# INSTRUCTION MANUAL

# LINE DIFFERENTIAL RELAY

# GRL100 - 7**B

TOSHIBA CORPORATION

© TOSHIBA Corporation 2006
All Rights Reserved.

( Ver. 0.3 )

www . ElectricalPartManuals . com

# Safety Precautions

Before using this product, please read this chapter carefully.

This chapter describes the safety precautions recommended when using the GRL100. 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 two kinds of 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. |
| **CAUTION** | Indicates a potentially hazardous situation which if not avoided, may result in property damage. |

www . ElectricalPartManuals . com

## ⚠ 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**

Invisible laser radiation
Do not view directly with optical instruments.
Class 1M laser product (Transmission distance: 30km class)

- the maximum output of laser radiation: 0.2 mW
- the pulse duration: 79.2 ns
- the emitted wavelength(s): 1310 nm

## ⚠CAUTION

- **Earth**

The earthing terminal of the equipment must be securely earthed.

## CAUTION

- **Operating environment**

The equipment must only 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.

www.ElectricalPartManuals.com

- **Modification**

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

- **Short-link**

Do not remove a short-link which is mounted at the terminal block on the rear of the relay before shipment, as this may cause the performance of this equipment such as withstand voltage, etc., to reduce.

- **Disposal**

When disposing of this equipment, do so in a safe manner according to local regulations.

www . ElectricalPartManuals . com

# Contents

**Safety Precautions** 1

**1. Introduction** 9

**2. Application Notes** 11

2.1 Protection Schemes 11
2.2 Current Differential Protection 12
2.2.1 Operation of Current Differential Protection 12
2.2.2 Segregated-phase Current Differential Protection 12
2.2.3 Zero-phase Current Differential Protection 13
2.2.4 Fail-safe Function 14
2.2.5 Remote Differential Trip 15
2.2.6 Transmission Data 17
2.2.7 Synchronized Sampling 17
2.2.8 Charging Current Compensation 24
2.2.9 Blind Zone Protection 25
2.2.10 Application to Three-terminal Lines 26
2.2.11 Dual Communication Mode 28
2.2.12 Application to One-and-a-half Breaker Busbar System 28
2.2.13 Communication System 29
2.2.14 Setting 35
2.3 Distance Protection 43
2.3.1 Time-Stepped Distance Protection 43
2.3.2 Command Protection 58
2.3.3 Power Swing Blocking 73
2.4 Directional Earth Fault Protection 76
2.4.1 Directional Earth Fault Command Protection 77
2.4.2 Directional Earth Fault Protection 81
2.5 Overcurrent Backup Protection 83
2.5.1 Inverse Time Overcurrent Protection 84
2.5.2 Definite Time Overcurrent Protection 86
2.6 Transfer Trip Function 87
2.7 Out-of-step Protection 88
2.8 Thermal Overload Protection 90
2.9 Overvoltage and Undervoltage Protection 93
2.9.1 Overvoltage Protection 93
2.9.2 Undervoltage Protection 97
2.10 Broken Conductor Protection 101
2.11 Breaker Failure Protection 104
2.12 Switch-Onto-Fault Protection 107
2.13 Stub Protection 109
2.13.1 STUB DIF Protection 109
2.13.2 STUB OC Protection 109

www.ElectricalPartManuals.com

2.13.3 Setting 110
2.14 Tripping Output 111
2.15 Autoreclose 113
2.15.1 Application 113
2.15.2 Scheme Logic 115
2.15.3 Autoreclose Output Signals 131
2.16 Characteristics of Measuring Elements 132
2.16.1 Segregated-phase Current Differential Element DIF and DIFSV 132
2.16.2 Zero-phase Current Differential Element DIFG 133
2.16.3 Distance Measuring Elements Z1, Z2, Z3, Z4, ZR and PSB 134
2.16.4 Phase Selection Element UVC 142
2.16.5 Directional Earth Fault Elements DEFF and DEFR 143
2.16.6 Inverse Definite Minimum Time (IDMT) Overcurrent Element OCI and EFI 144
2.16.7 Thermal Overload Element 145
2.16.8 Out-of-Step Element OST 145
2.16.9 Voltage and Synchronism Check Elements OVL, UVL, OVB, UVB and SYN 146
2.16.10 Current change detection elements OCD, OCD1 and EFD 147
2.16.11 Level Detectors 147
2.17 Fault Locator 149
2.17.1 Application 149
2.17.2 Starting Calculation 149
2.17.3 Displaying Location 149
2.17.4 Distance to Fault Calculation 150
2.17.5 Setting 154

