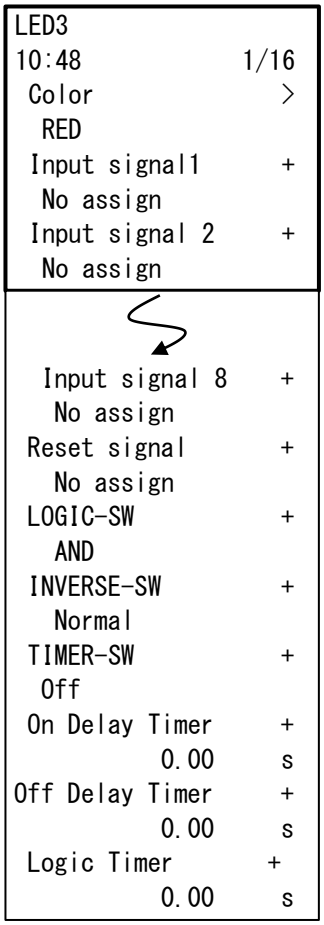


Figure 12.6-10 LED setting screen

12.7 Time sub-menu

In Time sub-menu, the user can change settings of Clock function, such as time zone, time synchronizing source, format of time displaying and so on. Figure below shows the Time sub-menu. (For more information, see *Chapter Technical description: Clock function*)

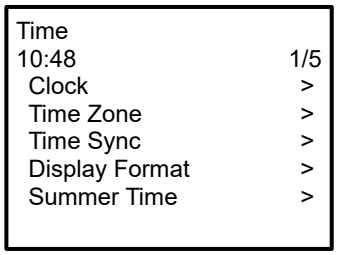


Figure 12.7-1 Time function screen

(i) Clock

The clock can run locally or synchronize with the external time source shown in [ActiveSyncSrc] menu. Figure 12.7-2 shows the Clock screen:

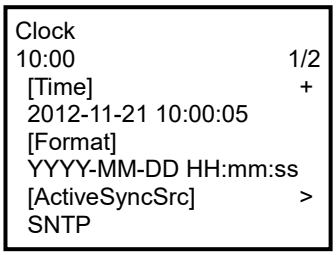
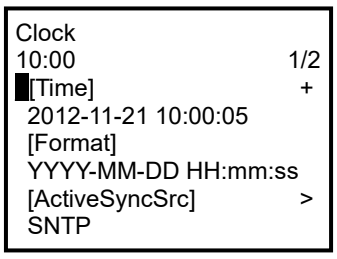


Figure 12.7-2 Clock screen

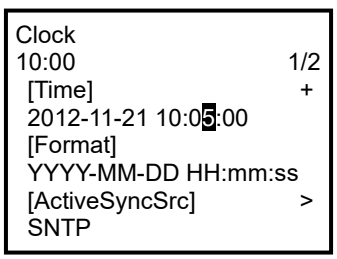
The Clock sub-menu is composed of the [Time] menu, [Format] menu and [ActiveSyncSrc] menu. Time for the IED can be set in the screen. When the active synchronizing source is SNTP, the user can go to another sub-menu to check the current active SNTP server.

Figure 12.7-3 shows how to handle this screen.

(i)-1 Time menu



(1) Move cursor to the Time menu and press ENTER.

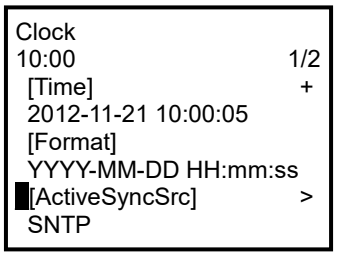


(2) Current time can be changed to press ▲ or ▼.

Figure 12.7-3 Clock format

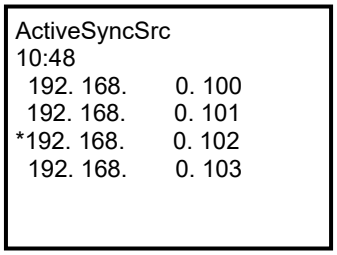
(i)-2 ActiveSyncSrc menu

ActiveSyncSrc can be shown by the following procedure.



(1) Move cursor to the [ActiveSyncSrc] menu and press ►.

*Note: When the active synchronizing source is not SNTP, the > is not shown in the screen.



(2) The ActiveSyncSrc screen shows the active IP address of active SNTP server.

Figure 12.7-4 ActiveSync

(ii) Time zone

The user can input time zone designated by UTC in Time zone screen. Time zone according as local area for the IED should be set. Figure 12.7-5 shows the Time Zone screen:

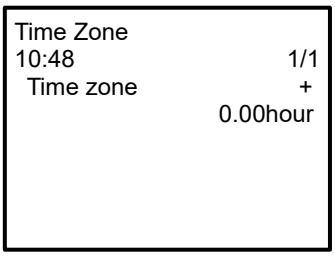
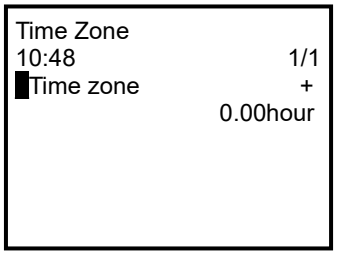


Figure 12.7-5 Time zone setting screen



(1) Move cursor to the Time zone menu and press ENTER.

Time zone can be set by 0.25 hour. The user has to fill the Time zone in accordance with UTC (Coordinate Universal Time).

Figure 12.7-6 TimeZone

(iii) Time synchronization

Time synchronization source can be selected in Time synchronization screen. The synchronization function can be activated by configuration of the On/Off switch in this menu. Figure 12.7-7 shows the configuration screen for the time synchronization function:

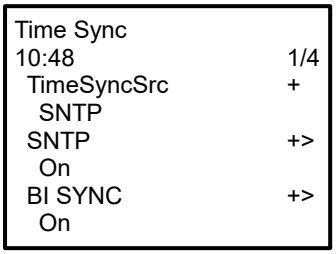
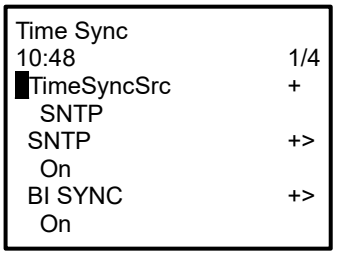


Figure 12.7-7 Time synchronization setting

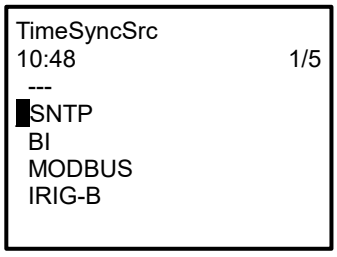
The following shows how to operate in this screen.

(iii)-1 TimeSyncSrc menu

Time SyncSrc (Time Synchronization Source) can be changed by the following procedure.



(1) Move cursor to the TimeSyncSrc menu and press ENTER.



(2) The TimeSyncSrc menu is composed of "---", SNTP, BI, MODBUS and IRIG-B.

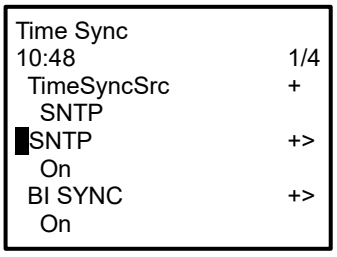
Note: When "---" is selected, it means that time synchronization is not operated.

Figure 12.7-8 TimeSyncSrc

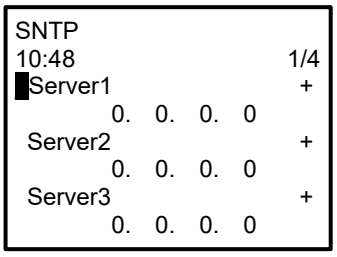
By using time synchronization via Ethernet with a SNTP server, the user can connect up to a maximum of four SNTP servers. If more than one SNTP is used, the priority of the servers can be decided in ascending order of synchronized stratum value (in order of higher-accuracy) and select the server with the smallest value.

(iii)-2 SNTP menu

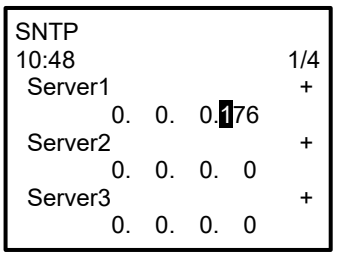
IP address of SNTP server can be set by the following procedure.



(1) To confirm that the SNTP synchronization function has been set for On. Subsequently move cursor to the SNTP menu and press ►.



(2) Move cursor to desired server number and press ENTER.



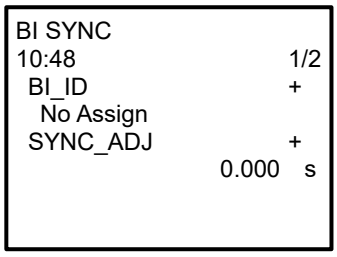
(3) The user can set IP address using ▲ or ▼ by each digit.
When the user has finished setting IP address of the server, press ENTER.

Figure 12.7-9 SNTP

(iii)-3 BI SYNC menu

When the "BI SYNC" is set to **On** in Time Sync menu, the user can choose a binary input circuit (BI) as a synchronization standard. Adjustment setting 'SYNC_ADJ' is provided.

Binary synchronization function can be set by the following procedure.



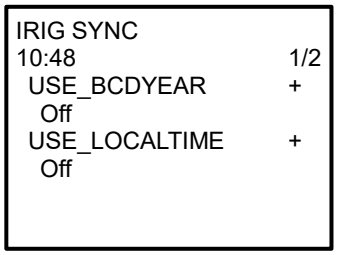
(1) Enter the Data ID of the BI output

(2) Set adjustment time for [**SYNC ADJ**]

Figure 12.7-10 BISYNC

(iii)-4 IRIG SYNC menu

When the "IRIG SYNC" is set to **On** in Time Sync menu, the user can choose IRIG signal for the synchronization.



(1) Set **On** if IRIG-B data is generated in IEEE C37.118/IRIG-B000 format. On the other hand, set On if the IRIG-B is generated with absence the C37.118.

Figure 12.7-11 IRIGSYNC

(iv) Display format

Display format of time in the IED can be selected in Display format screen. All time formats will be displayed according to Date_fmt setting. The IED provides different formats to display the date. Figure 12.7-12 shows display format menu:

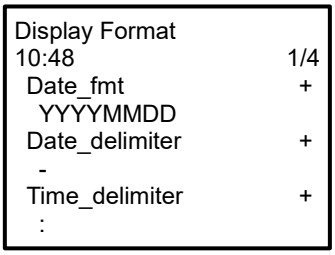
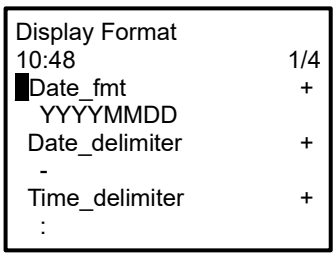


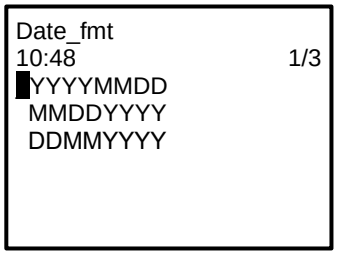
Figure 12.7-12 Display format menu

Display Format sub-menu is composed of Date_fmt menu, Date_delimiter setting Time_delimiter setting and Sec_delimiter setting.

(iv)-1 Date format menu



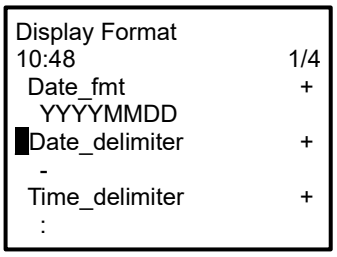
(1) Move cursor to "Date_fmt"; and press ENTER.



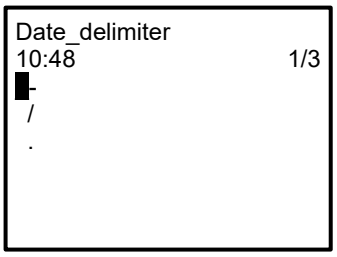
(2) Select desired format by moving cursor.

Figure 12.7-13 Date Format

(iv)-2 Date delimiter menu



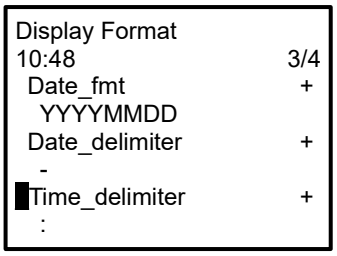
(1) Move cursor to the [Date_delimiter] menu and press ENTER.



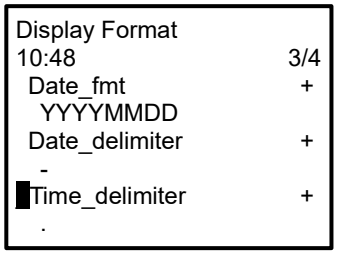
(2) Date delimiter can be selected by moving cursor to the desired format type.

Figure 12.7-14 Date delimite

(iv)-3 Time delimiter menu



(1) Move cursor to the [Time_delimiter] menu and press ENTER.

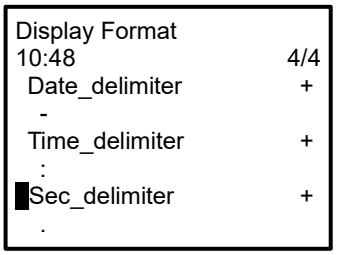


(2) The time delimiter mark is switched.

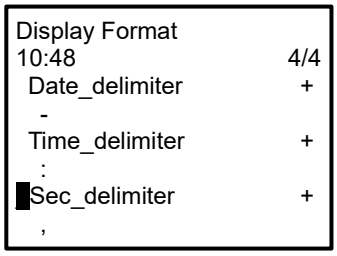
Figure 12.7-15 Time delimite

(iv)-4 Second delimiter menu

Second delimiter can be switched by the following procedure.



(1) Move cursor to the [Sec_delimiter] menu and press ENTER.



(2) The second delimiter mark is switched.

Figure 12.7-16 Second

(v) DST (Summer time)

When DST is **On**, the user is needed to set details:

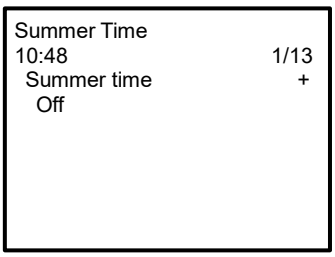
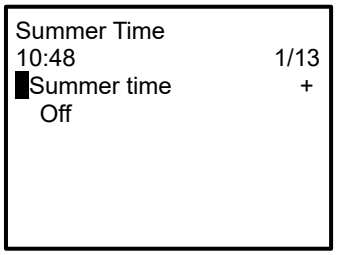
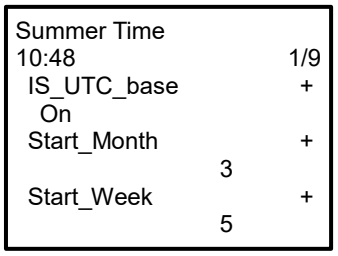


Figure 12.7-17 DST (Summer time) menu

Notice that summertime can be set by the following procedure If summertime is started or ended in the last week of the month, Start_Week and End_Week must be filled “5”. The IED controls starting or ending summer time day to set last week of the month on Start_Week or End_Week automatically.



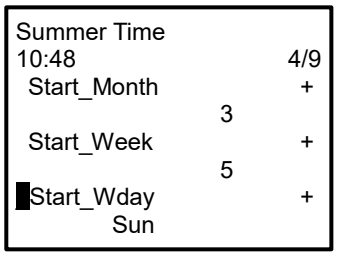
(1) Move cursor to the [Summer time] menu and press ENTER. Summer time mode can be switched On/Off by pressing ▶ or ◀. After Summer time mode is set to **On**, the user can set summer time in detail.



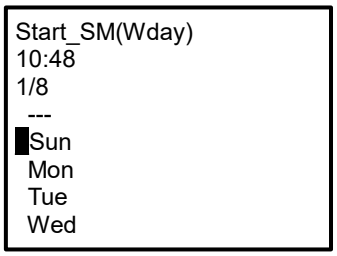
(2) In this screen, details of summer time setting can be set.

Figure 12.7-18 DST setting

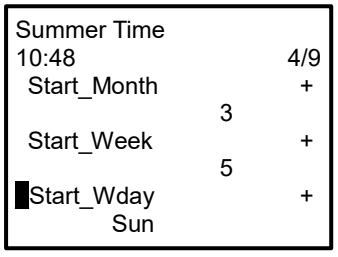
The user can set the starting date and ending of summer time. The following procedure is a case of starting weekday setting.



(1) Move cursor to the [Start_Wday] menu and press ▶.



(2) Move cursor to the desired weekday and press ENTER.



(3) Starting weekday is set.

Figure 12.7-19 DST setting

12.8 Test sub-menu

Test functions can be operated from the test screen available on the front panel of the IED.

(i) Test screen

The Test screen has functions such as Test Mode, Test Flag, Mode Change and Signal Monitoring. The user can select any of these test functions using the following test screen.

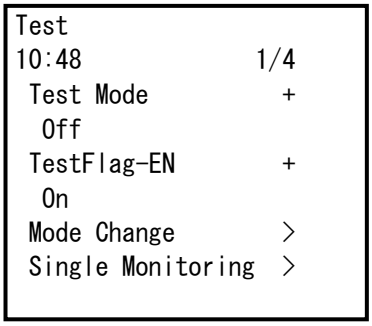


Figure 12.8-1 Test screen

(ii) Test mode screen

The Test Mode screen is shown in Figure 12.8-2. The Test Mode screen has four functions, Test Option, Function Test, Binary Input and Binary Output.

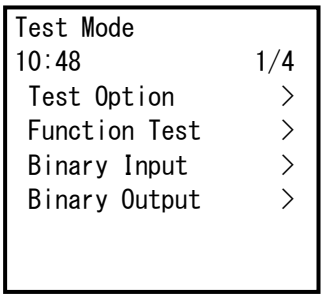


Figure 12.8-2 Test Mode screen

(ii)-1 **Test option screen**: The Test Option screen, shown in Figure 12.8-3, is used to select the following functions and perform a Test flag forced reset.

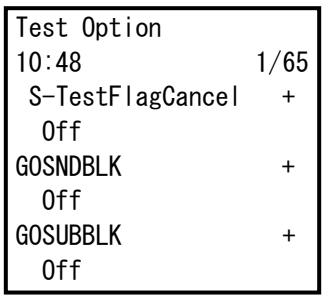


Figure 12.8-3 Test Option screen

- Test flag cancel (S-TestFlagCancel)

  This function is used to forcibly reset the Test flag in the communication packet. The Test flag is set to OFF by default. The Test flag is used in combination with another device in the Test mode. When this option is selected, the Test flag in the communication packet is reset temporarily to

reproduce a pseudo-operation condition.

- GOOSE sending block (GOSNDBLK)
  This function is used for selecting or disabling the GOOSE sending information in Test mode. This function is used when there is a conflict in communication with another active IED while sending a GOOSE signal.

- GOOSE receiving block (GOSUBBLK)
  This function is used for receiving or rejecting GOOSE subscription information from another IED in Test mode. This function is used for testing in case of bad reception (For example, Validation of Interlock determination). The user can simulate a bad reception condition passively by using two GOOSE Sending Blocks.

Note: The user may perform bad reception tests from a remote terminal using the GOSNDBLK function. However, carrying out the GOSNDBLK function at a remote terminal may influence the overall operation of other IEDs, because communication packets will not be received from the remote terminal. In order to avoid that the user can simulate bad reception tests for a particular IED using the GOSUBBLK function. As a result, testing will only affect the particular IED under test i.e. all other terminals will not be influenced by the tests.

(ii)-2 **Function test screen**: Function test screen is provided for testing; the use can program test operations, which can be implemented in protection and control functions. Figure 12.8-4 exemplifies the Test screen. Automatic supervision will stop when the user sets **Off** for A.M.F (for more information about the automatic supervision, see *Chapter Automatic supervision*).

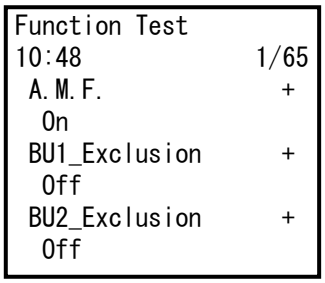


Figure 12.8-4 Function test menu (an example)

(ii)-3 **Binary input test screen**: The user can have a virtual signal to a binary input circuit using the binary input test screen. Figure 12.8-5 shows an example; the user can select IO#1 or IO#3. (Actually, the content displayed will differ depending upon the binary IO module inserted. Refer to Chapter *Technical*

description: Binary IO Module)

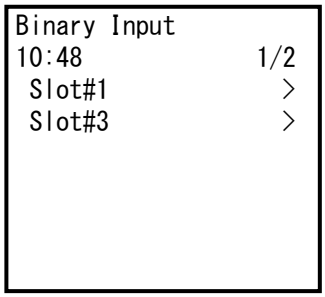


Figure 12.8-5 Binary input menu

Figure 12.8-6 is a case when IO#3 (Slot#03) is selected.

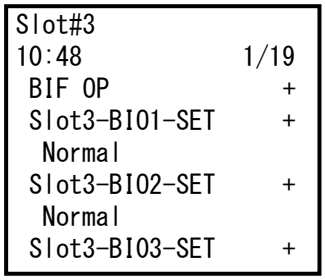


Figure 12.8-6 Setting menu for Slot #3 module

For example, if the user wishes to simulate binary input circuit #1 (BI1) on the BIO1A module at IO#3 slot, the user can select SLOT3-BI01-SET screen, as shown in Figure 12.8-6).

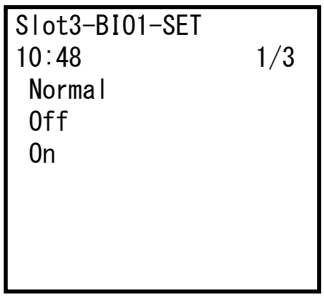


Figure 12.8-7 Setting menu after selecting "Slot #3-BIO1-SET"

The user can then make the following selections on the screen and configure the items required for simulation.

- **ON**: BI1 output is set forcibly to ON(Logic level=high(1)) regardless of the actual input signal.
- **OFF**: BI1 output is set forcibly to OFF(Logic level=low(0)) regardless of the actual input signal.
- **Normal**: Actual inputs are applied.

Use the screen shown in Figure 12.8-7 only to configure the BI signals for the

simulation test. This does not start the simulation.

The setting menu is shown in the manner of the screen illustrated in Figure 12.8-7, if the user needs to configure an Input Circuit other than BI01 (BI02 to BI18 in the screen shown in Figure 12.8-6); the user can configure each BI signal in a manner similar to that described for BI01.
After selecting OP in Figure 12.8-6, use the following screen to start the simulation test.

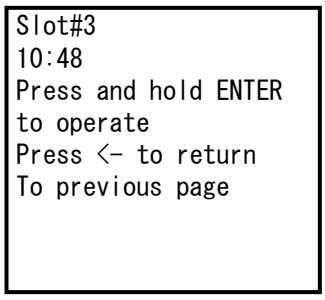


Figure 12.8-8 Execution menu of BI test

If key **ENTER** is pressed in Figure 12.8-8, the status will change to test status. The following screen will be displayed after pressing the key **ENTER**. Figure 12.8-9 shows that the IED is in simulation test mode.

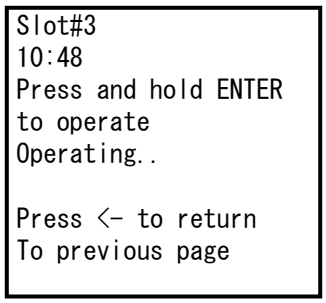


Figure 12.8-9 Running test menu

Note: The user has to continue to depress the key **ENTER** on the IED front panel during the simulation test period. The simulation status will be released if key **ENTER** is not pressed.

(ii)-4 **Binary output test screen**: The user is able to test a binary output circuit. Figure 12.8-10 is an example of how to select a binary output from the Test Mode screen.

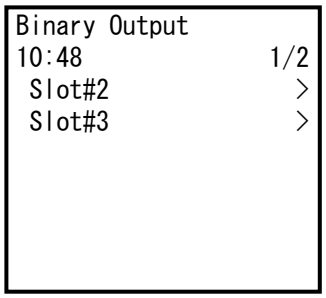


Figure 12.8-10 Binary output menu

Figure 12.8-11 shows selection of IO#2 (Slot #2).

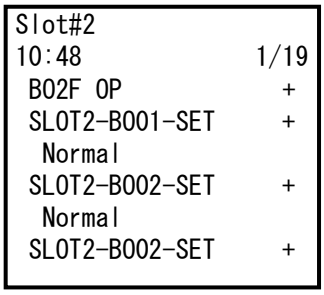


Figure 12.8-11 Setting menu for Slot #2 module

Figure 12.8-12 shows the Output Circuit configuration of BO01 at IO#2 (Slot#2). The procedure for operation is similar to the operation of the binary input circuit. (Refer to Figure 12.8-7 to Figure 12.8-9)

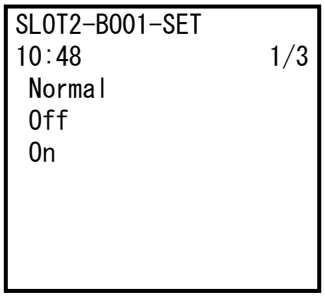


Figure 12.8-12 Setting menu after selecting "SLOT2-BO01-SET"

The user can configure the required settings for the simulation test of the binary output circuit.

- **ON**: Output signal for simulation test is ON
- **OFF**: Output signal for simulation test is OFF
- **Normal**: Actual inputs are applied.

(iii) TestFlag-EN screen

This function can set all communication protocol Test flags to Test mode. The user should select TestFlag-EN in Figure 12.8-1 and select **On** or **Off**.

(iv) Mode change screen

When the user selects "Mode Change" from the Test sub-menu shown in Figure 12.8-1, the following Mode change screen is displayed (Figure 12.8-13). This allows control from a remote device (For example, SAS server) by configuring the MDCTRL-EN setting.

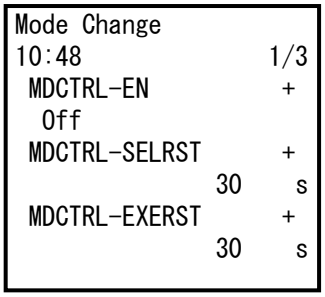


Figure 12.8-13 Mode Change sub-menu

(v) Signal monitoring screen

Figure 12.8-14 shows that the user can assign signal-monitoring points to the monitoring jacks (A, B, and C) on the IED front panel. Incidentally, points have not been assigned for the monitoring jacks in the menu below.

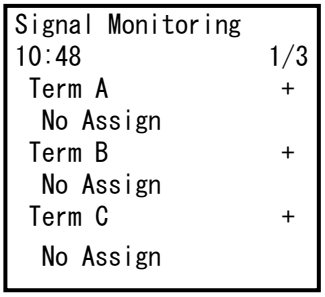


Figure 12.8-14 Signal monitoring sub-menu

When the user wishes to use monitoring jack A to monitor a signal-monitoring point, select "Term A" in the signal monitoring sub-menu (Figure 12.8-15). The user can then assign the signal monitoring point for Term A.

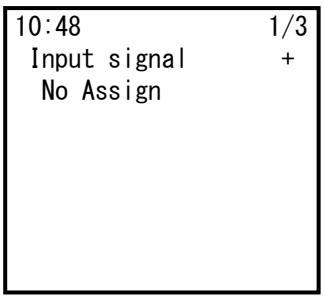


Figure 12.8-15 Selection menu

12.9 Information sub-menu

In the information sub-menu, the user can see the information about the IED. Those of the information are set in a factory, and not changed by the user. Figure 12.9-1 shows the Information sub-menu. Table 12.9-1 shows detail of information that is displayed in this screen.

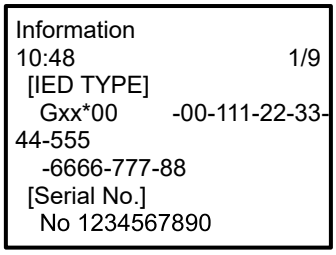


Figure 12.9-1 Information screen

Table 12.9-1 Information details

Display item	Remark
[IED TYPE]	
Gxx*00	Product name
-**-***-**-**-**-***	Hardware section information of ordering number
-****-***-**	Software section information of ordering number
[Serial No.]	
**********	Product serial number
[Plant Name]	
No name	Plant name which is input from GR-TIEMS by the user
[Description]	
No name	Information of the IED which is input from GR TIEMS by the user
[CP1M Software]	
**********	Name and version number of Main CPU Software
[CP1S Software]	
**********	Name and version number of Sub CPU Software
[CP2M Software]	
**********	Name and version number of extra CPU Software(This item is displayed in case of extra CPU implemented model only)
[IEC61850 eng]	
*********	Name and version number of IEC61850 engine (This item is displayed in case of IEC61850 implemented model only)
[IEC61850 Date Model]	
**********	Name and version number of IEC61850 Data Model (This item is displayed in case of IEC61850 implemented model only)
[IEC61850 Mapping]	
**********	Name and version number of IEC61850 Mapping (This item is

Display item	Remark
	displayed in case of IEC61850 implemented model only)
[GOOSE Subscribe]	
No Data	GOOSE Subscript (This item is displayed in case of IEC61850 implemented model only)
Interlock Data	
**********	Setting data of interlock (This item is displayed in case of interlock function implemented model only)
[PLC Date]	
**********	PLC Data name and version number
[Command Block Data]	
**********	Double command block data

12.10 Security setting sub-menu

The Access control function is accessed using the Security Setting sub-menu. Passwords, active or inactive and several allowed operations can be set for each user ID.

Table 12.10-1 Access control function settings

Display Order		1	2	3	4	5
User ID		Guest	Setting	Test	Operation	Full Access
Password (Default)		N.A	0000	0000	0000	0000
Functions (function keys) allowed to operate	View	✔	✔	✔	✔	✔
	Setting	N.A	✔	N.A	N.A	✔
	Security Setting	N.A	✔	N.A	N.A	✔
	Control	N.A	N.A	N.A	✔	✔
	Test	N.A	N.A	✔	✔	✔
	Clear record	N.A	✔	✔	N.A	✔
	Monitoring (Reset/Revise)	N.A	✔	✔	N.A	✔
	F1	✔	✔	✔	✔	✔
	F2	✔	✔	✔	✔	✔
	F3	✔	✔	✔	✔	✔
	F4	✔	✔	✔	✔	✔
	F5	✔	✔	✔	✔	✔
	F6	✔	✔	✔	✔	✔
	F7	✔	✔	✔	✔	✔

Note: Sign "✔" shows that the user can operate the function. Sign "N.A" shows that the user cannot operate the function. Password can be changed in Change-Password sub-menu in the Security setting.

Table 12.10-2 Meaning of allowed operation

Functions	Meaning
View	All users can see all screens/menus
Setting	In the "Setting" and "IO setting" menu the authorized user can change each setting item. Operation of the "Time" menu is also allowed. (Incidentally, all users can set the time.)
Security setting	Authorized users can change security settings
Control	An operator can control a device. An operator can also change the mode between "Remote" and "Local".
Test	A tester and an operator can access the "Test" menu.
Clear record	An authorized person, except for a guest and an operator can remove record information.
Monitoring	An authorized person, except for a guest and an operator can clear and change statistical data.
F1 to F7	Users can operate a function/an application with a function key.

12.11 Control sub-menu

The user can control external devices using the IED front panel. Control sub-menus are provided to operate; the user can operate the devices by pressing Operation keys. Note that Control sub-menus are only available when the IED is in "LOCAL" mode†. When the IED is in "REMOTE" mode, an error message will be shown on the screen. Remember that the IED will change to "REMOTE" mode if there is no operation for a while; then the IED can be monitored remotely. Figure 12.11-1 shows "Control" sub-menu.

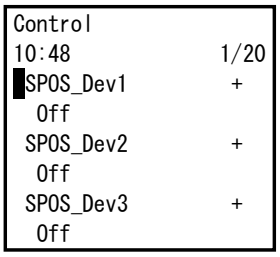


Figure 12.11-1 Control sub-menu on LCD screen

†Note: The IED will have "Local" mode automatically when the following menus are displayed on the LCD screen: "Main Menu", "Control sub-menu", "Selection Executing", "Operating completed", "Operating canceled" or "Operating failed".

Table 12.11-1 shows how to operate by the IED front panel. The IED can have several control functions, which are dependent on the ordering code. For more information, see *Chapter Control and monitoring application* or *Appendix: Ordering* for more information).

Table 12.11-1 Control step in DIR mode or SBO mode

Control Scheme	Operation step
Direct Control Operation Mode‡	1) Set DIR mode in each control function. 2) Select a device and choose DIR, and press **ENTER**. 3) Press **I** (Close) or **O** (Open) 4) A signal of control command is issued; control operation is performed.
Select Before Control Operation Mode‡	1) Set SBO mode in each control function. 2) Select a device and choose SBO, and press **ENTER**. 3) Verify that the selection is performed correctly and normally. 4) Press **I** (Close) or **O** (Open); controlling command is issued. 5) Control operation is carried out.

‡Note: We shall discuss about DIR and SBO modes in *Chapter General control function: Control mode.*

(i) CB operation

Figure 12.11-1 shows how to open CB (Off position).

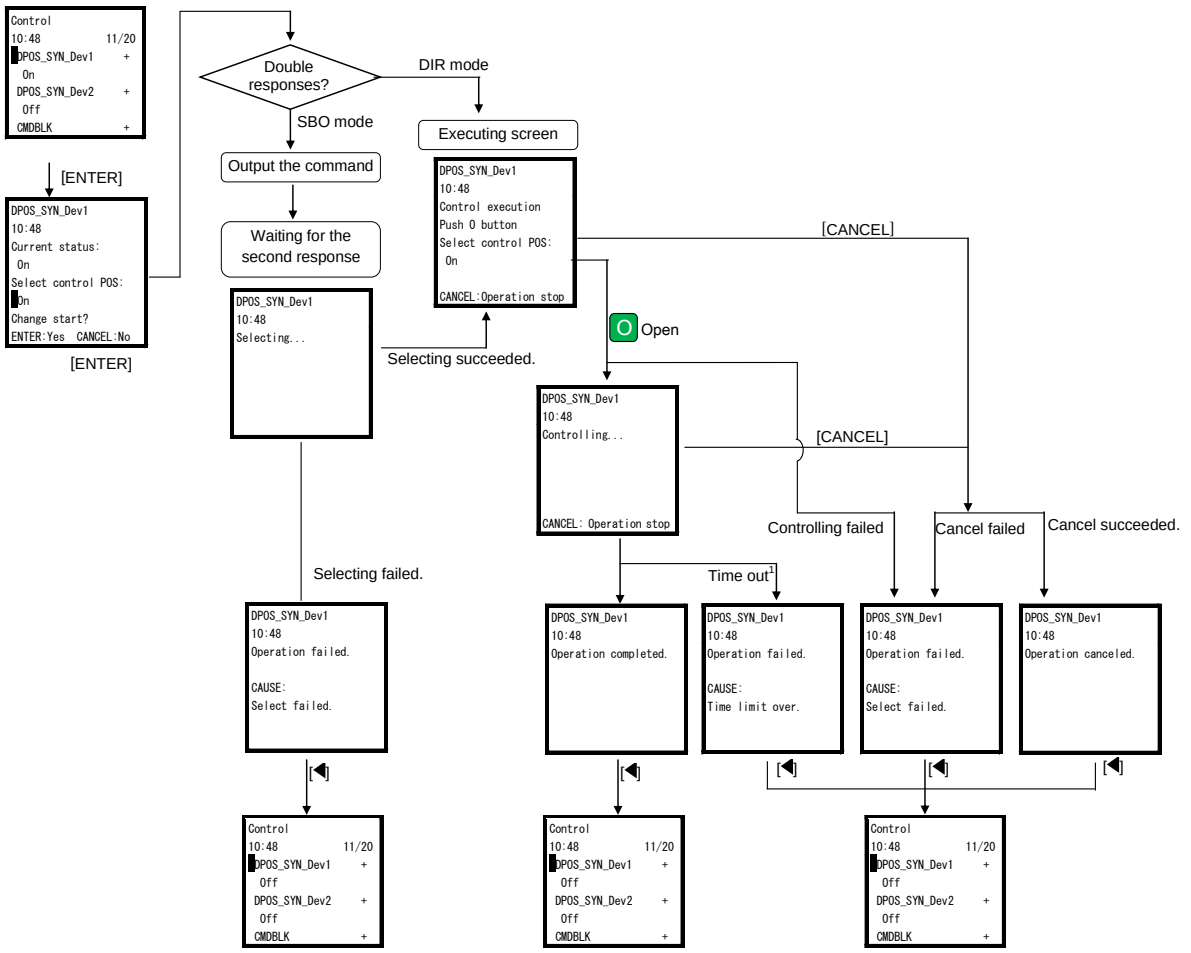


Figure 12.11-2 Operation for opening CB

[1]Note: Time out will occur if no responses come from CB device.

[2]Note: For control 'Circuit breaker', the user should connect 'DPSY01' function with circuit breakers using binary IO modules. See chapter *Control and monitoring application: Double position controller with synchronizing-checking (DPSY)*.

13 Installation

13.1 Caution for storage

You have to pack an IED in the original box after the IED is inspected, if the IED is not required to be installed now; and you have to store it in dry and clean condition.

Recommended storage condition:

- Temperature: 0 degree Celsius to +40 degree Celsius
- No condensation

13.2 Handling precautions

Modules of the IED should be handled in the electro static charge free environment. That is, the user shall use an anti-electrostatic-wrist-band; and it is grounded.

CAUTION

- Before removing a module, ensure that you are at the same electrostatic potential as the equipment by touching the case.
- Handle the module by its front plate, frame or edges of the printed circuit board. Avoid touching the electronic components, printed circuit board or connectors.
- Place the module on an anti-static surface, or on a conducting surface connected to the earth.

You have to check carefully the electronic circuitry for your handling area, which is defined in the IEC 60747 standard.

13.3 Unpack and inspection of hardware and software

The user should unpack and check the IED before use. Be in touch with Toshiba at email (www.toshiba-relays.com) for any issues.

(i) Opening and inspecting relay (IED) package

Open a relay package and inspect physical damage if any. Ensure that the following items are included in the package. If there is any noticeable physical damage, or any of the above items are missing, contact your agent.

- Relay (IED) unit
- Test record: One report sheet
- Installation guide: One guide sheet
- Instruction manuals: Provided within a CD-ROM
- Flange cover: Left cover and right cover
- Function keys label: One label sheet
- LEDs Label: One label sheet

(ii) Manufacture settings (In, Vn, fn, Vdc)

Find the hardware nameplate. The user can know the IED has been produced correctly in terms of rated current (In), voltage (Vn), frequency (fn), and DC rating (Vdc). The user can also find them with Factory settings (Figure 13.3-2).

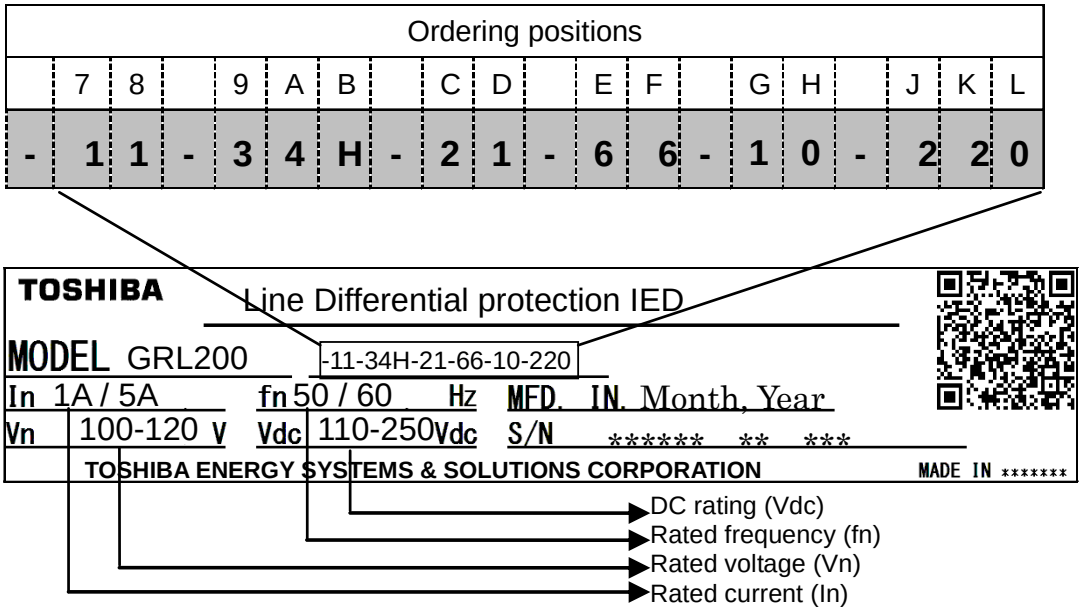


Figure 13.3-1 Hardware nameplate example on the rear

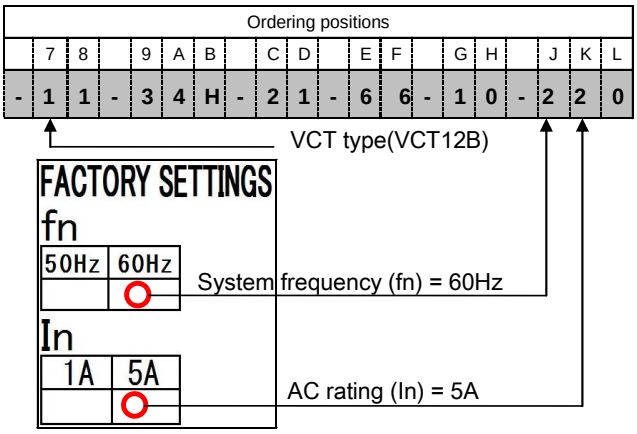


Figure 13.3-2 Factory setting example

Note: The user is not able to change rated values (fn and In); therefore, the user should return the IED for the manufacture if the rated ones are required to change.

(iii) Combination of VCT and BIOs

The transformer module (VCT) is located at the far right slot (e.g., at 'VC1' in Figure 13.3-3). Identify the code at Position '7' to know the VCT type (e.g., VCT12B is implemented by the instruction code at Position '7' in Figure 13.3-2).

The user can check the layout of the binary input and output modules (BI, BO, or BIO) using the ordering codes. For example, the user can find BI3A and BO1A modules in IED depending the ordering cords "4H" at Positions A&B. The user can also know the configuration with IO configuration label.

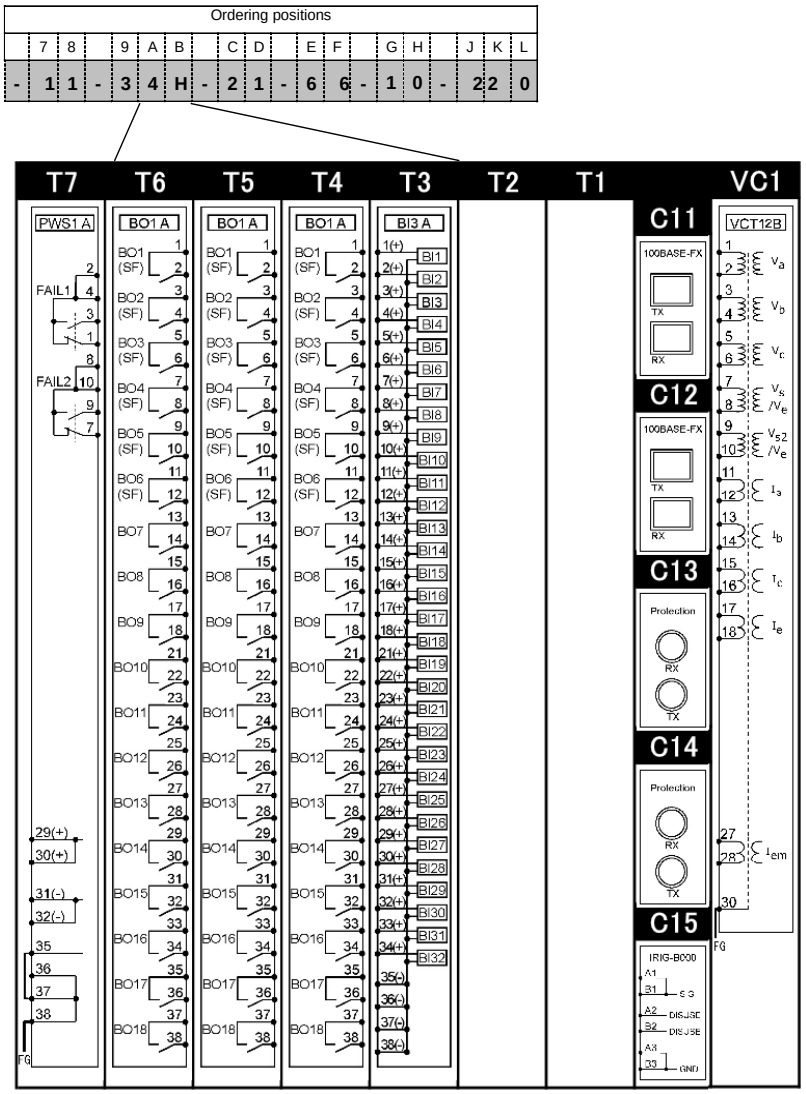


Figure 13.3-3 IO configuration label example (viewing from the back in 3/4 case)

Note: See Section *IED case and module slot* in Chapter *Technical description* to find the structure of IED cases and terminals. For more information about the BI, BO, and BIO circuits, see Section *Binary IO module* in the same chapter.

(iv) Communication modules (LAN and others)

Figure 13.3-3 shows communication modules are implemented at C11 to C15. The layouts of the communication modules are matched with Ordering codes at Positions 'C, D, E, and F'.

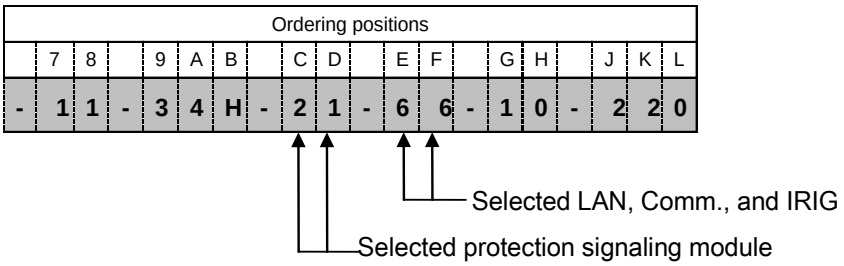


Figure 13.3-4 Example for module selected

(v) Relay and control software

Verifying relay software is possible to check the codes at Positons 'S, G, and T' on Software nameplate. For example of Figure 13.3-5, the IED has '013' software†. This IED can operate in the IEC61850 protocol‡.

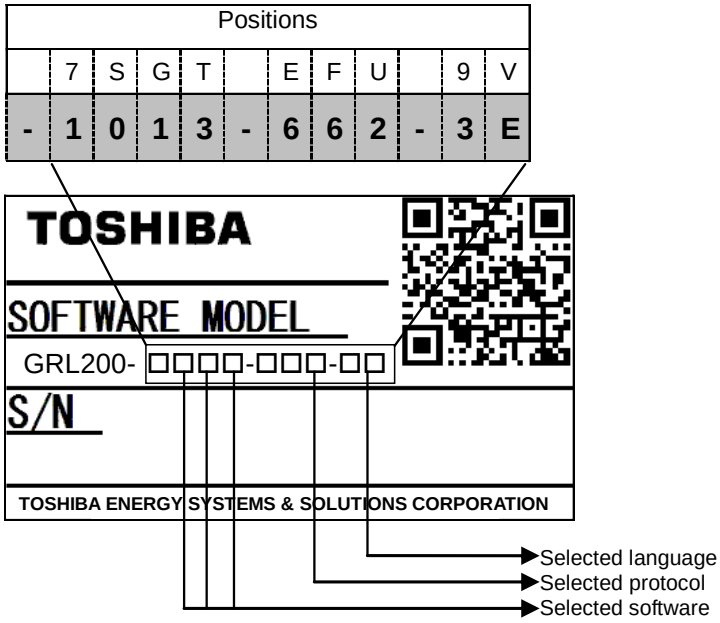


Figure 13.3-5 Software nameplate example on the rear

†Note: For more information about relay functions, see *Chapter Relay application*.

‡Note: For more information about the communication, see *Chapter Communication protocol*.

(vi) Flange covers and labels

Two flange covers (blue ones in Figure 13.3-6) are included in the package. The user can attach them on the IED when mounting into the rack (see succeeding section *Rack mounting*).

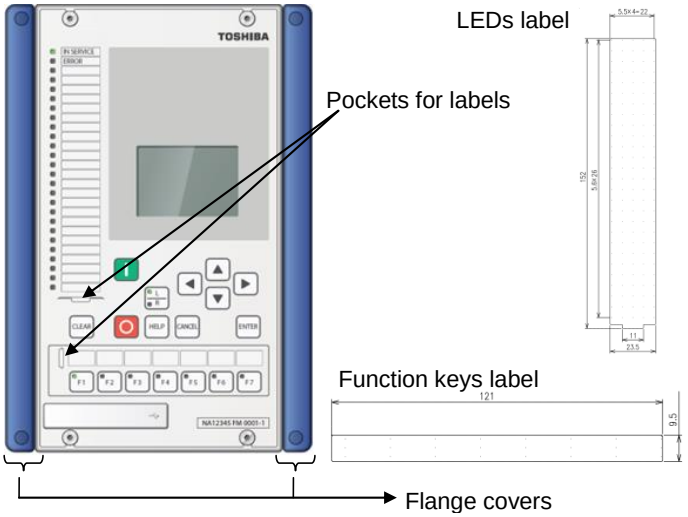


Figure 13.3-6 Flange cover and labels attached on IED

13.4 PWS alarm threshold setting

The IED has power supply module (PWS) at the far left slot. The user can confirm DC rated voltage on the hardware nameplate by checking the cord at Positions '8', but the user should select either alarm thresholds for dropping DC voltage by inserting a jumper on the PWS (Figure 13.4-1). See *Section Power supply module* in *Chapter Technical description*.

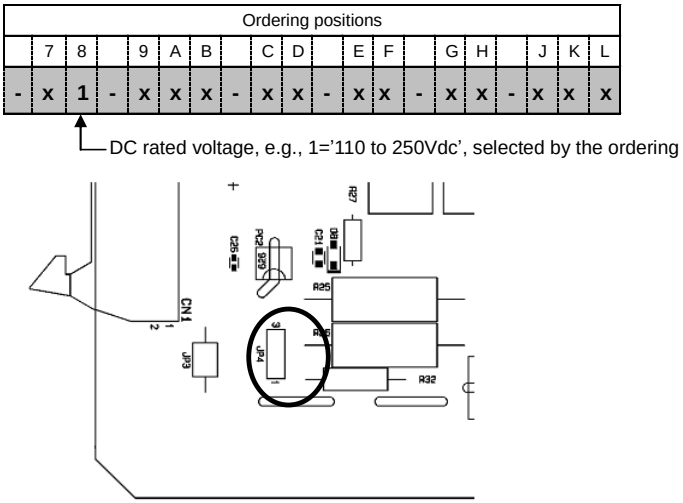


Figure 13.4-1 Alarm threshold can be set on the PWS module

⚠CAUTION

Note: The connection between terminal screw No. 35 and terminal screw No. 37 is made with a short-wire, which is installed by the manufacturer. The user shall remove this short-wire when undertaking the dielectric voltage test for the IED. Remember that the user shall reconnect the terminals with this short-wire after the test (See *Appendix: Notes for the dielectric voltage test*).

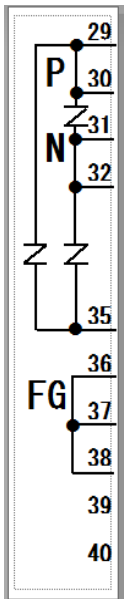


Figure 13.4-2 PWS terminal label

13.5 Removing and installation of an inside module

⚠WARNING

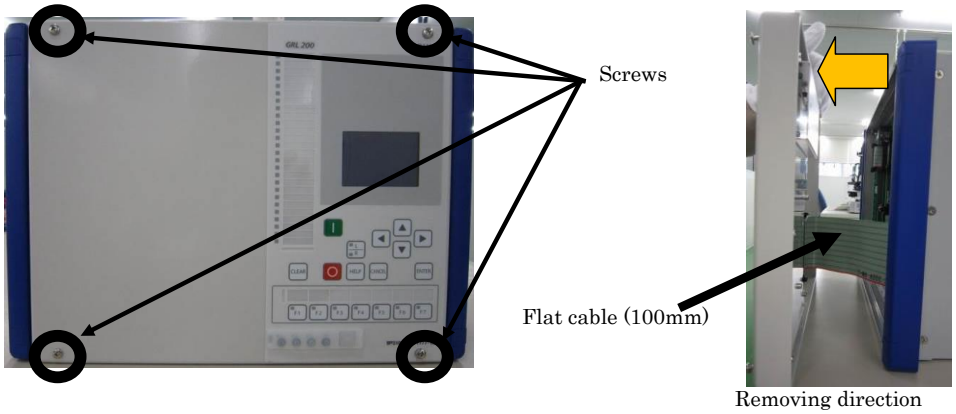
Switch off the DC power supply. Hazardous voltage may remain in the DC circuit just after switching off the DC power supply. It takes about 30 seconds for the voltage to discharge.

⚠CAUTION

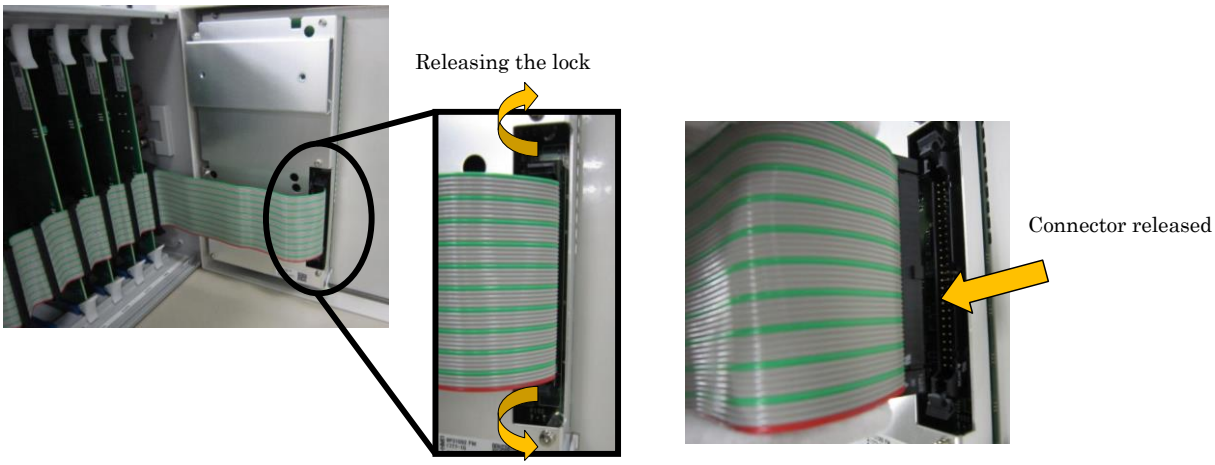
When handling a module, take anti-static measures such as wearing an earthed wrist band and place the modules on an earthed conductive mat. Otherwise, many of the electronic components may get damaged. After replacing the module, check all of the settings including the data related to the PLC, IEC103 and IEC61850, etc. are restored the original settings.