**3. Technical Description 158**

3.1 Hardware Description 158
3.1.1 Outline of Hardware Modules 158
3.1.2 Transformer Module 161
3.1.3 Signal Processing and Communication Module 162
3.1.4 Binary Input and Output Module 163
3.1.5 Human Machine Interface (HMI) Module 167
3.2 Input and Output Signals 169
3.2.1 Input Signals 169
3.2.2 Binary Output Signals 172
3.2.3 PLC (Programmable Logic Controller) Function 172
3.3 Automatic Supervision 173
3.3.1 Basic Concept of Supervision 173
3.3.2 Relay Monitoring 173
3.3.3 CT Circuit Current Monitoring 174
3.3.4 CT Circuit Failure Detection 175
3.3.5 Voltage Transformer Failure Supervision 175
3.3.6 Differential Current (Id) Monitoring 177
3.3.7 Telecommunication Channel Monitoring 178

www . ElectricalPartManuals . com

3.3.8 GPS Signal Reception Monitoring (For GPS-mode only) 178
3.3.9 Relay Address Monitoring 178
3.3.10 Disconnector Monitoring 178
3.3.11 Failure Alarms 179
3.3.12 Trip Blocking 180
3.3.13 Setting 180
3.4 Recording Function 181
3.4.1 Fault Recording 181
3.4.2 Event Recording 182
3.4.3 Disturbance Recording 182
3.5 Metering Function 184

**4. User Interface 185**

4.1 Outline of User Interface 185
4.1.1 Front Panel 185
4.1.2 Communication Ports 187
4.2 Operation of the User Interface 189
4.2.1 LCD and LED Displays 189
4.2.2 Relay Menu 192
4.2.3 Displaying Records 194
4.2.4 Displaying the Status 198
4.2.5 Viewing the Settings 204
4.2.6 Changing the Settings 205
4.2.7 Testing 225
4.3 Personal Computer Interface 232
4.4 Relay Setting and Monitoring System 232
4.5 IEC 60870-5-103 Interface 233
4.6 Clock Function 233

**5. Installation 234**

5.1 Receipt of Relays 234
5.2 Relay Mounting 234
5.3 Electrostatic Discharge 234
5.4 Handling Precautions 234
5.5 External Connections 235

**6. Commissioning and Maintenance 237**

6.1 Outline of Commissioning Tests 237
6.2 Cautions 238
6.2.1 Safety Precautions 238
6.2.2 Cautions on Tests 238
6.3 Preparations 239
6.4 Hardware Tests 240
6.4.1 User Interfaces 240
6.4.2 Binary Input Circuit 241
6.4.3 Binary Output Circuit 242
6.4.4 AC Input Circuits 243

www . ElectricalPartManuals . com

6.5 Function Test 244
6.5.1 Measuring Element 244
6.5.2 Timer 269
6.5.3 Protection Scheme 271
6.5.4 Metering and Recording 275
6.5.5 Fault Locator 275
6.6 Conjunctive Tests 277
6.6.1 On Load Test 277
6.6.2 Signaling Circuit Test 277
6.6.3 Tripping and Reclosing Circuit Test 279
6.7 Maintenance 281
6.7.1 Regular Testing 281
6.7.2 Failure Tracing and Repair 281
6.7.3 Replacing Failed Modules 283
6.7.4 Resumption of Service 285
6.7.5 Storage 285
**7. Putting Relay into Service 286**

www . ElectricalPartManuals . com

**Appendix A Block Diagram** 287
**Appendix B Signal List** 289
**Appendix C Variable Timer List** 323
**Appendix D Binary Output Default Setting List** 325
**Appendix E Details of Relay Menu and LCD & Button Operation** 329
**Appendix F Case Outline** 339
**Appendix G Typical External Connection** 347
**Appendix H Relay Setting Sheet** 351
**Appendix I Commissioning Test Sheet (sample)** 381
**Appendix J Return Repair Form** 387
**Appendix K Technical Data** 393
**Appendix L Symbols Used in Scheme Logic** 409
**Appendix M Multi-phase Autoreclose** 413
**Appendix N Data Transmission Format** 417
**Appendix O Example of Setting** 423
**Appendix P Programmable Reset Characteristics and Implementation of Thermal Model to IEC60255-8** 435
**Appendix Q IEC60870-5-103: interoperability** 439
**Appendix R Inverse Time Characteristics** 453
**Appendix S Failed Module Tracing and Replacement** 457
**Appendix S PLC Setting Sample** 463
**Appendix T Ordering** 467

www . ElectricalPartManuals . com

■ The data given in this manual are subject to change without notice. (Ver.0.3)

# 1. Introduction

The GRL100 provides high-speed phase-segregated current differential protection for use with telecommunication systems, and ensures high reliability and security for diverse faults including single-phase and multi-phase faults and double-faults on double-circuit lines, evolving faults and high-impedance earth faults.

The GRL100 is used as a main protection for the following two- or three-terminal lines in EHV or HV networks:

- Overhead lines or underground cables
- Lines with weak infeed or non-infeed terminals
- Single or parallel lines
- Lines with heavy load current
- Short- or long-distance lines

The GRL100 actuates high-speed single-shot autoreclose or multi-shot autoreclose.

The GRL100 can be used for lines associated with one-and-a-half busbar arrangement as well as single or double busbar arrangement.

For telecommunications using the current differential protection, dedicated optical fibres or 64 kbits/s multiplexed communication links can be employed.

Furthermore, in addition to current differential protection, the GRL100 provides distance, directional earth fault, overcurrent backup, thermal overload, under- and over-voltage, out-of-step and breaker failure protection.

The GRL100 is a member of the G-series family of numerical relays which utilise common hardware modules with the common features:

The GRL100 provides the following metering and recording functions.

- Metering
- Fault record
- Event record
- Fault location
- Disturbance record

The GRL100 provides the following menu-driven human interfaces for relay setting or viewing of stored data.

- Relay front panel; 4 × 40 character LCD, LED display and keypad
- Local PC
- Remote PC

Password protection is provided to change settings. Eight active setting groups are provided. This allows the user to set one group for normal operating conditions while other groups may be set to cover alternative operating conditions.

GRL100 provides either two or three serial ports, and an IRIG-B port for an external clock connection. A local PC can be connected via the RS232C port on the front panel of the relay. Either one or two rear ports (RS485 or fibre optic) are provided for connection to a remote PC and for IEC60870-5-103 communication with a substation control and automation system.

Further, the GRL100 provides the following functions.

- Configurable binary inputs and outputs

www.ElectricalPartManuals.com

- Programmable logic for I/O configuration, alarms, indications, recording, etc.
- Automatic supervision

The GRL100 has the following models:

Relay Type and Model

| **Relay Type:** |
|---|
| - Type GRL100; Numerical current differential relay |
| **Relay Model:** |
| - For two terminal line, With distance protection and autoreclose<br>• Model 701; 25 binary inputs, 19 binary outputs, 6 binary outputs for tripping<br>• Model 702; 28 binary inputs, 37 binary outputs, 6 binary outputs for tripping |
| - For three terminal line, With distance protection and autoreclose<br>• Model 711; 25 binary inputs, 19 binary outputs, 6 binary outputs for tripping<br>• Model 712; 28 binary inputs, 37 binary outputs, 6 binary outputs for tripping |