(i) Removal of the front panel and rear terminal

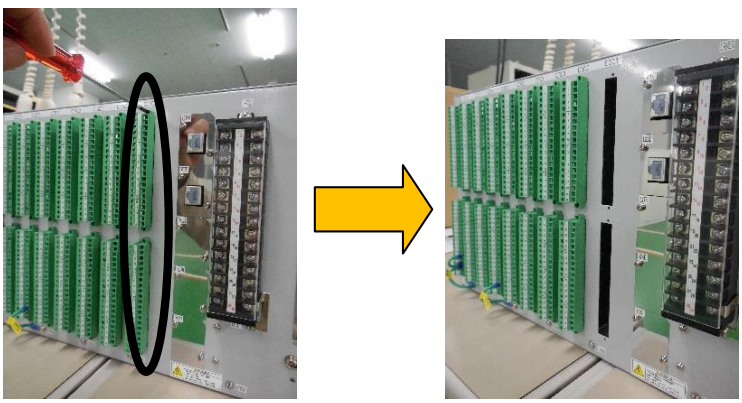
Step 1: Check the power has not been supplied to the equipment. Unscrew four screws on the front panel. Do not pull it forcibly, because inside modules are internally connected using an flat-cable (approximately 100 millimeters length).



Step 2: To remove the flat cable, release the locks at the connector.



Step 3: Detach the terminals where the user wants to replace a broken module with the new one.



(ii) Usage of hook tool for detaching rear terminal blocks

The user can remove the compression terminals using an optional hook tool (Optional code: EP-235). The user should follow the steps, as shown in the below figures.

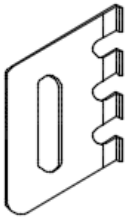
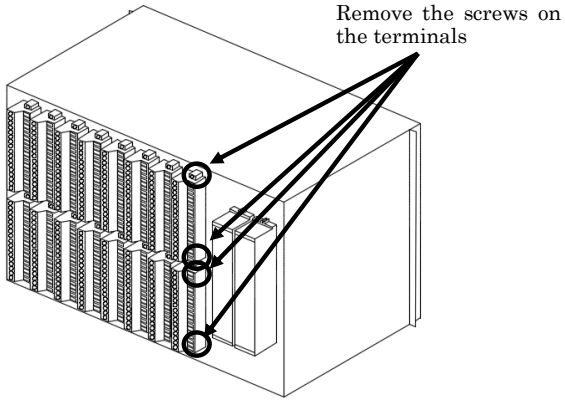
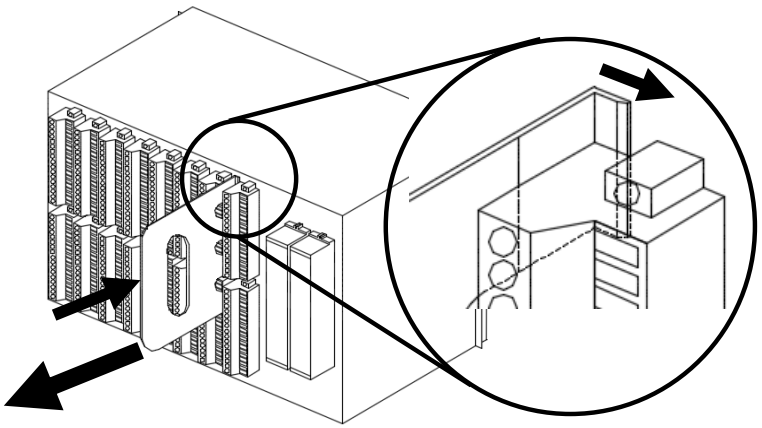


Figure 13.5-1 Hook tool for detaching compression terminals (EP-235)

Step 1: Check whether the power not been supplied for the device. Unscrew four screws on the terminal.

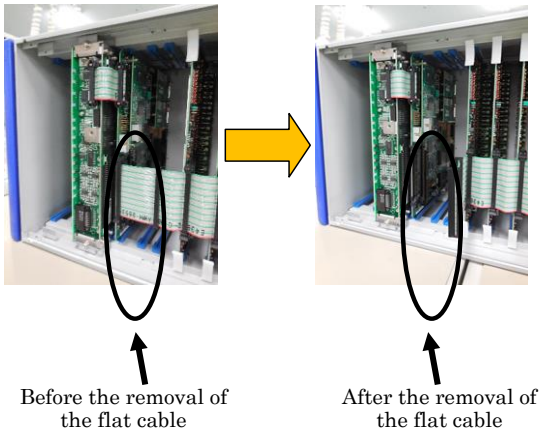


Step 2: For detaching, insert the hook in the gap between the terminal and the rear panel by the means of the illustration below. Check the hook thrusts into the gap between. Then pull the terminal toward you..

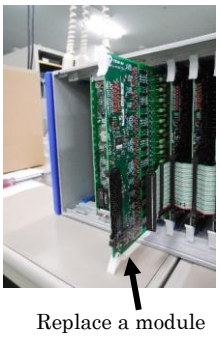


(iii) Replacement of modules

Step 1: Remove a flat cable off, which has been connected between CPU and BIO modules.



Step 2: Take out a module from the case, also insert the new one in the case.

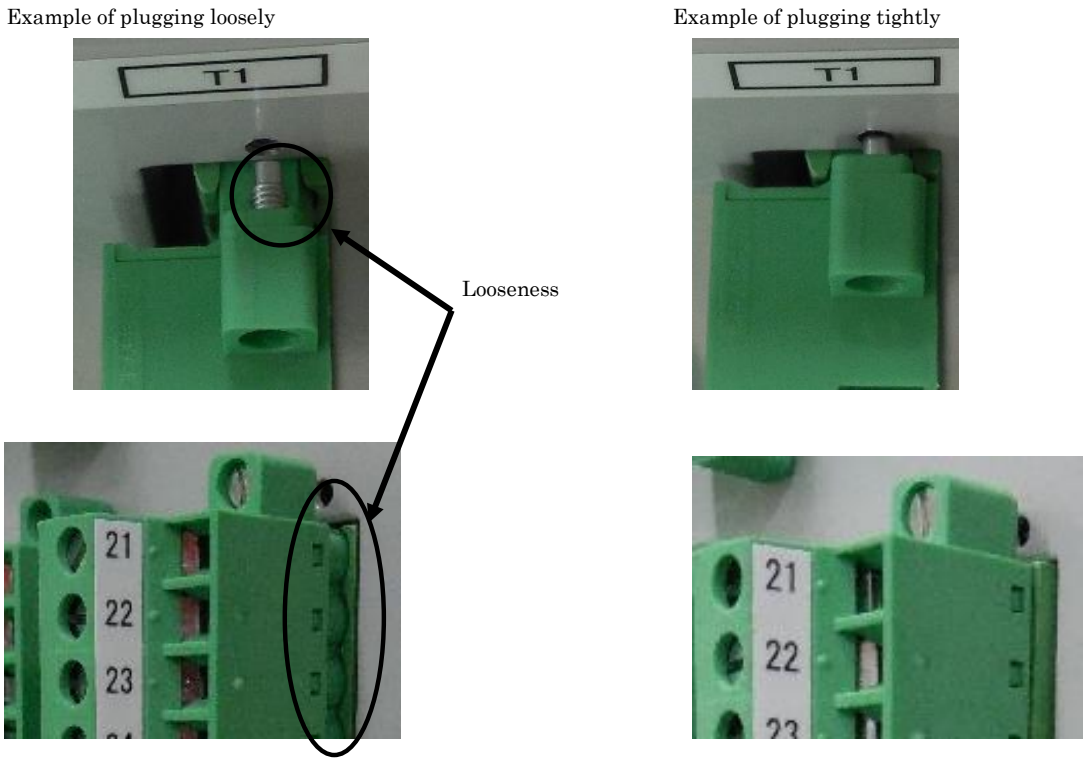


Step 3: Put the flat cable on the edges of the CPU and BIO modules. Check the connection between the modules is made securely by checking locks are enabled at the connector.

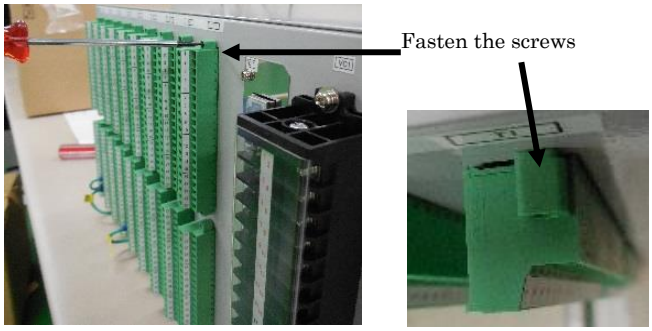


(iv) Installation of terminals

Step 1: Attach the terminal that was detached on the rear. Note that the upper terminal† has 20 screw-numbers denoted '1' to '20', whereas the lower terminal has 20 screw-numbers denoted '21' to '40'. Never attach the upper and lower terminals in the other way. Do not confuse adjacent terminals when the adjacent ones are detached together. Check the terminals are plugged in tightly without any clearances.



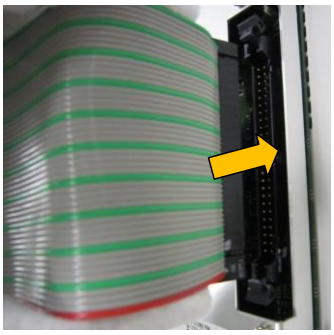
Step 2: Fasten the upper terminal and lower terminals by using the four screws.



†The description is intended for the instruction of the "Compressed type terminal". Hence, the works for other types are not matched, but the user shall check all the terminals including the above terminals are also attached securely.

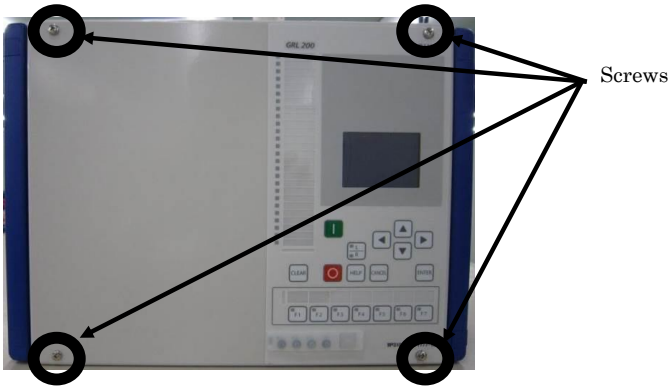
(v) Attachment of the front panel

Step 1: Plug the flat cable. Check the locks are tighten firmly.



Plug the cable in as far as a locking sound is heard.

Step 2: Cover the front panel by tightening the four screws; then the device is ready.



⚠CAUTION

Supply DC power after checking that all the modules are in their original positions and the flat cables are plugged in. If the flat cables are plugged in enough, then the module may get damaged.

13.6 Rack mounting

(i) Mounting 1/1 case

Figure 13.6-1 shows the dimensions for 1/1 case. The mounting procedure is illustrated in Figure 13.6-2. Remember that flange covers for the front panel is provided in the package.

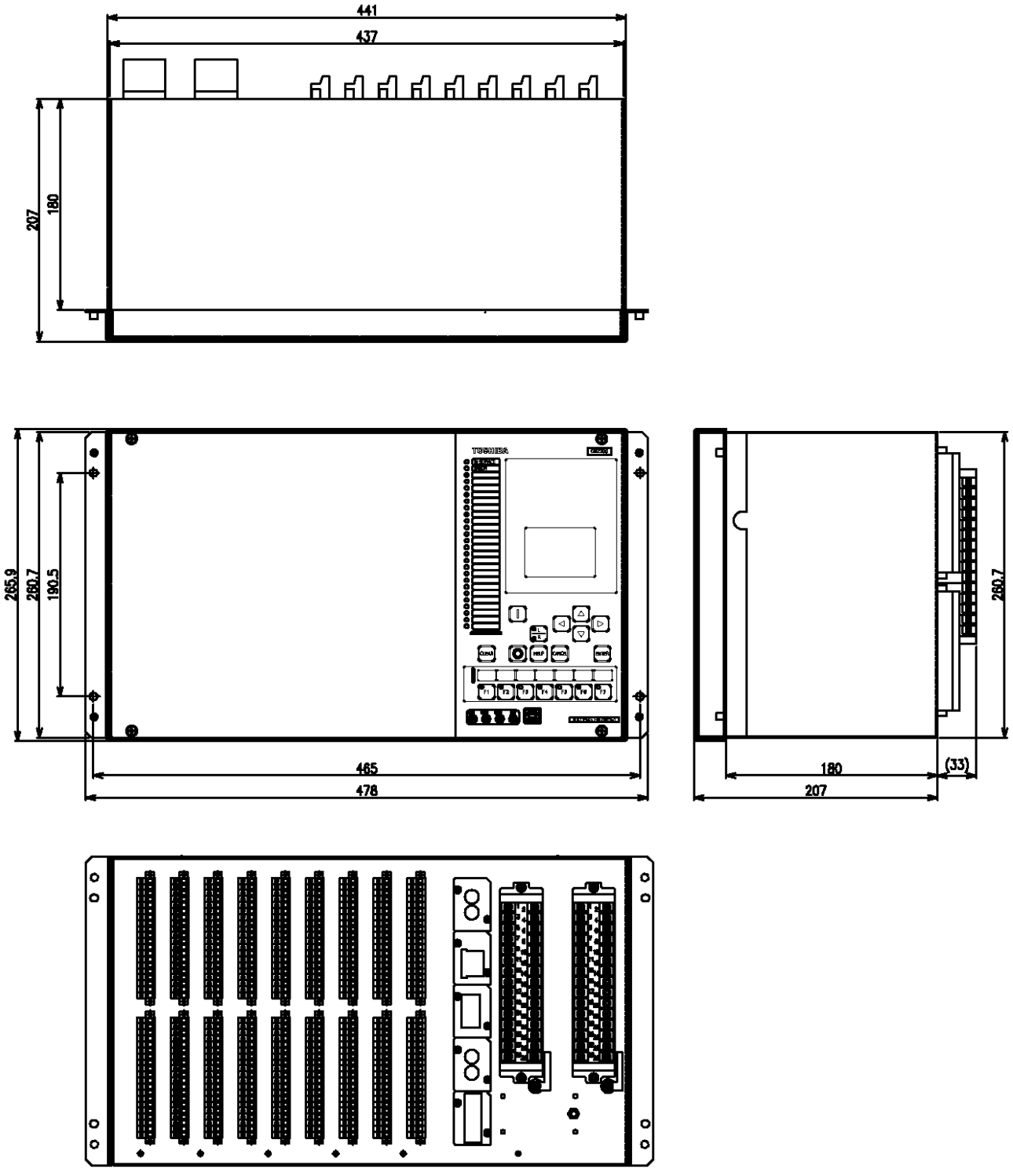


Figure 13.6-1 Dimension (19" × 1/1 size in millimeters)

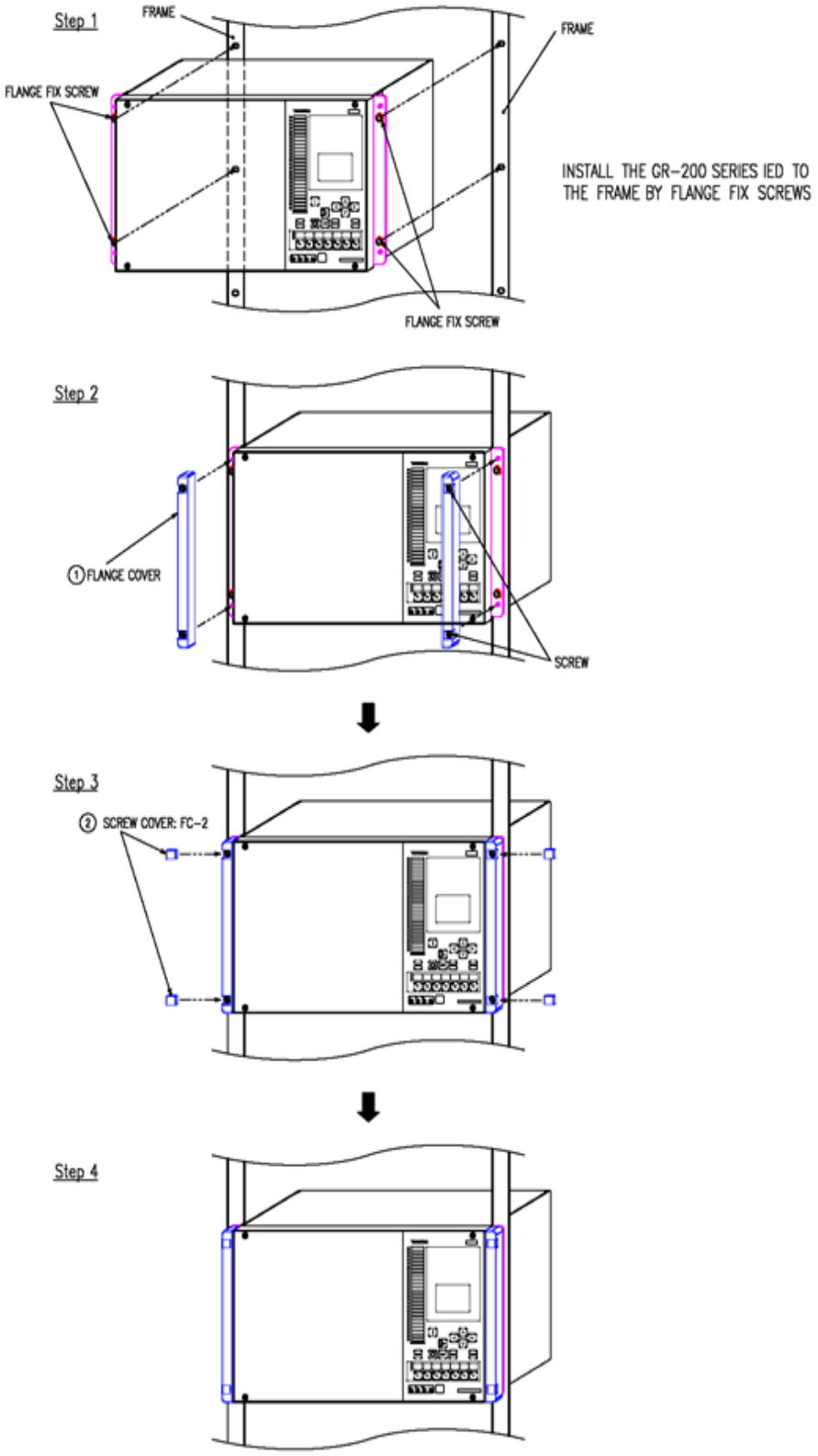


Figure 13.6-2 Mounting procedures

(ii) Mounting 1/2 case and others

For example, the user can mount 1/2 case using a mounting kit (optional accessary) for the rack. Figure 13.6-3 shows the dimension about 1/2 case; Figure 13.6-4 illustrates the IED case

is ready for mounting in the rack when the optional kit is attached on the IED. The procedure to mount the IED for the rack is similar to the instruction of Figure 13.6-2. To find the other cases and kits, see *Appendixes Rack mounting* and *Case outline*.

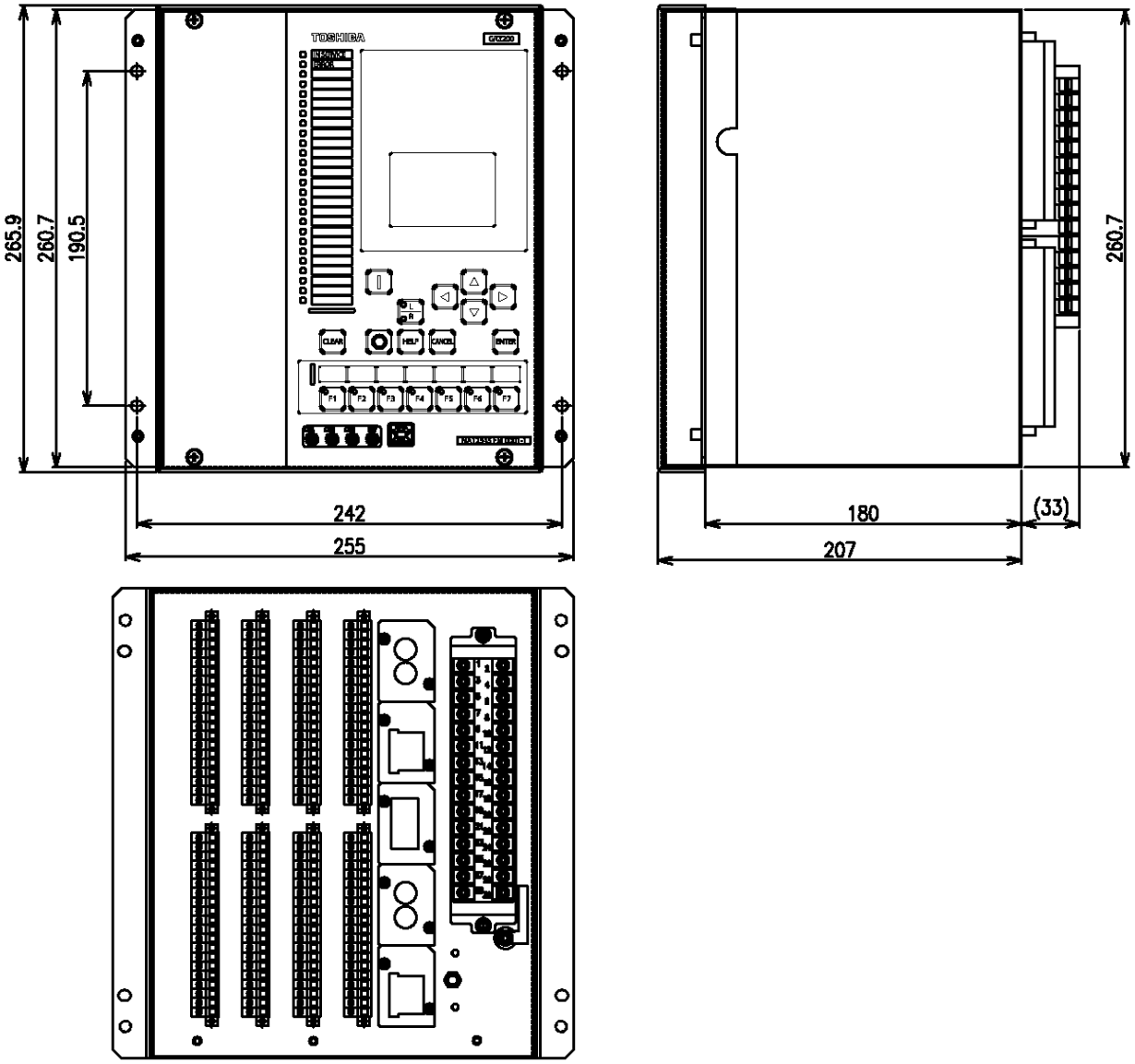


Figure 13.6-3 '1/2 case' dimension (19" × 1/2 size in millimeters)

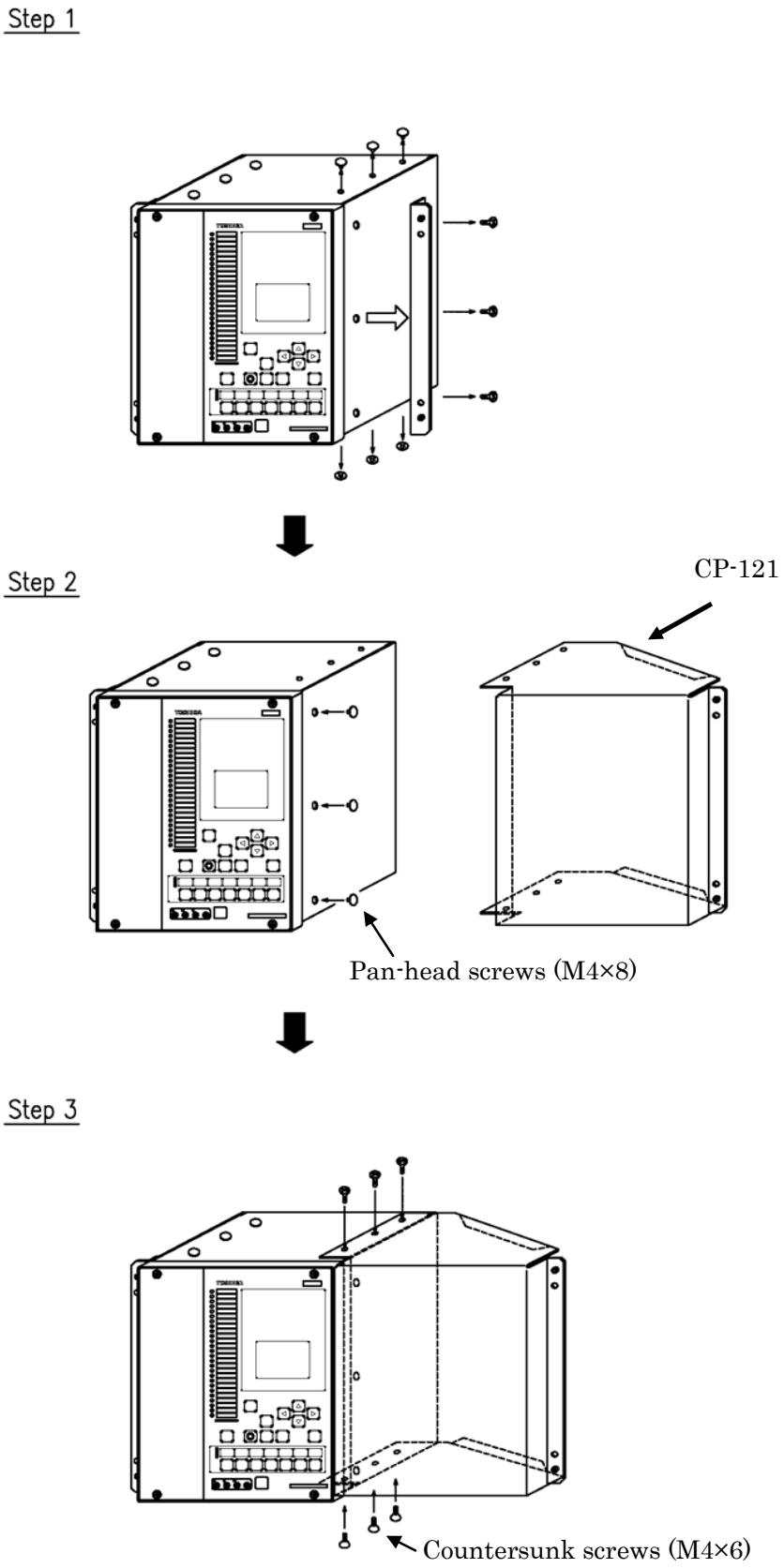


Figure 13.6-4 Optional kit to mount a '1/2 case'

Note: This procedure is not required for flash mounting, but remember that required to attach flange covers.

13.7 Wiring work

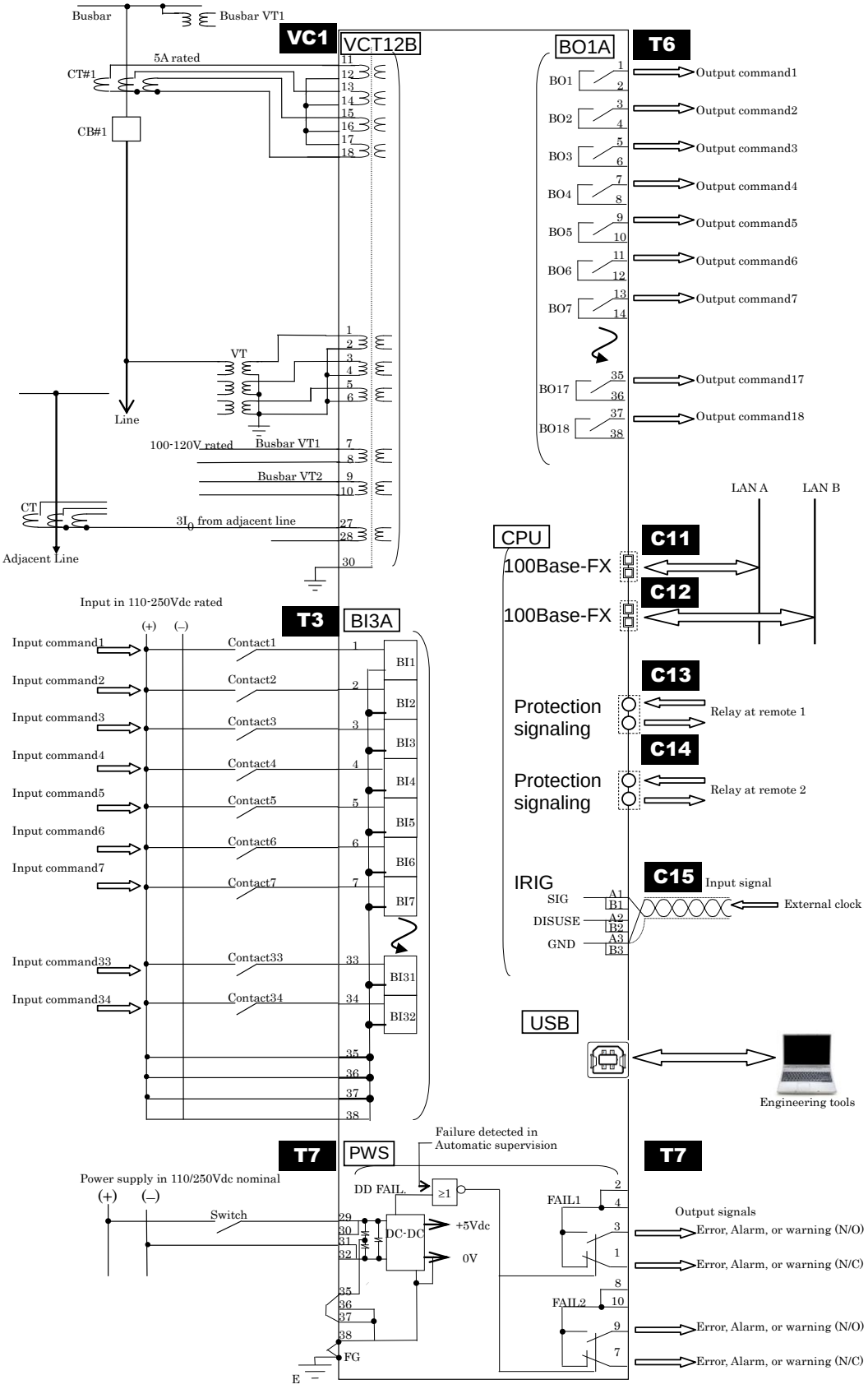


Figure 13.7-1 Cable wiring; example for VCT12B and the other modules

Figure 13.7-1 illustrates example wirings. Power, Current, Voltage, communication signals, contact signals, and signals for engineering tools are connected with the IED.

Table 13.7-1 Wire termination

Connecting for	Wire termination	Wire thickness
BI / BO / PWS	Stripping length = 10 mm (typical)	1.5mm^2 through 2.5 mm^2 or AWG14
VCT	M3.5 ring tongue with insulation	2.5 mm^2 through 5.5 mm^2
Protective earth (FG)	M5 ring tongue with insulation	5.5 mm^2 or larger



Figure 13.7-2 Ring tongue terminations for VCT; ferrule for BI, BO

Note: Use appropriate ferrules depending on the wire thickness.

(i) Power supply module PWS

Power supply module (PWS) can supply power for the relay and control applications when appropriate voltage is provided at Terminals 29 and 31.

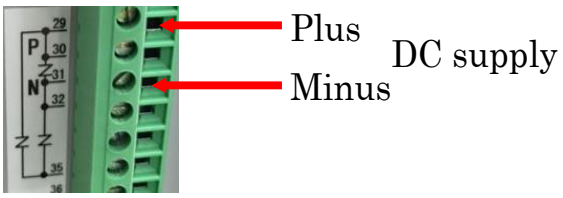


Figure 13.7-3 Terminals for PWS

Note: The error/alarm/warning signals can be also issued on the PWS (See *Chapter Automatic supervision* and *Chapter Technical description: Power supply module*).

(ii) Transformer module VCT

Transformer module (VCT) is provided for AC analog input. The user should connect to VT and CT referring the layout picture of VCT screw terminals.

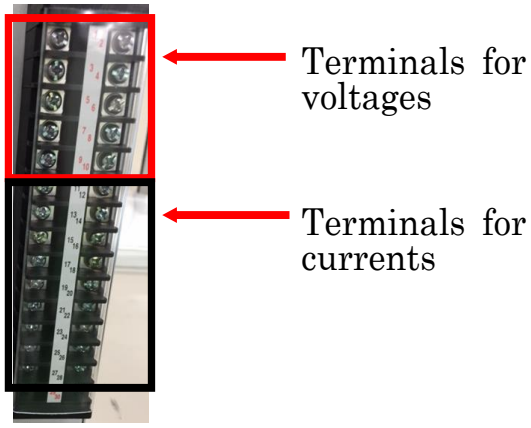


Figure 13.7-4 Terminals for VCT

Note: See *Chapter Technical description: Transformer module for AC analog input* of each IED instruction manual.

(iii) Binary input module BI, Binary output module BO

Terminals in compression type are provided for binary input and output signals. To know the module type and its circuit structure, refer the IO configuration label on the IED side.

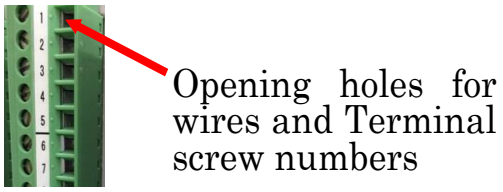


Figure 13.7-5 Terminals for BI and BO

Note: For more information, see *Chapter Technical description: Binary IO module*. The user can program input and output logics using settings.

13.8 Guide for optic cable work

If optic LAN or communication modules are provided, follow the instructions of Figure 13.8-2. For more information about the modules, see *Chapter Technical description: Signal processing and communication module* of each IED instruction manual.

Notice for Optic cable handling

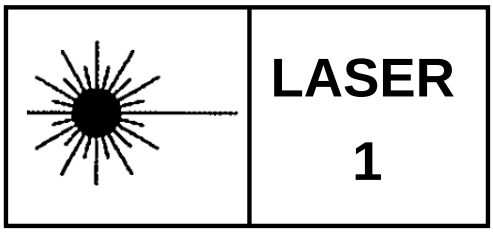


Figure 13.8-1 Class 1 Laser Warning Message

- Do not bend the cable.
- Do not twist the cable.
- Do not kink in the cable.
- Do not put and drop on the cable.

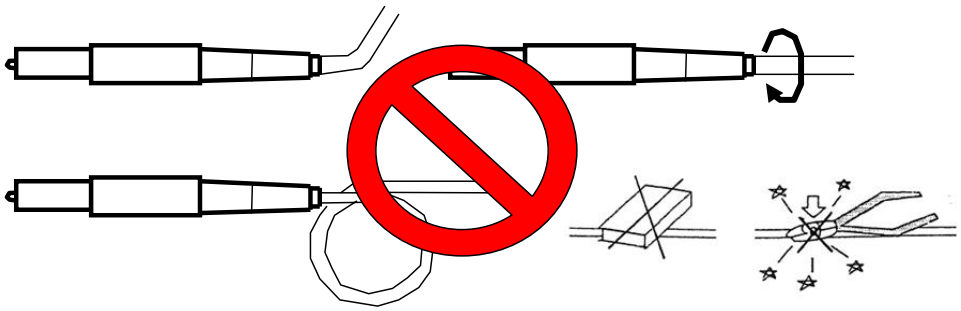


Figure 13.8-2 Fiber Optic Cable Precautions

(i) Communication to a local PC using USB

Figure 13.8-3 illustrates that the user can connect the local PC with the IED (type B receptacle) using a USB cable. Alternatively, the user can connect the local PC with the IED by connecting a RJ45 cable to the LAN port (if available in the IED). In Figure 13.8-4, when using the LAN port, the user has to select the communications option, which can be found from the Main menu in GR-TIEMS (go to "Tool" ->"Option…"; "Option" dialog will be displayed; change communications option with the second tab – 'Communication').

Note: For more information, see *Chapter Engineering tool* and *Chapter Communication protocol*.

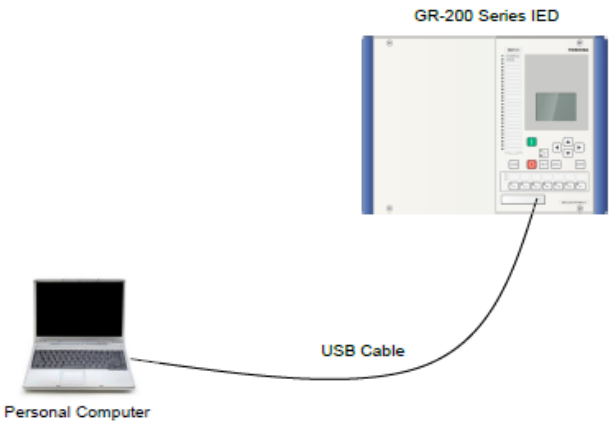


Figure 13.8-3 USB Communications

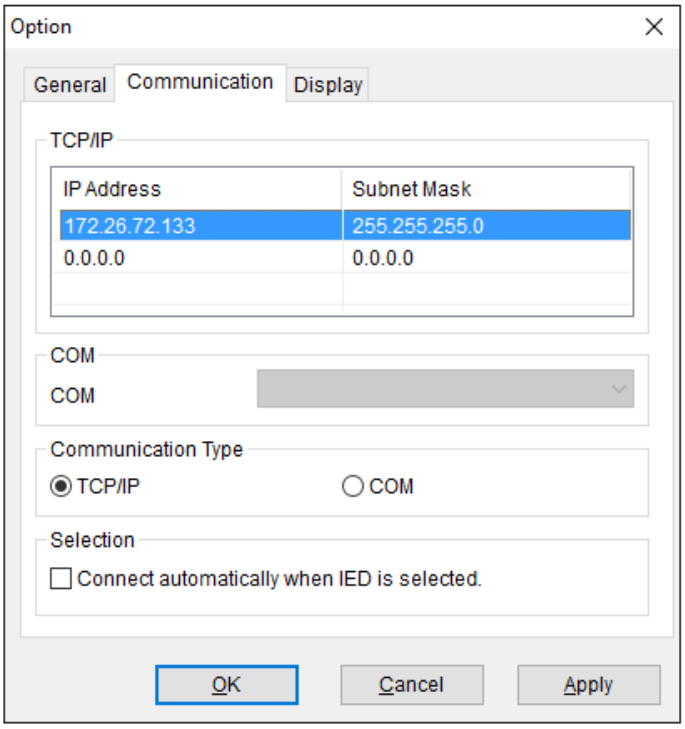


Figure 13.8-4 GR-TIEMs Communications Options

14 Commissioning and maintenance

The IED is fully numerical and the hardware is continuously monitored.
Commissioning tests can be kept to a minimum and need only include hardware tests and conjunctive tests. The function tests are at the user's discretion.
In these tests, user interfaces on the front panel of the IED or local PC can be fully applied.
Test personnel must be familiar with general function of IED testing practices and safety precautions to avoid personal injuries or equipment damage.

Hardware tests

These tests are performed for the following hardware to ensure that there is no hardware defect. Defects of hardware circuits other than the following can be detected by monitoring which circuits functions when the DC power is supplied.

User interfaces
Binary input circuits and output circuits
AC input circuits

Function tests

These tests are performed for the following functions that are fully software-based. Tests of the protection schemes and fault locator require a dynamic test set.

Measuring elements
Timers
Protection schemes
Autoreclose
Metering and recording
Fault locator

Conjunctive tests

The tests are performed after the relay is connected with the primary equipment, telecommunication equipment and other external equipment.
The following tests are included in these tests:

On load test: phase sequence check and polarity check
Signaling circuit test
Tripping and reclosing circuit test

14.1 Cautions

(i) Safety Precautions

⚠CAUTION

- The IED rack is provided with a grounding terminal.
  Before starting the work, always make sure the IED rack is grounded.
- When connecting the cable to the back of the IED, firmly fix it to the terminal block and attach the cover provided on top of it.
- Before checking the interior of the IED, be sure to turn off the power.
- Class 1 laser.

Failure to observe any of the precautions above may cause electric shock or malfunction.

(ii) Cautions on Tests

⚠CAUTION

- While the power is on, do not connect/disconnect the flat cable on the front of the printed circuit board (PCB).
- While the power is on, do not mount/dismount the PCB.
- Before the power is on, check the following:
  - Make sure the polarity and voltage of the power supply are correct.
  - Make sure the CT circuit is not open.
  - Make sure the VT circuit is not short-circuited.
- Transformer module is damaged due to an overcurrent or overvoltage.
- Clear test settings after the test; then, set original settings again.

Failure to observe any of the precautions above may cause damage or malfunction of the relay.
Before mounting/dismounting the PCB, take antistatic measures such as wearing an earthed wristband.

14.2 Preparations

Test equipment

The following test equipment is required for the commissioning tests.

1 Three-phase voltage source
2 Single-phase current sources
1 Dynamic three-phase test set (for protection scheme test)
1 DC power supply
3 DC voltmeters
3 AC voltmeters
3 Phase angle meters
2 AC ammeters

1 Time counter, precision timer

1 PC (not essential)

Relay settings

Before starting the tests, it must be specified whether the tests will use the user's settings or the default settings.

Visual inspection

After unpacking the product, check for any damage to the IED case. If there is any damage, the internal module might also have been affected. Contact the vendor.

Relay ratings

Check that the items described on the nameplate on the front of the IED conform to the user's specification. The items are: relay type and model, AC voltage, current and frequency ratings, and auxiliary DC supply voltage rating.

Local PC

To examine the IED with a PC locally, connect the PC with the IED using a USB cable. The GR-TIEMS software is required to install in the PC.

14.3 Test operations

The user can change IED to for Test mode by the operations on the IED front panel with Main/Sub menus, as shown in Figure 14.3-1.

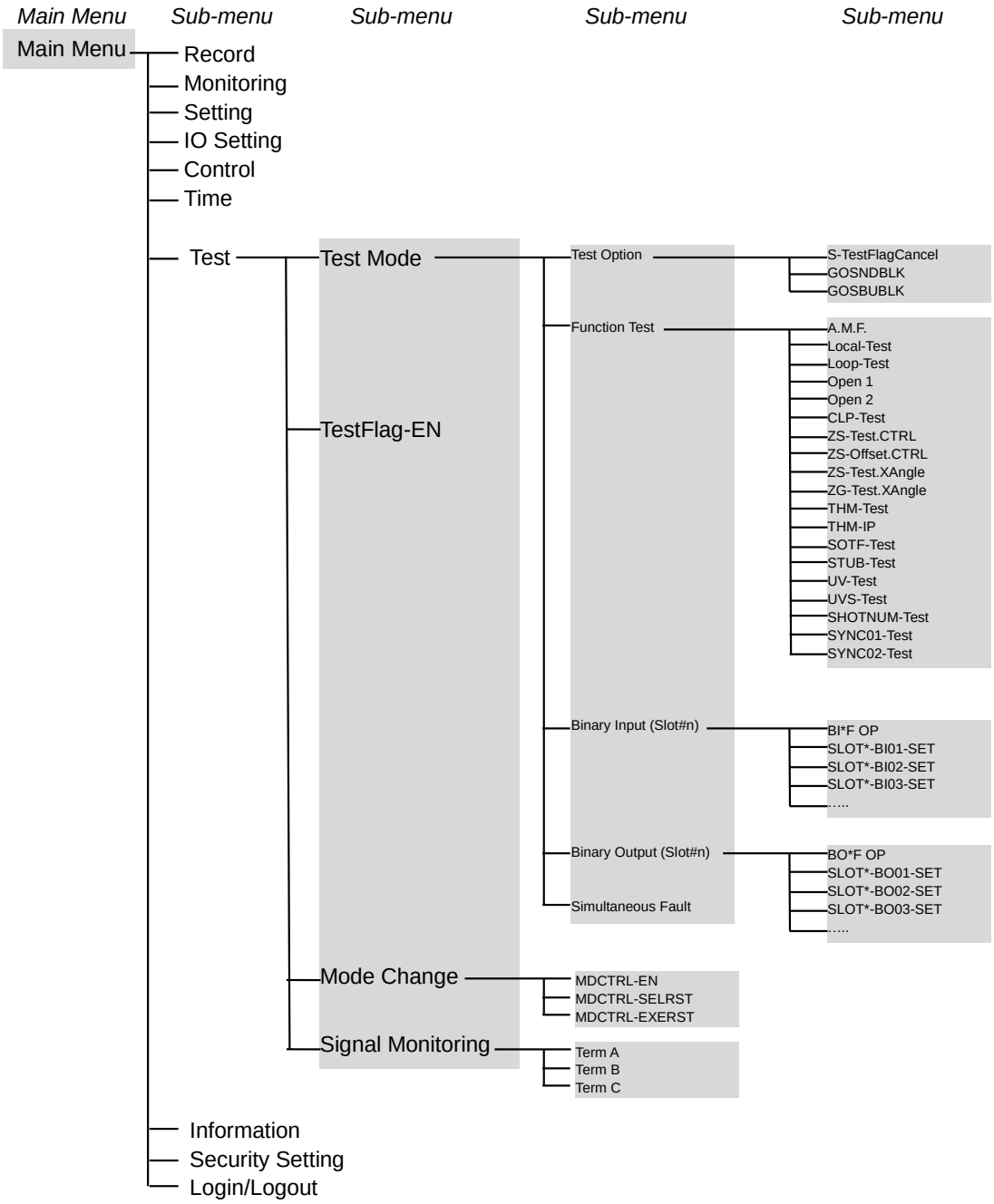


Figure 14.3-1 Structure of test menu

Note: The structure and the contents about sub-menus depend on the software.

14.3.1 Test for communication

(i) GOOSE sending block (GOSNDBLK)

This is used for selecting or disabling the GOOSE sending information where there is a conflict in communication with another active IED while sending a GOOSE signal.

(ii) GOOSE receiving block (GOSUBBLK)

This is used for receiving or rejecting GOOSE subscription information from another IED for testing bad reception. See Chapter *Communication protocol: IEC 61850 communication*.

(iii) Test flag cancel (S-TestFlagCancel)

Test flag in the communication packet will be removed unconditionally, when **On** is set for setting [**Test flag**].

(iv) Test for all communication (TestFlag-EN)

Setting [**TestFlag-EN**]=**On** allows to set test flags at all communication protocol (see Chapter *User interface: Test-submenu*).

14.3.2 Test for relay application

(i) Auto monitoring function (A.M.F)

Issuing alarms will be blocked when **Off** is set for [**A.M.F**]. For the content about the monitoring function, see Chapter *Automatic supervision function*.

(ii) Test flag cancel (S-TestFlagCancel)

Test flag in the communication packet will be removed unconditionally, when **On** is set for setting [**Test flag**].

(iii) Test of cold load protection (CLP-Test)

STATE0 or STATE3 will be selected temporally, if **STATE0** or **STATE3** is set for setting [**CLP-TEST**]. See Chapter *Relay application: Cold load protection* for more detail.

(iv) Local test (Local-test)

When [**Local-test**]=**On**, '1' is set at Local test bit of SCOM4 so that zero-ampere control is executed. For more information, see Chapter *Relay application: Communication application*.

(v) Local loop test (Loop-test)

If [**Loop-test**]=**On,** loop-back test is executed locally See Chapter *Relay application: Communication application* for more details.

(vi) Open test (OPEN 1/OPEN 2)

When setting [**OPEN 1/2**]=**On**, the communication channel#1/2 will be cut locally. Channel arrangements are discussed in Chapter *Relay application: Communication application*.

(vii) ZS, ZG test (ZS-Test.CTRL, ZS-Offset.CTRL, ZS/ZG-Test.XAngle)

(vii)-1 ZS-Test.CTRL

Setting [**ZS-Test.CTRL**]=**On** allows not to operate Zmin feature. For more information about the Zmin, see Chapter *Relay application: Distance protection*.

(vii)-2 ZS-Offset.CTRL

Setting [**ZS-Offset.CTRL**]=**Non-Offset** allows not to operate offset feature during the test.

(vii)-3 ZS-Test.XAngle, ZG-Test.XAngle

Setting [**ZS-Test.XAngle**]=**On** allows to take fixed knee characteristic during the test.

(viii) Thermal overload function test (THM-Test, THM-IP)

Setting [**THM-Test**]=**On** allows to have a test value for the pre-load current (Ip). The Ip value is discussed in Chapter *Relay application: Thermal overload function*.

(ix) SOTF test (SOTF-Test)

Setting [**SOTF-Test**]=**On** allows to generate the cold load condition mandatorily for testing, which is discussed in Chapter *Relay application: Switch on to fault*.

(x) STUB test (STUB-Test)

Setting [**STUB-Test**]=**On** allows to have an test STUB-OC operation in Stub protection area. See Chapter *Relay application: Stub protection with overcurrent relay*.

(xi) Under voltage test (UV,UVS-Test)

Settings [**UV-Test**] and [**UVS-Test**]=**On** is not to operate UV and UVS blocking elements for testing. See Chapter *Relay application: Phase* or *Phase-to-phase under-voltage protection*.

(xii) ARC shot number test (SHOTNUM-Test)

Setting [**SHOTNUM-Test**] is provided so that the user can have the preferred shot number for the ARC test, which is discussed in Chapter *Relay application: Autoreclose*.

14.3.3 Test for control application

(i) Synchronizing check test (SYNC01,02-Test)

Settings [**SYNC01-Test**] and [**SYNC02-Test**]=**On** allows to have test synchronized conditions. See Chapter *Control and monitoring application: Synch check for difference network*.

14.3.4 Test for BI and BO circuits

(i) Binary input circuit test (SLOT*BIxx-SET)

Setting [**SLOT*-BIxx-SET**] allows to have a virtual input at a binary input circuit.

(ii) Binary output circuit test (SLOT*BOxx-SET)

Setting [**SLOT*-BIxx-SET**] allows to have a virtual output at a binary input circuit.

Note: For the BI and BO test operation, see Chapter *User interface: Test sub-menu*, separately.

14.3.5 Test for mode change (MDCTRL)

The function is provided to detect a test mode. For more information, see Chapter *General control function: Mode control function*, separately.

14.3.6 Signal monitor

The function is provided in order that the user can observe IED internal signals. For more information, see Chapter *Technical description: Human machine interface: Monitoring jacks*, separately.

14.3.7 LED light test

The user can perform LED lighting test by pressing the keys ◀ and ▶. Press the both keys on the front panel for a few seconds. If there is no problem, all LEDs will be lit.