**Table 1.1 GRL100 Models**

| Model | 701B | 702B | 711B | 712B |
|---|---|---|---|---|
| 2- or 3-terminal line application | 2-terminal | 2-terminal | 3-terminal | 3-termnal |
| Segregated-phase current differential protection (DIF) | x | x | x | x |
| Zero-phase current differential protection (DIFG) | x | x | x | x |
| Charging current compensation (CCC) | x | x | x | x |
| Distance protection (DZ) | x | x | x | x |
| Power swing blocking (PSB) | x | x | x | x |
| Directional earth fault protection (DEF) | x | x | x | x |
| Switch-on-to-fault protection (SOTF) | x | x | x | x |
| Stub protection (STUB) | x | x | x | x |
| Phase overcurrent protection (OC) | x | x | x | x |
| Earth fault overcurrent protection (EF) | x | x | x | x |
| Thermal overload protection (THM) | x | x | x | x |
| Undervoltage protection (UV) | x | x | x | x |
| Overvoltage protection (OV) | x | x | x | x |
| Broken conductor detection (BCD) | x | x | x | x |
| Breaker failure protection (BF) | x | x | x | x |
| Out-of-step protection (OST) | x | x | x | x |
| Autoreclose (ARC) | x | x | x | x |
| Fault location (FL) | x | x | x | x |
| CT failure detection (CTF) | x | x | x | x |
| VT failure detection (VTF) | x | x | x | x |

www.ElectricalPartManuals.com

# 2. Application Notes

## 2.1 Protection Schemes

The GRL100 provides the following protection schemes (Appendix A shows block diagrams of the GRL100-700 series):

- Segregated-phase current differential protection
- Zero-phase current differential protection
- Three-stepped distance protection and command protection
- Directional earth fault protection
- SOTF and Stub protection
- Overcurrent backup protection
- Thermal overload protection
- Overvoltage and undervoltage protection
- Broken conductor detection
- Out-of-step protection
- Breaker failure protection
- Transfer trip protection

Zero-phase current differential protection enables sensitive protection for high-impedance earth faults.

Overcurrent backup protection provides both inverse time overcurrent and definite time overcurrent protection for phase faults and earth faults.

Out-of-step protection performs phase comparison of the local and remote voltages and operates only when the out-of-step loci cross the protected line.

Furthermore, the GRL100 incorporates autoreclose functions, charging current compensation for cable or long-distance lines and fault location. The autoreclose mode can be selected from single-phase, three-phase, single- and three-phase and multi-phase modes.

The current differential protection utilises with the microwave or fibre optic digital telecommunication systems to transmit instantaneous current values sampled synchronously at each terminal.

www . ElectricalPartManuals . com

## 2.2 Current Differential Protection

GRL100 is applicable to telecommunication systems which employ dedicated optical fibre, 64 kbit/s multiplexed communication channels or microwave links.

### 2.2.1 Operation of Current Differential Protection

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 GRL100 relay installed at each line terminal samples the local currents every 7.5 electrical degrees and transmits the current data to other terminals every four samples via the telecommunication system. The GRL100 performs master/master type current differential protection using the current data from all terminals.

As synchronized sampling of all terminals is performed in the GRL100, the current data are the instantaneous values sampled simultaneously at each terminal. Therefore, the differential current can be easily calculated by summing the local and remote current data with the identical sampling address. Thus, compensation of transmission delay time is not required.

The GRL100 utilises the individual three phase currents and residual current to perform segregated-phase and zero-phase current differential protection.

### 2.2.2 Segregated-phase Current Differential Protection

The segregated-phase differential protection transmits the three phase currents to the remote terminal, calculates the individual differential currents and detects both phase-to-phase and phase-to-earth faults on a per phase basis.

Figure 2.2.2.1 shows the scheme logic of the segregated-phase current differential protection. Output signals of differential elements DIF-A, -B and -C can perform instantaneous tripping of the breaker on a per phase basis and start the incorporated autoreclose function.

**Note**: For the symbols used in the scheme logic, see Appendix L.

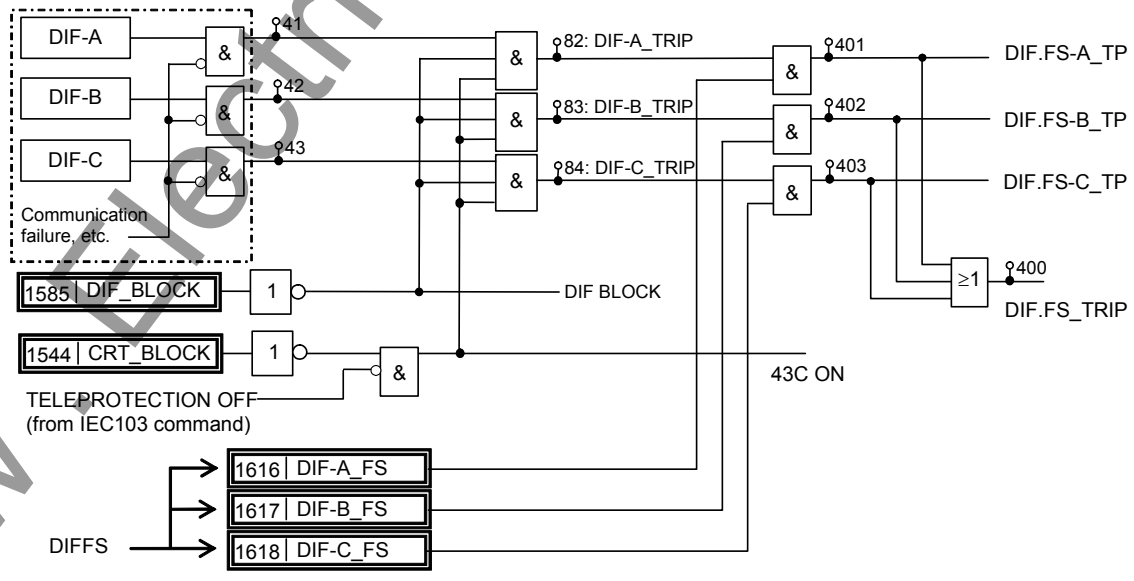



**Figure 2.2.2.1 Scheme Logic of Segregated-phase Current Differential Protection**

www.ElectricalPartManuals.com

Tripping output signals can be blocked by the PLC command DIF_BLOCK and CRT_BLOCK. The output signals of DIF-A, DIF-B and DIF-C are also blocked when a communication circuit failure is detected by the data error check, sampling synchronism check or interruption of the receive signals. For DIF-A_FS, DIF-B_FS and DIF-C_FS signals, see Section 2.2.4.

The differential elements DIF have a percentage restraining characteristic with weak restraint in the small current region and strong restraint in the large current region, to cope with CT saturation. (For details of the characteristic, see Section 2.16.)

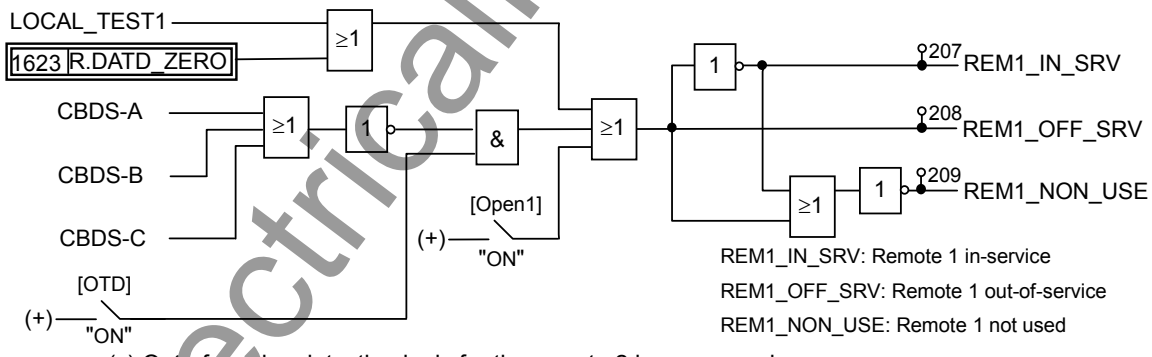
Erroneous current data may be transmitted from the remote terminal when the remote relay is out-of-service for testing or other purposes. To prevent false operation in this case, the relay sets the receiving current data to zero in the differential current calculation upon detecting that the remote terminal is out-of-service.

If the relay is applied to a three-terminal line, the zero setting is performed only for the current data received from an out-of-service terminal.