Appendix 1 Signal list for common function

◆ Signal monitoring point

CONST_VALUE (Function ID: 100001)

Name	Element ID	Description
C0_BIT	8000001220	Constant value 0 expressed with binary in BIT type
C1_BIT	8000011220	Constant value 1 expressed with binary in BIT type
C0_N8	2000001128	Constant value 0 expressed with unsigned integer in 8 bit
C1_N8	2000011128	Constant value 1 expressed with unsigned integer in 8 bit
C0_N16	2100001129	Constant value 0 expressed with unsigned integer in 16 bit
C1_N16	2100011129	Constant value 1 expressed with unsigned integer in 16 bit
C0_N32	220000112A	Constant value 0 expressed with unsigned integer in 32 bit
C1_N32	220001112A	Constant value 1 expressed with unsigned integer in 32 bit
C0_N64	230000112B	Constant value 0 expressed with unsigned integer in 64 bit
C1_N64	230001112B	Constant value 1 expressed with unsigned integer in 64 bit
C0_S8	2000001120	Constant value 0 expressed with signed integer in 8 bit
C1_S8	2000011120	Constant value 1 expressed with signed integer in 8 bit
C2_S8	2000021120	Constant value 2 expressed with signed integer in 8 bit
C3_S8	2000031120	Constant value 3 expressed with signed integer in 8 bit
C4_S8	2000041120	Constant value 4 expressed with signed integer in 8 bit
C5_S8	2000051120	Constant value 5 expressed with signed integer in 8 bit
C6_S8	2000061120	Constant value 6 expressed with signed integer in 8 bit
C7_S8	2000071120	Constant value 7 expressed with signed integer in 8 bit
C8_S8	2000081120	Constant value 8 expressed with signed integer in 8 bit
C9_S8	2000091120	Constant value 9 expressed with signed integer in 8 bit
C10_S8	20000A1120	Constant value 10 expressed with signed integer in 8 bit
C11_S8	20000B1120	Constant value 11 expressed with signed integer in 8 bit
C12_S8	20000C1120	Constant value 12 expressed with signed integer in 8 bit
C13_S8	20000D1120	Constant value 13 expressed with signed integer in 8 bit
C14_S8	20000E1120	Constant value 14 expressed with signed integer in 8 bit
C15_S8	20000F1120	Constant value 15 expressed with signed integer in 8 bit
C16_S8	2000101120	Constant value 16 expressed with signed integer in 8 bit
C17_S8	2000111120	Constant value 17 expressed with signed integer in 8 bit
C18_S8	2000121120	Constant value 18 expressed with signed integer in 8 bit
C19_S8	2000131120	Constant value 19 expressed with signed integer in 8 bit
C20_S8	2000141120	Constant value 20 expressed with signed integer in 8 bit
C21_S8	2000151120	Constant value 21 expressed with signed integer in 8 bit
C22_S8	2000161120	Constant value 22 expressed with signed integer in 8 bit
C23_S8	2000171120	Constant value 23 expressed with signed integer in 8 bit
C24_S8	2000181120	Constant value 24 expressed with signed integer in 8 bit
C25_S8	2000191120	Constant value 25 expressed with signed integer in 8 bit
C26_S8	20001A1120	Constant value 26 expressed with signed integer in 8 bit
C27_S8	20001B1120	Constant value 27 expressed with signed integer in 8 bit
C28_S8	20001C1120	Constant value 28 expressed with signed integer in 8 bit
C29_S8	20001D1120	Constant value 29 expressed with signed integer in 8 bit
C30_S8	20001E1120	Constant value 30 expressed with signed integer in 8 bit
C31_S8	20001F1120	Constant value 31 expressed with signed integer in 8 bit
C32_S8	2000201120	Constant value 32 expressed with signed integer in 8 bit
C40_S8	2000281120	Constant value 40 expressed with signed integer in 8 bit

◆ Signal monitoring point

CONST_VALUE (Function ID: 100001)

Name	Element ID	Description
C50_S8	2000321120	Constant value 50 expressed with signed integer in 8 bit
C60_S8	20003C1120	Constant value 60 expressed with signed integer in 8 bit
C70_S8	2000461120	Constant value 70 expressed with signed integer in 8 bit
C80_S8	2000501120	Constant value 80 expressed with signed integer in 8 bit
C90_S8	20005A1120	Constant value 90 expressed with signed integer in 8 bit
C100_S8	2000641120	Constant value 100 expressed with signed integer in 8 bit
C0_S16	2100001121	Constant value 0 expressed with signed integer in 16 bit
C1_S16	2100011121	Constant value 1 expressed with signed integer in 16 bit
C2_S16	2100021121	Constant value 2 expressed with signed integer in 16 bit
C3_S16	2100031121	Constant value 3 expressed with signed integer in 16 bit
C4_S16	2100041121	Constant value 4 expressed with signed integer in 16 bit
C5_S16	2100051121	Constant value 5 expressed with signed integer in 16 bit
C6_S16	2100061121	Constant value 6 expressed with signed integer in 16 bit
C7_S16	2100071121	Constant value 7 expressed with signed integer in 16 bit
C8_S16	2100081121	Constant value 8 expressed with signed integer in 16 bit
C9_S16	2100091121	Constant value 9 expressed with signed integer in 16 bit
C10_S16	21000A1121	Constant value 10 expressed with signed integer in 16 bit
C11_S16	21000B1121	Constant value 11 expressed with signed integer in 16 bit
C12_S16	21000C1121	Constant value 12 expressed with signed integer in 16 bit
C13_S16	21000D1121	Constant value 13 expressed with signed integer in 16 bit
C14_S16	21000E1121	Constant value 14 expressed with signed integer in 16 bit
C15_S16	21000F1121	Constant value 15 expressed with signed integer in 16 bit
C16_S16	2100101121	Constant value 16 expressed with signed integer in 16 bit
C17_S16	2100111121	Constant value 17 expressed with signed integer in 16 bit
C18_S16	2100121121	Constant value 18 expressed with signed integer in 16 bit
C19_S16	2100131121	Constant value 19 expressed with signed integer in 16 bit
C20_S16	2100141121	Constant value 20 expressed with signed integer in 16 bit
C21_S16	2100151121	Constant value 21 expressed with signed integer in 16 bit
C22_S16	2100161121	Constant value 22 expressed with signed integer in 16 bit
C23_S16	2100171121	Constant value 23 expressed with signed integer in 16 bit
C24_S16	2100181121	Constant value 24 expressed with signed integer in 16 bit
C25_S16	2100191121	Constant value 25 expressed with signed integer in 16 bit
C26_S16	21001A1121	Constant value 26 expressed with signed integer in 16 bit
C27_S16	21001B1121	Constant value 27 expressed with signed integer in 16 bit
C28_S16	21001C1121	Constant value 28 expressed with signed integer in 16 bit
C29_S16	21001D1121	Constant value 29 expressed with signed integer in 16 bit
C30_S16	21001E1121	Constant value 30 expressed with signed integer in 16 bit
C31_S16	21001F1121	Constant value 31 expressed with signed integer in 16 bit
C32_S16	2100201121	Constant value 32 expressed with signed integer in 16 bit
C40_S16	2100281121	Constant value 40 expressed with signed integer in 16 bit
C50_S16	2100321121	Constant value 50 expressed with signed integer in 16 bit
C60_S16	21003C1121	Constant value 60 expressed with signed integer in 16 bit
C70_S16	2100461121	Constant value 70 expressed with signed integer in 16 bit
C80_S16	2100501121	Constant value 80 expressed with signed integer in 16 bit

◆ Signal monitoring point

CONST_VALUE (Function ID: 100001)

Name	Element ID	Description
C90_S16	21005A1121	Constant value 90 expressed with signed integer in 16 bit
C100_S16	2100641121	Constant value 100 expressed with signed integer in 16 bit
C0_S32	2200001122	Constant value 0 expressed with signed integer in 32 bit
C1_S32	2200011122	Constant value 1 expressed with signed integer in 32 bit
C2_S32	2200021122	Constant value 2 expressed with signed integer in 32 bit
C3_S32	2200031122	Constant value 3 expressed with signed integer in 32 bit
C4_S32	2200041122	Constant value 4 expressed with signed integer in 32 bit
C5_S32	2200051122	Constant value 5 expressed with signed integer in 32 bit
C6_S32	2200061122	Constant value 6 expressed with signed integer in 32 bit
C7_S32	2200071122	Constant value 7 expressed with signed integer in 32 bit
C8_S32	2200081122	Constant value 8 expressed with signed integer in 32 bit
C9_S32	2200091122	Constant value 9 expressed with signed integer in 32 bit
C10_S32	22000A1122	Constant value 10 expressed with signed integer in 32 bit
C11_S32	22000B1122	Constant value 11 expressed with signed integer in 32 bit
C12_S32	22000C1122	Constant value 12 expressed with signed integer in 32 bit
C13_S32	22000D1122	Constant value 13 expressed with signed integer in 32 bit
C14_S32	22000E1122	Constant value 14 expressed with signed integer in 32 bit
C15_S32	22000F1122	Constant value 15 expressed with signed integer in 32 bit
C16_S32	2200101122	Constant value 16 expressed with signed integer in 32 bit
C17_S32	2200111122	Constant value 17 expressed with signed integer in 32 bit
C18_S32	2200121122	Constant value 18 expressed with signed integer in 32 bit
C19_S32	2200131122	Constant value 19 expressed with signed integer in 32 bit
C20_S32	2200141122	Constant value 20 expressed with signed integer in 32 bit
C21_S32	2200151122	Constant value 21 expressed with signed integer in 32 bit
C22_S32	2200161122	Constant value 22 expressed with signed integer in 32 bit
C23_S32	2200171122	Constant value 23 expressed with signed integer in 32 bit
C24_S32	2200181122	Constant value 24 expressed with signed integer in 32 bit
C25_S32	2200191122	Constant value 25 expressed with signed integer in 32 bit
C26_S32	22001A1122	Constant value 26 expressed with signed integer in 32 bit
C27_S32	22001B1122	Constant value 27 expressed with signed integer in 32 bit
C28_S32	22001C1122	Constant value 28 expressed with signed integer in 32 bit
C29_S32	22001D1122	Constant value 29 expressed with signed integer in 32 bit
C30_S32	22001E1122	Constant value 30 expressed with signed integer in 32 bit
C31_S32	22001F1122	Constant value 31 expressed with signed integer in 32 bit
C32_S32	2200201122	Constant value 32 expressed with signed integer in 32 bit
C40_S32	2200281122	Constant value 40 expressed with signed integer in 32 bit
C50_S32	2200321122	Constant value 50 expressed with signed integer in 32 bit
C60_S32	22003C1122	Constant value 60 expressed with signed integer in 32 bit
C70_S32	2200461122	Constant value 70 expressed with signed integer in 32 bit
C80_S32	2200501122	Constant value 80 expressed with signed integer in 32 bit
C90_S32	22005A1122	Constant value 90 expressed with signed integer in 32 bit
C100_S32	2200641122	Constant value 100 expressed with signed integer in 32 bit
C0_S64	2300001123	Constant value 0 expressed with signed integer in 64 bit
C1_S64	2300011123	Constant value 0 expressed with signed integer in 64 bit

◆ Signal monitoring point

CONST_VALUE (Function ID: 100001)

Name	Element ID	Description
C0_U8	3000001124	Constant value 0 expressed with unsigned integer in 8 bit
C1_U8	3000011124	Constant value 1 expressed with unsigned integer in 8 bit
C2_U8	3000021124	Constant value 2 expressed with unsigned integer in 8 bit
C3_U8	3000031124	Constant value 3 expressed with unsigned integer in 8 bit
C4_U8	3000041124	Constant value 4 expressed with unsigned integer in 8 bit
C5_U8	3000051124	Constant value 5 expressed with unsigned integer in 8 bit
C6_U8	3000061124	Constant value 6 expressed with unsigned integer in 8 bit
C7_U8	3000071124	Constant value 7 expressed with unsigned integer in 8 bit
C8_U8	3000081124	Constant value 8 expressed with unsigned integer in 8 bit
C9_U8	3000091124	Constant value 9 expressed with unsigned integer in 8 bit
C10_U8	30000A1124	Constant value 10 expressed with unsigned integer in 8 bit
C11_U8	30000B1124	Constant value 11 expressed with unsigned integer in 8 bit
C12_U8	30000C1124	Constant value 12 expressed with unsigned integer in 8 bit
C13_U8	30000D1124	Constant value 13 expressed with unsigned integer in 8 bit
C14_U8	30000E1124	Constant value 14 expressed with unsigned integer in 8 bit
C15_U8	30000F1124	Constant value 15 expressed with unsigned integer in 8 bit
C16_U8	3000101124	Constant value 16 expressed with unsigned integer in 8 bit
C17_U8	3000111124	Constant value 17 expressed with unsigned integer in 8 bit
C18_U8	3000121124	Constant value 18 expressed with unsigned integer in 8 bit
C19_U8	3000131124	Constant value 19 expressed with unsigned integer in 8 bit
C20_U8	3000141124	Constant value 20 expressed with unsigned integer in 8 bit
C21_U8	3000151124	Constant value 21 expressed with unsigned integer in 8 bit
C22_U8	3000161124	Constant value 22 expressed with unsigned integer in 8 bit
C23_U8	3000171124	Constant value 23 expressed with unsigned integer in 8 bit
C24_U8	3000181124	Constant value 24 expressed with unsigned integer in 8 bit
C25_U8	3000191124	Constant value 25 expressed with unsigned integer in 8 bit
C26_U8	30001A1124	Constant value 26 expressed with unsigned integer in 8 bit
C27_U8	30001B1124	Constant value 27 expressed with unsigned integer in 8 bit
C28_U8	30001C1124	Constant value 28 expressed with unsigned integer in 8 bit
C29_U8	30001D1124	Constant value 29 expressed with unsigned integer in 8 bit
C30_U8	30001E1124	Constant value 30 expressed with unsigned integer in 8 bit
C31_U8	30001F1124	Constant value 31 expressed with unsigned integer in 8 bit
C32_U8	3000201124	Constant value 32 expressed with unsigned integer in 8 bit
C40_U8	3000281124	Constant value 40 expressed with unsigned integer in 8 bit
C50_U8	3000321124	Constant value 50 expressed with unsigned integer in 8 bit
C60_U8	30003C1124	Constant value 60 expressed with unsigned integer in 8 bit
C70_U8	3000461124	Constant value 70 expressed with unsigned integer in 8 bit
C80_U8	3000501124	Constant value 80 expressed with unsigned integer in 8 bit
C90_U8	30005A1124	Constant value 90 expressed with unsigned integer in 8 bit
C100_U8	3000641124	Constant value 100 expressed with unsigned integer in 8 bit
C0_U16	3100001125	Constant value 0 expressed with unsigned integer in 16 bit
C1_U16	3100011125	Constant value 1 expressed with unsigned integer in 16 bit
C2_U16	3100021125	Constant value 2 expressed with unsigned integer in 16 bit
C3_U16	3100031125	Constant value 3 expressed with unsigned integer in 16 bit

◆ Signal monitoring point

CONST_VALUE (Function ID: 100001)

Name	Element ID	Description
C4_U16	3100041125	Constant value 4 expressed with unsigned integer in 16 bit
C5_U16	3100051125	Constant value 5 expressed with unsigned integer in 16 bit
C6_U16	3100061125	Constant value 6 expressed with unsigned integer in 16 bit
C7_U16	3100071125	Constant value 7 expressed with unsigned integer in 16 bit
C8_U16	3100081125	Constant value 8 expressed with unsigned integer in 16 bit
C9_U16	3100091125	Constant value 9 expressed with unsigned integer in 16 bit
C10_U16	31000A1125	Constant value 10 expressed with unsigned integer in 16 bit
C11_U16	31000B1125	Constant value 11 expressed with unsigned integer in 16 bit
C12_U16	31000C1125	Constant value 12 expressed with unsigned integer in 16 bit
C13_U16	31000D1125	Constant value 13 expressed with unsigned integer in 16 bit
C14_U16	31000E1125	Constant value 14 expressed with unsigned integer in 16 bit
C15_U16	31000F1125	Constant value 15 expressed with unsigned integer in 16 bit
C16_U16	3100101125	Constant value 16 expressed with unsigned integer in 16 bit
C17_U16	3100111125	Constant value 17 expressed with unsigned integer in 16 bit
C18_U16	3100121125	Constant value 18 expressed with unsigned integer in 16 bit
C19_U16	3100131125	Constant value 19 expressed with unsigned integer in 16 bit
C20_U16	3100141125	Constant value 20 expressed with unsigned integer in 16 bit
C21_U16	3100151125	Constant value 21 expressed with unsigned integer in 16 bit
C22_U16	3100161125	Constant value 22 expressed with unsigned integer in 16 bit
C23_U16	3100171125	Constant value 23 expressed with unsigned integer in 16 bit
C24_U16	3100181125	Constant value 24 expressed with unsigned integer in 16 bit
C25_U16	3100191125	Constant value 25 expressed with unsigned integer in 16 bit
C26_U16	31001A1125	Constant value 26 expressed with unsigned integer in 16 bit
C27_U16	31001B1125	Constant value 27 expressed with unsigned integer in 16 bit
C28_U16	31001C1125	Constant value 28 expressed with unsigned integer in 16 bit
C29_U16	31001D1125	Constant value 29 expressed with unsigned integer in 16 bit
C30_U16	31001E1125	Constant value 30 expressed with unsigned integer in 16 bit
C31_U16	31001F1125	Constant value 31 expressed with unsigned integer in 16 bit
C32_U16	3100201125	Constant value 32 expressed with unsigned integer in 16 bit
C40_U16	3100281125	Constant value 40 expressed with unsigned integer in 16 bit
C50_U16	3100321125	Constant value 50 expressed with unsigned integer in 16 bit
C60_U16	31003C1125	Constant value 60 expressed with unsigned integer in 16 bit
C70_U16	3100461125	Constant value 70 expressed with unsigned integer in 16 bit
C80_U16	3100501125	Constant value 80 expressed with unsigned integer in 16 bit
C90_U16	31005A1125	Constant value 90 expressed with unsigned integer in 16 bit
C100_U16	3100641125	Constant value 100 expressed with unsigned integer in 16 bit
C0_U32	3200001126	Constant value 0 expressed with unsigned integer in 32 bit
C1_U32	3200011126	Constant value 1 expressed with unsigned integer in 32 bit
C2_U32	3200021126	Constant value 2 expressed with unsigned integer in 32 bit
C3_U32	3200031126	Constant value 3 expressed with unsigned integer in 32 bit
C4_U32	3200041126	Constant value 4 expressed with unsigned integer in 32 bit
C5_U32	3200051126	Constant value 5 expressed with unsigned integer in 32 bit
C6_U32	3200061126	Constant value 6 expressed with unsigned integer in 32 bit
C7_U32	3200071126	Constant value 7 expressed with unsigned integer in 32 bit

◆ Signal monitoring point

CONST_VALUE (Function ID: 100001)

Name	Element ID	Description
C8_U32	3200081126	Constant value 8 expressed with unsigned integer in 32 bit
C9_U32	3200091126	Constant value 9 expressed with unsigned integer in 32 bit
C10_U32	32000A1126	Constant value 10 expressed with unsigned integer in 32 bit
C11_U32	32000B1126	Constant value 11 expressed with unsigned integer in 32 bit
C12_U32	32000C1126	Constant value 12 expressed with unsigned integer in 32 bit
C13_U32	32000D1126	Constant value 13 expressed with unsigned integer in 32 bit
C14_U32	32000E1126	Constant value 14 expressed with unsigned integer in 32 bit
C15_U32	32000F1126	Constant value 15 expressed with unsigned integer in 32 bit
C16_U32	3200101126	Constant value 16 expressed with unsigned integer in 32 bit
C17_U32	3200111126	Constant value 17 expressed with unsigned integer in 32 bit
C18_U32	3200121126	Constant value 18 expressed with unsigned integer in 32 bit
C19_U32	3200131126	Constant value 19 expressed with unsigned integer in 32 bit
C20_U32	3200141126	Constant value 20 expressed with unsigned integer in 32 bit
C21_U32	3200151126	Constant value 21 expressed with unsigned integer in 32 bit
C22_U32	3200161126	Constant value 22 expressed with unsigned integer in 32 bit
C23_U32	3200171126	Constant value 23 expressed with unsigned integer in 32 bit
C24_U32	3200181126	Constant value 24 expressed with unsigned integer in 32 bit
C25_U32	3200191126	Constant value 25 expressed with unsigned integer in 32 bit
C26_U32	32001A1126	Constant value 26 expressed with unsigned integer in 32 bit
C27_U32	32001B1126	Constant value 27 expressed with unsigned integer in 32 bit
C28_U32	32001C1126	Constant value 28 expressed with unsigned integer in 32 bit
C29_U32	32001D1126	Constant value 29 expressed with unsigned integer in 32 bit
C30_U32	32001E1126	Constant value 30 expressed with unsigned integer in 32 bit
C31_U32	32001F1126	Constant value 31 expressed with unsigned integer in 32 bit
C32_U32	3200201126	Constant value 32 expressed with unsigned integer in 32 bit
C40_U32	3200281126	Constant value 40 expressed with unsigned integer in 32 bit
C50_U32	3200321126	Constant value 50 expressed with unsigned integer in 32 bit
C60_U32	32003C1126	Constant value 60 expressed with unsigned integer in 32 bit
C70_U32	3200461126	Constant value 70 expressed with unsigned integer in 32 bit
C80_U32	3200501126	Constant value 80 expressed with unsigned integer in 32 bit
C90_U32	32005A1126	Constant value 90 expressed with unsigned integer in 32 bit
C100_U32	3200641126	Constant value 100 expressed with unsigned integer in 32 bit
C0_U64	3300001127	Constant value 0 expressed with unsigned integer in 64 bit
C1_U64	3300011127	Constant value 1 expressed with unsigned integer in 64 bit

◆ Signal monitoring point

BIO_FORCE (Function ID: 240101)

Name	Element ID	Description
BI1F OP	3110001198	BI1 forced operate start
BI2F OP	3111001198	BI2 forced operate start
BI3F OP	3112001198	BI3 forced operate start
BI4F OP	3113001198	BI4 forced operate start
BI5F OP	3114001198	BI5 forced operate start

◆ Signal monitoring point

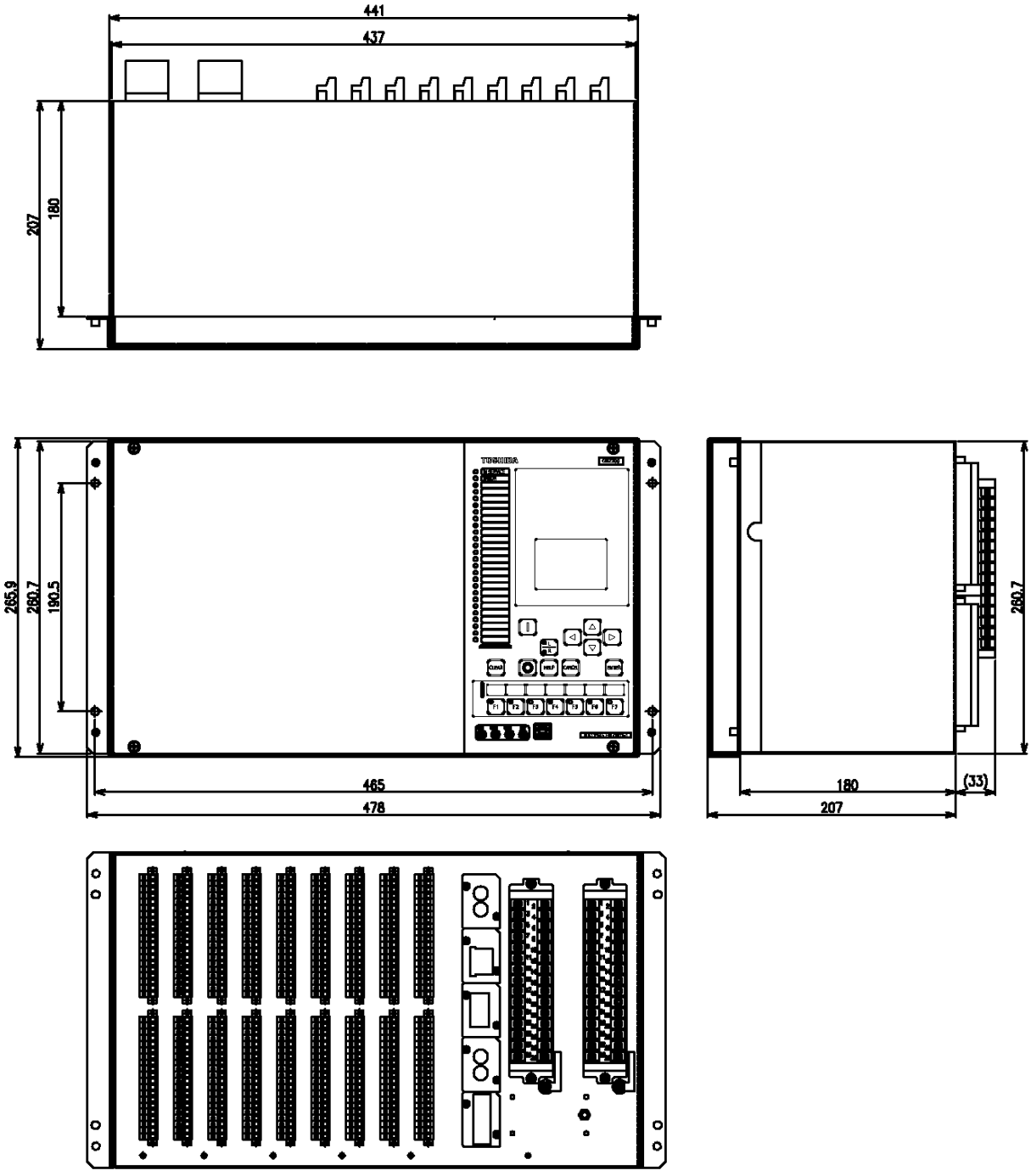
BIO_FORCE (Function ID: 240101)

Name	Element ID	Description
BI6F OP	3115001198	BI6 forced operate start
BI7F OP	3116001198	BI7 forced operate start
BI8F OP	3117001198	BI8 forced operate start
BI9F OP	3118001198	BI9 forced operate start
BI10F OP	3119001198	BI10 forced operate start
BI11F OP	311A001198	BI11 forced operate start
BI12F OP	311B001198	BI12 forced operate start
BI13F OP	311C001198	BI13 forced operate start
BI14F OP	311D001198	BI14 forced operate start
BI15F OP	311E001198	BI15 forced operate start
BI16F OP	311F001198	BI16 forced operate start
BO1F OP	3110201198	BO1 forced operate start
BO2F OP	3111201198	BO2 forced operate start
BO3F OP	3112201198	BO3 forced operate start
BO4F OP	3113201198	BO4 forced operate start
BO5F OP	3114201198	BO5 forced operate start
BO6F OP	3115201198	BO6 forced operate start
BO7F OP	3116201198	BO7 forced operate start
BO8F OP	3117201198	BO8 forced operate start
BO9F OP	3118201198	BO9 forced operate start
BO10F OP	3119201198	BO10 forced operate start
BO11F OP	311A201198	BO11 forced operate start
BO12F OP	311B201198	BO12 forced operate start
BO13F OP	311C201198	BO13 forced operate start
BO14F OP	311D201198	BO14 forced operate start
BO15F OP	311E201198	BO15 forced operate start
BO16F OP	311F201198	BO16 forced operate start
BI1F OP	3110001198	BI1 forced operate start
BI2F OP	3111001198	BI2 forced operate start
BI3F OP	3112001198	BI3 forced operate start
BI4F OP	3113001198	BI4 forced operate start
BI5F OP	3114001198	BI5 forced operate start
BI6F OP	3115001198	BI6 forced operate start
BI7F OP	3116001198	BI7 forced operate start
BI8F OP	3117001198	BI8 forced operate start
BI9F OP	3118001198	BI9 forced operate start
BI10F OP	3119001198	BI10 forced operate start
BI11F OP	311A001198	BI11 forced operate start
BI12F OP	311B001198	BI12 forced operate start
BI13F OP	311C001198	BI13 forced operate start
BI14F OP	311D001198	BI14 forced operate start

Appendix 2 Case outline

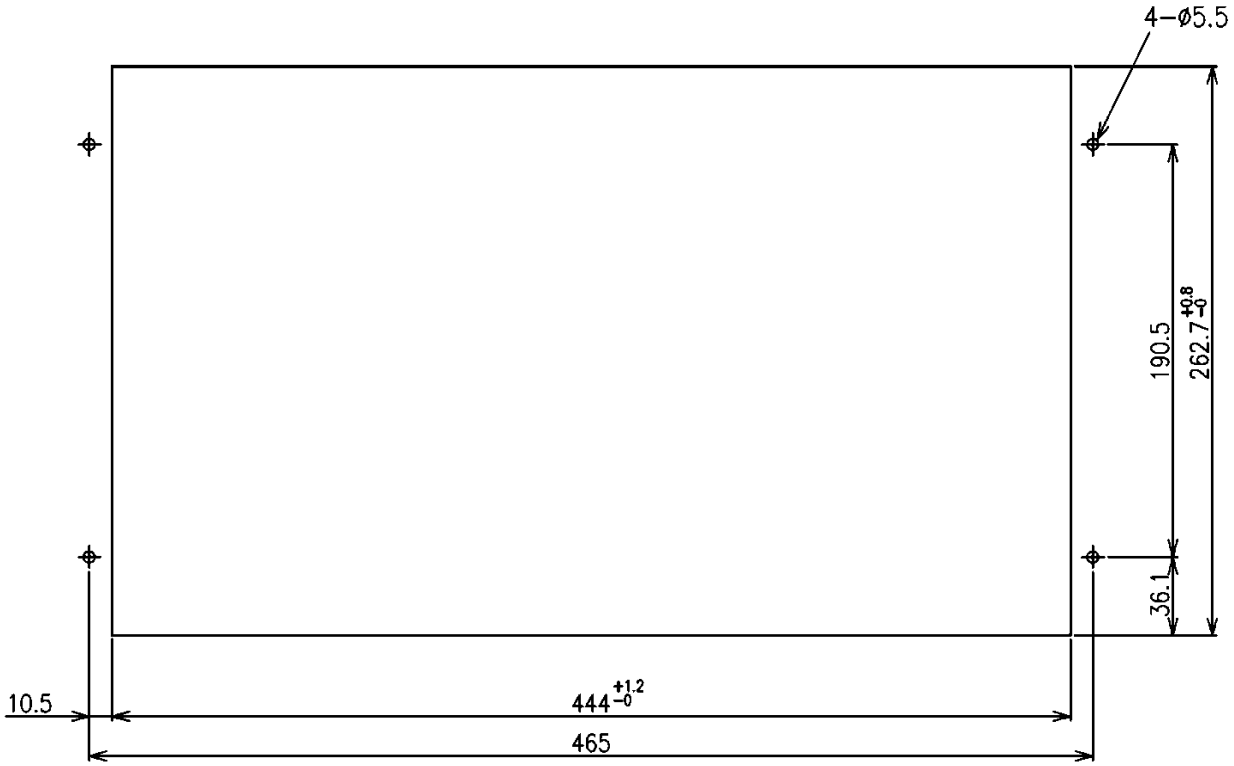
1/1 case size

1. Trihedral figure (1/1×19 inches) for "Compression type terminal" case

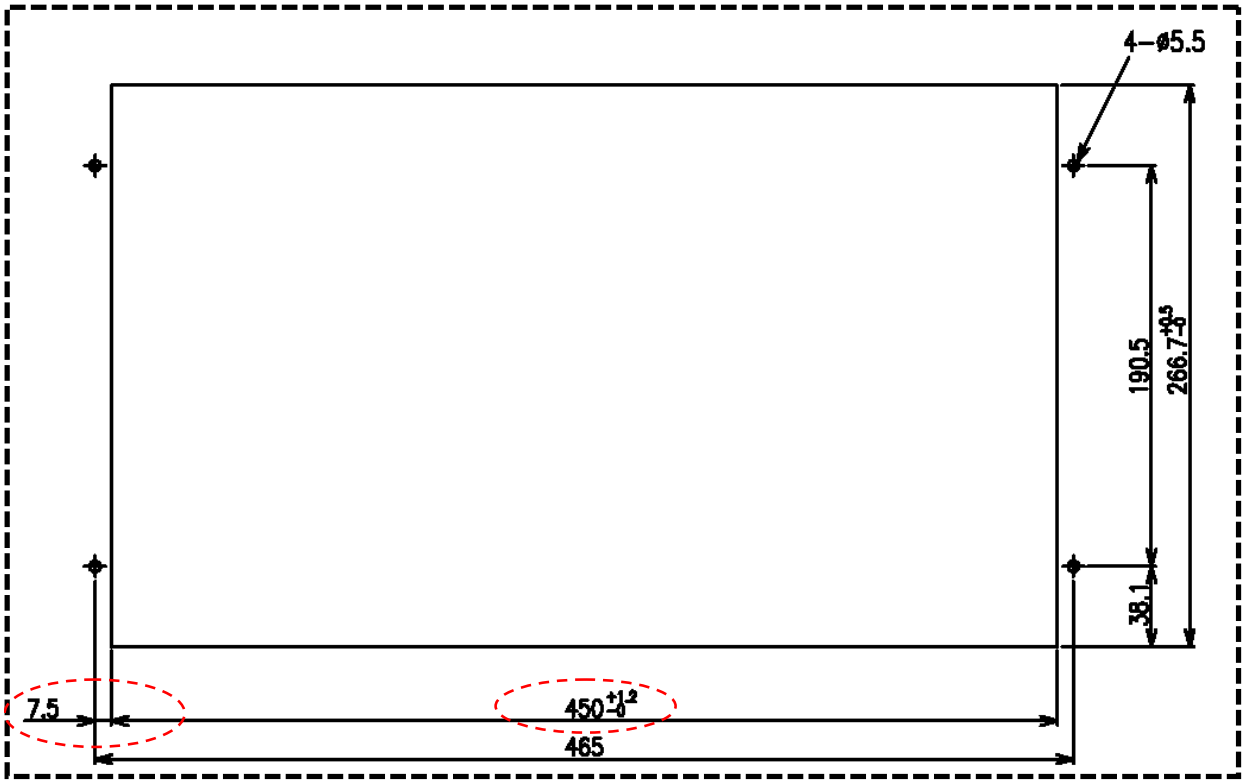


Note: Dimensions shown in millimeters

2. Panel cut out figure (1/1×19 inches) for "Compression type terminal" case



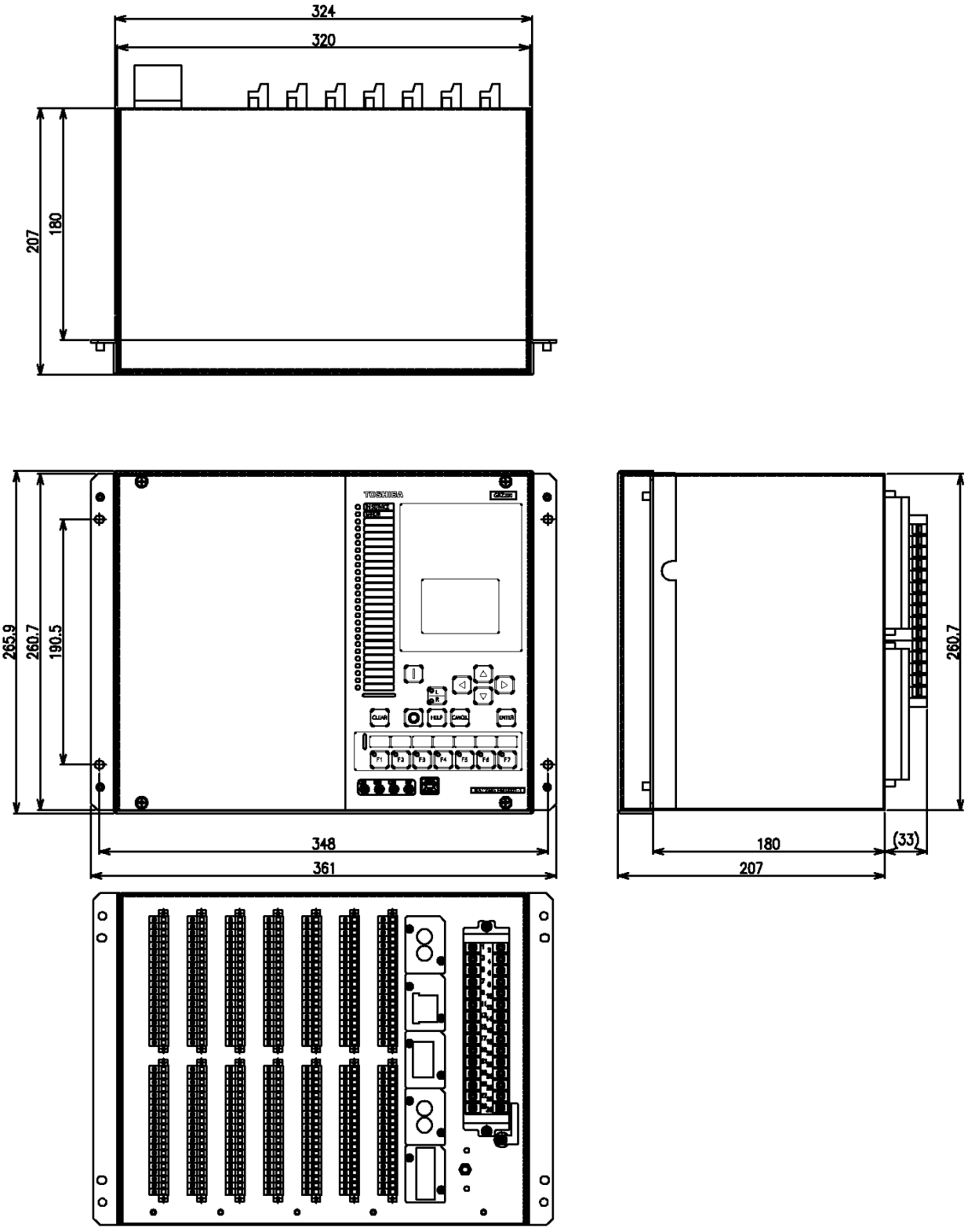
3. Panel cut out figure (1/1×19 inches) when "**Ring lug type terminal**" applied



Note: Dimensions shown in millimeter

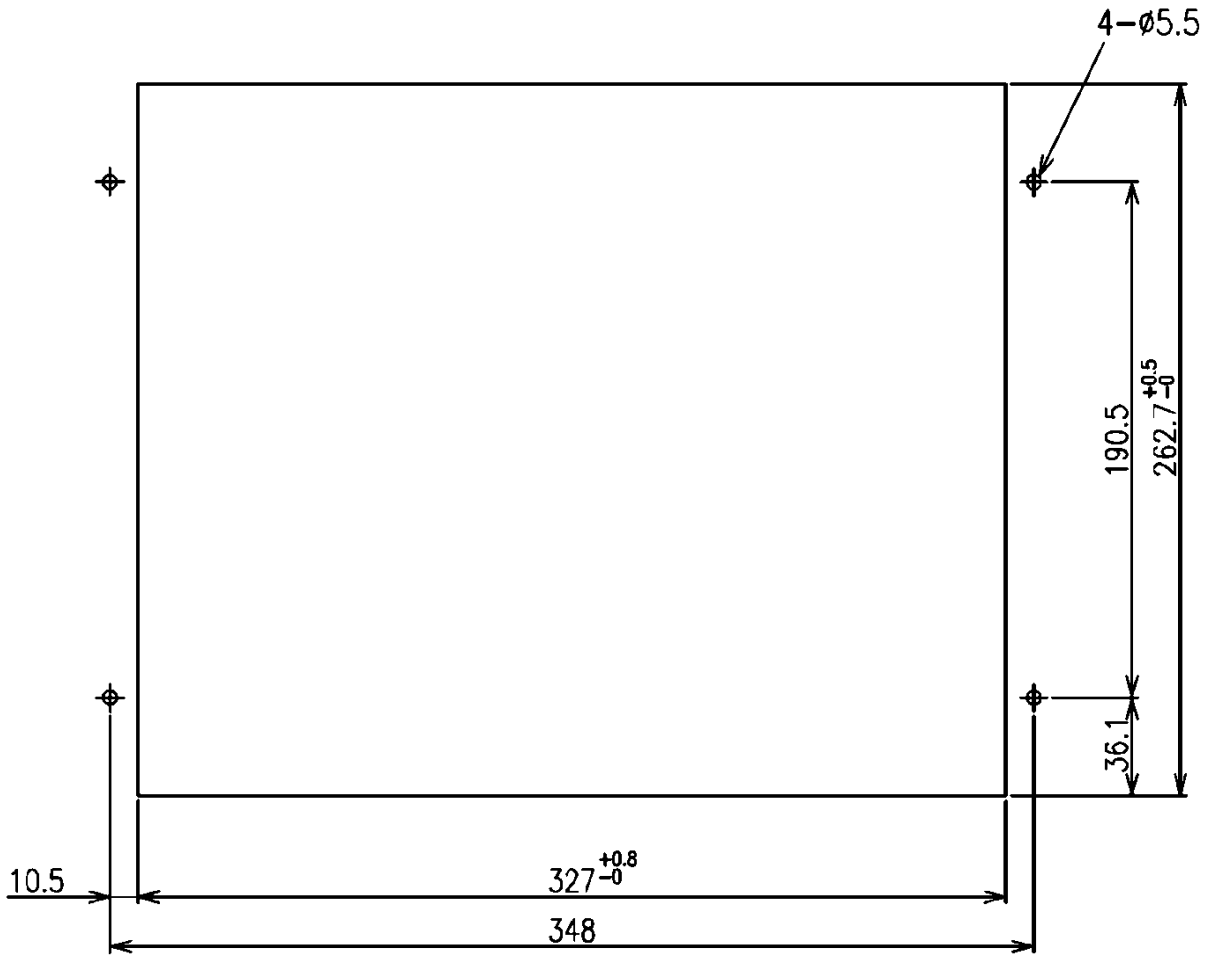
3/4 case size

1. Trihedral figure (3/4×19 inches) for "Compression type terminal" case



Note: Dimensions shown in millimeters

2. Panel cut out figure (3/4×19 inches) for "Compression type terminal" case



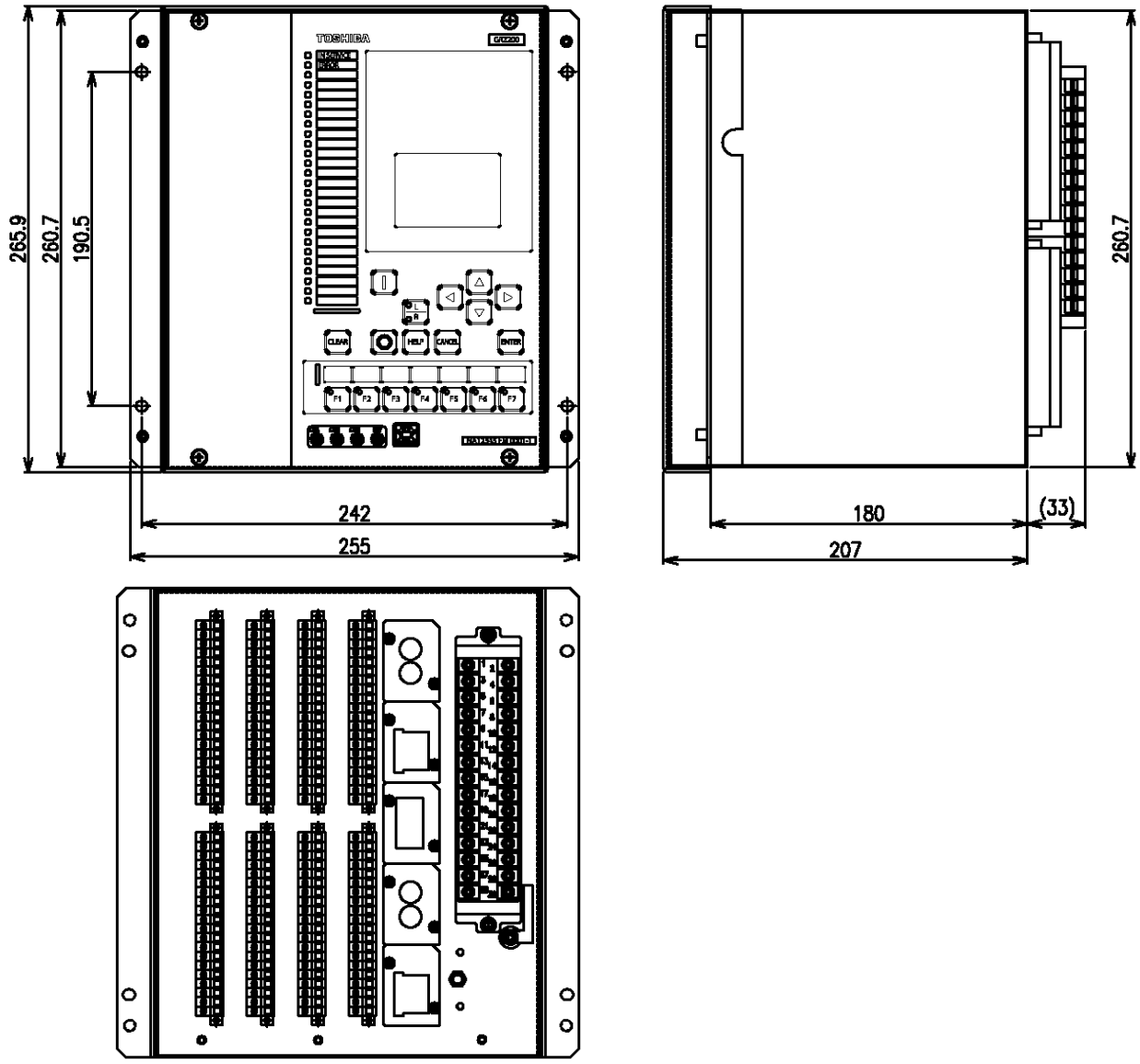
[1]Note: Dimensions shown in millimeters.

[2]Note: When you wish to know about the panel-cut-out-figures corresponding to rack-attachment kits, refer to *Appendix: Rack mounting*.

[3]Note: For the size relating to "Ring type terminal" case, see other figures.

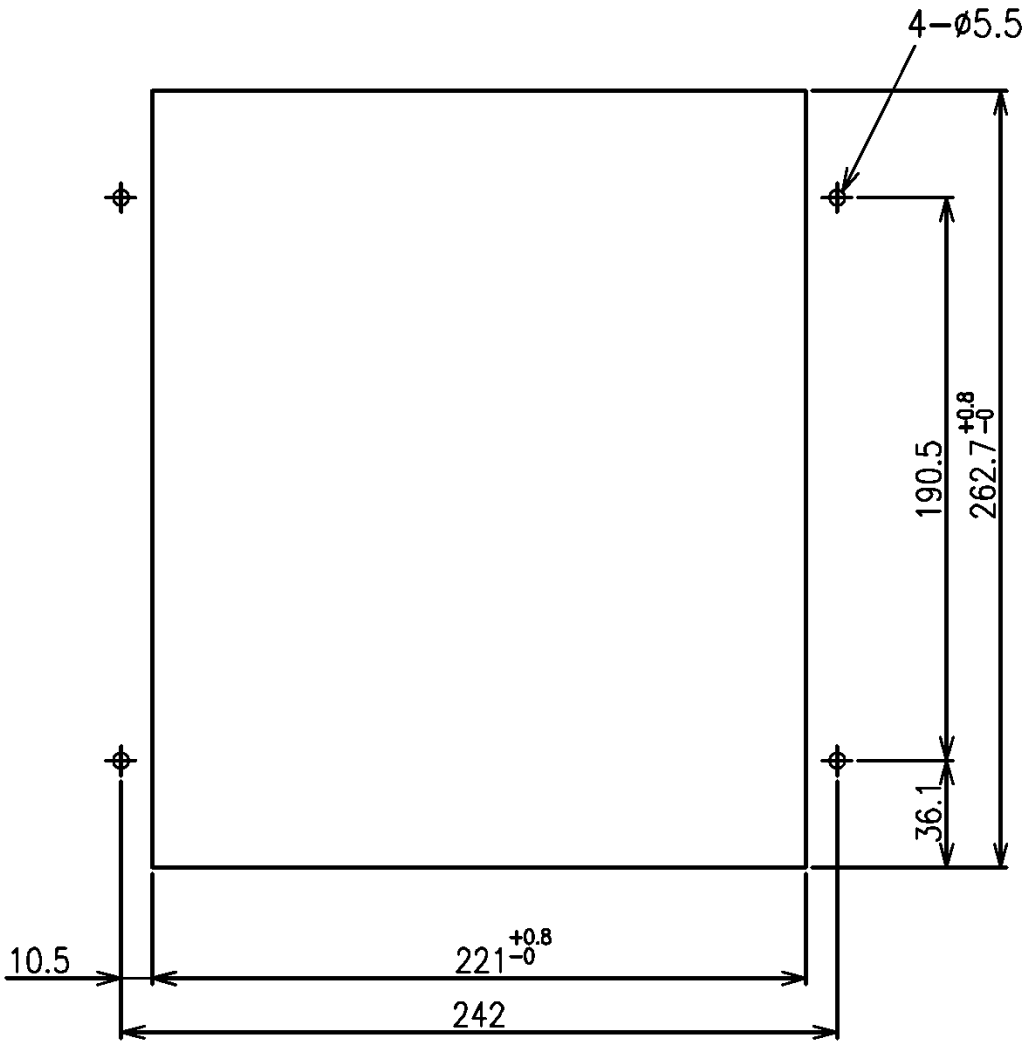
1/2 case size

1. Trihedral figure (1/2×19 inches) for "Compression type terminal" case



Note: Dimensions shown in millimeters

2. Panel cut out figure (1/2×19 inches) for "Compression type terminal" case



[1]Note: Dimensions shown in millimeters.

[2]Note: When you wish to know about the panel-cut-out-figures corresponding to rack-attachment kits, refer to *Appendix: Rack mounting*.

[3]Note: For the size relating to "Ring type terminal" case, see other figures.

Appendix 3 Typical external connection

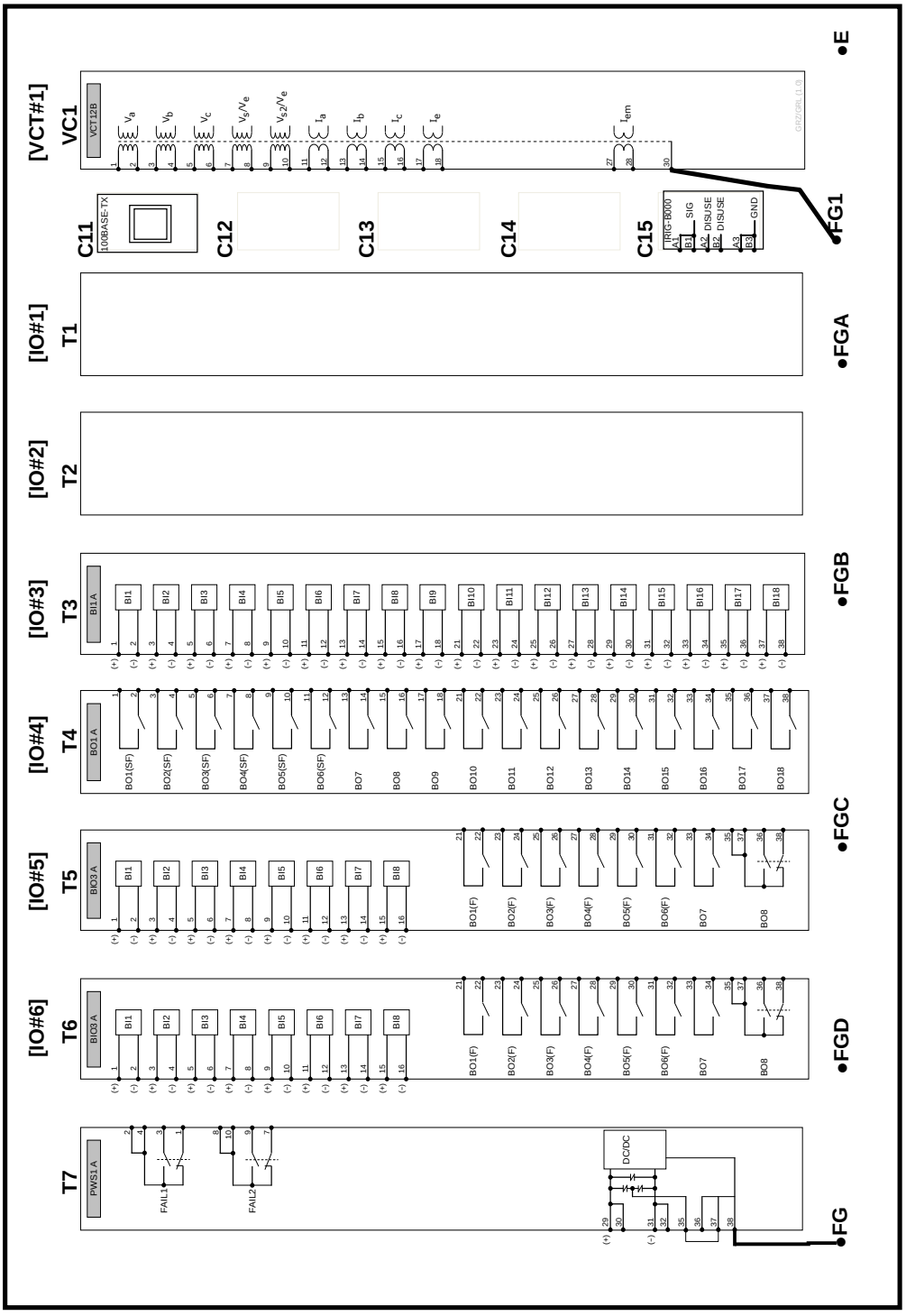
1.1. 3/4 case for Compression-type terminal

1.2. 3/4 case for Compression-type terminal

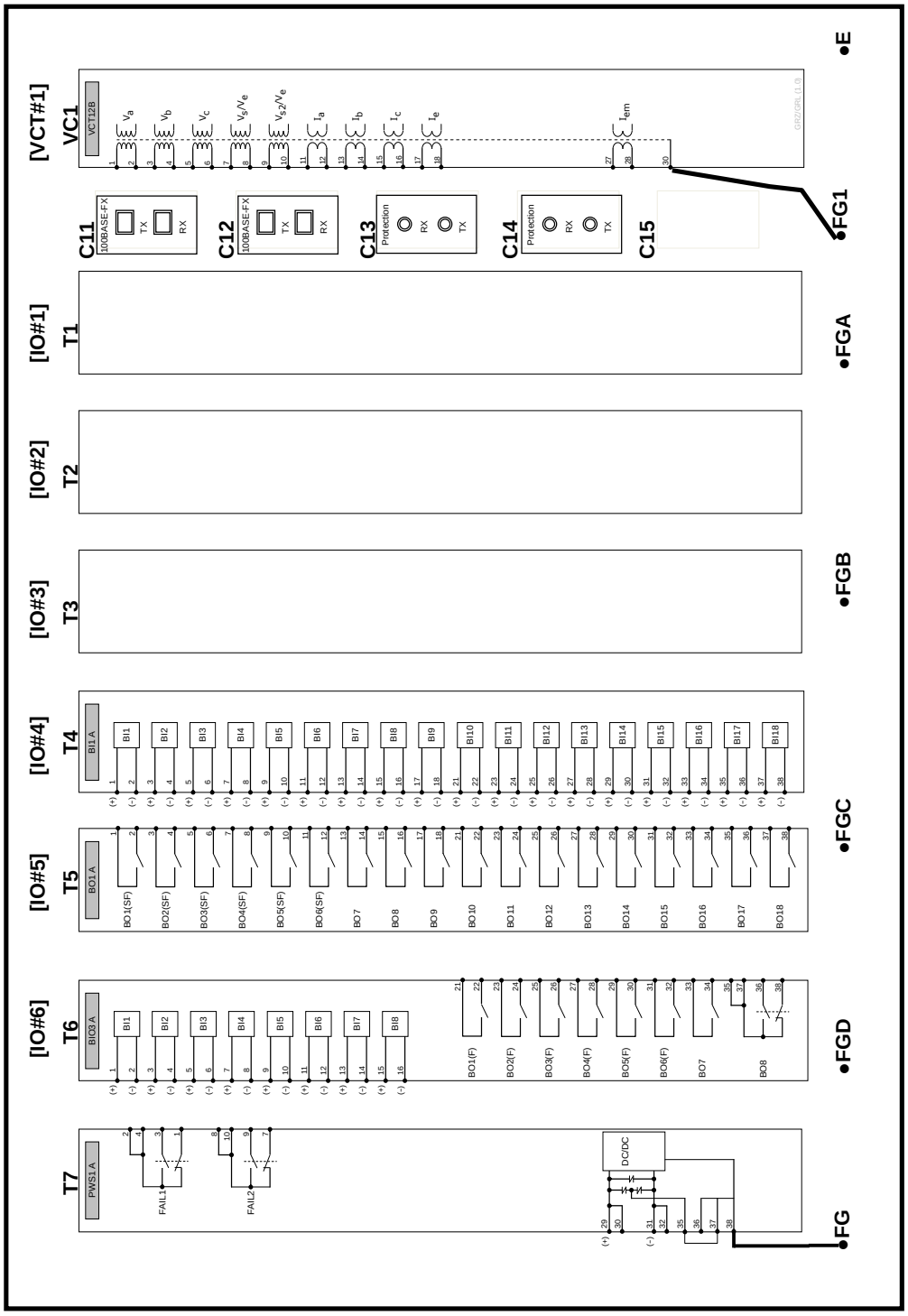
1.3. 1/2 case for Compression-type terminal

Typical external connection diagram for Compression-type terminal

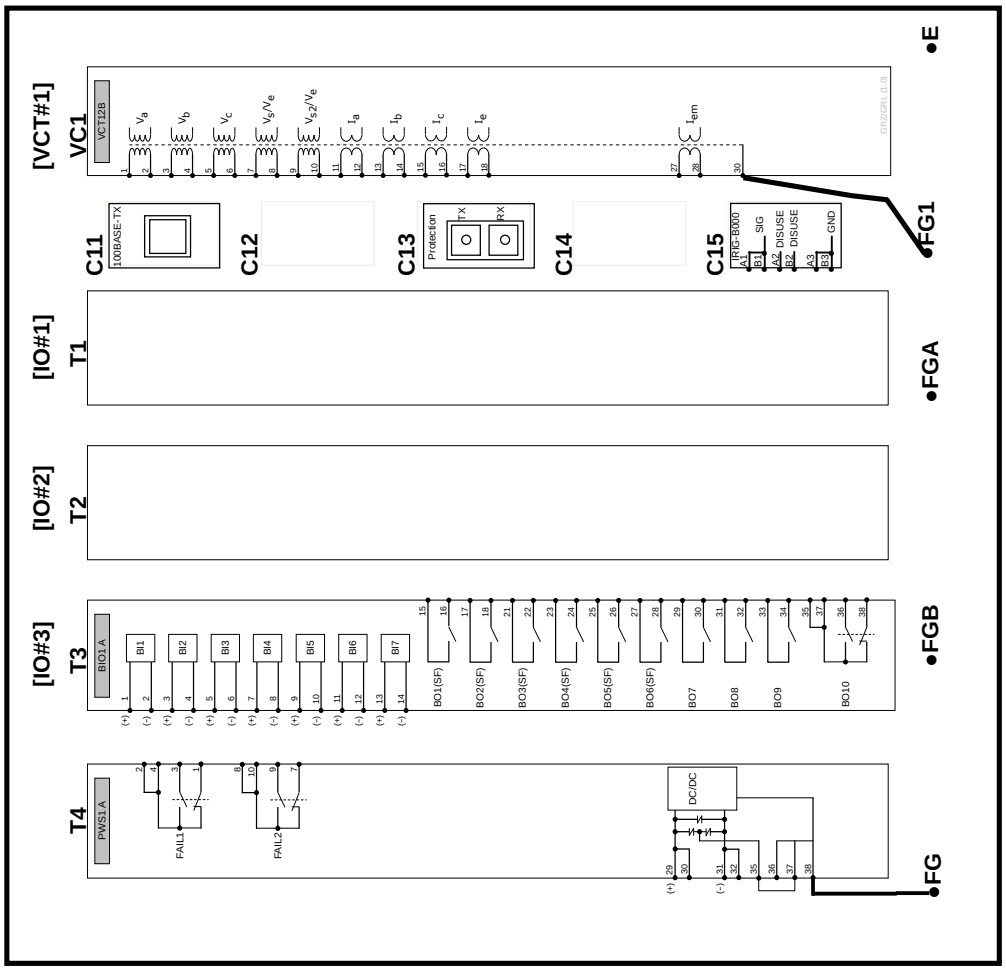
1.1. 3／4 case size for Compression-type terminal (GRL200-11-34B-21-46-20-110)



1.2. 3／4 case size for Compression-type terminal (GRL200-11-334-21-46-10-110)

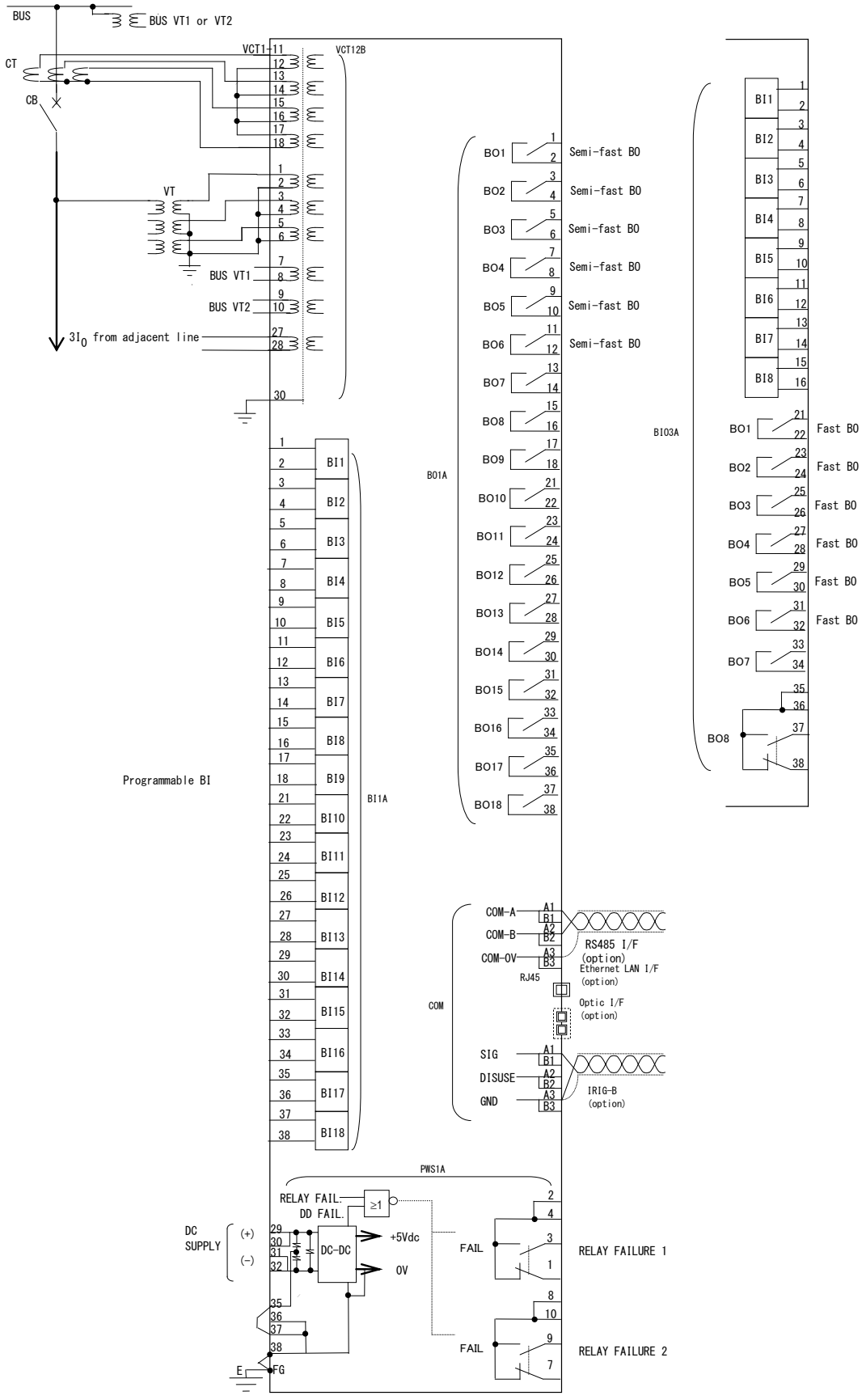


1.3. 1／2 case size for Compression-type terminal (GRL200-11-211-12-33-10-220)



Typical external connection diagram for Compression-type terminal

VCT12B, IO: BI1A, BO1A and BIO3A



Appendix 4 IEC61850 MICS, PICS, PIXIT, and TICS

#	Document names	Pages	Provisions
MICS	Model implementation conformance statement	1142	Edition 1
PICS	Protocol implementation conformance statement	1177	Edition 1
PIXIT	Protocol implementation extra information for testing	1184	Edition 1
TICS	Tissues conformance statement	1201	Edition 1

(MICS Edition 1)

IEC61850 Edition 1 Model Implementation Conformance Statement (MICS)

GRL200 (Line protection IED)

(Original document#: 6F2S1872 Ver. 0.0).