Figure 2.2.2.2 shows the remote terminal out-of-service detection logic. The local terminal detects that the remote terminal is out-of-service by receiving a signal LOCAL TEST which is transmitted when the scheme switch [L. TEST] is set to "ON" at the terminal under test. As an alternative means, the local terminal can detect it by using the circuit breaker and disconnector status signal CBDS-A, B and C transmitted from the remote out-of-service terminal. The signal CBDS-A is "1" when both the circuit breaker and disconnector are closed. Thus, out-of-service is detected when either the circuit breaker or disconnector is open in all three phases.

Zero setting of the receive current data is also performed at the terminal under test. If the scheme switch [L. TEST] is set to "ON" or the signal R.DATA_ZERO is input by PLC, all the receive current data transmitted from the in-service terminal is set to zero and this facilitates the local testing. The zero setting of the receive current data is not performed by the alternative way as mentioned above.

The out-of-service detection logic can be blocked by the scheme switch [OTD].




(*) Out-of-service detection logic for the remote 2 is same as above.

**Figure 2.2.2.2 Out-of-Service Detection Logic**

**Note**: When a communication circuit is disconnected or communication circuit failure occurs, do not close the circuit breaker. When closing it, make sure that the DIF element is blocked. (Otherwise, it may cause malfunction.)

### 2.2.3 Zero-phase Current Differential Protection

The GRL100 provides sensitive protection for high-impedance earth faults by employing zero-phase current differential protection. For more sensitive protection, residual current is introduced through an auxiliary CT in the residual circuit instead of deriving the zero-phase current from the three phase currents.

The zero-phase current differential element has a percentage restraining characteristic with weak

www.ElectricalPartManuals.com

restraint. For details of the characteristic, see Section 2.16.

The scheme logic is shown in Figure 2.2.3.1. The output signal of the differential element DIFG performs time-delayed three-phase tripping of the circuit breaker with the tripping output signal DIFG.FS_TRIP. DIFG.FS_TRIP can start the incorporated autoreclose function when the scheme switch [ARC-DIFG] is set to "ON". The DIFG can trip instantaneously by PLC command DIFG_INST_TP.

Tripping output signal can be blocked by the PLC command DIFG_BLOCK and CRT_BLOCK. The output signal is also blocked when a communication circuit failure is detected by data error check, sampling synchronism check or interruption of the receive signals. For DIFG_FS signal, see Section 2.2.4.

Since the DIFG is used for high-impedance earth fault protection, the DIFG output signal is blocked when zero-phase current is large as shown in the following equation:

$$\Sigma |I_{01}| \geq 2 \text{ pu} \quad \text{or} \quad \Sigma |I_{02}| \geq 2 \text{ pu}$$

where,

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

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

pu: per unit value

In GPS-mode setting and backup mode (refer to 2.2.7.2), DIFG is blocked.

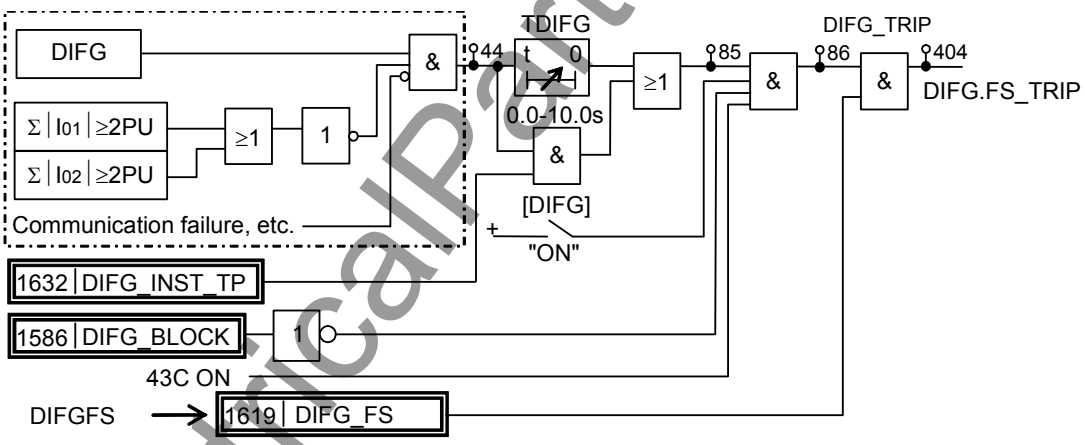



**Figure 2.2.3.1 Scheme Logic of Zero-phase Current Differential Protection**

### 2.2.4 Fail-safe Function

GRL100 provides OC1, OCD and EFD elements. These are used for fail-safe to prevent unnecessary operation caused by error data in communication failure. OC1 is phase overcurrent element and its sensitivity can be set. OCD is phase current change detection element, and EFD is zero-sequence current change detection element. Both of the OCD and EFD sensitivities are fixed. The scheme logic is shown in Figure 2.2.4.1.