(MICS Ed.1)

The GRL200 relay supports IEC 61850 logical nodes and common data classes as indicated in the following tables.

Logical nodes in IEC 61850-7-4

Logical Nodes	GRL200
L: System Logical Nodes	
LPHD	Yes
Common Logical Node	Yes
LLN0	Yes
P: Logical Nodes for Protection functions	
PDIF	Yes
PDIR	---
PDIS	Yes
PDOP	---
PDUP	---
PFRC	---
PHAR	Yes
PHIZ	---
PIOC	---
PMRI	---
PMSS	---
POPE	---
PPAM	---
PSCH	Yes
PSDE	---
PTEF	---
PTOC	Yes
PTOF	Yes
PTOV	Yes
PTRC	Yes
PTTR	Yes
PTUC	Yes
PTUV	Yes
PUPF	---
PTUF	Yes
PVOC	---
PVPH	---
PZSU	---
R: Logical Nodes for protection related functions	
RDRE	---
RADR	---
RBDR	---
RDRS	---
RBRF	Yes
RDIR	---
RFLO	Yes
RPSB	Yes
RREC	Yes
RSYN	Yes
C: Logical Nodes for Control	
CALH	---
CCGR	---
CILO	Yes
CPOW	---
CSWI	Yes
G: Logical Nodes for Generic references	
GAPC	Yes
GGIO	Yes

Nodes	GRL200
GGIO_GOOSE	Yes
GSAL	---
I: Logical Nodes for Interfacing and archiving	
IARC	---
IHMI	---
ITCI	---
ITMI	---
A: Logical Nodes for Automatic control	
ANCR	---
ARCO	---
ATCC	---
AVCO	---
M: Logical Nodes for Metering and measurement	
MDIF	Yes
MHAI	---
MHAN	---
MMTR	---
MMXN	---
MMXU	Yes
MSQI	Yes
MSTA	---
S: Logical Nodes for Sensors and monitoring	
SARC	---
SIMG	---
SIML	---
SPDC	---
X: Logical Nodes for Switchgear	
XCBR	Yes
XSWI	---
T: Logical Nodes for Instrument transformers	
TCTR	---
TVTR	---
Y: Logical Nodes for Power transformers	
YEFN	---
YLTC	---
YPSH	---
YPTR	---
Z: Logical Nodes for Further power system equipment	
ZAXN	---
ZBAT	---
ZCAB	---
ZCAP	---
ZCON	---
ZGEN	---
ZGIL	---
ZLIN	---
ZMOT	---
ZREA	---
ZRRC	---
ZSAR	---
ZTCF	---
ZTCR	---

(MICS Ed.1)

Common data classes in IEC61850-7-3

Common data classes	GRL200
Status information	
SPS	Yes
DPS	---
INS	Yes
ACT	Yes
ACT_ABC	Yes
ACD	Yes
ACD_ABC	Yes
SEC	---
BCR	---
Measured information	
MV	Yes
CMV	Yes
SAV	---
WYE	Yes
WYE_ABCN	Yes
DEL	Yes
SEQ	Yes
HMV	---
HWYE	---
HDEL	---
Controllable status information	
SPC	Yes
DPC	Yes
INC	Yes
BSC	---
ISC	---
Controllable analogue information	
APC	---
Status settings	
SPG	---
ING	Yes
Analogue settings	
ASG	Yes
CURVE	---
Description information	
DPL	Yes
LPL	Yes
CSD	---

(MICS Ed.1)

LPHD class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
PhyName	DPL	Physical device name plate		M	Y
PhyHealth	INS	Physical device health		M	Y
OutOv	SPS	Output communications buffer overflow		O	N
Proxy	SPS	Indicates if this LN is a proxy		M	Y
InOv	SPS	Input communications buffer overflow		O	N
NumPwrUp	INS	Number of Power ups		O	N
WrmStr	INS	Number of Warm Starts		O	N
WacTrg	INS	Number of watchdog device resets detected		O	N
PwrUp	SPS	Power Up detected		O	N
PwrDn	SPS	Power Down detected		O	N
PwrSupAlm	SPS	External power supply alarm		O	N
RsStat	SPC	Reset device statistics	T	O	N

Common Logical Node class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Mandatory Logical Node Information (Shall be inherited by ALL LN but LPHD)					
Mod	INC	Mode		M	Y
Beh	INS	Behavior		M	Y
Health	INS	Health		M	Y
NamPlt	LPL	Name plate		M	Y
Optional Logical Node Information					
Loc	SPS	Local operation		O	N
EEHealth	INS	External equipment health		O	N
EEName	DPL	External equipment name plate		O	N
OpCntRs	INC	Operation counter resettable		O	N
OpCnt	INS	Operation counter		O	N
OpTmh	INS	Operation time		O	N
Data Sets (see IEC 61850-7-2)					
Inherited and 1145specialized from Logical Node class (see IEC 61850-7-2)					
Control Blocks (see IEC 61850-7-2)					
Inherited and 1145specialized from Logical Node class (see IEC 61850-7-2)					
Services (see IEC 61850-7-2)					
Inherited and 1145specialized from Logical Node class (see IEC 61850-7-2)					

LLNO class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
Loc	SPS	Local operation for complete logical device		O	Y
OpTmh	INS	Operation time		O	N
Controls					
Diag	SPC	Run Diagnostics		O	Y
LEDRs	SPC	LED reset	T	O	Y

(MICS Ed.1)

PDIF class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resetable operation counter		O	N
Status Information					
Str	ACD_ABC	Start		O	Y
Op	ACT_ABC	Operate	T	M	Y
TmAst	CSD	Active curve characteristic		O	N
Measured Values					
DifAClc	WYE_ABCN	Differential Current		O	Y
RstA	WYE_ABCN	Restraint Current		O	Y
Settings					
LinCapac	ASG	Line capacitance (for load currents)		O	N
LoSet	ING	Low operate value, percentage of the nominal current		O	N
HiSet	ING	High operate value, percentage of the nominal current		O	N
MinOpTmms	ING	Minimum Operate Time		O	N
MaxOpTmms	ING	Maximum Operate Time		O	N
RstMod	ING	Restraint Mode		O	N
RsDlTmms	ING	Reset Delay Time		O	N
TmACrv	CURVE	Operating Curve Type		O	N

(MICS Ed.1)

PDIS class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Status Information					
Str	ACD_ABC	Start		M	Y
Op	ACT_ABC	Operate	T	M	Y
Settings					
PoRch	ASG	Polar Reach is the diameter of the Mho diagram		O	Y
PhStr	ASG	Phase Start Value		O	Y
GndStr	ASG	Ground Start Value		O	Y
DirMod	ING	Directional Mode		O	Y
PctRch	ASG	Percent Reach		O	N
Ofs	ASG	Offset		O	Y
PctOfs	ASG	Percent Offset		O	N
RisLod	ASG	Resistive reach for load area		O	N
AngLod	ASG	Angle for load area		O	N
TmDlMod	SPG	Operate Time Delay Mode		O	N
OpDlTmms	ING	Operate Time Delay		O	Y
PhDlMod	SPG	Operate Time Delay Multiphase Mode		O	N
PhDlTmms	ING	Operate Time Delay for Multiphase Faults		O	N
GndDlMod	SPG	Operate Time Delay for Single Phase Ground Mode		O	N
GndDlTmms	ING	Operate Time Delay for single phase ground faults		O	N
X1	ASG	Positive sequence line (reach) reactance		O	Y
LinAng	ASG	Line Angle		O	Y
RisGndRch	ASG	Resistive Ground Reach		O	Y
RisPhRch	ASG	Resistive Phase Reach		O	Y
K0Fact	ASG	Residual Compensation Factor K0		O	N
K0FactAng	ASG	Residual Compensation Factor Angle		O	N
RsDlTmms	ING	Reset Time Delay		O	N

PHAR class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Status Information					
Str	ACD_ABC	Start		M	Y
Settings					
HarRst	ING	Number of harmonic restrained		O	N
PhStr	ASG	Start Value		O	Y
PhStop	ASG	Stop Value		O	N
OpDlTmms	ING	Operate Delay Time		O	N
RsDlTmms	ING	Reset Delay Time		O	N

(MICS Ed.1)

PSCH class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Status Information					
ProTx	SPS	Teleprotection signal transmitted	T	M	Y
ProRx	SPS	Teleprotection signal received	T	M	Y
Str	ACD_ABC	Carrier Send		M	Y
Op	ACT_ABC	Operate	T	M	Y
CarRx	ACT	Carrier received after unblock logic		O	N
LosOfGrd	SPS	Loss of guard		O	N
Echo	ACT_ABC	Echo signal from weak end infeed function		O	Y
WeiOp	ACT_ABC	Operate signal from weak end infeed function		O	Y
RvABlk	ACT_ABC	Block signal from current reversal function		O	Y
GrdRx	SPS	Guard Received		O	N
Settings					
SchTyp	ING	Scheme Type		O	N
OpDlTmms	ING	Operate Delay Time		O	N
CrdTmms	ING	Co-ordination timer for blocking scheme		O	Y
DurTmms	ING	Minimum duration of carrier send signal		O	N
UnBlkMod	ING	Unblock function mode for scheme type		O	N
SecTmms	ING	Pickup security timer on loss of carrier guard signal		O	N
WeiMod	ING	Mode of weak end infeed function		O	N
WeiTmms	ING	Co-ordination time for weak end infeed function		O	N
PPVVal	ASG	Voltage level for weak end infeed function -phase-phase		O	N
PhGndVal	ASG	Voltage level for weak end infeed function -phase-ground		O	N
RvAMod	ING	Mode of current reversal function		O	N
RvATmms	ING	Pickup time for current reversal logic		O	N
RvRsTmms	ING	Delay time for reset of current reversal output		O	Y

(MICS Ed.1)

PTOC class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Status Information					
Str	ACD_ABC	Start		M	Y
Op	ACT_ABC	Operate	T	M	Y
TmASt	CSD	Active curve characteristic		O	N
Settings					
TmACrv	CURVE	Operating Curve Type		O	N
StrVal	ASG	Start Value		O	Y
TmMult	ASG	Time Dial Multiplier		O	N
MinOpTmms	ING	Minimum Operate Time		O	N
MaxOpTmms	ING	Maximum Operate Time		O	N
OpDITmms	ING	Operate Delay Time		O	Y
TypRsCrv	ING	Type of Reset Curve		O	N
RsDITmms	ING	Reset Delay Time		O	N
DirMod	ING	Directional Mode		O	N

PTOF class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Status Information					
Str	ACD	Start		M	Y
Op	ACT	Operate	T	M	Y
BlkV	SPS	Blocked because of voltage		O	Y
Settings					
StrVal	ASG	Start Value (frequency)		O	Y
BlkVal	ASG	Voltage Block Value		O	Y
OpDITmms	ING	Operate Delay Time		O	Y
RsDITmms	ING	Reset Delay Time		O	N

(MICS Ed.1)

PTOV class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Status Information					
Str	ACD_ABC	Start		M	Y
Op	ACT_ABC	Operate	T	O	Y
TmVSt	CSD	Active curve characteristic		O	N
Settings					
TmVCrv	CURVE	Operating Curve Type		O	N
StrVal	ASG	Start Value		O	Y
TmMult	ASG	Time Dial Multiplier		O	N
MinOpTmms	ING	Minimum Operate Time		O	N
MaxOpTmms	ING	Maximum Operate Time		O	N
OpDlTmms	ING	Operate Delay Time		O	Y
RsDlTmms	ING	Reset Delay Time		O	N

PTRC class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Status Information					
Tr	ACT_ABC	Trip		C	Y
Op	ACT	Operate (combination of subscribed Op from protection functions)		C	N
Str	ACD	Sum of all starts of all connected Logical Nodes		O	N
Settings					
TrMod	ING	Trip Mode		O	N
TrPlsTmms	ING	Trip Pulse Time		O	N

Condition C: At least one of the two status information (Tr, Op) shall be used.

(MICS Ed.1)

PTTR class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Measured Values					
Amp	MV	Current for thermal load model		O	N
Tmp	MV	Temperature for thermal load		O	N
TmpRl	MV	Relation between temperature and max. temperature		O	N
LodRsvAlm	MV	Load reserve to alarm		O	N
LodRsvTr	MV	Load reserve to trip		O	N
AgeRat	MV	Ageing rate		O	N
Status Information					
Str	ACD	Start		O	Y
Op	ACT	Operate	T	M	Y
AlmThm	ACT	Thermal Alarm		O	Y
TmTmpSt	CSD	Active curve characteristic		O	N
TmASt	CSD	Active curve characteristic		O	N
Settings					
TmTmpCrv	CURVE	Characteristic Curve for temperature measurement		O	N
TmACrv	CURVE	Characteristic Curve for current measurement /Thermal model		O	N
TmpMax	ASG	Maximum allowed temperature		O	N
StrVal	ASG	Start Value		O	Y
OpDlTmms	ING	Operate Delay Time		O	N
MinOpTmms	ING	Minimum Operate Time		O	N
MaxOpTmms	ING	Maximum Operate Time		O	N
RsDlTmms	ING	Reset Delay Time		O	N
ConsTms	ING	Time constant of the thermal model		O	N
AlmVal	ASG	Alarm Value		O	N

PTUC class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Status Information					
Str	ACD_ABC	Start		M	Y
Op	ACT_ABC	Operate	T	O	Y
TmVSt	CSD	Active curve characteristic		O	N
Settings					
TmACrv	CURVE	Operating Curve Type		O	N
StrVal	ASG	Start Value		O	Y
OpDlTmms	ING	Operate Delay Time		O	Y
TmMult	ASG	Time Dial Multiplier		O	N
MinOpTmms	ING	Minimum Operate Time		O	N
MaxOpTmms	ING	Maximum Operate Time		O	N
TypRsCrv	ING	Type of Reset Curve		O	N
RsDlTmms	ING	Reset Delay Time		O	N
DirMod	ING	Directional Mode		O	N

(MICS Ed.1)

PTUV class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Status Information					
Str	ACD_ABC	Start		M	Y
Op	ACT_ABC	Operate	T	M	Y
TmVSt	CSD	Active curve characteristic		O	N
Settings					
TmVCrv	CURVE	Operating Curve Type		O	N
StrVal	ASG	Start Value		O	Y
TmMult	ASG	Time Dial Multiplier		O	N
MinOpTmms	ING	Minimum Operate Time		O	N
MaxOpTmms	ING	Maximum Operate Time		O	N
OpDlTmms	ING	Operate Delay Time		O	Y
RsDlTmms	ING	Reset Delay Time		O	N

PTUF class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Status Information					
Str	ACD	Start		M	Y
Op	ACT	Operate	T	M	Y
BlkV	SPS	Blocked because of voltage		O	Y
Settings					
StrVal	ASG	Start Value (frequency)		O	Y
BlkVal	ASG	Voltage Block Value		O	Y
OpDlTmms	ING	Operate Delay Time		O	Y
RsDlTmms	ING	Reset Delay Time		O	N

(MICS Ed.1)

RBRF class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Status Information					
Str	ACD_ABC	Start, timer running		O	Y
OpEx	ACT	Breaker failure trip (“external trip”)	T	C	N
OpIn	ACT_ABC	Operate, retrip (“internal trip”)	T	C	Y
Setting					
FailMod	ING	Breaker Failure Detection Mode (current, breaker status, both, other)		O	Y
FailTmms	ING	Breaker Failure Time Delay for bus bar trip		O	Y
SPlTrTmms	ING	Single Pole Retrip Time Delay		O	N
TPTrTmms	ING	Three Pole Retrip Time Delay		O	N
DetValA	ASG	Current Detector Value		O	Y
ReTrMod	ING	Retrip Mode		O	N

Condition C: At least one of either data shall be used depending on the applied tripping schema.

RFLO class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Measured values					
FltZ	CMV	Fault Impedance		M	Y
FltDiskm	MV	Fault Distance in km		M	Y
Status Information					
FltLoop	INS	Fault Loop		O	Y
Setting					
LinLenKm	ASG	Line length in km		O	Y
R1	ASG	Positive-sequence line resistance		O	Y
X1	ASG	Positive-sequence line reactance		O	Y
R0	ASG	Zero-sequence line resistance		O	Y
X0	ASG	Zero-sequence line reactance		O	Y
Z1Mod	ASG	Positive-sequence line impedance value		O	N
Z1Ang	ASG	Positive-sequence line impedance angle		O	N
Z0Mod	ASG	Zero-sequence line impedance value		O	N
Z0Ang	ASG	Zero-sequence line impedance angle		O	N
Rm0	ASG	Mutual resistance		O	Y
Xm0	ASG	Mutual reactance		O	Y
Zm0Mod	ASG	Mutual impedance value		O	N
Zm0Ang	ASG	Mutual impedance angle		O	N

(MICS Ed.1)

RPSB class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Status Information					
Str	ACD	Start (Power Swing Detected)		C1	Y
Op	ACT	Operate (Out of step Tripping)	T	C2	N
BlkZn	SPS	Blocking of correlated PDIS zone		C1	Y
Setting					
ZeroEna	SPG	Zero Enable		O	N
NgEna	SPG	Negative Sequence Current Supervision Enabled		O	N
MaxEna	SPG	Max Current Supervision Enabled		O	N
SwgVal	ASG	Power Swing Delta		O	Y
SwgRis	ASG	Power Swing Delta R		O	N
SwgReact	ASG	Power Swing Delta X		O	N
SwgTmms	ING	Power Swing Time		O	Y
UnBlkTmms	ING	Unblocking Time		O	N
MaxNumSlp	ING	Maximum number of pole slips until tripping (Op, Out of step tripping)		O	N
EvTmms	ING	Evaluation time (time window, Out of step tripping)		O	N

Condition C1: Mandatory if RPSB is used for “Power swing blocking”
Condition C2: Mandatory if RPSB is used for “Out of step tripping”

(MICS Ed.1)

RREC class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Controls					
BlkRec	SPC	Block Reclosing		O	N
ChkRec	SPC	Check Reclosing		O	N
Status Information					
Auto	SPS	Automatic Operation (external switch status)		O	N
Op	ACT	Operate (used here to provide close to XCBR)	T	M	Y
AutoRecSt	INS	Auto Reclosing Status		M	Y
Setting					
Rec1Tmms	ING	First Reclose Time		O	N
Rec2Tmms	ING	Second Reclose Time		O	N
Rec3Tmms	ING	Third Reclose Time		O	N
PlsTmms	ING	Close Pulse Time		O	Y
RclTmms	ING	Reclaim Time		O	Y

(MICS Ed.1)

RSYN class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resettable operation counter		O	N
Controls					
RHz	SPC	Raise Frequency		O	N
LHz	SPC	Lower Frequency		O	N
RV	SPC	Raise Voltage		O	N
LV	SPC	Lower Voltage		O	N
Status Information					
Rel	SPS	Release		M	Y
VInd	SPS	Voltage Difference Indicator		O	N
AngInd	SPS	Angle Difference Indicator		O	N
HzInd	SPS	Frequency Difference Indicator		O	N
SynPrg	SPS	Synchronizing in progress		O	N
Measured values					
DifVClc	MV	Calculated Difference in Voltage		O	N
DifHzClc	MV	Calculated Difference in Frequency		O	N
DifAngClc	MV	Calculated Difference of Phase Angle		O	N
Setting					
DifV	ASG	Difference Voltage		O	N
DifHz	ASG	Difference Frequency		O	N
DifAng	ASG	Difference Phase Angle		O	Y
LivDeaMod	ING	Live Dead Mode		O	N
DeaLinVal	ASG	Dead Line Value		O	N
LivLinVal	ASG	Live Line Value		O	N
DeaBusVal	ASG	Dead Bus Value		O	N
LivBusVal	ASG	Live Bus Value		O	N
PlsTmms	ING	Close Pulse Time		O	N
BkrTmms	ING	Closing time of breaker		O	N

(MICS Ed.1)

CILO class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
Status Information					
EnaOpn	SPS	Enable Open		M	Y
EnaCls	SPS	Enable Close		M	Y

CSWI class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
Loc	SPS	Local operation		O	N
OpCntRs	INC	Resettable operation counter		O	N
Controls					
Pos	DPC	Switch, general		M	Y
PosA	DPC	Switch L1		O	N
PosB	DPC	Switch L2		O	N
PosC	DPC	Switch L3		O	N
OpOpn	ACT	Operation “Open Switch”	T	O	N
OpCls	ACT	Operation “Close Switch”	T	O	N

(MICS Ed.1)

GAPC class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
Loc	SPS	Local operation		O	N
OpCntRs	INC	Resettable operation counter		O	N
Controls					
SPCSO	SPC	Single point controllable status output		O	N
DPCSO	DPC	Double point controllable status output		O	N
ISCSO	INC	Integer status controllable status output		O	N
Status Information					
Auto	SPS	Automatic operation		O	N
Str	ACD_ABC	Start		M	Y
Op	ACT_ABC	Operate	T	M	Y
Setting					
StrVal	ASG	Start Value		O	N

(MICS Ed.1)

GGIO class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
EEHealth	INS	External equipment health (external sensor)		O	N
EEName	DPL	External equipment name plate		O	N
Loc	SPS	Local operation		O	N
OpCntRs	INC	Resettable operation counter		O	N
Measured values					
AnIn	MV	Analogue input		O	N
Controls					
SPCSO	SPC	Single point controllable status output		O	N
DPCSO	DPC	Double point controllable status output		O	N
ISCSO	INC	Integer status controllable status output		O	N
Status Information					
IntIn	INS	Integer status input		O	N
Alm	SPS	General single alarm		O	N
Ind01	SPS	General indication (binary input)		O	Y
Ind02	SPS	General indication (binary input)		O	Y
Ind03	SPS	General indication (binary input)		O	Y
Ind04	SPS	General indication (binary input)		O	Y
Ind05	SPS	General indication (binary input)		O	Y
Ind06	SPS	General indication (binary input)		O	Y
Ind07	SPS	General indication (binary input)		O	Y
Ind08	SPS	General indication (binary input)		O	Y
Ind09	SPS	General indication (binary input)		O	Y
Ind10	SPS	General indication (binary input)		O	Y
		:			
		:			
		:			
Ind64	SPS	General indication (binary input)		O	Y

(MICS Ed.1)

GGIO_GOOSE class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
EEHealth	INS	External equipment health (external sensor)		O	N
EEName	DPL	External equipment name plate		O	N
Loc	SPS	Local operation		O	N
OpCntRs	INC	Resettable operation counter		O	N
Measured values					
AnIn	MV	Analogue input		O	N
Controls					
SPCSO	SPC	Single point controllable status output		O	N
DPCSO	DPC	Double point controllable status output		O	N
ISCSO	INC	Integer status controllable status output		O	N
Status Information					
IntIn	INS	Integer status input		O	N
Alm	SPS	General single alarm		O	N
Ind01	SPS	General indication (binary input)		O	Y
Ind02	SPS	General indication (binary input)		O	Y
Ind03	SPS	General indication (binary input)		O	Y
Ind04	SPS	General indication (binary input)		O	Y
Ind05	SPS	General indication (binary input)		O	Y
Ind06	SPS	General indication (binary input)		O	Y
Ind07	SPS	General indication (binary input)		O	Y
Ind08	SPS	General indication (binary input)		O	Y
Ind09	SPS	General indication (binary input)		O	Y
Ind10	SPS	General indication (binary input)		O	Y
Ind11	SPS	General indication (binary input)		O	Y
Ind12	SPS	General indication (binary input)		O	Y
Ind13	SPS	General indication (binary input)		O	Y
Ind14	SPS	General indication (binary input)		O	Y
Ind15	SPS	General indication (binary input)		O	Y
Ind16	SPS	General indication (binary input)		O	Y

(MICS Ed.1)

MDIF class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
Measured values					
OpARem	WYE_ABCN	Operate Current (phasor) of the remote current measurement		C	Y
Amp1	SAV	Current (Sampled value) phase A		C	N
Amp2	SAV	Current (Sampled value) phase B		C	N
Amp3	SAV	Current (Sampled value) phase C		C	N

Condition C: Either OpARem or Amp1/Amp2/Amp3 shall be used.

MMXU class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
EEHealth	INS	External equipment health (external sensor)		O	N
Measured values					
TotW	MV	Total Active Power (Total P)		O	N
TotVAr	MV	Total Reactive Power (Total Q)		O	N
TotVA	MV	Total Apparent Power (Total S)		O	N
TotPF	MV	Average Power factor (Total PF)		O	N
Hz	MV	Frequency		O	Y
PPV	DEL	Phase to phase voltages (VL1VL2, …)		O	Y
PhV	WYE	Phase to ground voltages (VL1ER, …)		O	Y
A	WYE	Phase currents (IL1, IL2, IL3)		O	Y
W	WYE	Phase active power (P)		O	Y
VAr	WYE	Phase reactive power (Q)		O	Y
VA	WYE	Phase apparent power (S)		O	Y
PF	WYE	Phase power factor		O	Y
Z	WYE	Phase Impedance		O	N

(MICS Ed.1)

MSQI class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
EEHealth	INS	External equipment health (external sensor)		O	N
EEName	DPL	External equipment name plate		O	N
Measured values					
SeqA	SEQ	Positive, Negative and Zero Sequence Current		C	Y
SeqV	SEQ	Positive, Negative and Zero Sequence Voltage		C	Y
DQ0Seq	SEQ	DQ0 Sequence		O	N
ImbA	WYE	Imbalance current		O	N
ImbNgA	MV	Imbalance negative sequence current		O	N
ImbNgV	MV	Imbalance negative sequence voltage		O	N
ImbPPV	DEL	Imbalance phase-phase voltage		O	N
ImbV	WYE	Imbalance voltage		O	N
ImbZroA	MV	Imbalance zero sequence current		O	N
ImbZroV	MV	Imbalance zero sequence voltage		O	N
MaxImbA	MV	Maximum imbalance current		O	N
MaxImbPPV	MV	Maximum imbalance phase-phase voltage		O	N
MaxImbV	MV	Maximum imbalance voltage		O	N

Condition C: At least one of either data shall be used.

(MICS Ed.1)

XCBR class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRL200**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
EEHealth	INS	External equipment health (external sensor)		O	N
EEName	DPL	External equipment name plate		O	N
OpCnt	INS	Operation counter		M	Y
Controls					
Pos	DPC	Switch position		M	Y
BlkOpn	SPC	Block opening		M	Y
BlkCls	SPC	Block closing		M	Y
ChaMotEna	SPC	Charger motor enabled		O	Y
Metered Values					
SumSwARs	BCR	Sum of Switched Amperes, resettable		O	N
Status Information					
CBOpCap	INS	Circuit breaker operating capability		M	Y
POWCap	INS	Point On Wave switching capability		O	N
MaxOpCap	INS	Circuit breaker operating capability when fully charged		O	N

(MICS Ed.1)

SPS class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
status						
stVal	BOOLEAN	ST	dchg	TRUE | FALSE	M	Y
q	Quality	ST	qchg		M	Y
t	TimeStamp	ST			M	Y
substitution						
subEna	BOOLEAN	SV			PICS_SUBST	N
subVal	BOOLEAN	SV		TRUE | FALSE	PICS_SUBST	N
subQ	Quality	SV			PICS_SUBST	N
subID	VISIBLE STRING64	SV			PICS_SUBST	N
configuration, description and extension						
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 13						

INS class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
status						
stVal	INT32	ST	dchg		M	Y(*1)
q	Quality	ST	qchg		M	Y
t	TimeStamp	ST			M	Y
Substitution						
subEna	BOOLEAN	SV			PICS_SUBST	N
subVal	INT32	SV			PICS_SUBST	N
subQ	Quality	SV			PICS_SUBST	N
subID	VISIBLE STRING64	SV			PICS_SUBST	N
configuration, description and extension						
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 13						

(*1): “ENUM” type is also used.

(MICS Ed.1)

ACT class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
status						
general	BOOLEAN	ST	dchg		M	Y
phsA	BOOLEAN	ST	dchg		O	N
phsB	BOOLEAN	ST	dchg		O	N
phsC	BOOLEAN	ST	dchg		O	N
neut	BOOLEAN	ST	dchg		O	N
q	Quality	ST	qchg		M	Y
t	TimeStamp	ST			M	Y
configuration, description and extension						
operTm	TimeStamp	CF			O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 13						

ACT_ABC class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
status						
general	BOOLEAN	ST	dchg		M	Y
phsA	BOOLEAN	ST	dchg		O	Y
phsB	BOOLEAN	ST	dchg		O	Y
phsC	BOOLEAN	ST	dchg		O	Y
neut	BOOLEAN	ST	dchg		O	N
q	Quality	ST	qchg		M	Y
t	TimeStamp	ST			M	Y
configuration, description and extension						
operTm	TimeStamp	CF			O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 13						

(MICS Ed.1)

ACD class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
status						
general	BOOLEAN	ST	dchg		M	Y
dirGeneral	ENUMERATED	ST	dchg	unknown | forward | backward | both	M	Y
phsA	BOOLEAN	ST	dchg		GC_2 (1)	N
dirPhsA	ENUMERATED	ST	dchg	unknown | forward | backward	GC_2 (1)	N
phsB	BOOLEAN	ST	dchg		GC_2 (2)	N
dirPhsB	ENUMERATED	ST	dchg	unknown | forward | backward	GC_2 (2)	N
phsC	BOOLEAN	ST	dchg		GC_2 (3)	N
dirPhsC	ENUMERATED	ST	dchg	unknown | forward | backward	GC_2 (3)	N
neut	BOOLEAN	ST	dchg		GC_2 (4)	N
dirNeut	ENUMERATED	ST	dchg	unknown | forward | backward	GC_2 (4)	N
q	Quality	ST	qchg		M	Y
t	TimeStamp	ST			M	Y
configuration, description and extension						
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 13						

ACD_ABC class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
status						
general	BOOLEAN	ST	dchg		M	Y
dirGeneral	ENUMERATED	ST	dchg	unknown | forward | backward | both	M	Y
phsA	BOOLEAN	ST	dchg		GC_2 (1)	Y
dirPhsA	ENUMERATED	ST	dchg	unknown | forward | backward	GC_2 (1)	Y
phsB	BOOLEAN	ST	dchg		GC_2 (2)	Y
dirPhsB	ENUMERATED	ST	dchg	unknown | forward | backward	GC_2 (2)	Y
phsC	BOOLEAN	ST	dchg		GC_2 (3)	Y
dirPhsC	ENUMERATED	ST	dchg	unknown | forward | backward	GC_2 (3)	Y
neut	BOOLEAN	ST	dchg		GC_2 (4)	N
dirNeut	ENUMERATED	ST	dchg	unknown | forward | backward	GC_2 (4)	N
q	Quality	ST	qchg		M	Y
t	TimeStamp	ST			M	Y
configuration, description and extension						
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 13						

(MICS Ed.1)

MV class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
measured values						
instMag	AnalogueValue	MX			O	N
mag	AnalogueValue	MX	dchg		M	Y
range	ENUMERATED	MX	dchg	normal | high | low | high-high | low-low |…	O	N
q	Quality	MX	qchg		M	Y
t	TimeStamp	MX			M	Y
substitution						
subEna	BOOLEAN	SV			PICS_SUBST	N
subVal	AnalogueValue	SV			PICS_SUBST	N
subQ	Quality	SV			PICS_SUBST	N
subID	VISIBLE STRING64	SV			PICS_SUBST	N
configuration, description and extension						
units	Unit	CF		see Annex A	O	Y
db	INT32U	CF		0 … 100 000	O	N
zeroDb	INT32U	CF		0 … 100 000	O	N
sVC	ScaledValueConfig	CF			AC_SCAV	N
rangeC	RangeConfig	CF			GC_CON	N
smpRate	INT32U	CF			O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 21						

(MICS Ed.1)

CMV class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
measured values						
instCVal	Vector	MX			O	N
cVal	Vector	MX	dchg		M	Y
range	ENUMERATED	MX	dchg	normal | high | low | high-high | low-low |…	O	N
q	Quality	MX	qchg		M	Y
t	TimeStamp	MX			M	Y
substitution						
subEna	BOOLEAN	SV			PICS_SUBST	N
subVal	Vector	SV			PICS_SUBST	N
subQ	Quality	SV			PICS_SUBST	N
subID	VISIBLE STRING64	SV			PICS_SUBST	N
configuration, description and extension						
units	Unit	CF		see Annex A	O	Y
db	INT32U	CF		0 … 100 000	O	N
zeroDb	INT32U	CF		0 … 100 000	O	N
rangeC	RangeConfig	CF			GC_CON	N
magSVC	ScaledValueConfig	CF			AC_SCAV	N
angSVC	ScaledValueConfig	CF			AC_SCAV	N
angRef	ENUMERATED	CF		V | A | other …	O	N
smpRate	INT32U	CF			O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 21						

(MICS Ed.1)

WYE class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
Data						
phsA	CMV				GC_1	Y
phsB	CMV				GC_1	Y
phsC	CMV				GC_1	Y
neut	CMV				GC_1	N
net	CMV				GC_1	N
res	CMV				GC_1	N
DataAttribute						
configuration, description and extension						
angRef	ENUMERATED	CF		Va | Vb | Vc | Aa | Ab | Ac | Vab | Vbc | Vca | Vother | Aother	O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 21						

WYE_ABCN class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
Data						
phsA	CMV				GC_1	Y
phsB	CMV				GC_1	Y
phsC	CMV				GC_1	Y
neut	CMV				GC_1	Y
net	CMV				GC_1	N
res	CMV				GC_1	N
DataAttribute						
configuration, description and extension						
angRef	ENUMERATED	CF		Va | Vb | Vc | Aa | Ab | Ac | Vab | Vbc | Vca | Vother | Aother	O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 21						

(MICS Ed.1)

DEL class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
Data						
phsAB	CMV				GC_1	Y
phsBC	CMV				GC_1	Y
phsCA	CMV				GC_1	Y
DataAttribute						
configuration, description and extension						
angRef	ENUMERATED	CF		Va | Vb | Vc | Aa | Ab | Ac | Vab | Vbc | Vca | Vother | Aother	O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 21						

SEQ class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
Data						
c1	CMV				M	Y
c2	CMV				M	Y
c3	CMV				M	Y
DataAttribute						
measured attributes						
seqT	ENUMERATED	MX		pos-neg-zero | dir-quad-zero	M	Y
configuration, description and extension						
phsRef	ENUMERATED	CF		A | B | C | …	O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 21						

(MICS Ed.1)

SPC class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
control and status						
ctlVal	BOOLEAN	CO		off (FALSE) | on (TRUE)	AC_CO_M	N
operTm	TimeStamp	CO			AC_CO_O	N
origin	Originator_RO	CO, ST			AC_CO_O	Y
ctlNum	INT8U_RO	CO, ST		0..255	AC_CO_O	N
SBO	VISIBLE STRING65	CO			AC_CO_SBO_N_M	N
SBOw	SBOW	CO			AC_CO_SBOW_E_M	N
Oper	Oper	CO			AC_CO _M	Y
Cancel	Cancel	CO			AC_CO_SBO_N_M and AC_CO_SBOW_E_M and AC_CO_TA_E_M	N
stVal	BOOLEAN	ST	dchg	FALSE | TRUE	AC_ST	Y
q	Quality	ST	qchg		AC_ST	Y
t	TimeStamp	ST			AC_ST	Y
stSeld	BOOLEAN	ST	dchg		AC_CO_O	N
substitution						
subEna	BOOLEAN	SV			PICS_SUBST	N
subVal	BOOLEAN	SV		FALSE | TRUE	PICS_SUBST	N
subQ	Quality	SV			PICS_SUBST	N
subID	VISIBLE STRING64	SV			PICS_SUBST	N
configuration, description and extension						
pulseConfig	PulseConfig	CF			AC_CO_O	N
CtlModel	CtlModels	CF			M	Y
sboTimeout	INT32U	CF			AC_CO_O	N
sboClass	SboClasses	CF			AC_CO_O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 31						

(MICS Ed.1)

DPC class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
control and status						
ctlVal	BOOLEAN	CO		off (FALSE) | on (TRUE)	AC_CO_M	Y
operTm	TimeStamp	CO			AC_CO_O	N
origin	Originator	CO, ST			AC_CO_O	Y
ctlNum	INT8U	CO, ST		0..255	AC_CO_O	Y
SBO	VISIBLE STRING65	CO			AC_CO_SBO_N_M	N
SBOw	SBOW	CO			AC_CO_SBOW_E_M	Y
Oper	Oper	CO			AC_CO _M	Y
Cancel	Cancel	CO			AC_CO_SBO_N_M and AC_CO_SBOW_E_M and AC_CO_TA_E_M	Y
stVal	CODED ENUM	ST	dchg	intermediate-state | off | on | bad-state	M	Y
q	Quality	ST	qchg		M	Y
t	TimeStamp	ST			M	Y
stSeld	BOOLEAN	ST	dchg		AC_CO_O	N
Substitution						
subEna	BOOLEAN	SV			PICS_SUBST	N
subVal	CODED ENUM	SV		intermediate-state | off | on | bad-state	PICS_SUBST	N
subQ	Quality	SV			PICS_SUBST	N
subID	VISIBLE STRING64	SV			PICS_SUBST	N
configuration, description and extension						
pulseConfig	PulseConfig	CF			AC_CO_O	N
ctlModel	CtlModels	CF			M	Y
sboTimeout	INT32U	CF			AC_CO_O	N
sboClass	SboClasses	CF			AC_CO_O	Y
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 31						

(MICS Ed.1)

INC class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
control and status						
ctlVal	INT32	CO			AC_CO_M	N
operTm	TimeStamp	CO			AC_CO_O	N
origin	Originator	CO, ST			AC_CO_O	N
ctlNum	INT8U	CO, ST		0..255	AC_CO_O	N
SBO	VISIBLE STRING65	CO			AC_CO_SBO_N_M	N
SBOw	SBOW	CO			AC_CO_SBOW_E_M	N
Oper	Oper	CO			AC_CO _M	N
Cancel	Cancel	CO			AC_CO_SBO_N_M and AC_CO_SBOW_E_M and AC_CO_TA_E_M	N
stVal	INT32	ST	dchg		M	Y
Q	Quality	ST	qchg		M	Y
T	TimeStamp	ST			M	Y
stSeld	BOOLEAN	ST	dchg		AC_CO_O	N
substitution						
subEna	BOOLEAN	SV			PICS_SUBST	N
subVal	INT32	SV		FALSE | TRUE	PICS_SUBST	N
subQ	Quality	SV			PICS_SUBST	N
subID	VISIBLE STRING64	SV			PICS_SUBST	N
configuration, description and extension						
CtlModel	CtlModels	CF			M	Y
sboTimeout	INT32U	CF			AC_CO_O	N
sboClass	SboClasses	CF			AC_CO_O	N
minVal	INT32	CF			O	N
maxVal	INT32	CF			O	N
stepSize	INT32U	CF		1 … (maxVal – minVal)	O	N
D	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 31						

(MICS Ed.1)

ING class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
setting						
setVal	INT32	SP			AC_NSG_M	Y(*3)
setVal	INT32	SG, SE			AC_SG_M	N
configuration, description and extension						
minVal	INT32	CF			O	N
maxVal	INT32	CF			O	N
stepSize	INT32U	CF		1 … (maxVal – minVal)	O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 39						

(*3): “ENUM” type is also used.

ASG class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
setting						
setMag	AnalogueValue	SP			AC_NSG_M	Y
setMag	AnalogueValue	SG, SE			AC_SG_M	N
configuration, description and extension						
units	Unit	CF		see Annex A	O	Y
sVC	ScaledValueConfig	CF			AC_SCAV	Y
minVal	AnalogueValue	CF			O	N
maxVal	AnalogueValue	CF			O	N
stepSize	AnalogueValue	CF		1 … (maxVal – minVal)	O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 42						

(MICS Ed.1)

DPL class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
configuration, description and extension						
vendor	VISIBLE STRING255	DC			M	Y
hwRev	VISIBLE STRING255	DC			O	N
swRev	VISIBLE STRING255	DC			O	Y
serNum	VISIBLE STRING255	DC			O	N
model	VISIBLE STRING255	DC			O	Y
location	VISIBLE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 45						

LPL class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRL200**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
configuration, description and extension						
vendor	VISIBLE STRING255	DC			M	Y
swRev	VISIBLE STRING255	DC			M	Y
d	VISIBLE STRING255	DC			M	Y
dU	UNICODE STRING255	DC			O	N
configRev	VISIBLE STRING255	DC			AC_LN0_M	Y
ldNs	VISIBLE STRING255	EX		shall be included in **LLN0** only; for example "IEC 61850-7-4:2003"	AC_LN0_EX	N
lnNs	VISIBLE STRING255	EX			AC_DLD_M	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 45						

(This page is intentionally blank)

(PICS Editon1)

IEC61850 ACSI Conformance Statement for GR200 series IED

(Original document#: 6F2S1874 Ver. 0.6)

(PICS Ed.1)

Introduction

The template of this document is “Protocol Implementation Conformance Statement for the IEC 61850 interface in <device>” version 1.6 published by UCA International Users Group in Nov 19, 2015.

This document specifies the Protocol Implementation Conformance Statement (PICS) of the IEC 61850 interface in G2 series IED with communication firmware G2M850-01 series version equal to or upper than F (G2M850-01-F). Each tables of this document is specified in IEC 61850-7-2 Annex A.3 “ACSI models conformance statement”.

- ASCI basic conformance statement,
- ACSI models conformance statement,
- ACSI service conformance statement

Together with the MICS and the PIXIT, the PICS forms the basis for a conformance test according to IEC 61850-10.

Note: The IED does not support IEC 61850 Edition 2 (**Ed2**) .

(PICS Ed.1)

ASCI basic conformance statement

The basic conformance statement is defined in Table A.1.

Table A.1 – Basic conformance statement

		Client/ Subscriber	Server/ Publisher	Value/ Comments
Client-Server roles				
B11	**Server** side (of TWO-PARTY-APPLICATION-ASSOCIATION)	—	Y	
B12	**Client** side of (TWO-PARTY-APPLICATION-ASSOCIATION)	N	—	
SCSMs supported				
B21	**SCSM: IEC 61850-8-1 used**	Y	Y	Client/Subscriber side is only GOOSE and SNTP.
B22	**SCSM: IEC 61850-9-1 used**			Deprecated Ed2
B23	**SCSM: IEC 61850-9-2 used**			
B24	**SCSM: other**			
Generic substation event model (GSE)				
B31	**Publisher side**	—	Y	
B32	**Subscriber side**	Y	—	
Transmission of sampled value model (SVC)				
B41	**Publisher side**	—	N	
B42	**Subscriber side**	N	—	

- = not applicable
Y = supported
N or empty = not supported

(PICS Ed.1)

ACSI models conformance statement

The ACSI models conformance statement is defined in Table A.2.

Table A.2 – ACSI models conformance statement

		Client/ Subscriber	Server/ Publisher	Value/ Comments
If Server or Client side (B11/12) supported				
M1	Logical device	N	Y	
M2	Logical node	N	Y	
M3	Data	N	Y	
M4	Data set	N	Y	
M5	Substitution	N	N	
M6	Setting group control	N	Y	
	Reporting			
M7	Buffered report control	N	Y	
M7-1	sequence-number	N	Y	
M7-2	report-time-stamp	N	Y	
M7-3	reason-for-inclusion	N	Y	
M7-4	data-set-name	N	Y	
M7-5	data-reference	N	Y	
M7-6	buffer-overflow	N	Y	
M7-7	entryID	N	Y	
M7-8	BufTm	N	Y	
M7-9	IntgPd	N	Y	
M7-10	GI	N	Y	
M7-11	conf-revision	N	Y	
M8	Unbuffered report control	N	Y	
M8-1	sequence-number	N	Y	
M8-2	report-time-stamp	N	Y	
M8-3	reason-for-inclusion	N	Y	
M8-4	data-set-name	N	Y	
M8-5	data-reference	N	Y	
M8-6	BufTm	N	Y	
M8-7	IntgPd	N	Y	
M8-8	GI	N	Y	
M8-8	conf-revision	N	Y	
	Logging	N	N	
M9	Log control	N	N	
M9-1	IntgPd	N	N	
M10	Log	N	N	
M11	Control	N	Y	
M17	File Transfer	N	Y	
M18	Application Association	N	Y	
M19	GOOSE Control Block	N	Y	
M20	Sampled Value Control Block	N	N	
If GSE (B31/32) is supported				
M12	GOOSE	Y	Y	
M13	GSSE	N	N	Deprecated Ed2
If SVC (41/42) is supported				
M14	Multicast SVC	N	N	
M15	Unicast SVC	N	N	
For all IEDs				
M16	Time	Y	N	SNTP client functions are supported.
Y = service is supported N or empty = service is not supported				

Note: The IED does not support Ed2 (Edition 2) here.

(PICS Ed.1)

ACSI service conformance statement

The ACSI service conformance statement is defined in Table A.3 (depending on the statements in Table A.1).

Table A.3 – ACSI service Conformance statement(1/3)

	Ed	Services	AA: TP/MC	Client (C)	Server (S)	Comments
Server						
S1	1	GetServerDirectory (LOGICAL-DEVICE)	TP	N	Y	
Application association						
S2	1	Associate	TP	N	Y	
S3	1	Abort	TP	N	Y	
S4	1	Release	TP	N	Y	
Logical device						
S5	1	GetLogicalDeviceDirectory	TP	N	Y	
Logical node						
S6	1	GetLogicalNodeDirectory	TP	N	Y	
S7	1	GetAllDataValues	TP	N	Y	
Data						
S8	1	GetDataValues	TP	N	Y	
S9	1	SetDataValues	TP	N	Y	
S10	1	GetDataDirectory	TP	N	Y	
S11	1	GetDataDefinition	TP	N	Y	
Data set						
S12	1	GetDataSetValues	TP	N	Y	
S13	1	SetDataSetValues	TP	N	N	
S14	1	CreateDataSet	TP	N	N	
S15	1	DeleteDataSet	TP	N	N	
S16	1	GetDataSetDirectory	TP	N	Y	
Substitution						
S17	1	SetDataValues	TP	N	N	
Setting group control						
S18	1	SelectActiveSG	TP	N	Y	
S19	1	SelectEditSG	TP	N	N	
S20	1	SetSGValues	TP	N	N	
S21	1	ConfirmEditSGValues	TP	N	N	
S22	1	GetSGValues	TP	N	N	
S23	1	GetSGCBValues	TP	N	Y	

(PICS Ed.1)

Table A.3 – ACSI service Conformance statement(2/3)

Reporting						
Buffered report control block (BRCB)						
S24	1	Report	TP	N	Y	
S24-1	1	data-change (dchg)		N	Y	
S24-2	1	quality-change (qchg)		N	Y	
S24-3	1	data-update (dupd)		N	N	
S25	1	GetBRCBValues	TP	N	Y	
S26	1	SetBRCBValues	TP	N	Y	
Unbuffered report control block (URCB)						
S27	1	Report	TP	N	Y	
S27-1	1	data-change (dchg)		N	Y	
S27-2	1	quality-change (qchg)		N	Y	
S27-3	1	data-update (dupd)		N	N	
S28	1	GetURCBValues	TP	N	Y	
S29	1	SetURCBValues	TP	N	Y	

Logging						
Log control block						
S30	1	GetLCBValues	TP	N	N	
S31	1	SetLCBValues	TP	N	N	
Log						
S32	1	QueryLogByTime	TP	N	N	
S33	1	QueryLogAfter	TP	N	N	
S34	1	GetLogStatusValues	TP	N	N	

Generic substation event model (GSE)						
GOOSE						
S35	1	SendGOOSEMessage	MC	Y	Y	
GOOSE-CONTROL-BLOCK						
S36	1	GetGoReference	TP	N	N	
S37	1	GetGOOSEElementNumber	TP	N	N	
S38	1	GetGoCBValues	TP	N	Y	
S39	1	SetGoCBValues	TP	N	Y	
GSSE						
S40	1	SendGSSEMessage	MC	N	N	Deprecated in Ed2
GSSE-CONTROL-BLOCK						
S41	1	GetReference	TP	N	N	Deprecated in Ed2
S42	1	GetGSSEElementNumber	TP	N	N	Deprecated in Ed2
S43	1	GetGsCBValues	TP	N	N	Deprecated in Ed2
S44	1	SetGsCBValues	TP	N	N	Deprecated in Ed2

Note: The IED does not support Ed2 (Edition 2) here.

(PICS Ed.1)

Table A.3 – ACSI service Conformance statement(3/3)

Transmission of sampled value model (SVC)						
Multicast SV						
S45	1	SendMSVMessage	MC	N	N	
Multicast Sampled Value Control Block						
S46	1	GetMSVCBValues	TP	N	N	
S47	1	SetMSVCBValues	TP	N	N	
Unicast SV						
S48	1	SendUSVMessage	TP	N	N	
Unicast Sampled Value Control Block						
S49	1	GetUSVCBValues	TP	N	N	
S50	1	SetUSVCBValues	TP	N	N	

Control						
S51	1	Select		N	Y	
S52	1	SelectWithValue	TP	N	Y	
S53	1	Cancel	TP	N	Y	
S54	1	Operate	TP	N	Y	
S55	1	CommandTermination	TP	N	Y	
S56	1	TimeActivatedOperate	TP	N	N	

File transfer						
S57	1	GetFile	TP	N	Y	
S58	1	SetFile	TP	N	N	
S59	1	DeleteFile	TP	N	N	
S60	1	GetFileAttributeValues	TP	N	Y	
S61	1	GetServerDirectory (FILE-SYSTEM)	TP	N	Y	

Time						
T1	1	Time resolution of internal clock			10 (1ms)	nearest negative power of 2 in seconds
T2	1	Time accuracy of internal clock			T1	T0 (10ms) T1 (1ms) T2 (100μs) T3 (25μs) T4 (4μs) T5 (1μs)
T3	1	Supported TimeStamp resolution			10 (1ms)	nearest negative power of 2 in seconds

(PIXIT Edition 1)

Protocol implementation extra information for testing (PIXIT) of the IEC 61850 communication interface in GR200 series IED

Note: The template of this document is "PIXIT template extracted from server test procedures version 1.0 and updated according to TPCL version 1.2.6" published by UCA International Using Group.

(Original document#: 6F2S1875 Ver. 0.10)

(PIXIT Ed.1)

1. Introduction

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in G2 Series IED with communication firmware G2M850-02 series version equal & upper than A(G2M850-02-A).

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10. The PIXIT entries contain information which is not available in the PICS, MICS, TICS documents or SCL file.

Each table specifies the PIXIT for applicable ACSI service model as structured in IEC 61850-10.

Note: The IED does not support IEC 61850 Edition 2 (**Ed2**) .

2. CONTENTS OF THIS DOCUMENT

Each chapter specifies the PIXIT for each applicable ACSI service model as structured in IEC 61850-10.

3. PIXIT FOR DOCUMENTATION

ID	Ed	Description	Value / Clarification
Do1	2	How to expose required firmware versions not present in the data model	NA

(PIXIT Ed.1)

4. PIXIT FOR ASSOCIATION MODEL

ID	Ed	Description	Value / Clarification
As1	1	Maximum number of clients that can set-up an association simultaneously	6
As2	1,2	TCP_KEEPALIVE value. The recommended range is 1..20s	Configurable from 1 to 20 seconds (default is 20 seconds)
As3	1,2	Lost connection detection time	From 10 to 30 seconds (TCP_KEEPALIVE + 10sec.)
As4	-	Authentication is not supported yet	N
As5	1,2	What association parameters are necessary for successful association	Transport selector N Session selector N Presentation selector N AP Title N AE Qualifier N
As6	1,2	If association parameters are necessary for association, describe the correct values e.g.	N.A.
As7	1,2	What is the maximum and minimum MMS PDU size	Max MMS PDU size 16384 Min MMS PDU size Not limited. It depends on a request.
As8	1,2	What is the maximum start up time after a power supply interrupt	Typically about 130 seconds Please check LCD Monitoring -> Communication -> 61850STAT as “Active” (Note) The startup time depends on the type of IED and Its configuration/setting.
As9	1,2	Does this device function only as test equipment? (test equipment need not have a non-volatile configuration; but it cannot be part of the substation automation system)	N

Note: The IED does not support Ed2 (Edition 2) here.

(PIXIT Ed.1)

5. PIXIT FOR SERVER MODEL

ID	Ed	Description	Value / Clarification
Sr1	1,2	Which analogue value (MX) quality bits are supported (can be set by server)	Validity: Y Good, Y Invalid, N Reserved, Y Questionable N Overflow Y* OutofRange N BadReference N Oscillatory Y* Failure N OldData N Inconsistent Y* Inaccurate(OnlyHz) Source: N Process N Substituted Y Test N OperatorBlocked * Supports only for GBU Model
Sr2	1,2	Which status value (ST) quality bits are supported (can be set by server)	Validity: Y Good, Y Invalid, N Reserved, Y Questionable N BadReference Y Oscillatory Y Failure Y OldData Y Inconsistent N Inaccurate Source: N Process N Substituted Y Test N OperatorBlocked
Sr3	-	What is the maximum number of data object references in one GetDataValues request	Deprecated
Sr4	-	What is the maximum number of data object references in one SetDataValues request	Deprecated
Sr5	1	Which Mode values are supported	On Y Blocked N Test Y Test/Blocked N Off N
		<additional items>	
		The order of interpretation of write requests involving a list of variables.	Front-to-back order. This might influence on write request involving RptEna and other variables in the same RCB.

Note: The IED does not support Ed2 (Edition 2) here.

(PIXIT Ed.1)

6. PIXIT for Data set model

ID	Ed	Description	Value / Clarification
Ds1	1	What is the maximum number of data elements in one data set (compare ICD setting)	Not limited by an internal configuration parameter. This IED does not have CreateDataSet service. But any DataSet can be defined by using engineering tool. The maximum number depends on the memory size of IED.
Ds2	1	How many persistent data sets can be created by one or more clients (this number includes predefined datasets)	N.A.
Ds3	1	How many non-persistent data sets can be created by one or more clients	N.A.

7. PIXIT FOR SUBSTITUTION MODEL

Not applicable

8. PIXIT FOR SETTING GROUP CONTROL MODEL

ID	Ed	Description	Value / Clarification
Sg1	1	What is the number of supported setting groups for each logical device	8
Sg2	1,2	What is the effect of when and how the non-volatile storage is updated (compare IEC 61850-8-1 $16.2.4)	Just SelectActiveSG service will be supported according to PICS. When an IED receives correct SelectActiveSG request, the IED returns Response+ within 10 seconds. And the ActSG and LActTm variable are updated within 10 seconds after the Response+. (These times are typical values, and they depend on IED types and its configurations/settings.) After changing setting group number with LED panel, you can see new setting group with GetSGCBValue service.
Sg3	1	Can multiple clients edit the same setting group	N.A.
Sg4	1	What happens if the association is lost while editing a setting group	N.A.
Sg5	1	Is EditSG value 0 allowed	N.A.
Sg6	2	When ResvTms is not present how long is an edit setting group locked	N.A.

Note: The IED does not support Ed2 (Edition 2) here.

(PIXIT Ed.1)

9. PIXIT for Reporting model

ID	Ed	Description	Value / Clarification
Rp1	1	The supported trigger conditions are (compare PICS)	integrity Y data change Y quality change Y data update Y
Rp2	1	The supported optional fields are	sequence-numberY report-time-stamp Y reason-for-inclusion Y data- set-name Y data- reference Y buffer-overflow Y entryID Y conf- rev Y segmentation Y
Rp3	1,2	Can the server send segmented reports (when not supported it is allowed to refuse an association with a smaller than minimum PDU size)	Y
Rp4	1,2	Mechanism on second internal data change notification of the same analogue data value within buffer period (Compare IEC 61850-7-2 $14.2.2.9)	Send report immediately
Rp5	1	Multi client URCB approach (compare IEC 61850-7-2:2003 $14.2.1)	Each URCB is visible to all clients
Rp6	-	What is the format of EntryID	Deprecated

Note: The IED does not support Ed2 (Edition 2) here.

(PIXIT Ed.1)

9. PIXIT for Reporting model (continued)

ID	Ed	Description	Value / Clarification
Rp7	1,2	What is the buffer size for each BRCB or how many reports can be buffered	For example, LLN0STHealth can be stored 408 events.
Rp8	-	Pre-configured RCB attributes that are dynamic, compare SCL report settings	Deprecated
Rp9	1	May the reported data set contain: - structured data objects - data attributes	 Y Y
Rp10	1,2	What is the scan cycle for binary events Is this fixed, configurable	More than 1.6 milliseconds Configurable
Rp11	1	Does the device support to pre-assign a RCB to a specific client in the SCL	N
Rp12	2	After restart of the server is the value of ConfRev restored from the original configuration or retained prior to restart	Restored from original configuration
Rp13	1,2	Does the server accepts any client to configure/enable a BRCB with ResvTms= - 1? What fields are used to do the identification?	N AP - Title N AE - Qualifier N <other field> N
Rp14	2	When BRCB.ResvTms is exposed, what is default value for BRCB.ResvTms if client does not write (must be > 0) Or When BRCB.ResvTms is not exposed, what is the internal reservation time (must be >= 0)	N/A 60 seconds
		<additional items>	
		Is it supported to change LLN0.Mod online?	N

Note: The IED does not support Ed2 (Edition 2) here.

10. PIXIT FOR LOGGING MODEL

Not applicable

(PIXIT Ed.1)

11. PIXIT FOR GOOSE PUBLISH MODEL

ID	Ed	Description	Value / Clarification
Gp1	1,2	Can the test (Ed1) / simulation (Ed2) flag in the published GOOSE be set	N
Gp2	1	What is the behaviour when the GOOSE publish configuration is incorrect	If the configuration is incorrect, the GOOSE isn't published.
Gp3	1,2	Published FCD supported common data classes are	All CDC/data types can be published.
Gp4	1,2	What is the slow retransmission time Is it fixed or configurable	60 seconds with TAL = 120sec. Fixed
Gp5	1,2	What is the fastest retransmission time Is it fixed or configurable	10 milli-sec. with TAL=30 milli-sec. Fixed
Gp6	-	Can the GOOSE publish be turned on / off by using SetGoCBValues(GoEna)	Deprecated See PICS - SetGoCBValues
Gp7	1,2	What is the initial GOOSE sqNum after restart	The device starts sending GOOSE from stNum=1 and sqNum=1.
Gp8	1	May the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	 Y Y
Gp9	1,2	Does Server or ICT refuse GOOSE payload dataset length greater than SCSM supports?	Y Server Refuses the Configuration.
		<additional items>	
	1,2	Is the DUT a test equipment	N

Note: The IED does not support Ed2 (Edition 2) here.

(PIXIT Ed.1)

12. PIXIT FOR GOOSE SUBSCRIBE MODEL

ID	Ed	Description	Value / Clarification
Gs1	1,2	What elements of a subscribed GOOSE message are checked to decide the message is valid and the allData values are accepted? If yes, describe the conditions. Notes: the VLAN tag may be removed by a ethernet switch and shall not be checked the simulation flag shall always be checked (Ed2)	Y destination MAC address = as configured Y APPID Y gocbRef N timeAllowedtoLive N datSet Y goID =as configured N t N stNum Y sqNum Y simulation / test N confRev Y ndsCom N numDatSetEntries N out-of-order dataset members
Gs2	1,2	When is a subscribed GOOSE marked as lost (TAL = time allowed to live value from the last received GOOSE message)	[message does not arrive prior to TAL] GOOSE subscribe quality information will become QUESTIONABLE (=1100 0000 0000 0). GOOSE status change is accepted. The behavior can be changed by modifying PLC logic.
Gs3	1,2	What is the behaviour when one or more subscribed GOOSE messages isn't received or syntactically incorrect (missing GOOSE)	[stNum is out-of-order, or missed] No fail will be detected. [sqNum is out-of-order, or missed] GOOSE subscribe quality information will become QUESTIONABLE | INCONSISTENT (=1100 0000 1000 0). After receiving message with correct sqNum order, the quality information is set to GOOD (=0000 0000 0000 0). You can assign the information to any data attribute using our configuration tool. GOOSE status change is ignored The behavior can be changed by modifying PLC logic.

Note: The IED does not support Ed2 (Edition 2) here.

(PIXIT Ed.1)

12. PIXIT FOR GOOSE SUBSCRIBE MODEL (continued)

ID	Ed	Description	Value / Clarification
Gs4	1,2	What is the behaviour when a subscribed GOOSE message is out-of-order	Refer to Gs3
Gs5	1,2	What is the behaviour when a subscribed GOOSE message is duplicated	GOOSE subscribe quality information will become QUESTIONABLE | INCONSISTENT (=1100 0000 1000 0). GOOSE status change is accepted. The behavior can be changed by modifying PLC logic.
Gs6	1	Does the device subscribe to GOOSE messages with/without the VLAN tag	Y, with the VLAN tag Y, without the VLAN tag
Gs7	1	May the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	Y N
Gs8	1,2	Subscribed FCD supported common data classes are	[Supported CDC] All, excepts measurand CDC (MV, CMV, SAV, WYE, DEL, SEQ, HMV, HWYE and HDEL) [Supported data type] Boolean BitString Integer Unsigned Integer Other types (TimeStamp, OctetString, etc) will be ignored by IED. (NOTE) But each data size shall be less than 32 bits. Dataset including measurand CDC listed above cannot be subscribed.
Gs9	1,2	Are subscribed GOOSE with test=T (Ed1) / simulation=T (Ed2) accepted in test/simulation mode	GOOSE subscribe quality information will become QUESTIONABLE | TEST (=1100 0000 0001 0). GOOSE status change is ignored. The behavior can be changed by modifying PLC logic.

Note: The IED does not support Ed2 (Edition 2) here.

(PIXIT Ed.1)

12. PIXIT FOR GOOSE SUBSCRIBE MODEL (continued)

ID	Ed	Description	Value / Clarification
Gs10	1,2	Max number of dataset members	64
		<additional items>	
	1,2	Are subscribed GOOSE with ndsCom=T Accepted.	GOOSE subscribe quality information will become QUESTIONABLE | INACCURATE (=1100 0000 0100 0). GOOSE status change is ignored. The behavior can be changed by modifying PLC logic.

13. PIXIT for GOOSE performance

ID	Ed	Description	Value / Clarification	
Gf1	1,2	Performance class	P1(Ed.2) for System/LLN0GOgoST P3(Ed.2) for all other GOOSE	
Gf2	1,2	GOOSE ping-pong processing method	Scan cycle based	
Gf3	1,2	Application logic scan cycle (ms)	Max.	…. 200ms
			Min.	1.38ms in 60Hz
Gf4	1	Maximum number of data attributes in GOOSE dataset (value and quality has to be counted as separate attributes)	The dataset for System/LLN0GOgoST is fixed, and it contains 32 data attributes. All other dataset for GOOSE can be configurable, and there is no particular limitation about the maximum number of data attributes. However, the dataset definition shares the same dynamic memory area as other data model definitions such as LN, RCB, etc., so it is affected by them.	

Note: The IED does not support Ed2 (Edition 2) here.

(PIXIT Ed.1)

14. PIXIT FOR CONTROL MODEL

ID	Ed	Description	Value / Clarification
Ct1	-	What control models are supported (compare ICD file enums for Ed2)	DOns: Y SBOns: Y DOes: Y SBOes: Y
Ct2	1,2	Is the control model fixed, configurable and/or dynamic	Fixed
Ct3	-	Is TimeActivatedOperate supported (compare PICS or SCL)	Deprecated
Ct4	-	Is "operate-many" supported (compare sboClass)	Deprecated
Ct5	1	Will the DUT activate the control output when the test attribute is set in the SelectWithValue and/or Operate request (when N test procedure Ctl2 is applicable)	Y
Ct6	-	What are the conditions for the time (T) attribute in the SelectWithValue and/or Operate request	Deprecated
Ct7	-	Is pulse configuration supported (compare pulseConfig)	Deprecated
Ct8	1	What is the behaviour of the DUT when the check conditions are set Is this behaviour fixed, configurable, online changeable	Y synchrocheck Y interlock-check Both bits are checked. (NOTE) The result of Opening operation (ctval = F) is not Influenced by SynchroCheck bit. This behavior is fixed.

Note: The IED does not support Ed2 (Edition 2) here.

(PIXIT Ed.1)

14. PIXIT FOR CONTROL MODEL(Continued)

ID	Ed	Description	Value / Clarification
Ct9	1,2	Which additional cause diagnosis are supported	Y Unknown Y Not-supported Y Blocked-by-switching-hierarchy Y Select-failed Y Invalid-position Y Position-reached N Step-limit Y Blocked-by-Mode N Blocked-by-process Y Blocked-by-interlocking Y Blocked-by-synchrocheck Y Command-already-in-execution Y Blocked-by-health Y 1-of-n-control Y Abortion-by-cancel Y Time-limit-over Y Abortion-by-trip (only for BCPU) Y Object-not-selected Edition 1 specific values: Y Parameter-change-in-execution Edition 2 specific values: Y Object-already-selected N No-access-authority N Ended-with-overshoot N Abortion-due-to-deviation N Abortion-by-communication-loss N Blocked-by-command N None Y Inconsistent-parameters Y Locked-by-other-client N Parameter-change-in-execution*
Ct10	1,2	How to force a “test-not-ok” respond with SelectWithValue request	Set orCat with unsupported value. See below “Which origin categories are supported?”
Ct11	1,2	How to force a “test-not-ok” respond with Select request	Send SELECT request to the control object which is not mapped to control application.

Note: The IED does not support Ed2 (Edition 2) here.

(PIXIT Ed.1)

14. PIXIT FOR CONTROL MODEL(Continued)

ID	Ed	Description	Value / Clarification
Ct12	1,2	How to force a "test-not-ok" respond with Operate request	DOns, SBOns, DOes: [Example1] Set orCat as unsupported value -> Cause AddCause as "Not-supported(1)" [Example2] Set ctlCat same as stVal -> Cause AddCause as "Position-reached(5)" SBOes: (Only Ed1) Same as above. Or, [Example3] Set Oper parameters as different parameter from the parameter of SelectWithVal -> Cause AddCause as "Parameter-change-in-execution (6)"
Ct13	1,2	Which origin categories are supported / accepted	N bay-control Y station-control Y remote-control N automatic-bay Y automatic-station Y automatic-remote N maintenance N process maintenance (7): N process (8): N
Ct14	1,2	What happens if the orCat value is not supported or invalid	DOns, SBOns, DOes, SBOes: "test-not-ok" IED respond
Ct15	1,2	Does the IED accept a SelectWithValue / Operate with the same control value as the current status value Is this behaviour configurable	DOns, SBOns, DOes, SBOes: N Fixed
Ct16	1,2	Does the IED accept a select/operate on the same control object from 2 different clients at the same time	DOns: N SBOns: N DOes: N SBOes: N Note: Commands are refused until the new position is not reached or a timeout does not occur.

Note: The IED does not support Ed2 (Edition 2) here.

(PIXIT Ed.1)

14. PIXIT FOR CONTROL MODEL(Continued)

ID	Ed	Description	Value / Clarification
Ct17	1	Does the IED accept a Select/SelectWithValue from the same client when the control object is already selected (Tissue #334)	SBOns: N SBOes: N
Ct18	1,2	Is for SBOes the internal validation performed during the SelectWithValue and/or Operate step	Yes for both SelectWithValue and Operate
Ct19	-	Can a control operation be blocked by Mod=Off or [On-]Blocked (Compare PIXIT-Sr5)	Deprecated
Ct20	1,2	Does the IED support local / remote operation	Y
Ct21	1,2	Does the IED send an InformationReport with LastApplError as part of the Operate response-for control with normal security	SBOns: N DOns: N
Ct22	2	How to force a "parameter-change-in-execution"	N.A.
Ct23	1,2	How many SBOns/SBOes control objects can be selected at the same time?	SBOns: n = 1 SBOes: n = 1
Ct24	1,2	Can a controllable object be forced to keep its old state e.g. Internal Controllable Objects may not be accessible to force this, whereas a switch like Circuit Breaker outside the DUT can?	Y Need PLC Logic customization.
Ct25	1,2	When CDC=DPC is supported, is it possible to have DPC (Controllable Double Point) go to the intermediate state? (00)	Y
Ct26	1,2	Name a DOes point (if any) with a finite operate timeout and specify the timeout (in milliseconds)	The timeout time is setting. One example, DPSY01-RST Default value is 300[ms] (10[ms]-1000[ms])
Ct27	2	Does the IED support control objects with external signals?	DOns: N SBOns: N DOes: N SBOes: N

Note: The IED does not support Ed2 (Edition 2) here.

(PIXIT Ed.1)

15. PIXIT FOR TIME AND TIME SYNCHONISATION MODEL

ID	Ed	Description	Value / Clarification
Tm1	1	What time quality bits are supported (may be set by the IED)	Y LeapSecondsKnown N ClockFailure Y ClockNotSynchronized
Tm2	1,2	Describe the behaviour when the time server(s) ceases to respond	On one time server: IED tries to synchronize with another time server. On all time servers: The quality attribute "ClockNotSynchronized" will be set to TRUE.
		What is the time server lost detection time	The lost detection time depends on the network condition.
Tm3	1,2	How long does it take to take over the new time from time server	10 seconds
Tm4	1,2	When is the time quality bit "ClockFailure" set	RTC is out-of-order
Tm5	1,2	When is the time quality bit "Clock not Synchronized" set	It depends on the condition of synchronization. Typically from 1 to 10 minutes.
Tm6	-	Is the timestamp of a binary event adjusted to the configured scan cycle	Deprecated
Tm7	1	Does the device support time zone and daylight saving	Yes for both.
Tm8	1,2	Which attributes of the SNTP response packet are validated	Y Leap indicator not equal to 3? N Mode is equal to SERVER N OriginateTimestamp is equal to value sent by the SNTP client as Transmit Timestamp Y RX/TX timestamp fields are checked for reasonableness Y SNTP version 3 and/or 4 N other (describe)
Tm9	1,2	Do the COMTRADE files have local time or UTC time and is this configurable	UTC Not Configurable

Note: The IED does not support Ed2 (Edition 2) here.

(PIXIT Ed.1)

16. PIXIT FOR FILE TRANSFER MODEL

ID	Ed	Description	Value / Clarification
Ft1	1	What is structure of files and directories	Support tree structure
		Where are the COMTRADE files stored	"/COMTRADE/" directory (NOTE) At root directory in IED, the directory "/COMTRADE/" is Hidden. Therefore a client shall directly access this directory.
		Are comtrade files zipped and what files are included in each zip file	Not zipped
Ft2	1,2	Directory names are separated from the file name by	"/"
Ft3	1	The maximum file name size including path (recommended 64 chars)	64 chars
Ft4	1,2	Are directory/file name case sensitive	N
Ft5	1,2	Maximum file size for SetFile	Not limited by implementation or configuration. It depends on available memory.
Ft6	1	Is the requested file path included in the MMS fileDirectory respond file name	N (Ed2: always complete path)
Ft7	1	Is the wild char supported MMS fileDirectory request	No
Ft8	1,2	Is it allowed that 2 clients get a file at the same time	Y
Ft9	1,2	Which files can be deleted	N.A.

17. PIXIT FOR SERVICE TRACKING MODEL

ID	Ed	Description	Value / Clarification
Tr1	2	Which ACSI services are tracked by LTRK.GenTrk	N.A

Note: The IED does not support Ed2 (Edition 2) here.

(TICS Edition 1)

IEC61850 Tissues conformance statement (TICS) of the IEC 61850 communication interface in GR200 series IED

Note: The template of this document is "TISSUES Implementation Conformance Statement for the IEC 61850 interface in G2 series IED" published by KEMA consulting with document number "2008-v0.2".

(Original document#: 6F2S1876 Ver. 0.5)

(TICS Ed.1)

1. Introduction

According to the UCA IUG QAP the tissue conformance statement is required to perform a conformance test and is referenced on the certificate.

This document is applicable for G2 series IED with communication firmware G2M850-01 series version upper than F (G2M850-01-F).

Note: Term "**Ed**" is mentioning the edition number of IEC 61850. This document describes the IEC 61850 Edition 1 (**Ed1**).
Note that the IED does not support Edition 2 (Ed2).

(TICS Ed.1)

2. Mandatory Intop Tissues

During the October 2006 meeting IEC TC57 working group 10 decided that:

- green Tissues with the category “IntOp” are mandatory for IEC 61850 edition 1
- Tissues with the category “Ed.2” Tissues should not be implemented.

Below table gives an overview of the implemented IntOp Tissues.

Part	Tissue Nr	Description Implemented	Y/n.a.
8-1	116	GetNameList with empty response?	Y
	165	Improper Error Response for GetDataSetValues	Y
	183	GetNameList error handling	Y
7-4	None		
7-3	28	Definition of APC	n.a.
	54	Point def xVal, not cVal	n.a.
	55	Ineut = Ires ?	n.a.
	60	Services missing in tables	Y
	63	mag in CDC CMV	Y
	219	operTm in ACT	n.a.
	270	WYE and DEL rms values	Y
7-2	30	control parameter T	Y
	31	Typo	n.a.
	32	Typo in syntax	n.a.
	35	Typo Syntax Control time	n.a.
	36	Syntax parameter DSet-Ref missing	n.a.
	37	Syntax GOOSE "T" type	Y
	39	Add DstAddr to GoCB	Y
	40	GOOSE Message “AppID” to “GoID”	Y
	41	GsCB “AppID” to “GsID”	n.a.
	42	SV timestamp: “EntryTime” to “TimeStamp"	n.a.
	43	Control "T" semantic	Y
	44	AddCause - Object not sel	n.a.
	45	Missing AddCauses (neg range)	Y
	46	Synchro check cancel	n.a.
	47	"." in LD Name?	Y
	49	BRCB TimeOfEntry (part of #453)	Y
	50	LNName start with number?	Y
	51	ARRAY [0..num] missing	n.a.
	52	Ambiguity GOOSE SqNum	Y
	53	Add DstAddr to GsCB, SV	n.a.
	151	Name constraint for control blocks etc.	Y
	166	DataRef attribute in Log	n.a.
	185	Logging - Integrity periode	n.a.
	189	SV Format	n.a.
	190	BRCB: EntryId and TimeOfEntry (part of #453)	Y
	191	BRCB: Integrity and buffering reports (part of #453)	Y
	234	New type CtxInt (Enums are mapped to 8 bit integer)	n.a.
	275	Confusing statement on GI usage (part of #453)	Y
	278	EntryId not valid for a server (part of #453)	Y
Part 6	1	Syntax	Y
	5	tExtensionAttributeNameEnum is restricted	Y
	8	SIUnit enumeration for W	n.a.
	10	Base type for bitstring usage	Y
	17	DAI/SDI elements syntax	Y
	169	Ordering of enum differs from 7-3	Y
	534	Dbpos	Y

Note: Tissue 49, 190, 191, 275 and 278 are part of the optional tissue #453, all other technical tissues in the table are mandatory if applicable.

Note: Editorial tissues are marked as “n.a.”.

Note: Final proposal on tissue 45 is not defined yet

(TICS Ed.1)

3. Optional IntOp Tissues

After the approval of the server conformance test procedures version 2.2, the following IntOp tissues were added or changed. It is optional to implement these tissues.

Part	Tissue Nr	Description	Implemented Y/N/n.a.
8-1	246	Control negative response (SBOns) with LastApplError	N
8-1	545	Skip file directories with no files	Y
7-2	333	Enabling of an incomplete GoCB	n.a.
7-2	453	Combination of all reporting and logging tissues	N
6	245	Attribute RptId in SCL	N
6	529	Replace sev - Unknown by unknown	n.a.

3. Other Implemented Tissues

Part	Tissue Nr	Description	Implemented Y/N/n.a.
8-1	109	GOOSE, GSE, SV Addresses	Y
	118	File directory	Y
	121	GOOSE subscriber behavior	Y
	344	TimeOfEntry misspelled	Y
7-4	76	CBOpCap and SwOpCap	N
7-3	65	Deadband calculation of a Vector and trigger option	Y
7-2	38	Syntax "AppID" or "GoID"	Y
6	3	Missing ENUMs	Y
	6	ReportControl/OptFields	N
	7	Duplication of attributes	N
	11	Schema for IP Addr?	N
	15	bufOvfl in Schema?	Y

Appendix 5 IEC60870-5-103 interoperability

1. List of information
2. Troubleshooting
3. Semantics of information number in according to the IEC 60870-5-103 standard

1. List of information (Time tagged Measured)

1.1 Events

INF	Semantics	Contents	GI	Type ID	COT	GRL200 Function_ID	GRL200 Data_ID
16	Auto-reclose active	OK status for the auto-reclose operation	OK	1	1, 9	0x4A6001 (ARC)	4A60018000011B60 (ARC1 READY)
					11		
					12	No default setting	
17	Tele-protection active	Not applicable in GRL	OK	1	1, 9	0x410001 (DIF_LP)	4100018F00001BB2 (DIFL_BLOCK); inverted signal
					12	No default setting	
18	Protection active	OK status for the operation of the relays	OK	1	1, 9	0x410001 (DIF_LP)	4100018F00001BB2 (DIFL_BLOCK); inverted signal
					12	No default setting	
19	LED reset	'Trip LED reset' signal is sent.	NA	1	1	0x201B0 (LED)	201B013100041001 (LED-04); inverted signal
					11		
					12	Issued by GENERAL COMMAND, which is described below.	
20	Monitor direction blocked	Forbidding to send the IED message for the upper level	OK	1	9,11	0x304001 (103SLV)	3040013100003602 (103BLK)
21	Test mode	Available of test mode	OK	1	9,11	0x304001 (103SLV)	3040013100003601 (103TST)
22	Local parameter setting		OK	1			
23	Characteristic1	Available for group setting #1	OK	1	1, 9	0x304001(103SLV)	3040018020011001 (AG1STAT)
					11		
					12	Issued by GENERAL COMMAND, which is described below.	
24	Characteristic2	Available for group setting #2	OK	1	1, 9	0x304001 (103SLV)	3040018120021001 (AG2STAT)
					11		
					12	Issued by GENERAL COMMAND, which is described below.	

INF	Semantics	Contents	GI	Type ID	COT	GRL200 Function_ID	GRL200 Data_ID
25	Characteristic3	Available for group setting #3	OK	1	1, 9	0x304001 (103SLV)	3040018220031001 (AG3STAT)
					11		
					12	Issued by GENERAL COMMAND	
26	Characteristic4	Available for group setting #4	OK	1	1, 9	0x304001 (103SLV)	3040018320041001 (AG4STAT)
					11		
					12	Issued by GENERAL COMMAND	
27	Auxiliary input1	Reception for the signal#1 generated at an auxiliary contact	OK	1	1, 9	Issued by GENERAL COMMAND	
28	Auxiliary input2	Reception for the signal#2 generated at an auxiliary contact	OK	1	1, 9	Issued by GENERAL COMMAND	
29	Auxiliary input3	Reception for the signal#3 generated at an auxiliary contact	OK	1	1, 9	Issued by GENERAL COMMAND	
30	Auxiliary input4	Reception for the signal#4 generated at an auxiliary contact	OK	1	1, 9	Issued by GENERAL COMMAND	
32	Measured supervision I	Supervision of the current of the zero-sequence and the CT error	OK	1	1, 9	0x221901 (CHK_IZ)	2219013210001001 (RESULT)
33	Measured supervision V	Supervision of the voltage of the zero-sequence	OK	1	1, 9	0x221B01 (CHK_VZ)	221B013210001001 (RESULT)
35	Phase sequence supervision	Supervision of the voltage of the negative-sequence	OK	1	1, 9	0x221A01 (CHK_V2)	221A013210001001 (RESULT)
36	Trip circuit supervision	Supervision of a trip circuit	OK	1	1, 9	Not supported	
37	I>> back-up operation	Status on the OC relay being in DT mode	OK	1	1, 9	Issued by GENERAL COMMAND	
38	VT fuse failure	VTF	OK	1	1, 9	0x490001 (VTF)	4900018000001B62 (VTF_ALARM)
39	Tele-protection disturbed	Communication fail	OK	1	1, 9	0x225101 (CHK_CM_FAIL1)	2251013210001001 (RESULT)
46	Group warning	minor error	OK	1	1,9	0x220001 (MNT_LOGIC)	2200013110121001 (MINR_ERR)
47	Group alarm	serious error	OK	1	1, 9	0x220001 (MNT_LOGIC)	2200013110111001 (SERI_ERR)
48	Earth Fault L1	Earth fault with regard to phase-A	OK	1	1, 9	Issued by GENERAL COMMAND	
49	Earth Fault L2	Earth fault with regard to phase-B	OK	1	1, 9	Issued by GENERAL COMMAND	
50	Earth Fault L3	Earth fault with regard to phase-C	OK	1	1, 9	Issued by GENERAL COMMAND	

INF	Semantics	Contents	GI	Type ID	COT	GRL200	
						Function_ID	Data_ID
51	Earth Fault Fwd, i.e. line	Earth fault in the forward direction	OK	1	1, 9	Not supported	
52	Earth Fault Rev, i.e. busbar	Earth fault in the reverse direction	OK	1	1, 9	Not supported	
64	Start/pick-up L1	Relay operation in phase-A	OK	1	1, 9	0x4A0001 (TRC)	4A00018000001B71
65	Start/pick-up L2	Relay operation in phase-B	OK	1	1, 9	0x4A0001 (TRC)	4A00018100001B72
66	Start/pick-up L3	Relay operation in phase-C	OK	1	1, 9	0x4A0001 (TRC)	4A00018200001B73
67	Start/pick-up N	Relay operation in phase-N	OK	1	1, 9	No default setting	
68	General trip	Trip operation performed in the three-phase	NA	2	1	0x4A0001 (TRC)	4A00018300001B6F (GEN.TRIP)
69	Trip L1	Trip operation in phase-A	NA	2	1	No default setting	
70	Trip L2	Trip operation in phase-B	NA	2	1	No default setting	
71	Trip L3	Trip operation in phase-C	NA	2	1	No default setting	
72	Trip I>>(back-up operation)	Status on the OC relay being in IDMT mode	NA	2	1	No default setting	
73	Fault location X in ohms	Fault location determined (the condition of sending events are the same as the FMR)	NA	4	1	Carried out by Time tagged measured function, which is described below.	
74	Fault forward/ line	Fault occurred in the forward direction	NA	2	1	Not supported	
75	Fault reverse/ busbar	Fault occurred in the reverse direction	NA	2	1	Not supported	
76	Tele-protection Signal transmitted	Sending a carrier signal	NA	2	1	No default setting	
77	Tele-protection Signal received	Reception of a carrier signal	NA	2	1	No default setting	
78	Zone1	Zone1 trip	NA	2	1	No default setting	
79	Zone2	Zone2 trip	NA	2	1	No default setting	
80	Zone3	Zone3 trip	NA	2	1	No default setting	
81	Zone4	Zone4 trip	NA	2	1	No default setting	
82	Zone5	Zone5 trip	NA	2	1	No default setting	
83	Zone6	Zone6 trip	NA	2	1	Not supported	
84	General start/pick-up	The OR signal generated by operated relays	OK	2	1,9	No default setting	
85	Breaker failure	CBF relay trip	NA	2	1	0x453001 (CBF)	4530018B00011B27 (CBF1_TRIP)
86	Trip measuring system L1		NA	2	1	Not supported	
87	Trip measuring system L2		NA	2	1	Not supported	
88	Trip measuring system L3		NA	2	1	Not supported	
89	Trip measuring system E		NA	2	1	Not supported	

INF	Semantics	Contents	GI	Type ID	COT	GRL200	
						Function_ID	Data_ID
90	Trip I>	OC trip in the IDMT mode	NA	2	1	No default setting	
91	Trip I>>	OC trip in the DT mode	NA	2	1	No default setting	
92	Trip IN>	EF trip in the IDMT mode	NA	2	1	No default setting	
93	Trip IN>>	EF trip in the DT mode	NA	2	1	No default setting	
128	CB 'on' by AR		NA	1	1	0x4A6001 (ARC)	4A60018000011B6C (ARC1 CLOSE COMMAND)
129	CB 'on' by long-time AR		NA	1	1	Not supported	
130	AR blocked		OK	1	1, 9	0x4A6001 (ARC)	4A60018200001BB4 (ARC_BLOCK)

1.2 Time tagged measured function

	Comments	Type ID	INF	Coefficient	GRL200	
					Function_ID	Data_ID
Signal	Fault distance － Decision made in kilometer	4	73	0.1	0x496001 (FL-AZ)	4960018000101349 (FltFlag)
SCL Measured	Flt Flag － The flag is raised at the start of the FL operation; it is lowered in a certain time	4	73	0.1	0x496001 (FL-AZ)	4960014200101340 (FltDiskm)

1.3 General command

Interpretation	Type ID	INF	Valid time[ms]	Time Out[ms]	GRL200	
					Function_ID	Data_ID
Change for the group setting #1	20	23	1000	1200	0x304001(103slave)	(304001 8020016422) AG1CMD
Change for the group setting #2	20	24	1000	1200	0x304001(103slave)	(304001 8120026422) AG2CMD
Change for the group setting #3	20	25	1000	1200	0x304001(103slave)	(304001 8220036422) AG3CMD
Change for the group setting #4	20	26	1000	1200	0x304001(103slave)	(304001 8320046422) AG4CMD
Resetting Trip LED	20	19	1000	1200	0x304001(103slave)	(304001 8010006422) LEDRST_CMD

1.4 Measured

INF	144	Corresponded Function ID	Corresponded Data ID in primary values	Coefficients	MEA	Type ID
Semantics	Ia, Ib, Ic, I1,I2,I0,Ie Va,Vb,Vc,V1,V2,V0,Vs, P, Q, f					
I	Not applicable	0x711001	711001 4301001078 (Ib primary)	1706.666667		
V	Not applicable	0x711001	711001 4302051076 (Vab primary)	31.03030303		
IL1	OK	0x711001	711001 4301001050 (Ia secondary)	1706.666667	1706.666667	9
IL2	OK	0x711001	711001 4301001052 (Ib secondary)	1706.666667	1706.666667	9
IL3	OK	0x711001	711001 4301001054 (Ic secondary)	1706.666667	1706.666667	9
I1	OK	0x711001	711001 4301021050 (I1 secondary)	1706.666667	1706.666667	9
I2	OK	0x711001	711001 4301021052 (I2 secondary)	1706.666667	1706.666667	9
I0	OK	0x711001	711001 4301021056 (I0 secondary)	1706.666667	1706.666667	9
Ie	OK	0x711001	711001 43010a1056 (Ie secondary)	3413.333333	3413.333333	9
Ise	Not applicable	0x711001	711001 43092e1056 (Ise secondary)	3413.333333	3413.333333	9
VL1	OK	0x711001	711001 4302041050 (Va secondary)	53.74606142	3413.333333	9
VL2	OK	0x711001	711001 4302041052 (Vb secondary)	53.74606142	3413.333333	9
VL3	OK	0x711001	711001 4302041054 (Vc secondary)	53.74606142	3413.333333	9
V1	OK	0x711001	711001 4302061050 (V1 secondary)	53.74606142	3413.333333	9
V2	OK	0x711001	711001 4302061052 (V2 secondary)	53.74606142	3413.333333	9
V0	OK	0x711001	711001 4302061056 (V0 secondary)	53.74606142	3413.333333	9
Ve	Not applicable	0x711001	711001 4302c31056 (V4 primary)	53.74606142	3413.333333	9
Vs	OK	0x711001	711001 4302081056 (Vs primary)	53.74606142	3413.333333	9
P	OK	0x711001	711001 43030b1098 (P)	2.23942E-06	1706.666667	9
Q	OK	0x711001	711001 43040c1098 (Q)	2.23942E-06	1706.666667	9
f	OK	0x711002	711001 43060f105C (f)	68.26666667	3413.333333	9

Note: The above coefficients can be derived with the following equations:

(1) Currents in three-phase (I_{L1}, I_{L2}, I_{L3}) and in symmetrical component (I1, I2, I0):

$$\text{Coefficient}=\frac{4096}{\text{In}\times 2.4}$$

where, In: Secondary current rating

For example, in In=1A , we can have coefficient 1706.666667.

(2) Earth fault current (I_e) and I_e used for SEF (I_{se}) :

$$\text{Coefficient}=\frac{4096}{\text{In}\times 1.2}$$

where, In: Secondary current rating (or Ise rating current)

For example, in In=1A , we can have coefficient 3413.333333.

(3) Voltages in three-phase (V_{L1}, V_{L2}, V_{L3}), in symmetrical component (V1, V2, V0), in earth-fault (Ve) , and in reference (Vs):

$$\text{Coefficient}=\frac{4096}{\text{Vn}/\sqrt{3}\times 1.2}$$

where, Vn: Secondary phase-phase voltage rating

For example, in Vn=110V , we can have coefficient 53.74606142.

(4) Active and reactive power (P, Q):

$$\text{Coefficient}=\frac{4096}{\text{Vn}/\sqrt{3}\times \text{VTr}\times \text{In}\times \text{CTr}\times 2.4}$$

where, Vn: Secondary phase-phase voltage rating

In: Secondary current rating

CTr: CT ratio

VTr: VT ratio

For example, in Vn=110V, In=1A, CTr=2000, VTr=2000, we can have coefficient 2.23942E-6.

(5) Frequency (f):

$$\text{Coefficient}=\frac{4096}{\text{fr}\times 1.2}$$

where, fr: System frequency

For example, in fr=50Hz, we can have coefficient 68.26666667.

[Legend]

GI: General Interrogation

Type ID: Type IDentification

1 : time-tagged message
2 : time-tagged message with relative time
3 : measurands I
4 : time-tagged measurands with relative time
5 : identification
6 : time synchronization
8 : general interrogation termination
9 : measurands II
10: generic data
11: generic identification
20: general command
23: list of recorded disturbances
26: ready for transmission for disturbance data
27: ready for transmission of a channel
28: ready for transmission of tags
29: transmission of tags
30: transmission of disturbance values
31: end of transmission

COT: Cause of Transmission

1: spontaneous
2: cyclic
3: reset frame count bit (FCB)
4: reset communication unit (CU)
5: start / restart
6: power on
7: test mode
8: time synchronization
9: general interrogation
10: termination of general interrogation
11: local operation
12: remote operation
20: positive acknowledgement of command
21: negative acknowledgement of command
31: transmission of disturbance data
40: positive acknowledgement of generic write command
41: negative acknowledgement of generic write command
42: valid data response to generic read command
43: invalid data response to generic read command
44: generic write confirmation

FUN: Function type

DPI: Double-point Information

DCO: Double Command

2. Troubleshooting

No.	Phenomena	Supposed causes	Check / Confirmation	
			Object†	Procedure
1	Communication trouble (IEC103 communication is not available.)	Address setting is incorrect.	BCU RY	Match address setting between BCU and relay. Avoid duplication of address with other relay.
		Transmission baud rate setting is incorrect.	BCU RY	Match transmission baud rate setting between BCU and relay.
		Start bit, stop bit and parity settings of data that BCU transmits to relay is incorrect.	BCU	Go over the following settings via the BCU. Relay setting is fixed in accordance with the following settings. - Start bit: 1bit - Stop bit: 1bit - Parity setting: even‡
		RS485 or optic cable interconnection is incorrect.	Cable	- Check the connection port. - Check the interconnection for RS485 A/B/COM - Check the send and received interconnection for the optic cable.
		The setting of converter is incorrect. (RS485/optic conversion is executed with the transmission channel, etc.)	Converter	In the event of using G1IF2, change the DIPSW setting in reference to INSTRUCTION MANUAL (6F2S0794).
		The relationship between logical “0/1” of the signal and Sig.on/off is incorrect. (In the event of using optic cable)	BCU	Check the following; Logical0 : Sig.on Logical1:Sig.off
		Terminal resistor is not provided. (Especially when the RS485 cable is long.)	cable	Add terminal resistor (150[ohms]) to both ends of RS 485 cable.

No.	Phenomena	Supposed causes	Check / Confirmation	
			Object†	Procedure
		Relay cannot receive the requirement frame from BCU. (The timing coordination of sending and receiving switch control is irregular in half-duplex communication.)	BCU	Check to ensure that there is a margin of more than 15ms between receiving the reply frame from the relay and transmitting the next requirement frame from the BCU.
		The requirement frame from the BCU and the reply frame from relay contend. (The sending and receiving timing coordination is irregular in half-duplex communication.)	BCU	Check to set the time-out for the reply frame from the relay. Time-out setting: more than 100ms (acceptable value of response time 50ms plus margin)
2	HMI does not display IEC103 event on the SAS side.	The relevant event sending condition is not valid.	RY	Change the event sending condition (signal number) of the IEC103 configurator if there is a setting error. When the setting is correct, check the signal condition using the programmable LED, etc.
		The relevant event Information Number (INF) and/or Function Type (FUN) may be different between the relay and SAS.	RY SAS	Match the relevant event Information Number (INF) or Function Type (FUN) between the relay and SAS.
		The relay is not initialised after writing the IEC103 configurator setting.	RY	Check the sum value of the IEC103 setting data on the LCD screen. When differing from the sum value on the IEC103 configurator, initialise the relay.
		It changes to blocked mode.	RY	Change the setting [**RS485_1_BRATE_SW**] to Normal.

No.	Phenomena	Supposed causes	Check / Confirmation	
			Object†	Procedure
3	Time can be not synchronised with IEC103 communication.	BCU does not transmit the time synchronisation frame.	BCU	Transmit the time synchronisation frame.
		The settling of the time synchronisation source is set to other than IEC.	RY	Change the settling of time synchronisation source to IEC.

†Note:BCU: Bay control unit, RY: Relay

‡Note:The user should set “even” for the parity setting. Not allowed to set except “even”.

3. Semantics of information number in IEC 60870-5-103

3.1 In monitor direction

Table 3.1 Status indications in monitor direction

INF		Description	GI	TYP	COT	FUN (typical)
<16>	:=	auto-recloser active	x	1	1,7,9,11,12,20,21	t(z), I>>, ΔI_L
<17>	:=	teleprotection	x	1	1,7,9,11,12,20,21	t(z), I>>
<18>	:=	protection active	x	1	1,7,9,11,12,20,21	t(z), I>>, ΔI_T, ΔI_L
<19>	:=	LED reset	–	1	1,7,11,12,20,21	t(z), I>>, ΔI_T, ΔI_L
<20>	:=	monitor direction blocked	x	1	9,11	t(z), I>>, ΔI_T, ΔI_L
<21>	:=	test mode	x	1	9,11	t(z), I>>, ΔI_T, ΔI_L
<22>	:=	local parameter setting	x	1	9,11	t(z), I>>, ΔI_T, ΔI_L
<23>	:=	characteristic 1	x	1	1,7,9,11,12,20,21	t(z)
<24>	:=	characteristic 2	x	1	1,7,9,11,12,20,21	t(z)
<25>	:=	characteristic 3	x	1	1,7,9,11,12,20,21	t(z)
<26>	:=	characteristic 4	x	1	1,7,9,11,12,20,21	t(z)
<27>	:=	auxiliary input 1	x	1	1,7,9,11	t(z), I>>, ΔI_T, ΔI_L
<28>	:=	auxiliary input 2	x	1	1,7,9,11	t(z), I>>, ΔI_T, ΔI_L
<29>	:=	auxiliary input 3	x	1	1,7,9,11	t(z), I>>, ΔI_T, ΔI_L
<30>	:=	auxiliary input 4	x	1	1,7,9,11	t(z), I>>, ΔI_T, ΔI_L

Table 3.2 Supervision indications in monitor direction

INF		Description	GI	TYP	COT	FUN (typical)
<32>	:=	measurand supervision I	x	1	1,7,9	t(z), I>>
<33>	:=	measurand supervision V	x	1	1,7,9	t(z), I>>
<35>	:=	phase sequence supervision	x	1	1,7,9	t(z), I>>
<36>	:=	trip circuit supervision	x	1	1,7,9	t(z), I>>, ΔIT, ΔIL
<37>	:=	I>> back-up operation	x	1	1,7,9	t(z)
<38>	:=	VT fuse failure	x	1	1,7,9	t(z), I>>
<39>	:=	teleprotection disturbed	x	1	1,7,9	t(z), I>>, ΔIL
<46>	:=	group warning	x	1	1,7,9	t(z), I>>, ΔIT, ΔIL
<47>	:=	group alarm	x	1	1,7,9	t(z), I>>, ΔIT, ΔIL

VT:=voltage transformer

Table 3.3 Earth fault indications in monitor direction

INF		Description	GI	TYP	COT	FUN(typical)
<48>	:=	earth fault L1	x	1	1,7,9	t(z), I>>
<49>	:=	earth fault L2	x	1	1,7,9	t(z), I>>
<50>	:=	earth fault L3	x	1	1,7,9	t(z), I>>
<51>	:=	earth fault forward, i.e. line	x	1	1,7,9	t(z), I>>
<52>	:=	earth fault reverse, i.e. busbar	x	1	1,7,9	t(z), I>>

Table 3.4 Fault indications in monitor direction

INF		Description	GI	TYP	COT	FUN(typical)
<64>	:=	start /pick-up L1	x	2	1,7,9	t(z), I>>, ΔIL
<65>	:=	start /pick-up L2	x	2	1,7,9	t(z), I>>, ΔIL
<66>	:=	start /pick-up L3	x	2	1,7,9	t(z), I>>, ΔIL
<67>	:=	start /pick-up N	–	2	1,7,9	t(z), I>>, ΔIL
<68>	:=	general trip	–	2	1,7	t(z), I>>, ΔIT, ΔIL
<69>	:=	trip L1	–	2	1,7	t(z), I>>, ΔIT, ΔIL
<70>	:=	trip L2	–	2	1,7	t(z), I>>, ΔIT, ΔIL
<71>	:=	trip L3	–	2	1,7	t(z), I>>, ΔIT, ΔIL
<72>	:=	trip I>> (back-up operation)	–	2	1,7	t(z)
<73>	:=	fault location X in ohms	–	4	1,7	t(z), I>>
<74>	:=	fault forward/line	–	2	1,7	t(z), I>>
<75>	:=	fault reverse/busbar	–	2	1,7	t(z), I>>
<76>	:=	teleprotection signal transmitted	–	2	1,7	t(z), I>>
<77>	:=	teleprotection signal received	–	2	1,7	t(z), I>>
<78>	:=	zone 1	–	2	1,7	t(z)
<79>	:=	zone 2	–	2	1,7	t(z)
<80>	:=	zone 3	–	2	1,7	t(z)
<81>	:=	zone 4	–	2	1,7	t(z)
<82>	:=	zone 5	–	2	1,7	t(z)
<83>	:=	zone 6	–	2	1,7	t(z)
<84>	:=	general start/pick-up	x	2	1,7,9	t(z), I>>, ΔIT, ΔIL
<85>	:=	breaker failure	–	2	1,7	t(z), I>>
<86>	:=	trip measuring system L1	–	2	1,7	ΔIT
<87>	:=	trip measuring system L2	–	2	1,7	ΔIT
<88>	:=	trip measuring system L3	–	2	1,7	ΔIT
<89>	:=	trip measuring system E	–	2	1,7	ΔIT
<90>	:=	trip I>	–	2	1,7	I>>
<91>	:=	trip I>>	–	2	1,7	I>>
<92>	:=	trip IN>	–	2	1,7	I>>
<93>	:=	trip IN>>	–	2	1,7	I>>

Table 3.5 Auto-reclosure indications in monitor direction

INF		Description	GI	TYP	COT	FUN (typical)
<128>	:=	CB 'on' by AR*	–	1	1,7	t(z), I>>, ΔIL
<129>	:=	CB 'on' by long-time AR*	–	1	1,7	t(z), I>>, ΔIL
<130>	:=	AR blocked*	x	1	1,7,9	t(z), I>>, ΔIL

*CB:=circuit breaker; AR:=auto-recloser

Table 3.6 Measurands in monitor direction

INF		Description	GI	TYP	COT	FUN (typical)
<144>	:=	measurand I	–	3.1	2,7	t(z), I>>
<145>	:=	measurand I, V	–	3.2	2,7	t(z), I>>
<146>	:=	measurand I, V, P, Q	–	3.3	2,7	t(z)
<147>	:=	measurand IN, VEN	–	3.4	2,7	t(z), I>>
<148>	:=	measurand IL1,2,3, VL1,2,3, P, Q, f	–	9	2,7	t(z)

3.2 In control direction

Table 3.7 Status indications in monitor direction

INF		Description	COM	TYP	COT	FUN (typical)
<16>	:=	auto-recloser on/off	ON/OFF	20	20	t(z), I>>, ΔI_L
<17>	:=	Teleprotection on/off	ON/OFF	20	20	t(z), I>>
<18>	:=	protection on/off	ON/OFF	20	20	t(z), I>>, ΔIT, ΔIL
<19>	:=	LED reset	ON	20	20	t(z), I>>, ΔIT, ΔIL
<23>	:=	active characteristic 1	ON	20	20	t(z)
<24>	:=	active characteristic 2	ON	20	20	t(z)
<25>	:=	active characteristic 3	ON	20	20	t(z)
<26>	:=	active characteristic 4	ON	20	20	t(z)

Appendix 6 Ordering

[Hardware selection (1/3)]

		7	8		9	A	B		C	D		E	F		G	H		J	K	L
Configurations	**G R L 2 0 0 -**			**-**				**-**			**-**			**-**			**-**			**0**
Application of power system																				
For 1CB arrangement (VCT12B: 5xCT, 5xVT)		1																		
For 1.5CB arrangement (VCT11B: 9xCT, 5xVT)		2																		
System Frequency																				
50Hz																		1		
60Hz																		2		
AC Rating for Phase Currents																				
1A																			1	
5A																			2	
DC Rating																				
110-250 Vdc (or 100 - 220Vac[1])			1																	
Outline																				
Standard LCD, 1/2 x 19'' rack for flush mounting					2															
Standard LCD, 3/4 x 19'' rack for flush mounting					3															
Standard LCD, 1/1 x 19'' rack for flush/rack mounting					4															
Large LCD, 1/2 x 19'' rack for flush mounting					6															
Large LCD, 3/4 x 19'' rack for flush mounting					7															
Large LCD, 1/1 x 19'' rack for flush/rack mounting					8															
Standard LCD, 1/2 x 19'' rack for rack mounting[2]					F															
Standard LCD, 3/4 x 19'' rack for rack mounting[2]					G															
Large LCD, 1/2 x 19'' rack for rack mounting[2]					J															
Large LCD, 3/4 x 19'' rack for rack mounting[2]					K															
BI/BO Module																				
Refer to Number of BI/BO Table																				
BI/BO Terminal Type																				
Compression plug type terminal																0				
Ring type terminal																1				
Communication for Protection (1)																				
1CH									1											
2CH									2											
Communication for Protection (2)																				
Refer to communication Table																				

[1]Operation is not guaranteed in the AC power source.

[2]For 19" rack panel mounting, accessories of joint kits are available. (See *Appendix: Rack mounting*))

[Hardware selection (2/3)]

								7	8		9	A	B		C	D		E	F		G	H		J	K	L
Configurations	**G**	**R**	**L**	**2**	**0**	**0**	**-**			**-**				**-**			**-**			**-**			**-**				**0**

Number of Serial and/or Ethernet Communication and/or Time Synch Port(s)	
1 port	1
1 port + IRIG-B	3
2 ports	4
2 ports + IRIG-B	6
3 ports (Note: Selectable when Communication for Protection is 1 or 2 CH.)	7
3 ports + GPS (Note : Selectable when Communication for Protection is 1 CH.)	8
3 ports + IRIG-B (Note : Selectable when Communication for Protection is 1 CH.)	9
Selection of Serial and/or Ethernet Communication Port(s)	
100Base-TX x 1 port (When position E = 1 - 3 and B – D)	3
100Base-FX x 1 port (When position E = 1 - 3 and B – D)	4
100Base-TX x 2 ports (When position E = 4 - 6 and E – G)	5
100Base-FX x 2 ports (When position E = 4 - 6 and E – G)	6
RS485 x 1 port + 100Base-TX x 1 port (When position E = 4 - 6 and E – G)	A
RS485 x 1 port + 100Base-TX x 2 ports (When position E = 7 – 9 and H)	B
RS485 x 1 port + 100Base-FX x 1 port (When position E = 4 - 6 and E – G)	C
RS485 x 1 port + 100Base-FX x 2 ports (When position E = 7 - 9 and H)	D
Fiber optic (for serial) + 100Base-TX x 1 port (When position E = 4 - 6 and E – G)	E
Fiber optic (for serial) + 100Base-TX x 2 ports (When position E = 7 - 9 and H)	F
Fiber optic (for serial) + 100Base-FX x 1 port (When position E = 4 - 6 and E – G)	G
Fiber optic (for serial) + 100Base-FX x 2 ports (When position E = 7 - 9 and H)	H
Function Block (linked with software selection)	
See function table of software selection	

[Hardware selection (3/3)]

Communication

1CH Communication for Protection (Position "C" is set to "1")

Communication Type	Ordering No. (Position "D")
Protection signal GI 2km Class (C37.94)	1
Protection signal SM 30km Class	2
Protection signal DSF 80km Class	3

2CH Communication for Protection (Position "C" is set to "2")

Communication Type	Ordering No. (Position "D")
Protection signal GI 2km Class (C37.94) x2ch	1
Protection signal SM 30km Class x2ch	2
Protection signal DSF 80km Class x2ch	3
Protection signal GI 2km Class (C37.94) x1ch Protection signal SM 30km Class x1ch	4
Protection signal GI 2km Class (C37.94) x1ch Protection signal DSF 80km Class x1ch	5
Protection signal SM 30km Class x1ch Protection signal DSF 80km Class x1ch	6

[Software selection]

Configurations	G	R	L	2	0	0	-	7	S	G	T	-	E	F	U	-	9	V
									0			-				-		
Application of power system																		
Assignment on position “7”																		
Function Block																		
Refer to Function Table																		
Communication for Remote / Time Synch. (1)																		
Assignment on position “E”																		
Communication for Remote / Time Synch. (2)																		
Assignment on position “F”																		
Protocol																		
IEC 60870-5-103															0			
IEC 60870-5-103 + IEC 61850															1			
IEC 61850															2			
Outline																		
Assignment on position “9”																		
Language																		
English																		E

Note: Software selection codes “1” to “7”, “E”, “F” and “9” are common with hardware selection codes.

[Interface Converter]

Configurations	G	I	F	2	0	0	-		
Electrical interface protocol									
ITU-T - G703 - 1.2.1								0	1
ITU-T - G703 –1.2.3								0	2

Number of BI/BO

BI/BO 1 x I/O module

Number of BI/BO									Ordering No. (Position "A" to "B")	Configuration
Independent BI	Independent BI (variable)	Common BI	DC-AI	Fast-BO	Semi-fast BO	BO	Heavy duty BO	DC-AO		
7	-	-	-	-	6	4	-	-	**11**	1xBIO1
12	-	-	-	-	3	2	-	-	**12**	1xBIO2
8	-	-	-	6	-	2	-	-	**13**	1xBIO3
-	6	-	-	-	-	2	6	-	**14**	1xBIO4
18	-	-	-	-	-	-	-	-	**15**	1xBI1
-	12	-	-	-	-	-	-	-	**16**	1xBI2
-	-	32	-	-	-	-	-	-	**17**	1xBI3
Other Configuration									**ZZ**	To be specified at ordering

BI/BO 2 x I/O module

Number of BI/BO									Ordering No. (Position "A" to "B")	Configuration
Independent BI	Independent BI (variable)	Common BI	DC-AI	Fast-BO	Semi-fast BO	BO	Heavy duty BO	DC-AO		
-	-	32	-	-	6	12	-	-	**21**	1xBI3+1xBO1
7	-	32	-	-	6	4	-	-	**22**	1xBI3+1xBIO1
12	-	32	-	-	3	2	-	-	**23**	1xBI3+1xBIO2
18	-	-	-	-	6	12	-	-	**24**	1xBI1+1xBO1
25	-	-	-	-	6	4	-	-	**25**	1xBI1+1xBIO1
30	-	-	-	-	3	2	-	-	**26**	1xBI1+1xBIO2
8	-	-	-	6	6	14	-	-	**27**	1xBO1+1xBIO3
15	-	-	-	6	6	6	-	-	**28**	1xBIO1+1xBIO3
7	-	-	-	-	12	16	-	-	**29**	1xBO1+1xBIO1
16	-	-		12	-	4	-	-	**2A**	2xBIO3
-	-	32	-	-	-	-	16	-	**2B**	1xBI3+1xBO2
-	12	-	-	-	6	12	-	-	**2C**	1xBI2 +1xBO1
-	-	32	10	-	-	-	-	-	**2D**	1xBI3A+1xDCAI2
Other Configuration									**ZZ**	To be specified at ordering

BI/BO 3 x I/O module

Number of BI/BO									Ordering No. (Position "A" to "B")	Configuration
Independent BI	Independent BI (variable)	Common BI	DC-AI	Fast-BO	Semi-fast BO	BO	Heavy duty BO	DC-AO		
15	-	-	-	6	12	18	-	-	**31**	1xBO1+1xBIO1+1xBIO3
20	-	-	-	6	9	16	-	-	**32**	1xBO1+1xBIO2+1xBIO3
23	-	-	-	12	6	8	-	-	**33**	1xBIO1+2xBIO3
26	-	-	-	6	6	14	-	-	**34**	1xBI1+1xBO1+1xBIO3
8	-	32	-	6	6	14	-	-	**35**	1xBI3+1xBO1+1xBIO3
24	-	-	-	18	-	6	-	-	**36**	3xBIO3
25	-	-	-	-	12	16	-	-	**37**	1xBI1+1xBO1+1xBIO1
-	-	32	10	-	6	12	-	-	**38**	1xBI3+1xDCAI2+1xBO1
36	-	-	-	-	6	12	-	-	**39**	2xBI1+1xBO1
-	24	-	-	-	6	12	-	-	**3A**	2xBI2+1xBO1
18	6	-	-	-	6	14	6	-	**3B**	1xBI1+1xBO1+1xBIO4
7	-	32	-	-	6	4	16	-	**3C**	1xBI3+1xBIO1+1xBO2
7	-	32	-	-	12	16	-	-	**3D**	1xBI3+1xBO1+1xBIO1
-	-	32	-	-	6	12	16	-	**3E**	1xBI3+1xBO1+1xBO2
18	-	-	10	-	6	12	-	-	**3F**	1XBI1+1xDCAI2+1xBO1
16	-	-	-	12	6	16	-	-	**3G**	1xBO1+2xBIO3
-	6	32	-	-	6	14	6	-	**3H**	1xBI3+1xBO1+1xBIO4
-	-	64	-	-	6	12	-	-	**3K**	2xBI3+1xBO1
14	-	32	-	-	12	8	-	-	**3L**	1xBI3+2xBIO1
-	-	96	-	-	-	-	-	-	**3M**	3xBI3
8	12	-	-	6	6	14	-	-	**3N**	1xBI2+1xBO1+1xBIO3
-	-	32	-	-	12	24	-	-	**3P**	1xBI3 + 2xBO1
36	-	-	-	-	-	-	16	-	**3Q**	2xBI1A+ 1xBO2A
-	-	-	30	-	-	-	-	-	**3R**	3xDCAI2
Other Configuration									**ZZ**	To be specified at ordering

BI/BO 4 x I/O modules

Number of BI/BO									Ordering No. (Position "A" to "B")	Configuration
Independent BI	Independent BI (variable)	Common BI	DC-AI	Fast-BO	Semi-fast BO	BO	Heavy duty BO	DC-AO		
26	-	-	-	6	12	26	-	-	**41**	1xBI1+2xBO1+1xBIO3
32	-	-	-	24	-	8	-	-	**42**	4xBIO3
8	-	32	-	6	12	26	-	-	**43**	1xBI3+2xBO1+1xBIO3
-	-	64	-	-	12	24	-	-	**44**	2xBI3+2xBO1
8	-	32	10	6	6	14	-	-	**45**	1xBI3+1xDCAI2+1xBO1 +1xBIO3
54	-	-	-	-	6	12	-	-	**46**	3xBI1+1xBO1
20	-	32	-	6	9	16	-	-	**47**	1xBI3+1xBO1+1xBIO2 +1xBIO3
-	-	64	10	-	6	12	-	-	**4A**	2xBI3+1xDCAI2+1xBO1
20				6	15	28			**49**	2xBO1+1xBIO2+1xBIO3
-	-	64	10	-	6	12	-	-	**4A**	2xBI3+1xDCAI2+1xBO1
34	-	-	-	12	6	16	-	-	**4B**	1xBI1+1xBO1+2xBIO3
-	-	64	-	-	-	-	32	-	**4C**	2xBI3+2xBO2
21	-	32	-	-	18	12	-	-	**4D**	1xBI3+3xBIO1
-	-	128	-	-	-	-	-	-	**4E**	4xBI3
7		96			6	4			**4F**	3xBI3+1xBIO1
8	24	-	-	6	6	14	-	-	**4G**	2xBI2 +1xBO1 +1xBIO3
-	-	32	-	-	18	36	-	-	**4H**	1xBI3 + 3xBO1
26	12	-	-	6	6	14	-	-	**4J**	1xBI1 + 1xBI2 + 1xBO1 + 1xBIO3
24	-	32	-	-	12	16	-	-	**4K**	1xBI3+1xBO1+2xBIO2
15	-	-	-	6	18	30	-	-	**4L**	2xBO1+1xBIO1+1xBIO3
7	-	-	-	-	24	40	-	-	**4M**	3xBO1+1xBIO1
36	-	-	-	-	12	24	-	-	**4N**	2xBI1A+2xBO1A
8	-	64	-	6	6	14	-	-	**4P**	2xBI3A+1xBO1A+1xBIO3A
36	-	-	-	-	6	12	16	-	**4Q**	2xBI1A+1xBO1A+1xBO2A
Other Configuration									**ZZ**	To be specified at ordering

BI/BO 5 x I/O modules

Number of BI/BO									Ordering No. (Position "A" to "B")	Configuration
Independent BI	Independent BI (variable)	Common BI	DC-AI	Fast-BO	Semi-fast BO	BO	Heavy duty BO	DC-AO		
33	-	-	-	6	6	6	32	-	**51**	1xBI1+1xBIO1+1xBIO3 +2xBO2
44	-	-	-	6	12	26	-	-	**52**	2xBI1+2xBO1+1xBIO3
25	-	96	-	-	6	4	-	-	**53**	1xBI1+3xBI3+1xBIO1
8	-	96	-	6	6	14	-	-	**54**	3xBI3+1xBO1+1xBIO3
-	-	64	10	-	12	24	-	-	**55**	2xBI3+1xDCAI2+2xBO1
62	-	-	-	6	6	14	-	-	**56**	3xBI1+1xBO1+1xBIO3
54	6	-	-	-	6	14	6	-	**57**	3xBI1+1xBO1+1xBIO4
54	-	-	10	-	6	12	-	-	**58**	3xBI1+1xDCAI2+1xBO1
36	-	-	10	-	12	24	-	-	**59**	2xBI1+1xDCAI2+2xBO1
20	-	32	10	6	9	16	-	-	**5A**	1xBI3+1xDCAI2+1xBO1 +1xBIO2+1xBIO3
-	-	96	-	-	12	24	-	-	**5B**	3xBI3+2xBO1
-	-	96	10	-	6	12	-	-	**5C**	3xBI3+1xDCAI2+1xBO1
-	-	64	10	-	-	-	32	-	**5D**	2xBI3+1xDCAI2+2xBO2
-	-	128	-	-	6	12	-	-	**5E**	4xBI3+1xBO1
-	-	160	-	-	6	12	-	-	**5F**	5xBI3
44	12	-	-	6	6	14	-	-	**5G**	2xBI1 + 1xBI2 + 1xBO1 + 1xBIO3
15	-	-	-	6	24	42	-	-	**5H**	3xBO1+1xBIO1+1xBIO3
-	-	64	-	-	18	36	-	-	**5J**	2xBI3+3xBO1
7	-	96	10	-	6	4	-	-	**5K**	3xBI3+1xDCAI2+1xBIO1
-	-	-	-	-	30	60	-	-	**5L**	5xBO1
-	-	64	30	-	-	-	-	-	**5M**	2xBI3+3xDCAI2
-	-	96	20	-	-	-	-	-	**5N**	3xBI3+2xDCAI2
Other Configuration									**ZZ**	To be specified at ordering

BI/BO 6 x I/O modules

Number of BI/BO									Ordering No. (Position "A" to "B")	Configuration
Independent BI	Independent BI (variable)	Common BI	DC-AI	Fast-BO	Semi-fast BO	BO	Heavy duty BO	DC-AO		
51	-	-	-	6	18	30	-	-	**61**	2xBI1+2xBO1+1xBIO1 +1xBIO3
8	-	96	-	6	12	26	-	-	**62**	3xBI3+2xBO1+1xBIO3
-	-	128	-	-	12	24	-	-	**63**	4xBI3+2xBO1
8	-	128	-	6	6	14	-	-	**64**	4xBI3+1xBO1+1xBIO3
8	-	96	10	6	6	14	-	-	**65**	3xBI3+1xDCAI2+1xBO1 +1xBIO3
54	6	-	10	-	6	14	6	-	**66**	3xBI1+1xDCAI2+1xBO1 +1xBIO4
-	-	128	10	-	6	12	-	-	**67**	4xBI3+1xDCAI2+1xBO1
-	-	96	10	-	12	24	-	-	**68**	3xBI3+1xDCAI2+2xBO1
52	-	-	-	12	-	4	32	-	**69**	2xBI1+2xBIO3+2xBO2
52	-	-	-	12	12	28	-	-	**6A**	2xBI1+2xBO1+2xBIO3
36	-	-	-	-	24	48	-	-	**6B**	2xBI1+4xBO1
36	-	64	-	-	12	24	-	-	**6C**	2xBI1+2xBI3+2xBO1
44	-	-	-	6	18	38	-	-	**6D**	2xBI1+3xBO1+1xBIO3
-	-	160	-	-	6	12	-	-	**6E**	5xBI3+1xBO1
7	-	160	-	-	6	4	-	-	**6F**	5xBI3+1xBIO1
Other Configuration									**ZZ**	To be specified at ordering

BI/BO 7 x I/O modules

Number of BI/BO									Ordering No. (Position "A" to "B")	Configuration
Independent BI	Independent BI (variable)	Common BI	DC-AI	Fast-BO	Semi-fast BO	BO	Heavy duty BO	DC-AO		
80	-	-	-	6	12	26	-	-	**71**	4xBI1+2xBO1+1xBIO3
72	6	-	-	-	12	26	6	-	**72**	4xBI1+2xBO1+1xBIO4
8	-	96	-	6	18	38	-	-	**73**	3xBI3+3xBO1+1xBIO3
-	6	96	-	-	18	38	6	-	**74**	3xBI3+3xBO1+1xBIO4
36	12	-	10	-	-	4	44	-	**75**	2xBI1+1xDCAI2+2xBIO4 +2xBO2
-	-	96	20	-	12	24	-	-	**76**	3xBI3+2xDCAI2+2xBO1
7	-	64	20	-	6	4	32	-	**77**	2xBI3+2xDCAI2+1xBIO1 +2xBO2
-	60	-	-	-	6	12	16	-	**78**	5xBI2+1xBO1+1xBO2
-	-	160	-	-	12	24	-	-	**79**	5xBI3+2xBO1
52	-	-	10	12	12	28	-	-	**7A**	2xBI1+1xDCAI2+2xBIO3 +2XBO1
54	-	64	-	-	12	24	-	-	**7B**	3xBI1 + 2xBI3 + 2xBO1
18	-	96	10	-	12	24	-	-	**7C**	1xBI1+3xBI3+1xDCAI2 +2xBO1
-	-	128	-	-	18	36	-	-	**7D**	4xBI3+3xBO1
7	-	160	-	-	12	16	-	-	**7E**	5xBI3+1xBO1+1xBIO1
-	-	192	-	-	6	12	-	-	**7F**	6xBI3+1xBO1
7	-	192	-	-	6	4	-	-	**7G**	6xBI3+1xBIO1
-	-	224	-	-	-	-	-	-	**7H**	7xBI3
26	-	64	20	6	6	14	-	-	**7J**	1xBI1+2xBI3+2xDCAI2 +1xBO1+1xBIO3
-	-	128	30	-	-	-	-	-	**7K**	4xBI3+3xDCAI2
Other Configuration									**ZZ**	To be specified at ordering

BI/BO 8 x I/O modules

Number of BI/BO									Ordering No. (Position "A" to "B")	Configuration
Independent BI	Independent BI (variable)	Common BI	DC-AI	Fast-BO	Semi-fast BO	BO	Heavy duty BO	DC-AO		
-	-	128	10	-	18	36	-	-	**81**	4xBI3+1xDCAI2+3xBO1
54	12	-	10	-	-	4	44	-	**82**	3xBI1+1xDCAI2+2xBIO4 +2xBO2
-	-	160	-	-	18	36	-	-	**83**	5xBI3+3xBO1
-	-	160	20	-	6	12	-	-	**84**	5xBI3+2xDCAI2+1xBO1
-	-	192	10	-	6	12	-	-	**85**	6xBI3+1xDCAI2+1xBO1
-	-	96	10	-	24	48	-	-	**86**	3xBI3+1xDCAI2+4xBO1
-	60	-	-	-	6	12	32	-	**87**	5xBI2+1xBO1+2xBO2
8	-	128	-	6	18	38	-	-	**88**	4xBI3+3xBO1+1xBIO3
14	-	96	30	-	12	8	-	-	**89**	3xBI3+3xDCAI2+2xBIO1
-	-	128	20	-	12	24	-	-	**8A**	4xBI3+2xDCAI2+2xBO1
-	-	192	20	-	-	-	-	-	**8B**	6xBI3+2xDCAI2
-	-	256	-	-	-	-	-	-	**8C**	8xBI3
36	-	64	20	-	12	24	-	-	**8D**	2xBI1+2xBI3+2xDCAI2 +2xBO1
18	-	96	10	-	18	36	-	-	**8E**	1xBI1+3xBI3+1xDCAI2 +3xBO1
-	-	128	10	-	-	-	48	0	**8F**	4xBI3+1xDCAI2+3xBO2
7	-	224	-	-	6	4	-	-	**8G**	7xBI3+1xBIO1
-	-	192	-	-	12	24	-	-	**8H**	6xBI3+2xBO1
7	-	192	-	-	12	16	-	-	**8J**	6xBI3+1xBO1+1xBIO1
21	-	96	10	-	24	24	-	-	**8K**	3xBI3+1xDCAI2+1xBO1 +3xBIO1
-	-	128	30	-	6	12	-	-	**8L**	4xBI3+3xDCAI2+1xBO1
7	-	96	-	-	30	52	-	-	**8M**	3xBI3A+4xBO1A+1xBIO1A
Other Configuration									**ZZ**	To be specified at ordering

Note that the user should contact with the sales staffs when requiring "other configuration (Ordering number: ZZ)" not indicated in the ordering code above.

FUNCTION TABLE(1/2)

Function Block	Protection function		Ordering No. (Position "G & T")				
			10	11	13	19	22
DIFL	87	Phase-segregated current differential protection (DIFL)	●	●	●	●	●
	50FS	Fail safe OC (DIFLFS-OC)					
	27FS	Fail safe UV (DIFLFS-UV)					
	CCC	Charging current compensation (DIFL-ICC)					
	CTF	CT failure detection by Id (DIFL-CTF)					
	87R	Remote differential trip (DIFL-RIDF)					
	THC	Through-fault current countermeasure (TFC)	NA	NA	NA	NA	NA
	50STUB	Stub protection (STBU-OC)					
DIFGL	87N	Zero phase current differential protection (DIFGL)	●	●	●	●	●
	50N/51N FS	Fail safe EF (DIFGL-FS)					
	CCC	Charging current compensation (DIFGL-ICC)					
	87R	Remote differential trip (DIFGL-RDIF)					
	THC	Through-fault current countermeasure (TFC)	NA	NA	NA	NA	NA
	50STUB	Stub protection (STUB-OC)					
DTT	DTT	Direct transfer trip function(*1)		●	●	●	●
DISTANCE_ZS (Num. of zones)	21	Distance protection(for phase fault) with 4zone (ZS)			● (4)	● (5)	
	68	Power swing block (PSBS)					
	50SOTF	Switch on to fault protection (ZS-SOTF)					
DISTANCE_ZG (Num. of zones)	21N	Distance protection(for earth fault) with 4zone (ZG)			● (4)	● (5)	
	68	Power swing block (PSBG)					
	50SOTF	Switch on to fault protection (SOTF-OC)					
CARRIER-DEF	85-67N	Directional earth fault carrier command protection (DEFCAR)			●	●	
CARRIER_DISTANCE	85-21	Distance carrier command protection (DESCAR)			●	●	
SOTF-OC	50SOTF	Switch on to fault protection (SOTF-OC)		●	●	●†	●
OC (Num. of stages)	50/67	Non-directional / directional definite time OC protection (OC)	● (4)	● (2)	● (2)	●† (4)	● (2)
	51/67	Non-directional / directional inverse time OC protection (OC)					
EF (Num. of stages)	50N/67N	Non-directional / directional definite time earth fault overcurrent protection (EF)	● (4)	● (2)	● (2)	●† (4)	● (2)
	51N/67N	Non-directional / directional inverse time earth fault overcurrent protection (EF)					
OCN (Num. of stages)	46/67	Non-Directional / directional Negative sequence overcurrent protection (OCN)		● (2)	● (2)	●† (2)	● (2)
THR	49	Thermal overload protection (THM)		●	●	●†	●
BCD	46BC	Broken conductor protection (BCD)		●	●	●†	●
CBF	50BF	Circuit breaker failure protection (CBF)		●	●	●†	●
OV	59	Phase over-voltage protection (OV)		●	●	●†	●
OVS	59	Phase-phase over-voltage protection (OVS)		●	●	●†	●
UV	27	Phase under-voltage protection (UV)		●	●	●†	●
UVS	27	Phase-phase under-voltage protection (UVS)		●	●	●†	●
		Function for single breaker scheme (Position "7" is set to "1")	Basic	Standard for single breaker scheme	Standard for single breaker scheme, with Distance	Standard for single breaker scheme, with Distance	Standard for single breaker scheme, with Control

FUNCTION TABLE(2/2)

Function Block	Protection function		Ordering No. (Position "G & T")				
			10	11	13	19	22
FRQ	81	Frequency protection (FRQ/DFRQ)		●	●	●†	●
OSTV	56V	Out of step tripping by voltage (OSTV)		●	●	●	●
ICD	ICD	Inrush current detection function (ICD)	●	●	●	●	●
FS	FS	Fail-safe function (FS)		●	●	●†	●
VTF	VTF	VTF detection function (VTF)	●	●	●	●†	●
CTF	CTF	CTF detection function (CTF)	●	●	●	●†	●
FL-Z	21FL	Fault locator (FL)	●	●	●	●	●
FL-A	FL	Fault locator (FL)	●	●	●	●	●
ARC	79	Autoreclosing function (ARC)		●	●	●†	●
VCHK	25	Voltage check for autoreclosing (VCHK)		●	●	●†	●
Ctrl		Switching control Interlock function					●
		Function for single breaker scheme (Position "7" is set to "1")	Basic	Standard for single breaker scheme	Standard for single breaker scheme, with Distance	Standard for single breaker scheme, with Distance	Standard for single breaker scheme, with Control

†Note: Not to fail the IED operations, the user shall stop two or more (unnecessary) function blocks marked with '†', prior to run all stages of the ZS and ZG functions. To stop the unnecessary applications, use settings [*****_EN**] in respective functions: DISCAR, DEFCAR, OC, EF, OCN, THM, BCD, CBF, SOTF-OC, OV, OVS, UV, UVS, FRQ/DFRQ, FS, VTF, CTF, ARC, VCHK.

Appendix 7 Technical data

Technical data

Analog Inputs	
Rated current In	Either 1A or 5A (specified when the ordering)
Rated voltage Vn	100V to 120V
Rated Frequency	Either 50Hz or 60Hz (specified when the ordering)
Overload Rating	
Current inputs	4 times rated current continuous 5 times rated current for 3 minutes 6 times rated current for 2 minutes 30 times rated current for 10 seconds 100 times rated current for 1 second 250 times rated current for one power cycle (20 or 16.6ms)
Voltage inputs	2 times rated voltage continuous 2.5 times rated voltage for 1 second
Burden	
Phase current inputs	≤ 0.1VA at In = 1A, ≤ 0.2VA at In = 5A
Earth current inputs	≤ 0.3VA at In = 1A, ≤ 0.4VA at In = 5A
Sensitive earth fault inputs	≤ 0.3VA at In = 1A, ≤ 0.4VA at In = 5A
Voltage inputs	≤ 0.1VA at Vn
Power Supply	
Rated auxiliary voltage	110/250Vdc (Operative range: 88.0 – 300.0Vdc)
Superimposed AC ripple on DC supply	≤ 15%
Power Supply Interruption Withstand Period (IEC60255-11)	110/250Vdc rating : 50ms
Power consumption	≤ 15W (quiescent) ≤ 25W (maximum)

Binary Inputs	
Input circuit DC voltage	24/48/60Vdc (Operating range: 19.2 – 72Vdc), 48/110Vdc (Operative range: 38.4 – 150Vdc), 110/125/220/250Vdc (Operating range: 88 – 300Vdc) Note: Pick-up setting is available in BI2 and BIO4 (Setting range: 18V to 222V)
Capacitive discharge immunity	10μF charged to maximum supply voltage and discharged into the input terminals, according to ENA TS 48-4 with an external resistor
Maximum permitted voltage	72Vdc for 24/48/60Vdc rating, 300Vdc for 110/250Vdc rating
Power consumption	≤ 0.5W per input at 220Vdc
Binary Outputs	
Fast operating contacts	
Make and carry	5A continuously 30A, 290Vdc for 0.2s (L/R=5ms)
Break	0.15A, 290Vdc (L/R=40ms)
Operating time	Typically 3 ms
Semi-fast operating contacts	
Make and carry	8A continuously 30A, 240Vdc for 1s (L/R=5ms)
Break	0.1A at 250Vdc (L/R=40ms) 0.2A at 125Vdc (L/R=40ms)
Operating time	Typically 6 ms
Auxiliary contacts	
Make and carry	8A continuously 30A, 240Vdc for 1s (L/R=5ms)
Break	0.1A at 250Vdc (L/R=40ms) 0.2A at 125Vdc (L/R=40ms)
Operating time	Typically 8 ms
Hybrid contacts (10 A breaking)	
Make and carry	8A continuously 10A, 220Vdc for 0.5s (L/R=5ms)
Break	10A, 220Vdc (L/R=20ms) 10A, 110Vdc (L/R=40ms)
Operating time	1 ms
Durability	≥ 10,000 operations (loaded contact) ≥ 100,000 operations (unloaded contact)

Measuring input capability	
Full scale	
Standard current input	≥ 60A (1A rating) or 300A (5A rating)
Sensitive current input	≥ 3A (1A rating) or 15 A (5A rating)
Voltage input	≥ 200V
Sampling rate	48 samples / cycle
Frequency response	< 5% deviation over range 16.7Hz to 600Hz

Mechanical Design	
Installation	Flush mounting
Weight	Approx. 10kg (1/3 size), 12kg (1/2 size), 15kg (3/4 size), 25kg (1/1 size)
Case color	2.5Y7.5/1 (approximation to Munsell value)
LED	
Number	26 (Fixed for "In service" and "ERROR")
Color	Red / Yellow / Green (configurable) except In service (green) and Error (red)
Function keys	
Number	7
Local Interface	
USB	Type B
Maximum cable length	2 meters (less than)
Terminal Block	
CT/VT input	Ring type terminal Ring terminal: M3.5 Cables cross-section: 2.5 mm^2 – 5.5 mm^2
Binary input, Binary output	Compression plug type terminal Cables cross-section: 1.5 mm^2 – 2.5mm^2 (AWG14) Stripping length = 10mm (typical) Ring type terminal Ring terminal: M3.5



Compression plug type



Ring type

System Interface (rear port)	
100BASE-TX	Fast Ethernet
Physical medium	Twisted pair cable, RJ-45 connector
100BASE-FX	Fast Ethernet
Physical medium	50/125 or 62.5/125μm fibre, SC connector
Protocol	IEC 61850

Communication for Miscellaneous (serial communication; rear port)	
RS485	Protocol: IEC 60870-5-103
Connector type	Push-in spring terminal
Cable type	Shielded twisted pair cable

Communication for Protection (Protection Signal)	
Optical interface (2 km class)	
Type of fibre	Graded-index multi-mode 50/125μm or 62.5/125μm
Connector type	ST type
Wave length	820nm
Optical transmitter	LED, more than –19dBm(50/125μm), –16dBm(62.5/125μm)
Optical receiver	PIN diode, less than –24dBm†
Optical interface (30 km class)	
Type of fibre	Single mode 10/125μm
Connector type	Duplex LC
Wave length	1310nm
Optical transmitter	Laser, more than –13dBm
Optical receiver	PIN diode, less than –30dBm†
Optical interface (80 km class)	
Type of fibre	DSF 8/125μm
Connector type	Duplex LC
Wave length	1550nm
Optical transmitter	Laser, more than –5dBm
Optical receiver	PIN diode, less than –34dBm†

†If receiving signal is lower than a rated power, optical communication failures may occur in the IED because of insufficient receiving sensitivity.

Environmental performance

Atmospheric Environment		
Temperature	IEC 60068-2-1/2 IEC 60068-2-14	Operating range:–25°C to +55°C. Storage / Transit:–25°C to +70°C. Cyclic temperature test as per IEC 60068-2-14
Humidity	IEC 60068-2-30 IEC 60068-2-78	56 days at 40°C and 93% relative humidity. Cyclic temperature with humidity test as per IEC 60068-2-30
Enclosure Protection	IEC 60529	IP52 - Dust and Dripping Water Proof IP20 for rear panel
Mechanical Environment		
Vibration	IEC 60255-21-1	Response - Class 1 Endurance - Class 1
Shock and Bump	IEC 60255-21-2	Shock Response Class 1 Shock Withstand Class 1 Bump Class 1
Seismic	IEC 60255-21-3	Class 1
Electrical Environment		
Dielectric Withstand	IEC 60255-27	2kVrms for 1 minute between all terminals and earth. 2kVrms for 1 minute between independent circuits. 1kVrms for 1 minute across normally open contacts.
High Voltage Impulse	IEC 60255-27 IEEE C37.90	Three positive and three negative impulses of 5kV(peak), 1.2/50μs, 0.5J between all terminals and between all terminals and earth.
Voltage Dips, Interruptions, Variations and Ripple on DC supply	IEC 60255-11, IEC 61000-4-29, IEC 61000-4-17 IEC 60255-26 Ed 3	1. Voltage dips: 0 % residual voltage for 20 ms 40 % residual voltage for 200 ms 70 % residual voltage for 500 ms 2. Voltage interruptions: 0 % residual voltage for 5 s 3. Ripple: 15 % of rated d.c. value, 100 / 120 Hz 4. Gradual shut-down / start-up: 60 s shut-down ramp, 5 min power off, 60s start-up ramp 5. Reversal of d.c. power supply polarity: 1 min
Capacitive Discharge	ENA TS 48-4	10μF charged to maximum supply voltage and discharged into the input terminals with an external resistance

Environmental performance

Electromagnetic Environment		
High Frequency Disturbance / Damped Oscillatory Wave	IEC 60255-22-1 Class 3, IEC 61000-4-18 IEC 60255-26 Ed 3	1 MHz burst in common / differential modes Auxiliary supply and I/O ports: 2.5 kV / 1 kV Communications ports: 1 kV / 0 kV
Electrostatic Discharge	IEC 60255-22-2 Class 4, IEC 61000-4-2 IEEE C37.90.3-2001 IEC 60255-26 Ed 3	Contact: 2, 4, 6, 8kV Air: 2, 4, 8, 15kV
Radiated RF Electromagnetic Disturbance	IEC 60255-22-3, IEC 61000-4-3 Level 3 IEC 60255-26 Ed 3	Sweep test ranges: 80 MHz to 1 GHz and 1.4 GHz to 2.7 GHz. Spot tests at 80, 160, 380, 450, 900, 1850 and 2150 MHz. Field strength: 10 V/m
	IEEE C37.90.2-1995	Field strength 35V/m for frequency sweep of 25MHz to 1GHz.
Fast Transient Disturbance	IEC 60255-22-4 IEC 61000-4-4 IEC 60255-26 Ed 3	5 kHz, 5/50ns disturbance Auxiliary supply and input / output ports: 4 kV Communications ports: 2 kV
Surge Immunity	IEC 60255-22-5 IEC 61000-4-5 IEC 60255-26 Ed 3	1.2/50µms surge in common/differential modes: Auxiliary supply and input / output ports: 4, 2, 1, 0.5 kV / 1, 0.5 kV Communications ports: up to 1, 0.5 kV / 0 kV
Surge Withstand	IEEE C37.90.1-2002	3kV, 1MHZ damped oscillatory wave 4kV, 5/50ns fast transient
Conducted RF Electromagnetic Disturbance	IEC 60255-22-6 IEC 61000-4-6 IEC 60255-26 Ed 3	Sweep test range: 150 kHz to 80MHz Spot tests at 27 and 68 MHz. Voltage level: 10 V r.m.s
Power Frequency Disturbance	IEC 60255-22-7 IEC 61000-4-16 IEC 60255-26 Ed 3	50/60 Hz disturbance for 10 s in common / differential modes† Binary input ports: 300 V / 150 V
Power Frequency Magnetic Field	IEC 61000-4-8 Class 4 IEC 60255-26 Ed 3	Field applied at 50/60Hz with strengths of: 30A/m continuously, 300A/m for 1 second.
Conducted and Radiated Emissions	IEC 60255-25 EN 55022 Class A, EN 61000-6-4 IEC 60255-26 Ed 3	Conducted emissions: 0.15 to 0.50MHz: <79dB (peak) or <66dB (mean) 0.50 to 30MHz: <73dB (peak) or <60dB (mean) Radiated emissions 30 to 230 MHz: < 40 dB(uV/m) 230 to 1000 MHz: < 47 dB(uV/m) Measured at a distance of 10 m

†For differential mode, 'CMP_NUM' setting utilized.

European Commission Directives

European Commission Directives		
CE	2014/30/EU	Compliance with the European Commission Electromagnetic Compatibility Directive is demonstrated according to EN 60255-26:2013
	2014/35/EU	Compliance with the European Commission Low Voltage Directive for electrical safety is demonstrated according EN 60255-27:2014.

Performance and Functional Standards

Performance and Functional Standards	
Category	**Standards**
General	
Common requirements	IEC 60255-1
Data Exchange	IEC 60255-24 / IEEE C37.111 (COMTRADE)
Product Safety	IEC 60255-27

Functional data

Phase-segregated Current Differential Protection	
DIFI1 (Small current region)	0.10 to 2.00A in 0.01A steps (1A rating) 0.50 to 10.00A in 0.01A steps (5A rating)
DIFI2 (Large current region)	0.6 to 60.0A in 0.1A steps (1A rating) 3.0 to 300.0A in 0.1A steps (5A rating)
DIFL-Slope1 (Small current region)	10 to 50 %
DIFL-Slope2 (Large current region)	50 to 100 %
Time setting for DIF	0.00 to 100.00s in 0.01s steps
Reference voltage	100 to 120V in 1V step
Operating time	Less than 1 cycle at 300% of DIFI1
Resetting time	Less than 110 ms (for tripping output) Less than 40 ms (for signal output)
Zero-sequence Current Differential Protection for high-resistance earth	
DIFGI	0.05 to 1.00A in 0.01A steps (1A rating) 0.25 to 5.00A in 0.01A steps (5A rating)
DIFG-Slope	10 to 50 %
Timer	0.00 to 300.00s in 0.01s steps
Operating time	less than 45ms
Resetting time	less than 100ms
Charging Current Compensation	
DIFL-IcC	0.00 to 1.00A in 0.01A steps (1A rating) 0.00 to 5.00A in 0.01A steps (5A rating)
Differential Current Supervision	
DIFSV	0.05 to 2.00A in 0.01A steps (1A rating) 0.25 to 10.00A in 0.01A steps (5A rating)
Timer	0 to 300s in 1s steps
DIF Guard characteristic	
Overcurrent threshold	0.02 to 50.00A in 0.01A steps (1A rating) 0.10 to 250.00A in 0.01A steps (5A rating)
Rate of Overcurrent change threshold	0.05 to 0.20A in 0.01A steps (1A rating) 0.25 to 1.00A in 0.01A steps (5A rrating)
Phase sequence Undervoltage threshold	5.0 to 130.0V in 0.1V steps
Phase to Phase Undervoltage threshold	5.0 to 130.0V in 0.1V steps
Rate of voltage change threshold	1 to 20V in 1steps
DIFG Guard characteristic	
Rate of Earth fault change threshold	0.02 to 50.00A in 0.01A steps (1A rating) 0.10 to 250.00A in 0.01A steps (5A rating)
Phase Fault Distance Measuring Element	
Z*-Mho.Reach, Z*-X.Reach and Z*-R.Reach (Z1S, Z1XS, Z2S, Z3S, ZCSF and ZCSR)	0.10 to 500.00Ω in 0.01Ω steps (1A rating) 0.01 to 100.00Ω in 0.01Ω steps (5A rating)
Characteristic angle Z*-Mho.Angle and Z*-R.Angle (Z1S, Z1XS, Z2S, Z3S, ZCSF and ZCSR)	30° to 90° in 1° steps
Z*- DirX.Angle and Z*-DirR.Angle (Z1S, Z1XS, Z2S, Z3S, ZCSF and ZCSR)	0° to 60° in 1° steps
ZSF-X.GrAngle1 and ZSR-X.GrAngle1	0° to 45°in 1° steps
ZSF-X.GrAngle2 and ZSR-X.GrAngle2	45° to 90° in 1° steps

Earth Fault Distance Measuring Element	
Z*-Mho.Reach, Z*-X.Reach and Z*-R.Reach (Z1G, Z1XG, Z2G, Z3G, ZCGF, ZCGR)	0.10 to 500.00Ω in 0.01Ω steps (1A rating) 0.01 to 100.00Ω in 0.01Ω steps (5A rating)
Characteristic angle	
Z*-Mho.Angle and Z*-R.Angle (Z1G, Z1XG, Z2G, Z3G, ZCGF, ZCGR)	30° to 90° in 1° steps
Z*- DirX.Angle and Z*-DirR.Angle (Z1G, Z1XG, Z2G, Z3G, ZCGF, ZCGR)	0° to 60° in 1° steps
ZGF-X.GrAngle1 and ZGR-X.GrAngle1	0° to 45°in 1° steps
ZGF-X.GrAngle2 and ZGR-X.GrAngle2	45° to 90°in 1° steps
Timer Setting	
Time setting of Z1S, Z1XS, Z2S, Z3S, Z1S, Z1G, Z1XG, Z2G, Z3G	0.00 to 100.00s in 0.01steps
Overcurrent Element for Fail-safe	
Overcurrent elements Z*_OCFS for supervision distance measuring elements (Z1S, Z1XS, Z2S, Z3S, Z1G, Z1XG, Z2G, Z3G)	0.02 to 5.00A in 0.01A steps (1A rating) 0.10 to 25.00A in 0.01A steps (5A rating)
Command Protection Distance Scheme	
Time for current reverse block	0.00 to 10.00s in 0.01s steps
Coordination time for BOP scheme	0 to 50ms in 1ms steps
Delayed drop-off timer	0.00 to 1.00s in 0.01s steps
Command Protection Earth Fault Scheme	
Time for delay trip	0.00 - 0.30s in 0.01s steps
Time for current reverse block	0.00 to 10.00s in 0.01s steps
Coordination time for BOP scheme	0 to 50ms in 1ms steps
delayed drop-off timer	0.00 to 1.00s in 0.01s steps
Power Swing Block	
Detection zone (PSBGS) Detection timer (TPSBS)	2.50 to 75.00Ω in 0.01Ω steps (1A rating) 0.50 to 15.00Ω in 0.01Ω steps (5A rating)
Load Encroachment	
Minimum load resistance (LESR, LESL)	0.10 to 500.00Ω in 0.01Ω steps (1A rating) 0.01 to 100.00Ω in 0.01Ω steps (5A rating)
Maximum load angle (LESR-Angle, LESL-Angle)	5° to 75° in 1° steps
Charging Current Compensation	
Charging current compensation for distance relay	0.00 to 1.00A in 0.01A steps (1A rating) 0.00 to 5.00A in 0.01A steps (5A rating)
Rated voltage for charging current compensation	100 to 120V in 1V steps
Minimum Operating Current	
Current	0.08A fixed (1A relay) 0.4A fixed (5A relay)
Earth fault current	0.10 to 1.00A in 0.01A steps(1A rating) 0.50 to 5.00A in 0.01A steps (5A rating)

Switch-on-to-fault Protection	
Overcurrent threshold	0.02 to.5.00A in 0.01A steps (1A rating) 0.10 to 15.00A in 0.01A steps (5A rating)
Stub Protection	
Overcurrent threshold	0.02 to 5.00A in 0.01A steps (1A rating) 0.10 to 15.00A in 0.01A steps (5A rating)
Out-of-step Protection (Out of step tripping (voltage phase comparison)	
Out-of-step trip	OFF / TRIP / BO(separated from other trip signals)
Out-of-step Protection (impedance locus)	
Resistive reach (at Right side)	15.00 to 150.00Ω in 0.01Ω steps (1A rating) 3.000 to 30.000Ω in 0.01Ω steps (5A rating)
Resistive reach (at Left side)	5.00 to 50.00Ω in 0.01Ω steps (1A rating) 1.000 to 10.000Ω in 0.01Ω steps (5A rating)
Resistive reach (at Forward)	5.00 to 250.00Ω in 0.01Ω steps (1A rating) 1.000 to 50.000Ω in 0.001Ω steps (5A rating)
Resistive reach (at Backward)	1.0 to 50.00Ω in 0.01Ω steps (1A rating) 0.200 to 10.000Ω in 0.001Ω steps(5A rating)
Detection time	0.01 to 1.00s in 0.01s steps
Breaker Failure (BF) Protection	
Overcurrent element	0.1 to 2.0A in 0.1A steps (1A rating) 0.5 to 10.0A in 0.1A steps (5A rating)
BF timer for retry-trip of failed breaker	50 to 500ms in 1ms steps
BF timer for related breaker trip	50 to 500ms in 1ms steps
Non-directional and Directional Overcurrent Protection	
1st, 2nd, 3rd, 4th Definite time overcurrent threshold	0.02 to 50.00A in 0.01A steps (1A rating) 0.10 to 250.00A in 0.01A steps (5A rating)
1st, 2nd, 3rd, 4th Inverse time overcurrent threshold	0.02 to 5.00A in 0.01A steps (1A rating) 0.10 to 25.00A in 0.01A steps (5A rating)
Direction characteristic	Non Directional / Forward / Backward
Polarising voltage	1.0 V(fixed)
Characteristic angle	0 – 180 deg in 1 deg steps
Delay type	DT / IEC-NI / IEC-VI / IEC-EI / UK-LTI / IEEE-MI / IEEE-VI / IEEE-EI / US-CO2 / US-CO8 / Original
Drop-out/pick-up ratio	10 to 100% in 1% steps
DTL delay	0.00 to 300.00s in 0.01s steps
IDMTL Time Multiplier Setting TMS	0.010 to 50.000 in 0.001 steps
Reset type	Definite Time or Dependent Time
Reset definite delay	0.00 to 300.00s in 0.01s steps
Reset Time Multiplier Setting RTMS	0.010 to 50.000 in 0.001 steps

Non-directional and Directional Earth Fault Protection	
1st, 2nd, 3rd, 4th Definite time earth fault threshold	0.02 to 50.00A in 0.01A steps (1A rating) 0.10 to 250.00A in 0.01A steps (5A rating)
1st, 2nd, 3rd, 4th Inverse time earth fault threshold	0.02 to 5.00A in 0.01A steps (1A rating) 0.10 to 25.00A in 0.01A steps (5A rating)
Direction characteristic	Non Directional / Forward / Backward
Characteristic angle	0 to 180° in 1° steps (3I0 lags for −3V0)
Polarising voltage (3V0)	0.5 to 100.0V in 0.1V steps
Delay type	DT / IEC-NI / IEC-VI / IEC-EI / UK-LTI / IEEE-MI / IEEE-VI / IEEE-EI / US-CO2 / US-CO8 / Original
Drop-out/pick-up ratio	10 to 100% in 1% steps
DTL delay	0.00 to 300.00s in 0.01s steps
IDMTL Time Multiplier Setting TMS	0.010 to 50.000 in 0.001 steps
Reset type	Definite Time or Dependent Time
Reset definite delay	0.00 to 300.00s in 0.01s steps
Reset Time Multiplier Setting RTMS	0.010 to 50.000 in 0.001 steps
Non-directional and Directional Negative Sequence Phase Overcurrent (NOC) Protection	
1st, 2nd, 3rd, 4th Definite time NOC threshold	0.02 to 50.00A in 0.01A steps (1A rating) 0.10 to 250.00A in 0.01A steps (5A rating)
1st, 2nd, 3rd, 4th Inverse time NOC threshold	0.02 to 5.00A in 0.01A steps (1A rating) 0.10 to 25.00A in 0.01A steps (5A rating)
Direction characteristic	Non Directional / Forward / Backward
Characteristic angle	0 to 180° in 1° steps (3I0 lags for −3V0)
Polarising voltage	0.5 to 25.0V in 0.1V steps
Delay type	DT / IEC-NI / IEC-VI / IEC-EI / UK-LTI / IEEE-MI / IEEE-VI / IEEE-EI / US-CO2 / US-CO8 / Original
Drop-out/pick-up ratio	10 to 100% in 1% steps
DTL delay	0.00 to 300.00s in 0.01s steps
IDMTL Time Multiplier Setting TMS	0.010 to 50.000 in 0.001 steps
Reset type	Definite Time or Dependent Time
Reset definite delay	0.00 to 300.00s in 0.01s steps
Reset Time Multiplier Setting RTMS	0.010 to 50.000 in 0.001 steps
Inrush Current Detection	
Second harmonic detection	10 to 50% in 1% steps
Inrush current thresholds	0.10 to 5.00A in 0.01A steps (1A rating) 0.5 to 25.0A in 0.1A steps (5A rating)
Thermal overload Protection	
Thermal setting (THM = k.IFLC)	0.40 – 2.00A in 0.01A steps (1A rating) 2.0 – 10.0A in 0.1A steps (5A rating)
Time constant (τ)	0.5 – 500.0mins in 0.1min steps
Thermal alarm	OFF, 50% to 100% in 1% steps
Pre-load current setting	0.00 – 1.00A in 0.01A steps (1A rating) 0.0 – 5.0A in 0.1A steps (5A rating)

Broken Conductor Detection	
Broken conductor threshold	0.10 to 1.00 in 0.01 steps
DTL delay	0.00 to 300.00s in 0.01s steps
Phase Overvoltage Protection	
1st, 2nd overvoltage threshold	1.0 to 220.0V in 0.1V steps
Delay type	DTL, IDMT, Original
Drop-out/pick-up ratio	10 to 100% in 1% steps
DTL delay	0.00 to 300.00s in 0.01s steps
IDMTL Time Multiplier Setting TMS	0.010 to 100.000 in 0.001 steps
Reset delay	0.0 to 300.0s in 0.1s steps
Phase to Phase Overvoltage Protection	
1st, 2nd overvoltage threshold	1.0 to 220.0V in 0.1V steps
Delay type	DTL, IDMT, Original
Drop-out/pick-up ratio	10 to 100% in 1% steps
DTL delay	0.00 to 300.00s in 0.01s steps
IDMTL Time Multiplier Setting TMS	0.010 to 100.000 in 0.001 steps
Reset delay	0.0 to 300.0s in 0.1s steps
Phase Undervoltage Protection	
1st, 2nd undervoltage threshold	5.0 to 130.0V in 0.1V steps
Delay type	DTL, IDMT, Original
Drop-out/pick-up ratio	100 to 120% in 1% steps
DTL delay	0.00 to 300.00s in 0.01s steps
IDMTL Time Multiplier Setting TMS	0.010 to 100.000 in 0.001 steps
Reset delay	0.0 to 300.0s in 0.1s steps
Undervoltage block threshold	5.0 to 20.0V in 0.1V steps
Undervoltage block delay	0.00 to 300.00s in 0.01s steps
Phase to Phase Undervoltage Protection	
1st, 2nd undervoltage threshold	5.0 to 130.0V in 0.1V steps
Delay type	DTL, IDMT, Original
Drop-out/pick-up ratio	100 to 120% in 1% steps
DTL delay	0.00 to 300.00s in 0.01s steps
IDMTL Time Multiplier Setting TMS	0.010 to 100.000 in 0.001 steps
Reset delay	0.0 to 300.0s in 0.1s steps
Undervoltage block threshold	5.0 to 20.0V in 0.1V steps
Undervoltage block delay	0.00 to 300.00s in 0.01s steps
Under/Over Frequency Protection	
1st - 4th under/overfrequency threshold	(Fnom – 10.00Hz) – (Fnom + 10.00Hz) in 0.01Hz steps Fnom: nominal frequency
DTL delay:	0.00 – 300.00s in 0.01s steps
Frequency UV Block	40.0 – 100.0V in 0.1V steps

Autoreclosing	
Number of shots	1 to 5 shots
Dead time for single-phase autoreclose	0.01 to 300.00s in 0.01s steps
Dead time for three-phase autoreclose	0.01 to 300.00s in 0.01s steps
Multi-shot dead line time	0.01 to 300.00s in 0.01s steps
Reclaim time	0.0 to 600.0s in 0.1s steps
Pulse width of reclosing signal output	0.01 to 10.00s in 0.01s steps
Autoreclose reset time	0.01 to 310.00s in 0.01s steps
Reset time for developing fault	0.01 to 300.00s in 0.01s steps
Follower breaker autoreclose delay time	0.01 to 300.00s in 0.01s steps
Voltage and Synchronism Check	
Synchronism check angle	0° to 75° in 1° steps
UV element	10 to 150V in 1V steps
OV element	10 to 150V in 1V steps
Busbar or line dead check	10 to 150V in 1V steps
Busbar or line live check	10 to 150V in 1V steps
Synchronism check time	0.01 to 100.00s in 0.01s steps
Voltage check time	0.01 to 100.00s in 0.01s steps
Voltage Transformer Failure Supervision	
Undervoltage element (phase-to-phase)	50 to 100V in 1V steps
Undervoltage element (phase-to-earth)	10 to 60V in 1V steps
Current change detection element	0.1A fixed (1A rating) 0.5A fixed (5A rating)
Residual voltage element	20V fixed
Residual current element	Common use with earth fault detection element
Fault Locator	
Line reactance and resistance setting	0.0 to 999.9Ω in 0.1Ω steps (1A rating) 0.00 to 199.99Ω in 0.01Ω steps (5A rating)
Line length	0.0 to 399.9km in 0.1km steps
Correction factor of impedance between lines	80 to 120% in 1% steps
Correction factor of impedance between in each phase	80 to 120% in 1% steps
Accuracy	±0.4km (up to 20km, without fault at near end) ±2% (up to 399.9km, without fault at near end)
Minimum measuring cycles	2.5 cycles

Metering Function	
AC current	Accuracy ± 0.5% (at rating)
AC voltage	Accuracy ± 0.5% (at rating)
Energy (Wh, varh)	Accuracy ± 1.0% (at rating)
Power (P, Q)	Accuracy ± 1.0% (at rating when power quantities being fed)
Frequency	Accuracy ± 0.03%
Time Synchronisation	
Protocol	SNTP

Cabling

The table below shows the recommended cables in the cross-section and rated-voltage for the connection with the transformer module (VCT), the binary IO module (BI, BO, and BIO), and the power supply module (PWS). Rated-voltage required for the cable is 600Vac.

Table Cables for the connection with module

Connecting for	Wire termination	Wire thickness
BI / BO / PWS	Stripping length = 10 mm (typical)	1.5mm^2 through 2.5 mm^2 or AWG14
VCT	M3.5 ring tongue with insulation	2.5 mm^2 through 5.5 mm^2
Protective earth (FG)	M5 ring tongue with insulation	5.5 mm^2 or larger

Fuses

The table below shows the required fuse in the PWS. DO NOT change the fuse by the user. The fuse is complies with IEC60127-2 Sheet 5.

Table Fuse specification in PWS

Specification	Description
Rated current	3.15A
Rated voltage	500Vac & 400Vdc
Cutoff velocity	Type "T"
Manufacture	Littelfuse, Inc.
Type	04773.15XP

Safety and environment

The table below shows the safety category of the insulation resistance and the environment.

Table Safety and environment requirement

Safety requirement	Definition in IEC	Specification
Insulation resistance	IEC 60255-27	More than 100 M-ohm at 500V d.c.
Protection bonding continuity test	IEC 60255-27	Test current: 10 A a.c. Resistance: less than 0.1 ohm
Protective bonding resistance test	IEC 60255-27	Resistance: less than 0.2 ohm
Creepage distance and clearance	IEC 60255-27	Pollution degree 2 Overvoltage category III
Protective class	IEC 60255-27	Class I

Appendix 8 Manufacture setting

LED Setting for GRL200 (Type: Standard +Control)

LED No	Standard3(Standard2+Control)					
	Logic		Attribute			Remarks
	Label	Fixed	Color	Blink	Fixed	
1	IN SERVICE	x	Green	–	x	Lit when IED is in service.
2	ERROR	o	Red	–	x	Lit when failure is detected. User configurable only Logic condition.
3						
4	TRIP		Red			Lit when trip command issued.
5						
6	TEST		Yellow			Lit when test mode changed.
7	TIME SYNC.FAIL		Yellow			Lit on a time synchronization failure between IED and the Time-server.
8	LAN COMM. FAIL		Yellow			Lit on a communication failure between IED and the Server.
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						

PF-Key

GR RELAY (DIFFERENTIAL)

PF-Key / Model	F1	F2	F3	F4	F5	F6	F7
GRL200	Metering	Fault Record	Event Record1	Event Record2	Event Record3	—	—

Appendix 9 Matrix between VCT terminals and relay applications

Matrix table for VCT11B

		Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12	Ch13	Ch14
		Screw numbers Voltage signals					Screw numbers Current signals								
		1–2	3–4	5–6	7–8	9–10	11-12	13–14	15–16	17–18	19-20	21–22	23–24	25–26	27–28
Relay applications (Function ID)	**Abbr.**	V_a	V_b	V_c	V_s	V_{s2}	I_a	I_b	I_c	I_e	I_{a2}	I_{b2}	I_{c2}	I_{e2}	Iem
Differential protection (FB: 410001)	DIFL						X	X	X		X	X	X		
Differential protection (FB: 411001)	DIFGL									X					
Distance protection (FB: 430001)	ZS	X	X	X			X	X	X						
Distance protection (FB: 431001)	ZG	X	X	X			X	X	X						X
Direct transfer trip (FB: 485001)	DTT														
Dis. carr. command (FB: 436001)	DISCAR														
Dis. EF command (FB: 437001)	DEFCAR														
Switch on to fault (FB: 454001)	SOTF-OC						X	X	X						
Overcurrent (FB: 440001)	OC	X	X	X			X	X	X						
Earth fault (FB: 441001)	EF	X	X	X			X	X	X	X					
Negative OC (FB: 443001)	OCN	X	X	X			X	X	X						
Thermal overload (FB: 451001)	THM						X	X	X						
Broken conductor (FB: 452001)	BCD						X	X	X						
Circuit breaker (FB: 453001)	CBF						X	X	X	X	X	X	X	X	
Overvoltage (FB: 460001)	OV	X	X	X											
Overvoltage (FB: 461001)	OVS	X	X	X											
Undervoltage (FB: 470001)	UV	X	X	X											
Undervoltage (FB: 471001)	UVS	X	X	X											

Matrix table for VCT11B

		Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12	Ch13	Ch14
		Screw numbers Voltage signals					Screw numbers Current signals								
		1–2	3–4	5–6	7–8	9–10	11-12	13–14	15–16	17–18	19-20	21–22	23–24	25–26	27–28
Relay applications (Function ID)	**Abbr.**	V_a	V_b	V_c	V_s	V_{s2}	I_a	I_b	I_c	I_e	I_{a2}	I_{b2}	I_{c2}	I_{e2}	Iem
Frequency (FB: 475001)	FRQ	X	X	X											
Out of step (FB: 479001)	OSTV	X	X	X											
Inrush current detection (FB: 480001)	ICD						X	X	X						
Fail safe (FB: 48B001)	FS	X	X	X			X	X	X	X					
VT failure detection (FB: 490001)	VTF	X	X	X			X	X	X	X					
CT failure detection (FB: 491001)	CTF	X	X	X	X		X	X	X						
Fault locator (FB: 496001)	FL	X	X	X			X	X	X						X
Voltage check (FB: 4A8001)	VCHK	X	X	X	X	X									
Protection common (FB: 48A001)	PROT_COMM	X	X	X			X	X	X						

Note: X: Applicable

Blank: Not applicable.

Matrix table for VCT12B

		Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch14
		Screw numbers Voltage signals					Screw numbers Current signals				
		1–2	3–4	5–6	7–8	9–10	11-12	13–14	15–16	17–18	27–28
Relay applications (Function ID)	**Abbr.**	**V_a**	**V_b**	**V_c**	**V_s**	**V_{s2}**	**I_a**	**I_b**	**I_c**	**I_e**	**Iem**
Differential protection (FB: 410001)	DIFL						X	X	X		
Differential protection (FB: 411001)	DIFGL									X	
Distance protection (FB: 430001)	ZS	X	X	X			X	X	X		
Distance protection (FB: 431001)	ZG	X	X	X			X	X	X		X
Direct transfer trip (FB: 485001)	DTT										
Dis. carr. command (FB: 436001)	DISCAR										
Dis. EF command (FB: 437001)	DEFCAR										
Switch on to fault (FB: 454001)	SOTF-OC						X	X	X		
Overcurrent (FB: 440001)	OC	X	X	X			X	X	X		
Earth fault (FB: 441001)	EF	X	X	X			X	X	X	X	
Negative OC (FB: 443001)	OCN	X	X	X			X	X	X		
Thermal overload (FB: 451001)	THM						X	X	X		
Broken conductor (FB: 452001)	BCD						X	X	X		
Circuit breaker (FB: 453001)	CBF						X	X	X	X	
Overvoltage (FB: 460001)	OV	X	X	X							
Overvoltage (FB: 461001)	OVS	X	X	X							
Undervoltage (FB: 470001)	UV	X	X	X							
Undervoltage (FB: 471001)	UVS	X	X	X							
Frequency (FB: 475001)	FRQ	X	X	X							

Matrix table for VCT12B

		Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch14
		Screw numbers Voltage signals					Screw numbers Current signals				
		1–2	3–4	5–6	7–8	9–10	11-12	13–14	15–16	17–18	27–28
Relay applications (Function ID)	**Abbr.**	V_a	V_b	V_c	V_s	V_{s2}	I_a	I_b	I_c	I_e	Iem
Out of step (FB: 479001)	OSTV	X	X	X							
Inrush current detection (FB: 480001)	ICD						X	X	X		
Fail safe (FB: 48B001)	FS	X	X	X			X	X	X	X	
VT failure detection (FB: 490001)	VTF	X	X	X			X	X	X	X	
CT failure detection (FB: 491001)	CTF	X	X	X	X		X	X	X		
Fault locator (FB: 496001)	FL	X	X	X			X	X	X		X
Voltage check (FB: 4A8001)	VCHK	X	X	X	X	X					
Protection common (FB: 48A001)	PROT _COMM	X	X	X			X	X	X		

Note: X: Applicable

Blank: Not applicable.

Appendix 10 Rack mounting

Table-1 shows mounting methods for 19" rack; the user can mount non-1/1 case (i.e., 3/4 case, 1/2 case) using optional mounting kits (Table-2). The combined mounting is also available for 1/2 cases. Follow the below steps when mounting:

Step1: Remove the flange(s) on the sides of the case.

Step2: Attach parts of the optional kit; e.g. joint plates, lock bracket, and screws.

Step3: Mount the case for the rack using screws‡

‡Screws are not included in the kit. Prepare the screws by yourself.

Table-1 Methods for rack mounting

Mounting methods	Applicable sizes
Flush mount	1/2 case, 3/4 case 1/1 case
Rack mount	1/1 case, 1/2 case†, 3/4 case†

†Use a mount kit.

Table-2 Required mounting kits (optional parts)

Mounting for the 19" rack	Optional kit names	Parts codes	References
Simple mounting in a 1/2 case	Joint kits for single 1/2 case	EP−204	Figure-4
Combined mounting in double 1/2 cases	Joint kits for two 1/2 case	EP−205	Figure-5
Simple mounting for a 3/4 case	Joint kits for single 3/4 case	EP−206	

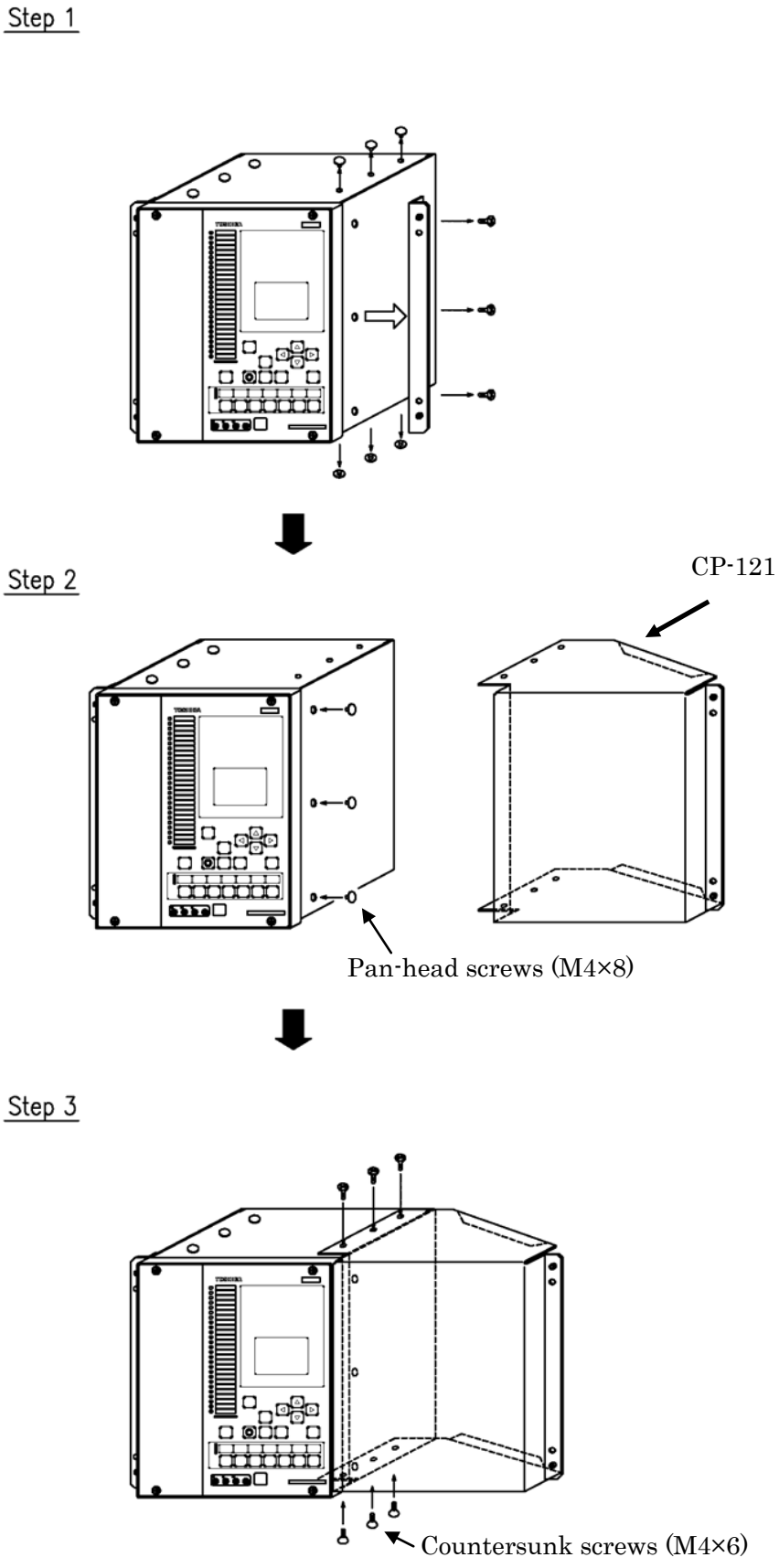


Figure-4 Mounting a 1/2 case for the rack

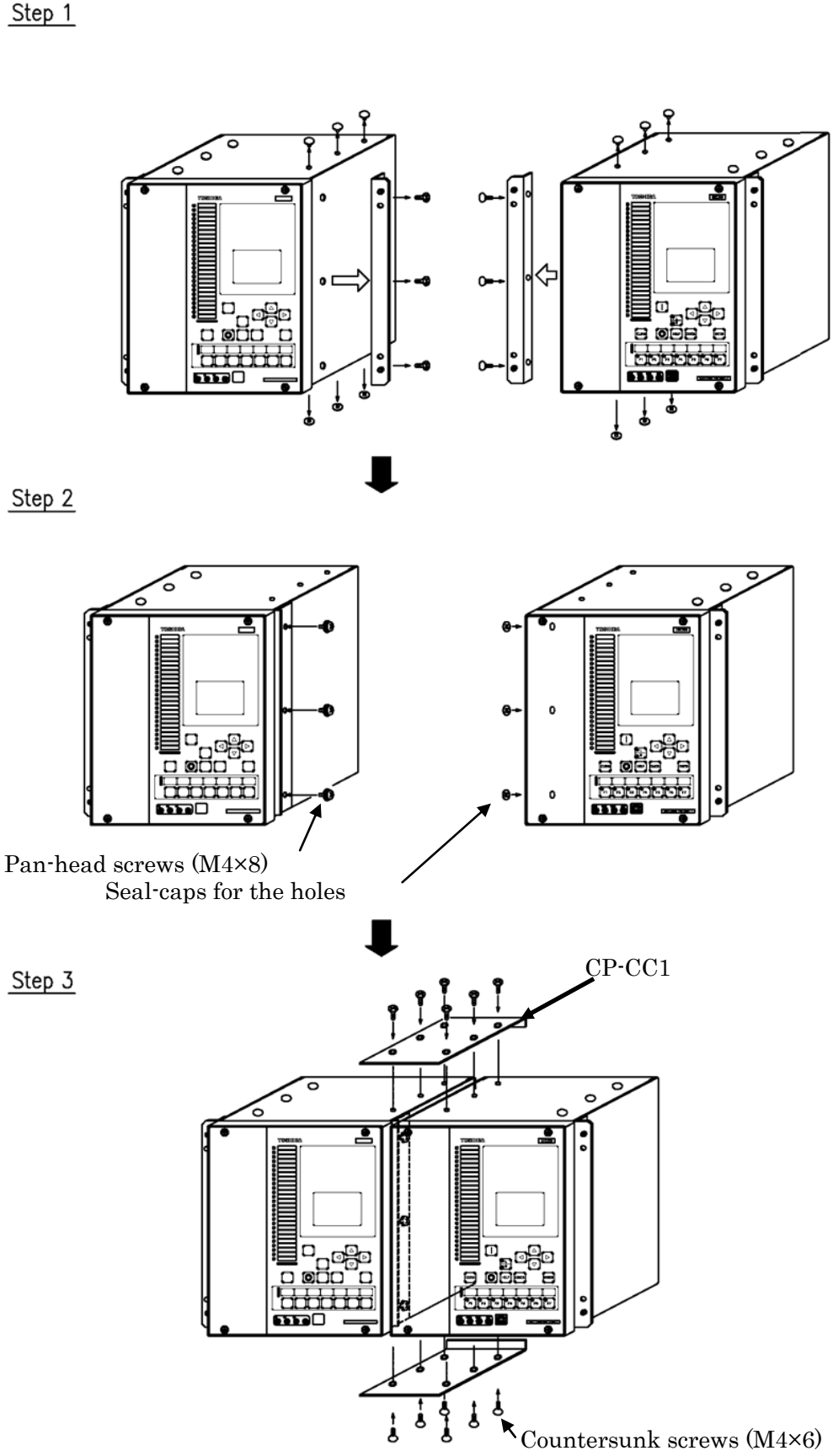


Figure-5 Mounting double 1/2 case for the rack

Appendix 11 Input dummy for relay application

The PLC connection points described in the main chapter are applicable to use when the user wishes to create a custom logic by itself provided both the custom logic and the functions provided by the manufacture are implemented in the same CPU. On the other hand, the custom logic and the logic provided are not accommodated in the same CPU, or the custom logic is required to connect with the BIO modules or others modules, the user cannot use the PLC connection point directly. That is, exchanging data between CPUs and modules are not achieved by the PLC function only. Therefore, dummy connection points are provided for the user†; the user can program the PLC logic using the dummy connection points when exchanging data is required between CPUs and modules.

†Note:The dummy connection points are available just for models 10, 13 and 19, where mark 'X' is checked in the table below. Symbol '–' represents that the input dummy is not required to use.

to ZS (Dummy FB: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
LES BLOCK	8B0003EBBB	OUT_LES BLOCK	8B00031BBB	→	LES BLOCK	430001 800008EBB2	–	X	X
PSBS BLOCK	8C0003EBBC	OUT_PSBS BLOCK	8C00031BBC	→	PSBS BLOCK	430001 800008EBB0	–	X	X
PSBS F.RESET	8D0003EBBD	OUT_PSBS F.RESET	8D00031BBD	→	PSBS F.RESET	430001 810008EBB1	–	X	X
SOTF-Z1S BLOCK	8E0003EBBE	OUT_SOTF-Z1S BLOCK	8E00031BBE	→	SOTF-Z1S BLOCK	430001 800001EBB3	–	X	X
SOTF-Z1XS BLOCK	8F0003EBBF	OUT_SOTF-Z1XS BLOCK	8F00031BBF	→	SOTF-Z1XS BLOCK	430001 810006EBB3	–	X	X
SOTF-Z2S BLOCK	800003EBC0	OUT_SOTF-Z2S BLOCK	8000031BC0	→	SOTF-Z2S BLOCK	430001 820002EBB3	–	X	X
SOTF-Z3S BLOCK	810003EBC1	OUT_SOTF-Z3S BLOCK	8100031BC1	→	SOTF-Z3S BLOCK	430001 830003EBB3	–	X	X
SOTF-Z4S BLOCK	820003EBC2	OUT_SOTF-Z4S BLOCK	8200031BC2	→	SOTF-Z4S BLOCK	430001 840004EBB3	–		X
Z1STP_BLOCK	840003EBC4	OUT_Z1STP_BLOCK	8400031BC4	→	Z1STP_BLOCK	430001 800001EBB0	–	X	X
Z1S_ARCBLOCK	850003EBC5	OUT_Z1S_ARCBLOCK	8500031BC5	→	Z1S_ARCBLOCK	430001 800001EBB2	–	X	X
Z1S_INST_OP	860003EBC6	OUT_Z1S_INST_OP	8600031BC6	→	Z1S_INST_OP	430001 800001EBB1	–	X	X
Z1XSTP_BLOCK	870003EBC7	OUT_Z1XSTP_BLOCK	8700031BC7	→	Z1XSTP_BLOCK	430001 810006EBB0	–	X	X
Z1XS_ARCBLOCK	880003EBC8	OUT_Z1XS_ARCBLOCK	8800031BC8	→	Z1XS_ARCBLOCK	430001 810006EBB2	–	X	X
Z1XS_INST_OP	890003EBC9	OUT_Z1XS_INST_OP	8900031BC9	→	Z1XS_INST_OP	430001 810006EBB1	–	X	X
Z2STP_BLOCK	8A0003EBCA	OUT_Z2STP_BLOCK	8A00031BCA	→	Z2STP_BLOCK	430001 820002EBB0	–	X	X
Z2S_ARCBLOCK	8B0003EBCB	OUT_Z2S_ARCBLOCK	8B00031BCB	→	Z2S_ARCBLOCK	430001 820002EBB2	–	X	X
Z2S_INST_OP	8C0003EBCC	OUT_Z2S_INST_OP	8C00031BCC	→	Z2S_INST_OP	430001 820002EBB1	–	X	X
Z3STP_BLOCK	8D0003EBCD	OUT_Z3STP_BLOCK	8D00031BCD	→	Z3STP_BLOCK	430001 830003EBB0	–	X	X
Z3S_ARCBLOCK	8E0003EBCE	OUT_Z3S_ARCBLOCK	8E00031BCE	→	Z3S_ARCBLOCK	430001 830003EBB2	–	X	X
Z3S_INST_OP	8F0003EBCF	OUT_Z3S_INST_OP	8F00031BCF	→	Z3S_INST_OP	430001 830003EBB1	–	X	X
Z4STP_BLOCK	800003EBD0	OUT_Z4STP_BLOCK	8000031BD0	→	Z4STP_BLOCK	430001 840004EBB0	–		X
Z4S_ARCBLOCK	810003EBD1	OUT_Z4S_ARCBLOCK	8100031BD1	→	Z4S_ARCBLOCK	430001 840004EBB2	–		X
Z4S_INST_OP	820003EBD2	OUT_Z4S_INST_OP	8200031BD2	→	Z4S_INST_OP	430001 840004EBB1	–		X
Z5STP_BLOCK	830003EBD3	OUT_Z5STP_BLOCK	8300031BD3	→	Z5STP_BLOCK	430001 850005EBB0	–		X
Z5S_ARCBLOCK	840003EBD4	OUT_Z5S_ARCBLOCK	8400031BD4	→	Z5S_ARCBLOCK	430001 850005EBB2	–		X
Z5S_INST_OP	850003EBD5	OUT_Z5S_INST_OP	8500031BD5	→	Z5S_INST_OP	430001 850005EBB1	–		X

to ZG (Dummy FB: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
LEG BLOCK	8A0002EBEA	OUT_LEG BLOCK	8A00021BEA	→	LEG BLOCK	431001 800008EBB2	–	X	X
PSBG BLOCK	8B0002EBEB	OUT_PSBG BLOCK	8B00021BEB	→	PSBG BLOCK	431001 800008EBB0	–	X	X

to ZG (Dummy FB: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
PSBG F.RESET	8C0002EBEC	OUT_PSBG F.RESET	8C00021BEC	→	PSBG F.RESET	431001 810008EBB1	–	X	X
SOTF-Z1G BLOCK	8D0002EBED	OUT_SOTF-Z1G BLOCK	8D00021BED	→	SOTF-Z1G BLOCK	431001 800001EBB4	–	X	X
SOTF-Z1XG BLOCK	8E0002EBEE	OUT_SOTF-Z1XG BLOCK	8E00021BEE	→	SOTF-Z1XG BLOCK	431001 810006EBB4	–	X	X
SOTF-Z2G BLOCK	8F0002EBEF	OUT_SOTF-Z2G BLOCK	8F00021BEF	→	SOTF-Z2G BLOCK	431001 820002EBB4	–	X	X
SOTF-Z3G BLOCK	800002EBF0	OUT_SOTF-Z3G BLOCK	8000021BF0	→	SOTF-Z3G BLOCK	431001 830003EBB4	–	X	X
SOTF-Z4G BLOCK	810002EBF1	OUT_SOTF-Z4G BLOCK	8100021BF1	→	SOTF-Z4G BLOCK	431001 840004EBB4	–		X
SOTF-Z5G BLOCK	820002EBF2	OUT_SOTF-Z5G BLOCK	8200021BF2	→	SOTF-Z5G BLOCK	431001 850005EBB4	–		X
Z1GTP_BLOCK	830002EBF3	OUT_Z1GTP_BLOCK	8300021BF3	→	Z1GTP_BLOCK	431001 800001EBB0	–	X	X
Z1G_3PTP	840002EBF4	OUT_Z1G_3PTP	8400021BF4	→	Z1G_3PTP	431001 800001EBB2	–	X	X
Z1G_ARCBLOCK	850002EBF5	OUT_Z1G_ARCBLOCK	8500021BF5	→	Z1G_ARCBLOCK	431001 800001EBB3	–	X	X
Z1G_INST_OP	860002EBF6	OUT_Z1G_INST_OP	8600021BF6	→	Z1G_INST_OP	431001 800001EBB1	–	X	X
Z1XGTP_BLOCK	870002EBF7	OUT_Z1XGTP_BLOCK	8700021BF7	→	Z1XGTP_BLOCK	431001 810006EBB0	–	X	X
Z1XG_3PTP	880002EBF8	OUT_Z1XG_3PTP	8800021BF8	→	Z1XG_3PTP	431001 810006EBB2	–	X	X
Z1XG_ARCBLOCK	890002EBF9	OUT_Z1XG_ARCBLOCK	8900021BF9	→	Z1XG_ARCBLOCK	431001 810006EBB3	–	X	X
Z1XG_INST_OP	8A0002EBFA	OUT_Z1XG_INST_OP	8A00021BFA	→	Z1XG_INST_OP	431001 810006EBB1	–	X	X
Z2GTP_BLOCK	8B0002EBFB	OUT_Z2GTP_BLOCK	8B00021BFB	→	Z2GTP_BLOCK	431001 820002EBB0	–	X	X
Z2G_3PTP	8C0002EBFC	OUT_Z2G_3PTP	8C00021BFC	→	Z2G_3PTP	431001 820002EBB2	–	X	X
Z2G_ARCBLOCK	8D0002EBFD	OUT_Z2G_ARCBLOCK	8D00021BFD	→	Z2G_ARCBLOCK	431001 820002EBB3	–	X	X
Z2G_INST_OP	8E0002EBFE	OUT_Z2G_INST_OP	8E00021BFE	→	Z2G_INST_OP	431001 820002EBB1	–	X	X
Z3GTP_BLOCK	8F0002EBFF	OUT_Z3GTP_BLOCK	8F00021BFF	→	Z3GTP_BLOCK	431001 830003EBB0	–	X	X
Z3G_3PTP	800003EBB0	OUT_Z3G_3PTP	8000031BB0	→	Z3G_3PTP	431001 830003EBB2	–	X	X
Z3G_ARCBLOCK	810003EBB1	OUT_Z3G_ARCBLOCK	8100031BB1	→	Z3G_ARCBLOCK	431001 830003EBB3	–	X	X
Z3G_INST_OP	820003EBB2	OUT_Z3G_INST_OP	8200031BB2	→	Z3G_INST_OP	431001 830003EBB1	–	X	X
Z4GTP_BLOCK	830003EBB3	OUT_Z4GTP_BLOCK	8300031BB3	→	Z4GTP_BLOCK	431001 840004EBB0	–		X
Z4G_3PTP	840003EBB4	OUT_Z4G_3PTP	8400031BB4	→	Z4G_3PTP	431001 840004EBB2	–		X
Z4G_ARCBLOCK	850003EBB5	OUT_Z4G_ARCBLOCK	8500031BB5	→	Z4G_ARCBLOCK	431001 840004EBB3	–		X
Z4G_INST_OP	860003EBB6	OUT_Z4G_INST_OP	8600031BB6	→	Z4G_INST_OP	431001 840004EBB1	–		X
Z5G_3PTP	880003EBB8	OUT_Z5G_3PTP	8800031BB8	→	Z5G_3PTP	431001 850005EBB2	–		X
Z5G_ARCBLOCK	890003EBB9	OUT_Z5G_ARCBLOCK	8900031BB9	→	Z5G_ARCBLOCK	431001 850005EBB3	–		X
Z5G_INST_OP	8A0003EBBA	OUT_Z5G_INST_OP	8A00031BBA	→	Z5G_INST_OP	431001 850005EBB1	–		X
Z5GTP_BLOCK	870003EBB7	OUT_Z5GTP_BLOCK	8700031BB7	→	Z5GTP_BLOCK	431001 850005EBB0	–		X

To ZS, ZG common (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
Z1CNT_MPROT	890002EBE9	OUT_Z1CNT_MPROT	8900021BE9	→	Z1CNT_MPROT	432001 800000EBB0	–	X	X

To DEFCAR (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
DEF PHSEL-A	820002EBB2	OUT_DEF PHSEL-A	8200021BB2	→	DEF PHSEL-A	437001 800000EBBB	–	X	X
DEF PHSEL-B	830002EBB3	OUT_DEF PHSEL-B	8300021BB3	→	DEF PHSEL-B	437001 810000EBBC	–	X	X
DEF PHSEL-C	840002EBB4	OUT_DEF PHSEL-C	8400021BB4	→	DEF PHSEL-C	437001 820000EBBD	–	X	X
DEF-ECHO BLOCK	850002EBB5	OUT_DEF-ECHO BLOCK	8500021BB5	→	DEF-ECHO BLOCK	437001 800000EBBE	–	X	X
DEF-WKIT BLOCK	860002EBB6	OUT_DEF-WKIT BLOCK	8600021BB6	→	DEF-WKIT BLOCK	437001 810000EBBF	–	X	X
DEFCAR-R1	870002EBB7	OUT_DEFCAR-R1	8700021BB7	→	DEFCAR-R1	437001 800000EBB1	–	X	X
DEFCAR-R1-2	880002EBB8	OUT_DEFCAR-R1-2	8800021BB8	→	DEFCAR-R1-2	437001 800000EBB2	–	X	X
DEFCAR-R2	890002EBB9	OUT_DEFCAR-R2	8900021BB9	→	DEFCAR-R2	437001 810000EBB3	–	X	X

To DEFCAR (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
DEFCAR-R2-2	8A0002EBBA	OUT_DEFCAR-R2-2	8A00021BBA	→	DEFCAR-R2-2	437001 810000EBB4	–	X	X
DEFCAR_3PTP	8B0002EBBB	OUT_DEFCAR_3PTP	8B00021BBB	→	DEFCAR_3PTP	437001 800000EBC0	–	X	X
DEFCAR_ARCBLOCK	8C0002EBBC	OUT_DEFCAR_ARCBLOCK	8C00021BBC	→	DEFCAR_ARCBLOCK	437001 810000EBC1	–	X	X
DEFCAR_BLOCK	8D0002EBBD	OUT_DEFCAR_BLOCK	8D00021BBD	→	DEFCAR_BLOCK	437001 800000EBB0	–	X	X
DEFCAR_F.BLOCK	8E0002EBBE	OUT_DEFCAR_F.BLOCK	8E00021BBE	→	DEFCAR_F.BLOCK	437001 800000EBC2	–	X	X
DEFCAR_F.PERMIT	8F0002EBBF	OUT_DEFCAR_F.PERMIT	8F00021BBF	→	DEFCAR_F.PERMIT	437001 810000EBC3	–	X	X
INT.DISCAR-R1-A	800002EBD0	OUT_INT.DEFCAR-R1-A	8000021BC0	→	INT.DEFCAR-R1-A	437001 800000EBB5	–	X	X
INT.DISCAR-R1-B	810002EBD2	OUT_INT.DEFCAR-R1-B	8100021BC1	→	INT.DEFCAR-R1-B	437001 810000EBB6	–	X	X
INT.DISCAR-R1-C	820002EBD3	OUT_INT.DEFCAR-R1-C	8200021BC2	→	INT.DEFCAR-R1-C	437001 820000EBB7	–	X	X
INT.DISCAR-R2-A	830002EBD1	OUT_INT.DEFCAR-R2-A	8300021BC3	→	INT.DEFCAR-R2-A	437001 840000EBB8	–	X	X
INT.DISCAR-R2-B	840002EBD2	OUT_INT.DEFCAR-R2-B	8400021BC4	→	INT.DEFCAR-R2-B	437001 850000EBB9	–	X	X
INT.DISCAR-R2-C	850002EBD3	OUT_INT.DEFCAR-R2-C	8500021BC5	→	INT.DEFCAR-R2-C	437001 860000EBBA	–	X	X

To DISCAR and DEFCAR common (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
CAR_BLOCK	810002EBB1	OUT_CAR_BLOCK	8100021BB1	→	CAR_BLOCK	438001 800000EBB0	–	X	X

To OC (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
OC1_BLOCK	860003EBF6	OUT_OC1_BLOCK	8600031BF6	→	OC1_BLOCK	440001 800001EBB0	–	X	X
OC1_INST_OP	870003EBF7	OUT_OC1_INST_OP	8700031BF7	→	OC1_INST_OP	440001 800001EBB4	–	X	X
OC2_BLOCK	880003EBF8	OUT_OC2_BLOCK	8800031BF8	→	OC2_BLOCK	440001 810002EBB1	–	X	X
OC2_INST_OP	890003EBF9	OUT_OC2_INST_OP	8900031BF9	→	OC2_INST_OP	440001 810002EBB5	–	X	X
OC3_BLOCK	8A0003EBFA	OUT_OC3_BLOCK	8A00031BFA	→	OC3_BLOCK	440001 820003EBB2	–		X
OC3_INST_OP	8B0003EBFB	OUT_OC3_INST_OP	8B00031BFB	→	OC3_INST_OP	440001 820003EBB6	–		X
OC4_BLOCK	8C0003EBFC	OUT_OC4_BLOCK	8C00031BFC	→	OC4_BLOCK	440001 830004EBB3	–		X
OC4_INST_OP	8D0003EBFD	OUT_OC4_INST_OP	8D00031BFD	→	OC4_INST_OP	440001 830004EBB7	–		X

To EF (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
EF1_BLOCK	860003EBD6	OUT_EF1_BLOCK	8600031BD6	→	EF1_BLOCK	441001 800001EBB0	–	X	X
EF1_INST_OP	870003EBD7	OUT_EF1_INST_OP	8700031BD7	→	EF1_INST_OP	441001 800001EBB1	–	X	X
EF2_BLOCK	880003EBD8	OUT_EF2_BLOCK	8800031BD8	→	EF2_BLOCK	441001 810002EBB0	–	X	X
EF2_INST_OP	890003EBD9	OUT_EF2_INST_OP	8900031BD9	→	EF2_INST_OP	441001 810002EBB1	–	X	X
EF3_BLOCK	8A0003EBDA	OUT_EF3_BLOCK	8A00031BDA	→	EF3_BLOCK	441001 820003EBB0	–		X
EF3_INST_OP	8B0003EBDB	OUT_EF3_INST_OP	8B00031BDB	→	EF3_INST_OP	441001 820003EBB1	–		X
EF4_BLOCK	8C0003EBDC	OUT_EF4_BLOCK	8C00031BDC	→	EF4_BLOCK	441001 830004EBB0	–		X
EF4_INST_OP	8D0003EBDD	OUT_EF4_INST_OP	8D00031BDD	→	EF4_INST_OP	441001 830004EBB1	–		X

To OCN (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
OCN1_BLOCK	8E0003EBFE	OUT_OCN1_BLOCK	8E00031BFE	→	OCN1_BLOCK	443001 800001EBB0	–	X	X
OCN1_INST_OP	8F0003EBFF	OUT_OCN1_INST_OP	8F00031BFF	→	OCN1_INST_OP	443001 800001EBB1	–	X	X
OCN2_BLOCK	800004EBB0	OUT_OCN2_BLOCK	8000041BB0	→	OCN2_BLOCK	443001 810002EBB0	–	X	X

To OCN (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
OCN2_INST_OP	810004EBB1	OUT_OCN2_INST_OP	8100041BB1	→	OCN2_INST_OP	443001 810002EBB1	–	X	X

To THM (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
THMA_BLOCK	8D0004EBBD	OUT_THMA_BLOCK	8D00041BBD	→	THMA_BLOCK	451001 800001EBB0	–	X	X
THMT_BLOCK	8E0004EBBE	OUT_THMT_BLOCK	8E00041BBE	→	THMT_BLOCK	451001 810002EBB0	–	X	X

To BCD (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
BCD_BLOCK	800002EBB0	OUT_BCD_BLOCK	8000021BB0	→	BCD_BLOCK	452001 800000EBB0	–	X	X

To CBF (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
CBF1-RE_INST	890002EBD9	OUT_CBF1-RE_INST	8900021BD9	→	CBF1-RE_INST	453001 810001EBB5	–	X	X
CBF1-TP_INST	8A0002EBDA	OUT_CBF1-TP_INST	8A00021BDA	→	CBF1-TP_INST	453001 820001EBB6	–	X	X
CBF1_BLOCK	8B0002EBDB	OUT_CBF1_BLOCK	8B00021BDB	→	CBF1_BLOCK	453001 800001EBB4	–	X	X
CBF2-RE_INST	8C0002EBDC	OUT_CBF2-RE_INST	8C00021BDC	→	CBF2-RE_INST	453001 810002EBB5	–	X	X
CBF2-TP_INST	8D0002EBDD	OUT_CBF2-TP_INST	8D00021BDD	→	CBF2-TP_INST	453001 820002EBB6	–	X	X
CBF2_BLOCK	8E0002EBDE	OUT_CBF2_BLOCK	8E00021BDE	→	CBF2_BLOCK	453001 800002EBB4	–	X	X
EXT.CBF1_START	8F0002EBDF	OUT_EXT.CBF1_START	8F00021BDF	→	EXT.CBF1_START	453001 830001EBB3	–	X	X
EXT.CBF1_START-A	800002EBE0	OUT_EXT.CBF1_START-A	8000021BE0	→	EXT.CBF1_START-A	453001 800001EBB0	–	X	X
EXT.CBF1_START-B	810002EBE1	OUT_EXT.CBF1_START-B	8100021BE1	→	EXT.CBF1_START-B	453001 810001EBB1	–	X	X
EXT.CBF1_START-C	820002EBE2	OUT_EXT.CBF1_START-C	8200021BE2	→	EXT.CBF1_START-C	453001 820001EBB2	–	X	X

To SOTF (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
OC-RTP.EN	8A0004EBBA	OUT_OC-RTP.EN	8A00041BBA	→	OC-RTP.EN	454001 800000EBB1	–	X	X
SOTFOC_BLOCK	8B0004EBBB	OUT_SOTFOC_BLOCK	8B00041BBB	→	SOTFOC_BLOCK	454001 800000EBB0	–	X	X

To STUB (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
STUBOC_BLOCK	8C0004EBBC	OUT_STUBOC_BLOCK	8C00041BBC	→	STUBOC_BLOCK	455001 800000EBB0	–	X	X

To OV (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
OV1_BLOCK	860004EBB6	OUT_OV1_BLOCK	8600041BB6	→	OV1_BLOCK	460001 800001EBB0	–	X	X
OV2_BLOCK	870004EBB7	OUT_OV2_BLOCK	8700041BB7	→	OV2_BLOCK	460001 810002EBB0	–	X	X

To OVS (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
OVS1_BLOCK	880004EBB8	OUT_OVS1_BLOCK	8800041BB8	→	OVS1_BLOCK	461001 800001EBB0	–	X	X
OVS2_BLOCK	890004EBB9	OUT_OVS2_BLOCK	8900041BB9	→	OVS2_BLOCK	461001 810002EBB0	–	X	X

To UV (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
CB_APH_OPEN	8F0004EBBF	OUT_CB_APH_OPEN	8F00041BBF	→	CB_APH_OPEN	470001 800000EBB0	–	X	X
CB_BPH_OPEN	800004EBC0	OUT_CB_BPH_OPEN	8000041BC0	→	CB_BPH_OPEN	470001 810000EBB1	–	X	X
CB_CPH_OPEN	810004EBC1	OUT_CB_CPH_OPEN	8100041BC1	→	CB_CPH_OPEN	470001 820000EBB2	–	X	X
UV1_BLOCK	820004EBC2	OUT_UV1_BLOCK	8200041BC2	→	UV1_BLOCK	470001 800001EBB0	–	X	X
UV2_BLOCK	830004EBC3	OUT_UV2_BLOCK	8300041BC3	→	UV2_BLOCK	470001 810002EBB0	–	X	X

To UVS (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
CB_APH_OPEN	840004EBC4	OUT_CB_APH_OPEN	8400041BC4	→	CB_APH_OPEN	471001 800000EBB0	–	X	X
CB_BPH_OPEN	850004EBC5	OUT_CB_BPH_OPEN	8500041BC5	→	CB_BPH_OPEN	471001 810000EBB1	–	X	X
CB_CPH_OPEN	860004EBC6	OUT_CB_CPH_OPEN	8600041BC6	→	CB_CPH_OPEN	471001 820000EBB2	–	X	X
UVS1_BLOCK	870004EBC7	OUT_UVS1_BLOCK	8700041BC7	→	UVS1_BLOCK	471001 800001EBB0	–	X	X
UVS2_BLOCK	880004EBC8	OUT_UVS2_BLOCK	8800041BC8	→	UVS2_BLOCK	471001 810002EBB0	–	X	X

To FRQ/DFRQ (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
DFRQ-S1-OPT	8E0003EBDE	OUT_DFRQ-S1-OPT	8E00031BDE	→	DFRQ-S1-OPT	475001 800011EBB1	–	X	X
DFRQ-S2-OPT	8F0003EBDF	OUT_DFRQ-S2-OPT	8F00031BDF	→	DFRQ-S2-OPT	475001 810012EBB1	–	X	X
DFRQ-S3-OPT	800003EBE0	OUT_DFRQ-S3-OPT	8000031BE0	→	DFRQ-S3-OPT	475001 820013EBB1	–	X	X
DFRQ-S4-OPT	810003EBE1	OUT_DFRQ-S4-OPT	8100031BE1	→	DFRQ-S4-OPT	475001 830014EBB1	–	X	X
DFRQ-S5-OPT	820003EBE2	OUT_DFRQ-S5-OPT	8200031BE2	→	DFRQ-S5-OPT	475001 840015EBB1	–	X	X
DFRQ-S6-OPT	830003EBE3	OUT_DFRQ-S6-OPT	8300031BE3	→	DFRQ-S6-OPT	475001 850016EBB1	–	X	X
DFRQ1_BLOCK	840003EBE4	OUT_DFRQ1_BLOCK	8400031BE4	→	DFRQ1_BLOCK	475001 800011EBB0	–	X	X
DFRQ2_BLOCK	850003EBE5	OUT_DFRQ2_BLOCK	8500031BE5	→	DFRQ2_BLOCK	475001 810012EBB0	–	X	X
DFRQ3_BLOCK	860003EBE6	OUT_DFRQ3_BLOCK	8600031BE6	→	DFRQ3_BLOCK	475001 820013EBB0	–	X	X
DFRQ4_BLOCK	870003EBE7	OUT_DFRQ4_BLOCK	8700031BE7	→	DFRQ4_BLOCK	475001 830014EBB0	–	X	X
DFRQ5_BLOCK	880003EBE8	OUT_DFRQ5_BLOCK	8800031BE8	→	FRQ-S5-OPT	475001 840005EBB1	–	X	X
DFRQ6_BLOCK	890003EBE9	OUT_DFRQ6_BLOCK	8900031BE9	→	FRQ-S6-OPT	475001 850006EBB1	–	X	X
FRQ-S1-OPT	8A0003EBEA	OUT_FRQ-S1-OPT	8A00031BEA	→	FRQ-S1-OPT	475001 800001EBB1	–	X	X
FRQ-S2-OPT	8B0003EBEB	OUT_FRQ-S2-OPT	8B00031BEB	→	FRQ-S2-OPT	475001 810002EBB1	–	X	X
FRQ-S3-OPT	8C0003EBEC	OUT_FRQ-S3-OPT	8C00031BEC	→	FRQ-S3-OPT	475001 820003EBB1	–	X	X
FRQ-S4-OPT	8D0003EBED	OUT_FRQ-S4-OPT	8D00031BED	→	FRQ-S4-OPT	475001 830004EBB1	–	X	X
FRQ-S5-OPT	8E0003EBEE	OUT_FRQ-S5-OPT	8E00031BEE	→	FRQ5_BLOCK	475001 840005EBB0	–	X	X
FRQ-S6-OPT	8F0003EBEF	OUT_FRQ-S6-OPT	8F00031BEF	→	FRQ6_BLOCK	475001 850006EBB0	–	X	X
FRQ1_BLOCK	800003EBF0	OUT_FRQ1_BLOCK	8000031BF0	→	FRQ1_BLOCK	475001 800001EBB0	–	X	X
FRQ2_BLOCK	810003EBF1	OUT_FRQ2_BLOCK	8100031BF1	→	FRQ2_BLOCK	475001 810002EBB0	–	X	X
FRQ3_BLOCK	820003EBF2	OUT_FRQ3_BLOCK	8200031BF2	→	FRQ3_BLOCK	475001 820003EBB0	–	X	X
FRQ4_BLOCK	830003EBF3	OUT_FRQ4_BLOCK	8300031BF3	→	FRQ4_BLOCK	475001 830004EBB0	–	X	X
FRQ5_BLOCK	840003EBF4	OUT_FRQ5_BLOCK	8400031BF4	→	DFRQ5_BLOCK	475001 840015EBB0	–	X	X
FRQ6_BLOCK	850003EBF5	OUT_FRQ6_BLOCK	8500031BF5	→	DFRQ6_BLOCK	475001 850016EBB0	–	X	X

To VTF (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
VTF BLOCK	8A0004EBCA	OUT_VTF BLOCK	8A00041BCA	→	VTF BLOCK	490001 800000EBB0	–	X	X
EXTERNAL VTF	890004EBC9	OUT_EXTERNAL VTF	8900041BC9	→	EXTERNAL VTF	490001 810000EBB1	–	X	X

To CTF (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
CTF BLOCK	870002EBE7	OUT_CTF BLOCK	8700021BE7	→	CTF BLOCK	491001 800000EBB0	–	X	X
EXTERNAL CTF	880002EBE8	OUT_EXTERNAL CTF	8800021BE8	→	EXTERNAL CTF	491001 810000EBB1	–	X	X

To ARC (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
ARC NO ACT	800001EBB0	OUT_ARC NO ACT	8000011BB0	→	ARC NO ACT	4A6001 800000EBB3	–	X	X
ARC1-S2 COND	810001EBB1	OUT_ARC1-S2 COND	8100011BB1	→	ARC1-S2 COND	4A6001 810001EBC9	–	X	X
ARC1-S3 COND	820001EBB2	OUT_ARC1-S3 COND	8200011BB2	→	ARC1-S3 COND	4A6001 820001EBCA	–	X	X
ARC1-S4 COND	830001EBB3	OUT_ARC1-S4 COND	8300011BB3	→	ARC1-S4 COND	4A6001 830001EBCB	–	X	X
ARC1-S5 COND	840001EBB4	OUT_ARC1-S5 COND	8400011BB4	→	ARC1-S5 COND	4A6001 840001EBCC	–	X	X
ARC1_BLOCK	850001EBB5	OUT_ARC1_BLOCK	8500011BB5	→	ARC1_BLOCK	4A6001 800001EBCF	–	X	X
ARC1_MODE-FT	860001EBB6	OUT_ARC1_MODE-FT	8600011BB6	→	ARC1_MODE-FT	4A6001 810001EBB1	–	X	X
ARC1_MODE-MPAR	870001EBB7	OUT_ARC1_MODE-MPAR	8700011BB7	→	ARC1_MODE-MPAR	4A6001 850001EBB5	–	X	X
ARC1_MODE-OFF	880001EBB8	OUT_ARC1_MODE-OFF	8800011BB8	→	ARC1_MODE-OFF	4A6001 800001EBB0	–	X	X
ARC1_MODE-ORG	890001EBB9	OUT_ARC1_MODE-ORG	8900011BB9	→	ARC1_MODE-ORG	4A6001 860001EBB6	–	X	X
ARC1_MODE-S&T	8A0001EBBA	OUT_ARC1_MODE-S&T	8A00011BBA	→	ARC1_MODE-S&T	4A6001 840001EBB4	–	X	X
ARC1_MODE-SPAR	8B0001EBBB	OUT_ARC1_MODE-SPAR	8B00011BBB	→	ARC1_MODE-SPAR	4A6001 820001EBB2	–	X	X
ARC1_MODE-TPAR	8C0001EBBC	OUT_ARC1_MODE-TPAR	8C00011BBC	→	ARC1_MODE-TPAR	4A6001 830001EBB3	–	X	X
ARC2_BLOCK	8D0001EBBD	OUT_ARC2_BLOCK	8D00011BBD	→	ARC2_BLOCK	4A6001 810002EBB7	–	X	X
ARC2_MODE-FT	8E0001EBBE	OUT_ARC2_MODE-FT	8E00011BBE	→	ARC2_MODE-FT	4A6001 810002EBB1	–	X	X
ARC2_MODE-MPAR	8F0001EBBF	OUT_ARC2_MODE-MPAR	8F00011BBF	→	ARC2_MODE-MPAR	4A6001 850002EBB5	–	X	X
ARC2_MODE-OFF	800001EBC0	OUT_ARC2_MODE-OFF	8000011BC0	→	ARC2_MODE-OFF	4A6001 800002EBB0	–	X	X
ARC2_MODE-ORG	810001EBC1	OUT_ARC2_MODE-ORG	8100011BC1	→	ARC2_MODE-ORG	4A6001 860002EBB6	–	X	X
ARC2_MODE-S&T	820001EBC2	OUT_ARC2_MODE-S&T	8200011BC2	→	ARC2_MODE-S&T	4A6001 840002EBB4	–	X	X
ARC2_MODE-SPAR	830001EBC3	OUT_ARC2_MODE-SPAR	8300011BC3	→	ARC2_MODE-SPAR	4A6001 820002EBB2	–	X	X
ARC2_MODE-TPAR	840001EBC4	OUT_ARC2_MODE-TPAR	8400011BC4	→	ARC2_MODE-TPAR	4A6001 830002EBB3	–	X	X
ARC_BLOCK	850001EBC5	OUT_ARC_BLOCK	8500011BC5	→	ARC_BLOCK	4A6001 820000EBB4	–	X	X
CB1 F.BRIDGE	860001EBC6	OUT_CB1 F.BRIDGE	8600011BC6	→	CB1 F.BRIDGE	4A6001 800001EBB8	–	X	X
CB1-ARC READY	870001EBC7	OUT_CB1-ARC READY	8700011BC7	→	CB1-ARC READY	4A6001 800001EBB7	–	X	X
CB1_MANUAL_CLOSE	880001EBC8	OUT_CB1_MANUAL_CLOSE	8800011BC8	→	CB1_MANUAL_CLOSE	4A6001 800001EBCD	–	X	X
CB2 F.BRIDGE	890001EBC9	OUT_CB2 F.BRIDGE	8900011BC9	→	CB2 F.BRIDGE	4A6001 810002EBB9	–	X	X
CB2-ARC READY	8A0001EBCA	OUT_CB2-ARC READY	8A00011BCA	→	CB2-ARC READY	4A6001 810002EBB8	–	X	X
CB2_MANUAL_CLOSE	8B0001EBCB	OUT_CB2_MANUAL_CLOSE	8B00011BCB	→	CB2_MANUAL_CLOSE	4A6001 810002EBCA	–	X	X
EXT.ARC_START-A	8C0001EBCC	OUT_EXT.ARC_START-A	8C00011BCC	→	EXT.ARC_START-A	4A6001 800000EBB0	–	X	X
EXT.ARC_START-B	8D0001EBCD	OUT_EXT.ARC_START-B	8D00011BCD	→	EXT.ARC_START-B	4A6001 810000EBB1	–	X	X
EXT.ARC_START-C	8E0001EBCE	OUT_EXT.ARC_START-C	8E00011BCE	→	EXT.ARC_START-C	4A6001 820000EBB2	–	X	X
F.CB1_94TT	8F0001EBCF	OUT_F.CB1_94TT	8F00011BCF	→	F.CB1_94TT	4A6001 800001EBCE	–	X	X
F.CB2_94TT	800001EBD0	OUT_F.CB2_94TT	8000011BD0	→	F.CB2_94TT	4A6001 810002EBCB	–	X	X
MPAR1_COND	810001EBD1	OUT_MPAR1_COND	8100011BD1	→	MPAR1_COND	4A6001 830001EBC6	–	X	X
MPAR1_START	820001EBD2	OUT_MPAR1_START	8200011BD2	→	MPAR1_START	4A6001 830001EBC5	–	X	X
MPAR1_SUB_COND	830001EBD3	OUT_MPAR1_SUB_COND	8300011BD3	→	MPAR1_SUB_COND	4A6001 830001EBC8	–	X	X
MPAR1_SUB_START	840001EBD4	OUT_MPAR1_SUB_START	8400011BD4	→	MPAR1_SUB_START	4A6001 830001EBC7	–	X	X
MPAR2_COND	850001EBD5	OUT_MPAR2_COND	8500011BD5	→	MPAR2_COND	4A6001 830002EBC7	–	X	X
MPAR2_START	860001EBD6	OUT_MPAR2_START	8600011BD6	→	MPAR2_START	4A6001 830002EBC6	–	X	X
MPAR2_SUB_COND	870001EBD7	OUT_MPAR2_SUB_COND	8700011BD7	→	MPAR2_SUB_COND	4A6001 830002EBC9	–	X	X
MPAR2_SUB_START	880001EBD8	OUT_MPAR2_SUB_START	8800011BD8	→	MPAR2_SUB_START	4A6001 830002EBC8	–	X	X
ORGAR1_COND	890001EBD9	OUT_ORGAR1_COND	8900011BD9	→	ORGAR1_COND	4A6001 820001EBC2	–	X	X
ORGAR1_START	8A0001EBDA	OUT_ORGAR1_START	8A00011BDA	→	ORGAR1_START	4A6001 820001EBC1	–	X	X
ORGAR1_SUB_COND	8B0001EBDB	OUT_ORGAR1_SUB_COND	8B00011BDB	→	ORGAR1_SUB_COND	4A6001 820001EBC4	–	X	X
ORGAR1_SUB_START	8C0001EBDC	OUT_ORGAR1_SUB_START	8C00011BDC	→	ORGAR1_SUB_START	4A6001 820001EBC3	–	X	X

To ARC (Function ID: 715001)

PLC connection points		PLC monitoring points		to	Actual destinations		Models		
	Element ID		Element ID			Data ID	10	13	19
ORGAR2_COND	8D0001EBDD	OUT_ORGAR2_COND	8D00011BDD	→	ORGAR2_COND	4A6001 820002EBC3	–	X	X
ORGAR2_START	8E0001EBDE	OUT_ORGAR2_START	8E00011BDE	→	ORGAR2_START	4A6001 820002EBC2	–	X	X
ORGAR2_SUB_COND	8F0001EBDF	OUT_ORGAR2_SUB_COND	8F00011BDF	→	ORGAR2_SUB_COND	4A6001 820002EBC5	–	X	X
ORGAR2_SUB_START	800001EBE0	OUT_ORGAR2_SUB_START	8000011BE0	→	ORGAR2_SUB_START	4A6001 820002EBC4	–	X	X
P.INTCONN-A_LR1	810001EBE1	OUT_P.INTCONN-A_LR1	8100011BE1	→	P.INTCONN-A_LR1	4A6001 800000EBB8	–	X	X
P.INTCONN-A_LR2	820001EBE2	OUT_P.INTCONN-A_LR2	8200011BE2	→	P.INTCONN-A_LR2	4A6001 800000EBBB	–	X	X
P.INTCONN-A_LR3	830001EBE3	OUT_P.INTCONN-A_LR3	8300011BE3	→	P.INTCONN-A_LR3	4A6001 800000EBBE	–	X	X
P.INTCONN-A_LR4	840001EBE4	OUT_P.INTCONN-A_LR4	8400011BE4	→	P.INTCONN-A_LR4	4A6001 800000EBC1	–	X	X
P.INTCONN-B_LR1	850001EBE5	OUT_P.INTCONN-B_LR1	8500011BE5	→	P.INTCONN-B_LR1	4A6001 810000EBB9	–	X	X
P.INTCONN-B_LR2	860001EBE6	OUT_P.INTCONN-B_LR2	8600011BE6	→	P.INTCONN-B_LR2	4A6001 810000EBBC	–	X	X
P.INTCONN-B_LR3	870001EBE7	OUT_P.INTCONN-B_LR3	8700011BE7	→	P.INTCONN-B_LR3	4A6001 810000EBBF	–	X	X
P.INTCONN-B_LR4	880001EBE8	OUT_P.INTCONN-B_LR4	8800011BE8	→	P.INTCONN-B_LR4	4A6001 810000EBC2	–	X	X
P.INTCONN-C_LR1	890001EBE9	OUT_P.INTCONN-C_LR1	8900011BE9	→	P.INTCONN-C_LR1	4A6001 820000EBBA	–	X	X
P.INTCONN-C_LR2	8A0001EBEA	OUT_P.INTCONN-C_LR2	8A00011BEA	→	P.INTCONN-C_LR2	4A6001 820000EBBD	–	X	X
P.INTCONN-C_LR3	8B0001EBEB	OUT_P.INTCONN-C_LR3	8B00011BEB	→	P.INTCONN-C_LR3	4A6001 820000EBC0	–	X	X
P.INTCONN-C_LR4	8C0001EBEC	OUT_P.INTCONN-C_LR4	8C00011BEC	→	P.INTCONN-C_LR4	4A6001 820000EBC3	–	X	X
RYOP-A	8D0001EBED	OUT_RYOP-A	8D00011BED	→	RYOP-A	4A6001 800000EBB5	–	X	X
RYOP-B	8E0001EBEE	OUT_RYOP-B	8E00011BEE	→	RYOP-B	4A6001 810000EBB6	–	X	X
RYOP-C	8F0001EBEF	OUT_RYOP-C	8F00011BEF	→	RYOP-C	4A6001 820000EBB7	–	X	X
SPAR1_COND	800001EBF0	OUT_SPAR1_COND	8000011BF0	→	SPAR1_COND	4A6001 800001EBBA	–	X	X
SPAR1_START	810001EBF1	OUT_SPAR1_START	8100011BF1	→	SPAR1_START	4A6001 800001EBB9	–	X	X
SPAR1_SUB_COND	820001EBF2	OUT_SPAR1_SUB_COND	8200011BF2	→	SPAR1_SUB_COND	4A6001 800001EBBC	–	X	X
SPAR1_SUB_START	830001EBF3	OUT_SPAR1_SUB_START	8300011BF3	→	SPAR1_SUB_START	4A6001 800001EBBB	–	X	X
SPAR2_COND	840001EBF4	OUT_SPAR2_COND	8400011BF4	→	SPAR2_COND	4A6001 800002EBBB	–	X	X
SPAR2_START	850001EBF5	OUT_SPAR2_START	8500011BF5	→	SPAR2_START	4A6001 800002EBBA	–	X	X
SPAR2_SUB_COND	860001EBF6	OUT_SPAR2_SUB_COND	8600011BF6	→	SPAR2_SUB_COND	4A6001 800002EBBD	–	X	X
SPAR2_SUB_START	870001EBF7	OUT_SPAR2_SUB_START	8700011BF7	→	SPAR2_SUB_START	4A6001 800002EBBC	–	X	X
TPAR1_COND	880001EBF8	OUT_TPAR1_COND	8800011BF8	→	TPAR1_COND	4A6001 810001EBBE	–	X	X
TPAR1_START	890001EBF9	OUT_TPAR1_START	8900011BF9	→	TPAR1_START	4A6001 810001EBBD	–	X	X
TPAR1_SUB_COND	8A0001EBFA	OUT_TPAR1_SUB_COND	8A00011BFA	→	TPAR1_SUB_COND	4A6001 810001EBC0	–	X	X
TPAR1_SUB_START	8B0001EBFB	OUT_TPAR1_SUB_START	8B00011BFB	→	TPAR1_SUB_START	4A6001 810001EBBF	–	X	X
TPAR2_COND	8C0001EBFC	OUT_TPAR2_COND	8C00011BFC	→	TPAR2_COND	4A6001 810002EBBF	–	X	X
TPAR2_START	8D0001EBFD	OUT_TPAR2_START	8D00011BFD	→	TPAR2_START	4A6001 810002EBBE	–	X	X
TPAR2_SUB_COND	8E0001EBFE	OUT_TPAR2_SUB_COND	8E00011BFE	→	TPAR2_SUB_COND	4A6001 810002EBC1	–	X	X
TPAR2_SUB_START	8F0001EBFF	OUT_TPAR2_SUB_START	8F00011BFF	→	TPAR2_SUB_START	4A6001 810002EBC0	–	X	X
ARC NO ACT	800001EBB0	OUT_ARC NO ACT	8000011BB0	→	ARC NO ACT	4A6001 800000EBB3	–	X	X
ARC1-S2 COND	810001EBB1	OUT_ARC1-S2 COND	8100011BB1	→	ARC1-S2 COND	4A6001 810001EBC9	–	X	X
ARC1-S3 COND	820001EBB2	OUT_ARC1-S3 COND	8200011BB2	→	ARC1-S3 COND	4A6001 820001EBCA	–	X	X
ARC1-S4 COND	830001EBB3	OUT_ARC1-S4 COND	8300011BB3	→	ARC1-S4 COND	4A6001 830001EBCB	–	X	X

Appendix 12 Notes for the dielectric voltage test

Dielectric voltage testing shall be carried out after reading the below notices carefully.

Cable connections

Figure-12.A illustrates external connection around the power supply module (PWS). During dielectric voltage testing, two short-wires attached on PSW shall be carefully handled; follow the below instructions (1) and (2).

(1) Short-wire between terminal screw No.35 and No.37

- ✓ Remove this short-wire for undertaking the dielectric voltage test. If this short-wire is not removed, the IED will be damaged.
- ✓ After the test, reconnect this short-wire to the original positons.

(2) Short-wire between terminal screw No.38 and FG

- ✓ Never remove this short wire. If this short-wire is removed, the IED will be damaged.

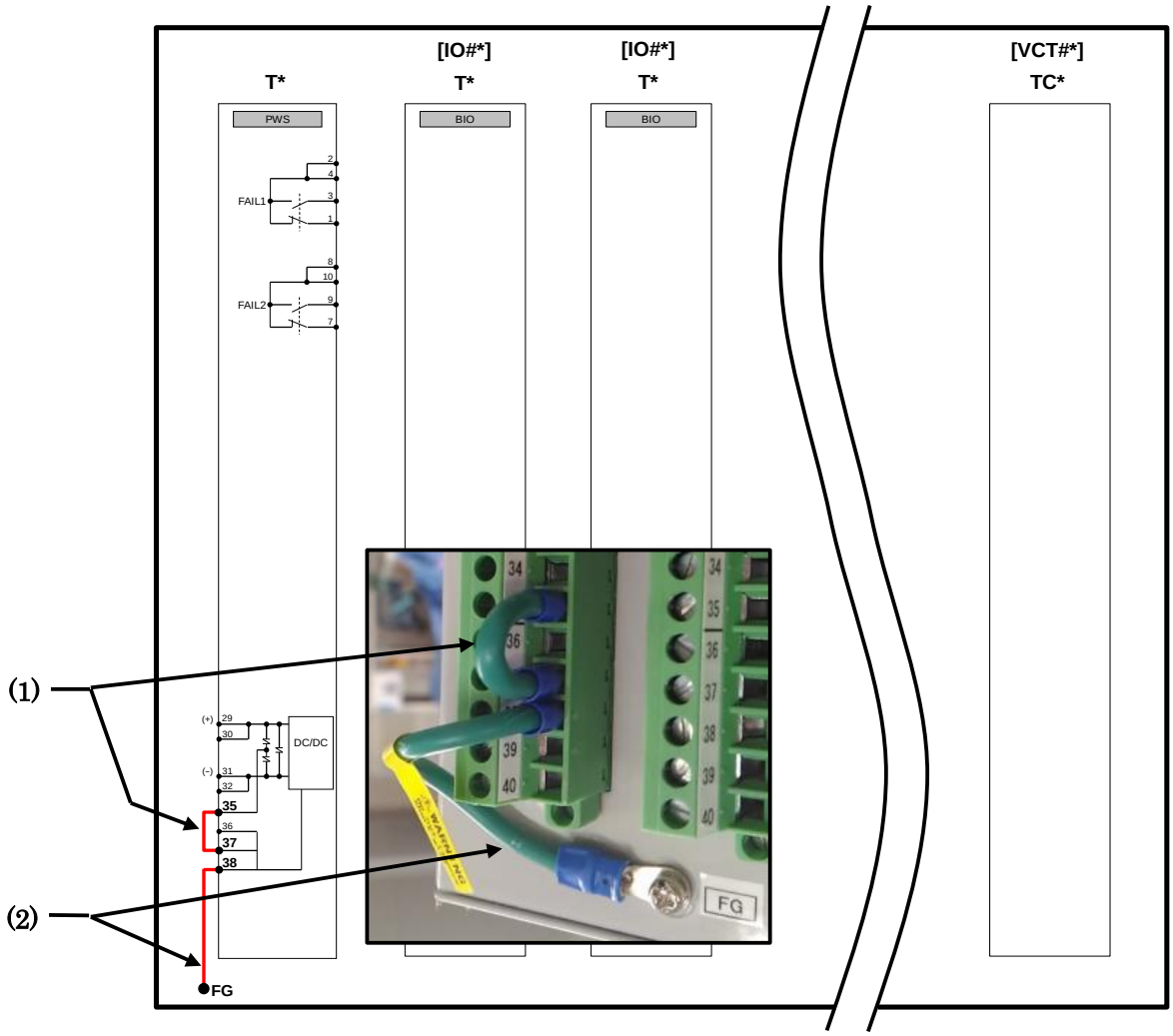


Figure-12.A Short-wires shall be handled with Cautions

Revision-up Records

Rev. and Date	Section (page)	Change place and contents	Approved by	Checked by	Prepared by
-- Feb. 17 2014	--	First issue	A. Morimoto Feb. 17	A. Morimoto Feb. 17	T. Kaneko Feb. 16
0.1 Jun. 12 2014	Chap. 3	Added VCT ratio setting	A. Morimoto Jun. 12	A. Morimoto Jun. 12	T. Kaneko Jun. 11
0.2 Jul. 31 2014	Chap. 2	ICD function added	A. Morimoto Jul. 31	A. Morimoto Jul. 31	T. Kaneko Jul. 30
0.3 Aug. 3 2014	Appendix	BIO3 module added	A. Morimoto Aug. 3	A. Morimoto Aug. 3	T. Kaneko Aug. 2
0.31 Sep. 3 2014	Chap. 3	LED setting added	A. Morimoto Sep. 3	A. Morimoto Sep. 3	T. Kaneko Sep. 2
0.33 Sep. 8 2014	Chap. 3 Appendix	Revised descriptions of communication modules Revised specs with regard to IEC 60255-27	A. Morimoto Sep. 8	A. Morimoto Sep. 8	T. Kaneko Sep. 7
0.4 Oct. 31 2014	Chap. 2.5.3 Chap. 2.8.1 Chap. 2.9.1 Chap. 2.27 Chap. 2.32.1	PSB reset timer added in ZS and ZG TDEFC timer added in DEFCAR PLC Point ADD.SOTF_EN added in SOTF Missing TRC texts inserted Timer TCBLOSPH added in PORT_COMMON	M. Okai Oct. 31	A. Morimoto Feb. 17	T. Kaneko Oct. 29
0.41 Nov. 6 2014	Chap. 2.8.4	Examples of TDEFC timer added in DEFEF	M. Okai Nov.6	X. Tang Nov. 6	T. Kaneko Nov. 6
0.5 Jan. 30 2015	Chap. 2.1 Chap. 2.5 Chap. 2.10 Chap. 2.11 Chap. 2.12 Chap. 12.5	Description revised in DIF Description in Offset ZS revised Description revised in OC Description revised in EF Description revised in OCN Signal control function revised	A. Morimoto Jan. 30	K. Kobayashi Jan. 30	T. Kaneko Jan. 27
0.51 Feb. 4 2015	Chap. 2.5 Chap. 2.24 Chap. 2.25 Chap. 2.26	Erroneous polarity revised in Fig 2.4 Description revised entirely in VTF Description revised entirely in CTF Page layout revised in FL-AZ	A. Morimoto Feb. 4	K. Kobayashi Feb. 4	T. Kaneko Feb. 2
0.6 Mar. 12 2015	Chap. 5	Added clock and function key features	K. Kobayashi Mar. 6	T. Ohnari Mar. 5	T. Kaneko Feb. 2
	Chap. 11.3 Appendix	Added IEC103 features Added IEC103 default settings	F. Kawano Mar. 6	A. Fukui Mar. 5	T. Kaneko Mar. 3
	Appendix	Added input dummies	F. Kawano Mar. 10	A. Morimoto Feb. 10	T. Kaneko Mar. 9
	Chap. 5	Corrected channel allocations on the VCT	F. Kawano Mar. 10	T. Sugamoto Mar. 10	T. Kaneko Mar. 9
	Chap. 2.5	Revised description of blinders in ZS/ZG	H. Amoh Mar. 10	A. Morimoto Mar. 10	T. Kaneko Mar. 9
	Chap. 2.13	Changed the time units to “minutes” in THM	F. Kawano Mar. 10	M. Takazawa Mar. 10	T. Kaneko Mar. 10
0.7 Jun. 30 2015	Chap. 2.3 Chap. 2.30	Flame format corrected in RDIF C37.94 format added in COMM_APPL	A. Morimoto Jun. 29	A. Morimoto Jun. 29	T. Kaneko Jun. 26
	Chap. 2.16 Chap. 2.17 Chap. 2.18 Chap. 2.19 Chap. 2.20 Chap. 2.22 Chap. 2.24 Appendix	Erroneous reset settings revised in OV Erroneous reset settings revised in OVS Erroneous reset settings revised in UV Erroneous reset settings revised in UVS Missing setting items added in DFRQ Corrected a ramp line in ICD characteristic Typos corrected in VTF Tables of BIO codes modified	A. Morimoto Mar. 26	N. Nagano Mar. 26	T. Kaneko Mar. 26
	Chap. 2.28	Erroneous Data IDs corrected in TRC	K. Ohashi Jun 16	K. Ohashi Jun 16	T. Kaneko Jun. 16

Rev. and Date	Section (page)	Change place and contents	Approved by	Checked by	Prepared by
	Chap. 6.5	Added a notice for recording w.r.t clock setting	F. Kawano Jun 23	F. Kawano Jun 23	T. Kaneko Jun. 20
	Appendix	Revised BIO tables	F. Kawano Mar. 16	N. Yokoya Mar. 16	T. Kaneko Mar. 16
0.71 Aug. 26, 2015	Chap. 1.1	Revised the discussion for protection relays	A. Morimoto Aug 17	A. Morimoto Aug 17	T. Kaneko Aug 17
	Chap. 2.4	Added PSB characteristic in Quad characteristic Added the meaning of setting CovCoeff	H. Amoh July 31	A. Morimotoi July 31	T. Kaneko July 30
	Chap. 2.4.2	Revised the features of Z1 offset action	H. Amoh Aug 1	A. Morimotoi Aug 1	T. Kaneko July 30
	Chap. 2.9	Added the OC minimum sensing voltage for polarizing Added the rating current depends on the VCT setting	A. Morimoto July 31	K. Ohashi July 31	T. Kaneko July 30
	Chap. 2.10, 2.11	Added the rating current depends on the VCT setting in EF and OCN	A. Morimoto July 31	K. Ohashi July 31	T. Kaneko July 30
	Chap. 2.19	Added the setting notice about threshold settings for blocking the operation of FRQ	A. Morimoto Aug 20	S. Gondou Aug 20	T. Kaneko Aug. 20
	Chap. 2.28	Modified the erroneous voltage checking condition in zone D2 in Table 2.28 of VCHK	A. Morimoto Aug.7	A. Morimoto Aug.7	T. Kaneko Aug 7
	Chap. 7.3	Modified the PLC driver descriptions	A. Morimoto Aug.24	M. Okai Aug.24	T. Kaneko Aug 24
	Chap. 11.3 Appendix 5	Added the configure procedures about the IEC 103 Added semantics information	F. Kawano July 31	K. Shibata July 31	T. Kaneko July 30
	Chap. 13.6 Appendix 9	Added the instruction for replacing modules Combined the replacing methods with Chap. 13.6	A. Morimoto July 31	A. Morimoto July 31	T. Kaneko July 20
	Appendix 6	Tables of BIO codes modified	A. Morimoto Aug 26	N. Yokoya Aug 26	T. Kaneko Aug. 26
0.72 Sep. 4, 2015	Chap. 2.29 Ordering	Deleted the electrical interface X.21	A. Morimoto Sep 2	T.Sugamoto Sep 2	T. Kaneko Sep. 2
	Chap. 2.31	Revised the PROT_COM and unified into one section.	A. Morimoto Sep 4	N. Nagano Sep 4	T. Kaneko Sep 4
0.73 Oct. 23 2015	Chap. 2.3	Revised Equations (2.3-1 and -2) to correct the way to derive the zero-sequence following at local and remote	A. Morimoto Oct. 1	A. Morimoto Oct. 1	T. Kaneko Sep. 30
	Chap. 2.4	Typos revised in Fig 2.4-20,21,22,24,25,26,27,29 and 31.	K. Kobayashi Oct. 23	M. Oohashi Oct. 23	T. Kaneko Oct. 22
	Chap. 2.27	Replace OR logic by AND logic in Fig. 2.27-1	K. Kobayashi Oct. 19	K. Kobayashi Oct. 19	T. Kaneko Oct. 19
	Chap. 2.29	Deleted the Clause 1.2.2 of G.703 and modified about the N=1 and 3 operation in the IEEE C37.94	F. Kawano Oct 23	T. Sugamoto Oct. 19	T. Kaneko Oct. 19
	Chap. 2.31	Revised the time-width about setting TCBLOSPH in Fig 2.31-1	K. Kobayashi Oct. 19	K. Kobayashi Oct. 19	T. Kaneko Oct. 19
	Chap. 5.5	Revised the operation meanings at the FAIL1 and Fail2 contacts; revised the operation conditions	H. Hiramatsu Oct 8	T. Ohnari Oct. 5	T. Kaneko Sep. 25
	Chap. 10	Revised whole contents	H. Hiramatsu Oct 23	H. Hiramatsu Oct 23	T. Kaneko Oct. 17
	Appendix 1	Organized signal lists	H. Hiramatsu Oct. 30	H. Hiramatsu Oct. 30	T. Kaneko Oct. 30
	Appendix 4	Added PIXIT and TICS	H. Hiramatsu Oct 23	H. Hiramatsu Oct 23	T. Kaneko Oct. 22
	Appendix 6	Tables of BIO codes modified	A. Morimoto Sep 11	N. Yokoya Sep 10	T. Kaneko Sep. 9
	Appendix 6	Revised typos about the VCT in Ordering	H. Hiramatsu Oct. 2	H. Hiramatsu Oct. 2	T. Kaneko Oct. 2
	Appendix 6	Deleted Clause 1.2.2 of ITU-T G.703 w.r.t GIF200	F. Kawano Oct 23	F. Kawano Oct 23	T. Kaneko Oct. 22

Rev. and Date	Section (page)	Change place and contents	Approved by	Checked by	Prepared by
	Appendix 7	Modified at contact spec. of BO circuits as to Break capability when 0.2A current flowing	T.Sugamoto Sep. 10	T.Sugamoto Sep. 10	T. Kaneko Sep. 10
0.74 Nov. 4 2015	Chap. 5.5 Appendix 7	Added the notice not to guarantee the operation on the AC power source	T.Sugamoto Nov. 4	T.Sugamoto Nov. 4	T. Kaneko Nov. 4
0.75 Nov. 24 2015	Chap. 9	Revised and added new information over all for monitoring and metering functions	H. Hiramatsu Nov 20	A. Morimoto Nov 20	T. Kaneko Nov. 19
	Chap. 11.1	Added the description to monitor the LAN communication	M. Okai Nov 19	M. Okai Nov 19	T. Kaneko Nov. 19
	Chap. 11.2	Revised the performance value about GOOSE sending to other Logical Node device in Table 11.2-3	S. Katayama Nov 19	S. Katayama Nov 19	T. Kaneko Nov. 19
	Appendix 4	Deleted “PBSB_OST Class” in MICS lists of IEC61850	S. Katayama Nov 19	S. Katayama Nov 19	T. Kaneko Nov. 19
	Appendix 4	PIXIT8: PIXIT FOR REPORTING MODEL: 11: PIXIT FOR CONTROL MODEL: Modified from 'N' to 'Y', '40' to '408', respectively in in "data update" and "The number of events". Changed descriptions from "station-level" to "station-control" based on the standard in. Changed from Y to N at "maintenance" and "process". TICS: Added Dpos in part 6 of2. Mandatory Intop Tissues.	M. Okai Nov. 24	M. Okai Nov. 24	T. Kaneko Nov. 24
	Appendix 6	Tables of BIO codes modified	H. Hiramatsu Nov 20	N. Yokoya Nov 18	T. Kaneko Nov. 17
0.76 Dec. 7, 2015	Chap. 2.27	Renewed the contents of ARC function	H. Hiramatsu Dec. 7	H. Hiramatsu Dec. 7	T. Kaneko Dec. 4
	Appendix 6	Tables of BIO codes modified	H. Hiramatsu Dec. 7	N. Yokoya Dec 1	T. Kaneko Dec. 1
0.77 Jan. 6, 2016	Chap. 1.1.5	Modified the description of the distance relay due for adding a zone element (Z4) in the ordering model ‘19’	F. Kawano Jan. 6	N. Nagano Jan. 6	T. Kaneko Jan. 6
	Chap. 2.4	Added another zone element (Z4) for distance protection in the ordering model ‘19’	F. Kawano Jan. 6	N. Nagano Jan. 6	T. Kaneko Jan. 6
	Chap. 2.25	Revised the contents of TRC	F. Kawano Dec. 28	N. Nagano Dec 28	T. Kaneko Dec. 27
	Chap. 2.35	Removed the DIFG and RDIFG elements from Figs 2.25-5 and 2.25-6	H. Hiramatsu Dec 16	A. Fukui Dec 16	T. Kaneko Dec. 16
	Chap. 4.2	Modified the number of functions to ‘2’ in the DPSY function	H. Hiramatsu Dec. 18	J. Nagata Dec 16	T. Kaneko Dec. 16
	Appendix 6	Added new ordering ‘19’ for Function table in Ordering	F. Kawano Jan. 5	N. Nagano Jan. 5	T. Kaneko Jan. 5
	Appendix 10	Revised the table for the dummy inputs owing for the model ‘19’ ordering	F. Kawano Jan. 6	N. Nagano Jan. 6	T. Kaneko Jan. 6
0.78 Jan. 18, 2016	Chap. 2.8	Revised the SOTF-OC logic about the signals coming from the ICD function	H. Hiramatsu Jan 16	H. Hiramatsu Jan 16	T. Kaneko Jan. 16
	Chap. 2.9	Revised the OC logic about the signals coming from the ICD function	H. Hiramatsu Jan 16	H. Hiramatsu Jan 16	T. Kaneko Jan. 16
	Chap. 2.9	Added the note for the OC signal characterized with the DT and IDMT operations	K. Oohashi Jan. 17	T. Nagano Jan 17	T. Kaneko Jan. 17
	Chap. 2.10	Revised the EF logic about the signals coming from the ICD function	H. Hiramatsu Jan 16	H. Hiramatsu Jan 16	T. Kaneko Jan. 16
	Chap. 2.10	Added the note for the EF signal characterized with the DT and IDMT operations	K. Oohashi Jan. 17	T. Nagano Jan 17	T. Kaneko Jan. 17
	Chap. 2.11	Revised the OCN logic about the signals coming from the ICD function	H. Hiramatsu Jan 16	H. Hiramatsu Jan 16	T. Kaneko Jan. 16
	Chap. 2.11	Added the note for the OCN signal characterized with the DT and IDMT operations	K. Oohashi Jan. 17	T. Nagano Jan 17	T. Kaneko Jan. 17

Rev. and Date	Section (page)	Change place and contents	Approved by	Checked by	Prepared by
	Chap. 2.13	Revised the BCD logic about the signals coming from the ICD function	H. Hiramatsu Jan 16	H. Hiramatsu Jan 16	T. Kaneko Jan. 16
	Chap. 2.21	Added the destinations for the signals generated in ICD function. Refined the contents	H. Hiramatsu Jan 16	H. Hiramatsu Jan 16	T. Kaneko Jan. 16
	Appendix 6	Tables of BIO codes modified	H. Hiramatsu Jan. 12	N. Yokoya Jan 12	T. Kaneko Jan. 12
0.79 Jan. 29, 2016	Appendix 6	Added the setting terms in the function table	H. Hiramatsu Jan. 28	H. Hiramatsu Jan. 28	T. Kaneko Jan. 27
0.80 Feb. 5, 2016	Chap. 8	Revised and added new information over all for recording functions	H. Hiramatsu Feb. 5	T. Nagano Feb 5	T. Kaneko Jan. 1
	Appendix 10	Revised the lists of Input dummy	H. Hiramatsu Feb. 5	T. Nagano Feb 5	T. Kaneko Jan. 25
0.81 Feb. 15, 2016	Chap. 5.3.2	Added the value of the input register of IRIG-B000 module	H.Hiramatsu Feb 8	F. Kawano Feb. 8	T. Kaneko Feb. 6
	Chap. 11.2.6	Added the information about the quality signal in IEC 61850 communication	H.Hiramatsu Feb. 12	M. Okai Feb. 10	T. Kaneko Feb. 10
0.82 Apr. 8, 2016	Chap. 3.3.1	Deleted the DCB feature	H. Hiramatsu Mar. 17	H. Hiramatsu Mar. 17	T. Kaneko Mar. 17
	Chap. 4.5.2(i)	Revised the settings about the variable type in BI2 and BIO4	T.Kawasaki Mar. 30	T.Kawasaki Mar. 30	T. Kaneko Mar. 29
0.83 May 16,2016	Chap. 2.30	Added the setting for the 2term terminals in COMM_APPL	K.Kobayashi May 10	K. Oohashi May 10	T. Kaneko May 10
	Chap. 4.1	Corrected the lists described in the other way around in Table 4.1-2&3 in SPOS	J. Nagata Apr. 20	T. Utsumi Apr. 20	T. Kaneko Apr. 18
	Chap. 4.1	Typos of the PLC connection points about Receiving "operate command On and Off" using PLC logic	J. Nagata Apr. 25	T. Utsumi Apr. 25	T. Kaneko Apr. 23
	Chap. 4.2	Corrected signal names to "PLC_BIT_0535/0543" from "PLC_BIT_0643/0635" in Fig. 4.2-30 in DPSY	J. Nagata Apr. 22	T. Utsumi Apr. 22	T. Kaneko Apr. 22
	Chap. 5.4.5	Added FG cable for BI2A module	H. Hiramatsu May 10	N. Fujiyama May 10	T. Kaneko May 10
	Chap. 5.8	Revised the example logics for the group setting function	H. Hiramatsu May 10	K. Oohashi May 10	T. Kaneko May 10
	Chap. 10.2.36	Revised the information about Data(commslv) error	F. Kawano May 10	M. Okai May 10	T. Kaneko May 10
	Appendix 6	Tables of BIO codes modified	H. Hiramatsu May 10	M. Ueda May 10	T. Kaneko May 10
	Appendix 7	Added a CMP_NUM notice in Electromagnetic Environment for the Environmental performance	H. Hiramatsu May 16	K.Oohashi May. 16	T. Kaneko May 16
0.84 June28,2016	Chap. 2.4	Corrected typo 'Z1S-X.Reach' to 'Z1S-Mho.Reach' in Figure 2.4-11	K. Oohashi June 1	T. Nakatsuka June 1	T. Kaneko June 1
	Chap. 2.28	Added calibration factors when the rating voltages are different in VCHK	K. Oohashi June 16	T. Nagano Jun 16	T. Kaneko Jun. 16
	Chap. 4.1	Corrected the setting name for SPOS01_LGCNFFC in the description above Fig 4.1-18	K. Oohashi June 2	K. Oohashi June 2	T. Kaneko June. 2
	Chap. 5.5.2(i)	Corrected Typo in the notice with regard to the contents about the variable type in BI2 and BIO4	T.Sugamoto June 15	T.Sugamoto June 15	T. Kaneko June 15
	Appendix 6	Added new code 4M in the ordering about the BIO modules	K. Oohashi June 1	M. Ueda June 1	T. Kaneko May 31
	Appendix 6	Deleted '3J', '3Q', and '48' codes in the ordering about the BIO modules	K. Oohashi June 21	M. Ueda June 21	T. Kaneko Jun 21
	Appendix 6	Added the performance notice about the relay operation when '19' software code is chosen	K. Oohashi June 20	T. Nagano June 20	T. Kaneko June 18
0.85 July1,2016	Chap. 1.7	Corrected element ID w.r.t 'OC1_BLOCK' in Figure 1.7-1	K. Oohashi June 28	T. Nakatsuka June 28	T. Kaneko June 28

Rev. and Date	Section (page)	Change place and contents	Approved by	Checked by	Prepared by
	Chap. 2.9.6	Corrected 'OC1_BLOCK' and 'OC1_INST_OP" connection points in Figure 2.9-8	K. Oohashi June 28	T. Nakatsuka June 28	T. Kaneko June 28
	Chap. 3.4	Revised LOCRNT logic in Figure 3.4-1	J. Nagata June 28	T. Nakatsuka June 28	T. Kaneko June 28
	Appendix 7	Deleted 'COMFEDE' in the Data exchange at General performance	S.Katayama June 29	S.Katayama June 29	T. Kaneko June 29
0.86 Aug8,2016	Chap. 2.2.8	Added the methods for CT ratios when different CTs are used at local and remote ends	K. Oohashi Aug. 8	K. Oohashi Aug. 8	T. Kaneko Aug 8
	Chap. 3.4	Added the notice that the local mode will be canceled when key operations are not carried out.	K.Oohashi Aug. 8	T. Utsumi Aug. 8	T. Kaneko Aug 8
	Chap. 5.5	Added the contents of threshold setting for dropping DC voltage generated in the PWS	K.Oohashi Aug. 8	M. Ueda Aug 8	T. Kaneko Aug 8
	Chap. 10.2.30	Revised the contents for the occurrence of Power errors; added the info. about PWS threshold set	K.Oohashi Aug. 8	K.Oohashi Aug. 8	T. Kaneko Aug 8
0.87 Nov. 1 2016	Chap5.2.1etc. Appendix 6	Unifying several type names of VCTs to one name (e.g., VCT type xxB→VCTxxB)	K.Oohashi Nov. 1	K.Oohashi Nov. 1	T. Kaneko Nov 1
	Chap. 5.3.2	Revised the figure for GIO cable structure; added FG wire-connection	K.Oohashi Nov. 1	K.Oohashi Nov. 1	T. Kaneko Nov 1
	Chap. 5.5	Revised the value of threshold level setting on PSW	K.Oohashi Nov. 1	K.Oohashi Nov. 1	T. Kaneko Nov 1
	Chap. 10.1	Corrected the PSW contact outputs in Serious error	K.Oohashi Nov. 1	K.Oohashi Nov. 1	T. Kaneko Nov 1
	Chap. 10.2	Revised the list orders in Table 10.2-1; rearranged the order of error contents	K.Oohashi Oct. 30	K.Oohashi Oct. 30	T. Kaneko Oct 14
	Appendix 6	Added new codes '5K' and '7J' in the ordering about the BIO modules	K.Oohashi Nov 1	M. Ueda Nov 1	T. Kaneko Nov. 1
	Appendix 7	Revised the range (–10° to +55°C) of the operating temperature for the new one (–25° to +55°C).	T.Sugamoto Sep. 1	T.Sugamoto Sep. 1	T. Kaneko Sep. 1
	Appendix 7	Revised the contents of the CE to comply with 2014 rules	K.Oohashi Oct.27	T.Sugamoto Sep. 30	T. Kaneko Sep. 6
	Appendix 10	Corrected Z5STP_BLOCK element ID etc. numbers	K.Oohashi Oct. 14	T. Nakatsuka Oct. 14	T. Kaneko Oct 14
0.88 Nov. 15, 016	Chap. 5.4	Corrected BIO circuits w.r.t inversion signals in Fig. 5.4-1 and 5.4-5	K.Oohashi Nov.15	X. Tung Nov. 11	T. Kaneko Nov. 11
	Chap. 5.6	Corrected LED circuits w.r.t inversion signals in Fig. 5.6-2	K.Oohashi Nov.15	G. Suzuki Nov. 14	T. Kaneko Nov. 14
0.89 Jan. 12, 2017	Chap. 2.2	Corrected the signal numbers of DIFL element of Fig. 2.2-3; corrected Function ID in signal lists	K. Oohashi Nov. 16	K. Oohashi Nov. 16	T. Kaneko Nov. 16
	Chap. 2.8	Corrected the test setting name of SOTF-OC element of Fig. 2.8-1	K. Oohashi Nov. 16	K. Oohashi Nov. 16	T. Kaneko Nov. 16
	Chap. 2.31	Corrected the signal numbers of OCD element of Fig. 2.31-5	K. Oohashi Nov. 16	K. Oohashi Nov. 16	T. Kaneko Nov. 16
	Chap. 11.3.4(ii)	Revised the usage note of the DPI qualifications regarding in FUN and INF	S. Katayama Dec. 7	S. Katayama Dec. 7	T. Kaneko Dec. 6
	Chap. 13	Revised all contents in Chapter Installation	M. Ueda Jan. 6	M. Ueda Jan. 6	T. Kaneko Dec. 26
	Appendix 6	Added new BIO codes	K. Oohashi Dec. 28	M. Ueda Dec. 28	T. Kaneko Dec. 26
0.90 Apr. 7 2017	Chap. 2.2	Added DIFLFS-EN switch in Fig. 2.2-4; revised the content when Check relay operation is not required.	K. Oohashi Jan.26	K. Oohashi Jan.26	T. Kaneko Jan. 26
	Chap. 2.12	Corrected the signal destinations for TRC in Fig. 2.12-2 in THM	K. Oohashi Jan.26	K. Oohashi Jan.26	T. Kaneko Jan. 26
	Chap. 2.18	Corrected the UVS signal destinations for TRC in Fig. 2.18-4	K. Oohashi Mar.27	K. Oohashi Mar.27	T. Kaneko Mar 27

Rev. and Date	Section (page)	Change place and contents	Approved by	Checked by	Prepared by
	Chap. 2.26	Corrected the tables for trip signals coming from respective relays (Table 2.26-2 and -6)	K. Oohashi Mar.27	K. Oohashi Mar.27	T. Kaneko Mar 27
	Chap. 8.2	Added the notice about displaying the event information on GR-TIEMS	K. Oohashi Jan.30	K. Oohashi Jan.30	T. Kaneko Jan. 26
	Chap. 10	Added time information (i.e., current time) in the error screen in Fig. 10.1-1	T. Kawasaki Jan. 18	T. Kawasaki Jan. 18	T. Kaneko Jan. 18
	Appendix 5	Added calculation examples to get measurement coefficients in IEC103 communication	K. Oohashi Apr. 7	K. Oohashi Apr. 7	T. Kaneko Apr. 7
0.91 Apr. 27 2017	Cover sheet	Revised the notice how to recognize the software codes on the nameplate	K. Oohashi Apr.26	K. Oohashi Apr.26	T. Kaneko Apr. 26
	Chap. 13.3	Revised the check method about the software code using ordering codes	K. Oohashi Apr.26	K. Oohashi Apr.26	T. Kaneko Apr. 26
0.92 Aug 9,2017	Chap. 2.28	Revised the setting Tips and notices of [SYN1-Angle] and [T_SYN1] in VCHK	K. Oohashi Aug. 9	K. Oohashi Aug. 9	T. Kaneko July 31
	Chap. 2.28	Corrected the incoming voltage about the relationship between Vs, Vs2, Vb in VCHK	Y. Sonobe Aug. 9	G. Suzuki Aug. 3	T. Kaneko Aug. 3
	Chap. 2.29	Corrected the Equation expansions in Equations (2.29-2) and (2.29-6)	K. Oohashi June.16	K. Oohashi June.16	T. Kaneko June 14
	Chap. 2.30	Corrected Ry addresses of Star network in Fig 2.30-1	K. Oohashi July.5	T.Kawasaki July 5	T. Kaneko June 30
	Chap. 4.6	Added the setting Tips and notices of [SyncR1-Angle] and [SYNC01_TSYN] in Sync check	K. Oohashi Aug. 9	K. Oohashi Aug. 9	T. Kaneko July 31
	Chap. 10.3.4	Added the notice in the content of Communication failure (Com fail)	K. Oohashi June.16	K. Oohashi June.16	T. Kaneko June 13
	Chap. 11.1	Added Auto reset function in Communication protocol	K. Oohashi June.22	M. Okai June.22	T. Kaneko June 21
	Chap. 11.2	Corrected the definitions of quality bits in IEC61850	K. Oohashi June.6	K. Oohashi June.6	T. Kaneko June 6
	Chap. 11.3	Revised the values of Time-tagged message in Table 11.3-3&4	K. Oohashi June 15	K. Shibata June 14	T. Kaneko June 14
	Chap. 11.3	Revised the DPI number and its characteristics in Chap 11.3.5.(ii)-6	K. Oohashi July 26	M. Okai July 25	T. Kaneko July 25
	Appendix 4	Corrected the “Sr1” and “Sr2” validity values “ in the PIXIT table	K. Oohashi June.16	K. Oohashi June.16	T. Kaneko June 14
	Appendix 11	Added the notes for Dielectric voltage test	J. Nagata Aug. 3	T.Sugamoto Aug. 3	T. Kaneko Aug. 2
0.93 Oct. 2,2017	Chap. 2.3	Corrected the signals coming from DIFL function in Fig. 2.3-8	K. Oohashi Aug. 22	K. Oohashi Aug. 22	T. Kaneko July 21
	Chap. 2.28.3	Corrected the contents about synchronism condition; Revised the Notice and tips for SYN check relay	Y. Sonobe Aug. 22	K. Oohashi Aug. 22	T. Kaneko Aug. 21
	Chap. 4.6.2	Revised the Tips and notices of Synchronism-relays in SYNDIF	K. Oohashi Aug. 22	K. Oohashi Aug. 22	T. Kaneko Aug 21
	--	Republished under the spin-off company	K. Oohashi Sep. 28	K. Oohashi Sep. 28	T. Kaneko Sep. 28
0.94 Nov.20,2017	Chap. 2.29	Corrected the delay difference equation (2.29-2) and the range of Tdd setting with [CH1_TCDT]	K. Oohashi Nov. 1	K. Oohashi Nov. 1	T. Kaneko Oct. 31
	Chap. 5.3.2	Deleted the content about GIO module in CPU section	K. Oohashi Nov. 16	M. Kobayashi Nov. 16	T. Kaneko Nov. 16
	Chap. 11.2	Corrected the notice about 61850 quality value in Table 11.2-5	K. Oohashi Oct. 12	K. Oohashi Oct. 12	T. Kaneko Oct. 12
	Appendix 6	Deleted the selection about GIO in Ordering	K. Oohashi Nov. 16	M. Kobayashi Nov. 16	T. Kaneko Nov. 16
0.95 Feb. 15,2018	Chap. 2.14	Corrected and added the blocking ARC signal in Figure 2.14-2&3 of CBF	K. Oohashi Dec. 18	K. Kobayashi Dec. 18	T. Kaneko Dec. 15

Rev. and Date	Section (page)	Change place and contents	Approved by	Checked by	Prepared by
	Chap. 2.26	Corrected the FSRY_OP signal coming from FS function in Fig. 2.26-3 in TRC	K. Oohashi Jan. 30	K. Kobayashi Jan. 30	T. Kaneko Jan. 29
	Chap. 4.6	Corrected Equation (4.6-14) and the meaning of CB advance time in SYNDIF	K. Oohashi Dec. 18	K. Kobayashi Dec. 18	T. Kaneko Dec. 15
	Chap. 2.1	Revised the contents about Z*S/G-MSDET settings used in multi-phase fault in Sec. 2.1.3(ii)-3/(iii)-2	K. Oohashi Mar. 8	K. Kobayashi Mar. 8	T. Kaneko Mar. 7
0.96 Mar.30,2018	Chap. 10.2	Corrected the direction of inequality symbol in Eq. (10.2-3) and (10.2-4)	K. Oohashi Mar. 7	K. Kobayashi Mar. 7	T. Kaneko Feb. 7
	Chap. 11.2	Corrected 61850 attributes 'Good & Questionable' regarding 'Alarm and Warning' in Table 11.2-5	K. Oohashi Feb. 20	K. Oohashi Feb. 20	T. Kaneko Feb. 20
	Chap. 2.3 7	Corrected a typo in Note of Figure 2.3-6 in RDIF	K. Oohashi June 21	K. Kobayashi June 20	T. Kaneko June 19
	Chap. 2.29 2.(i)	Revised the contents about IEDs arrangement and setup in DIF_COMM	K. Oohashi June 21	K. Kobayashi June 20	T. Kaneko June 19
	Chap. 2.29 2.(ii)	Corrected the upside-down arrows on communication channel in Figure 2.29-5 in DIF_COMM	K. Oohashi June 21	K. Kobayashi June 20	T. Kaneko June 19
	Chap. 2.29 3	Corrected a typo about switch [TERM_TOPOLPGY]	K. Oohashi June 21	K. Kobayashi June 20	T. Kaneko June 19
0.97 July 7, 2018	Chap. 2.29 4(ii)	Add 'properly' at the end of contents about Multiplexer setting	K. Oohashi June 21	K. Kobayashi June 20	T. Kaneko June 19
	Chap. 2.29 5	Correct not matched contents in settings 'COM_WIDTH', T.SFT', 'B.SYN', and 'TCDT'	K. Oohashi June 21	K. Kobayashi June 20	T. Kaneko June 19
	Chap. 2.30	Corrected the incorrect the flame name 'C37.93' to 'C37.94' in Table 2.30.2, -3, and -4 in COMM_APPL	K. Oohashi Apr. 16	K. Kobayashi Apr. 16	T. Kaneko Apr. 16
	Appendix 5	Corrected typo and revised the contents at INF=19 (LED reset) in information list	K. Oohashi June. 20	K. Oohashi June. 20	T. Kaneko June. 19
	Appendix 6	Corrected the function block name at Voltage check for autoreclosing (SYNC→VCHK)	K. Oohashi June 21	K. Kobayashi June 20	T. Kaneko June 19
	Chap. 2.2	Corrected a plus/minus typo in equation (2.2-8) in DIFL	K. Oohashi Aug. 21	K. Kobayashi Aug. 20	T. Kaneko Aug. 20
	Chap. 2.2	Added RYBLK-CH signals in Fig. 2.2-3 and the contents about the relay block signals	K. Oohashi Aug. 24	Y. Sumida Aug. 23	T. Kaneko Aug. 23
	Chap. 2.2	Corrected connection lines at DUV-DIFL and the names (DIFL-DUV-EN, UV-EN, UVS-EN) in Fig2.2-4	K. Oohashi Aug. 24	Y. Sumida Aug. 23	T. Kaneko Aug. 23
	Chap.2.4.9	Added the test operation content in ZS and ZG functions	K. Oohashi Aug. 6	K. Kobayashi Aug. 6	T. Kaneko Aug. 4
	Chap. 2.14	Revised information about Retrip settings (2.14.2 and 2.14.5) and corrected typos in Fig. 2.14-2 (CBF)	K. Oohashi July. 5	K. Kobayashi July. 5	T. Kaneko July. 5
	Chap. 2.17	Added the test operation content in UV	K. Oohashi Aug. 6	K. Kobayashi Aug. 6	T. Kaneko Aug. 4
0.98 Aug.24, 2018	Chap. 2.18	Added the test operation content in UVS	K. Oohashi Aug. 6	K. Kobayashi Aug. 6	T. Kaneko Aug. 4
	Chap. 2.23	Corrected typos in setting lists (VTF)	K. Oohashi July. 5	K. Kobayashi July. 5	T. Kaneko July. 5
	Chap. 2.24	Corrected a delay timer value and add NOT operation in Fig. 2.24-1. Revised a setting content (CTF)	K. Oohashi July. 5	K. Kobayashi July. 5	T. Kaneko July. 5
	Chap. 2.25	Corrected typos in Equations 2.25-15, -16, -19, -21 in FL function	K. Oohashi Aug. 9	K. Kobayashi Aug. 8	T. Kaneko Aug. 8
	Chap. 2.26	Corrected typos of OPT signals in Figure 2.26.5 at TRC function	K. Oohashi Aug. 24	K. Kobayashi Aug. 23	T. Kaneko Aug. 23
	Chap. 2.30	Added the test operation contents in COMM_APPL	K. Oohashi Aug. 6	K. Kobayashi Aug. 6	T. Kaneko Aug. 4
	Chap. 10.3.11	Corrected the time for issuing Master-slave monitoring error	K. Oohashi Aug. 6	K. Kobayashi Aug. 6	T. Kaneko Aug. 4

Rev. and Date	Section (page)	Change place and contents	Approved by	Checked by	Prepared by
	Chap. 14.3	Added the operation contents about test settings	K. Oohashi Aug. 6	K. Kobayashi Aug. 6	T. Kaneko Aug. 4
0.99 Dec.14,2018	Chap. 2.4	Corrected incorrect figure about generator locations in Fig. 2.4-3	K. Oohashi Nov. 5	Y. Sumida Sep. 26	T. Kaneko Sep. 26
	Chap. 2.4	Revised the contents about MPFBlk setting in ZG elements in Sec. 2.4.3 (iii)-2	K. Oohashi Nov. 5	Y. Sumida Sep. 26	T. Kaneko Sep. 26
	Chap. 2.4	Revised the content about setting PSBSFR in ZS/ZG elements in Sec. 2.4.4 (i)-1	K. Oohashi Nov. 5	Y. Sumida Sep. 26	T. Kaneko Sep. 26
	Chap. 2.6	Corrected incorrect logic connecting lines in Figs. 2.6-3, 2.6-5, 2.6-6, 2.6-12	K. Oohashi Nov. 5	Y. Sumida Sep. 26	T. Kaneko Sep. 26
	Chap. 2.6	Added signals for POP signals in Fig. 2.6-4; Corrected incorrect logics	K. Oohashi Nov. 5	Y. Sumida Sep. 26	T. Kaneko Sep. 26
	Chap. 2.6	Corrected incorrect entering signal name in Fig. 2.6-8	K. Oohashi Nov. 5	Y. Sumida Sep. 26	T. Kaneko Sep. 26
	Chap. 2.15	Corrected the number of decimal places about curve coefficient in Table 2.15-2 in OV function	K. Oohashi Nov. 9	K. Kobayashi Nov. 9	T. Kaneko Nov. 8
	Chap. 2.16	Corrected the number of decimal places about curve coefficient in Table 2.16-2 in OVS function	K. Oohashi Nov. 9	K. Kobayashi Nov. 9	T. Kaneko Nov. 8
	Chap. 2.17	Corrected the number of decimal places about curve coefficient in Table 2.17-2 in UV function	K. Oohashi Nov. 9	K. Kobayashi Nov. 9	T. Kaneko Nov. 8
	Chap. 2.18	Corrected the number of decimal places about curve coefficient in Table 2.18-2 in UVS function	K. Oohashi Nov. 9	K. Kobayashi Nov. 9	T. Kaneko Nov. 8
	Chap. 2.19	Corrected the contents about the trip decision timing in FRQ function	K. Oohashi Nov. 9	K. Kobayashi Nov. 9	T. Kaneko Nov. 8
	Chap. 5.4.4(vi)	Added the notice about Latch output during power turn on/off	K. Oohashi Sep. 3	H. Amoh Sep. 3	T. Kaneko Sep. 1
	Chap.5.6.3	Corrected F7 setting names of Table 5.6-6 in HMI contents	K. Oohashi Oct. 25	K. Kobayashi Oct. 25	T. Kaneko Oct. 24
	Chap. 11.1.5	Added signals for GATEWAYs and SUBNETs in TCPIP_DRV list	K. Oohashi Dec. 4	K. Kobayashi Dec. 4	T. Kaneko Dec. 4
	Chap. 13.3	Modified the inquiry address at Toshiba Energy Systems & Solutions Corporation	K. Oohashi Oct. 1	K. Kobayashi Oct. 1	T. Kaneko Oct. 1
	Chap. 13.8	Corrected required wire thickens in Table 13.8-1	K. Oohashi Nov. 22	M. Ueda Nov. 22	T. Kaneko Nov. 22
	Appendix 7	Added the notice when the IED cannot have sufficient optical power at the communication in Technical data	K. Oohashi Oct. 24	K. Oohashi Oct. 24	T. Kaneko Oct. 23
	Appendix 6	Corrected the technical information about Power supply data in Technical data	K. Oohashi Dec. 7	K. Kobayashi Dec. 7	T. Kaneko Dec. 5
	Appendix 9	Added matrix table between VCT and relay application	K. Oohashi Oct. 23	G. Suzuki Oct. 22	T. Kaneko Oct. 22
1.00 Feb.28,2019	Safety precautions	Corrected warning message at Fiber optic (Invisible laser radiation → Class 1 laser product)	K. Oohashi Feb. 19	M. Ueda Feb. 18	T. Kaneko Feb. 18
	Chap. 2.31	Corrected the signal destination of CB-ALLPH_CLOSE in Fig. 2.31-1 of PROT_COMM	K. Oohashi Jan. 11	K. Kobayashi Jan. 11	T. Kaneko Jan. 11
	Chap. 11.2	Added the contents about GOOSE monitoring status in 61850 communication	K. Oohashi Feb. 5	M. Okai Feb. 5	T. Kaneko Feb. 4
	Chap. 13.7	Revised the content about optical cable handlings and Fig. 13.7-6	K. Oohashi Feb. 19	M. Ueda Feb. 18	T. Kaneko Feb. 18
	Appendix 4	Revised the information about 61850 Ed.1	K. Oohashi Feb. 5	M. Okai Feb. 5	T. Kaneko Feb. 4
1.01 June.14,2019	Chap. 2.3	Corrected the description of DIFGL computation. DIFGL does not use 3Io, but Ie	K. Oohashi June 6	K. Kobayashi June 6	T. Kaneko June 5
	Chap. 2.8	Corrected the incorrect switch position about OCSOTF-2PBlk in SOTF-OC logic (Fig. 2.8-1)	H. Amoh Jun. 11	G. Suzuki Jun. 11	T. Kaneko Jun. 6

Rev. and Date	Section (page)	Change place and contents	Approved by	Checked by	Prepared by
	Appendix 9	Corrected matrix table about DILG input signal	K. Oohashi June 7	K. Kobayashi June 7	T. Kaneko June. 7
1.02 Mar 2,2020	Chap. 2.3	Added the notice of setting [DIFGL-EN] in section 2.3.1 (v) (DIFGL).	H. Amoh Feb. 14	K. Oohashi Feb. 14	T. Kaneko Feb. 13
	Chap. 2.3	Added the contents about the output is blocked except for the micro earth faults. Revise Fig. 2.3-3 (DIFGL)	H. Amoh Feb. 20	K. Oohashi Feb. 20	T. Kaneko Aug. 20
	Chap. 2.6	Corrected errors in ECHO logic in Fig. 2.6-8 in DISCAR	H. Amoh Dec. 19	M. Gordon Dec. 18	T. Kaneko Dec. 18
	Chap. 2.7	Corrected errors in ECHO logic in Fig. 2.7-7 in DEFCAR	H. Amoh Dec. 19	M. Gordon Dec. 18	T. Kaneko Dec. 18
	Chap. 2.8	Added a missing signal monitoring point of SOTFOC-TRIP in Fig 2.8-1	H. Amoh Jan. 31	K. Kobayashi Nov. 12	T. Kaneko Nov. 12
	Chap. 2.10	Corrected the EF plc monitoring points' names in Table 2.10-5 and Figure 2.10-6 about EF1 and EF1PU	H. Amoh Feb. 10	Y. Sonobe Jan. 20	T. Kaneko Jan. 10
	Chap. 2.11	Corrected OCN plc monitoring points' names in Table 2.11-5 and Figure 2.11-6 about OCN1 and OCN1PU	H. Amoh Feb. 10	Y. Sonobe Jan. 20	T. Kaneko Jan. 10
	Chap. 2.15	Corrected incorrect signal name regarding OV-ARC-BLOCK (Fig.2.15-4)	H. Amoh Jul. 19	K. Oohashi Jul. 19	T. Kaneko Jul. 19
	Chap. 2.16	Corrected incorrect signal name regarding OVS-ARC-BLOCK (Fig.2.16-4)	H. Amoh Jul. 19	K. Oohashi Jul. 19	T. Kaneko Jul. 19
	Chap. 2.17	Corrected incorrect positons of logic timer and gate regarding the output of UVBLK element (Fig. 2.17-4)	H. Amoh Jul. 3	K.Kobayashi Jul. 3	T. Kaneko Jul. 2
	Chap. 2.18	Corrected incorrect positons of logic timer and gate regarding the output of UVSBLK element(Fig.2.18-4)	H. Amoh Jul. 3	K.Kobayashi Jul. 3	T. Kaneko Jul. 2
	Chap. 2.18	Corrected CB-phase-open incoming part in Fig 2.28-4(UVS)	Y. Sonobe Dec. 9	K.Kobayashi Dec. 9	T. Kaneko Dec. 9
	Chap. 2.19	Corrected incorrect signal names regarding FRQ/DFRQ-ARC-BLOCK (Fig.2.19-2 and 4)	H. Amoh Jul. 19	K. Oohashi Jul. 19	T. Kaneko Jul. 19
	Chap. 2.30	Added and revised the information about [INTCOMM] in 2.30.4 (COMM_APPL)	H. Amoh Feb. 14	K. Oohashi Feb. 14	T. Kaneko Feb. 13
	Chap. 3.4	Corrected the information at signal monitoring point of LRSW01_LR_ST_RMT in Table 3.4-5	H. Amoh Jan. 31	T. Utsumi Nov. 25	T. Kaneko Nov. 25
	Chap. 10.1	Added new information about [ErrorLED_cond] to turn off In-service for the occurrence of minor error	H. Amoh Feb. 14	K. Oohashi Feb. 13	T. Kaneko Sep. 27

Archive: G2 manuals' word files (all) 20200302rev1

TOSHIBA ENERGY SYSTEMS & SOLUTIONS CORPORATION