The outputs of DIF.FS_OP and DIFG.FS_OP signals are connected to DIF-A_FS, DIF-B_FS, DIF-C_FS and DIFG_FS respectively by PLC function. These are connected at the default setting.

The fail-safe functions are disabled by [DIF-FS] and [DIFG-FS] switches. In the [DIF-FS], OC1 or OCD or both elements can be selected. If these switches are set to “OFF”, the signals of DIF.FS_OP and DIFG.FS_OP are “1” and the fail-safe is disabled.

www.ElectricalPartManuals.com

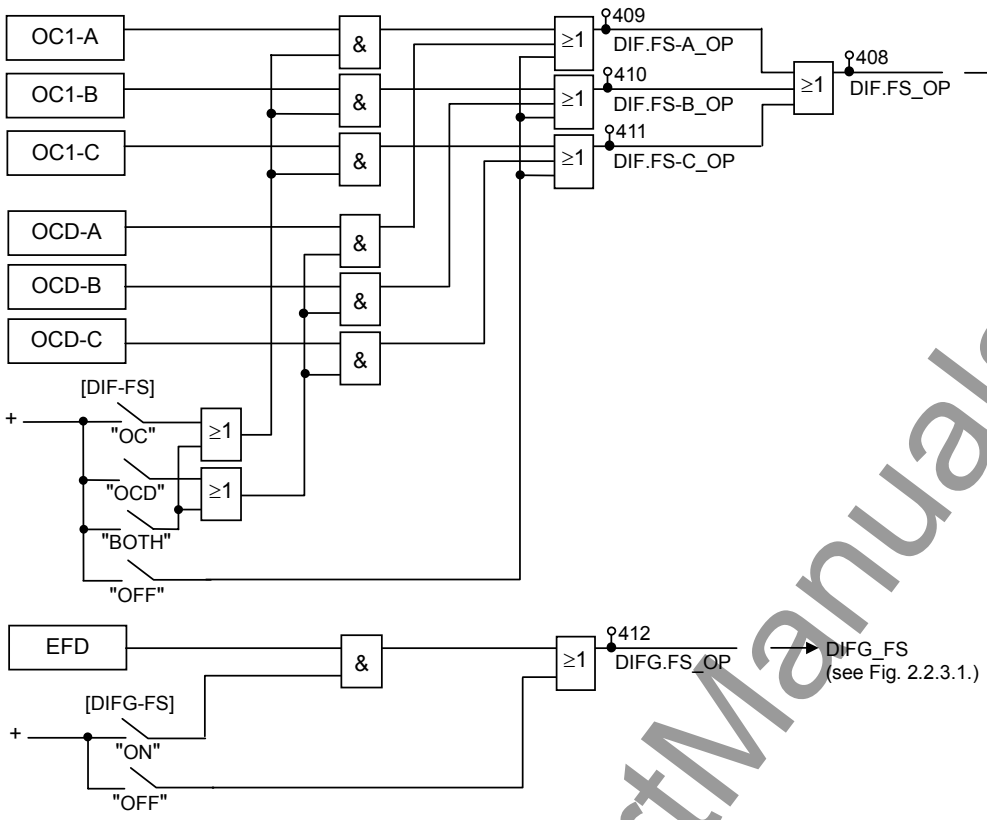



**Figure 2.2.4.1 Fail-safe Logic**

## 2.2.5 Remote Differential Trip

Note: This function is available only when the three-terminal protection is applied by setting the scheme switch [TERM] to "3-TERM". In the case of A-MODE setting, this function is not available.

When one of the telecommunication channels fails, the terminal using the failed channel is disabled from performing current differential protection, as a result of the failure being detected through by the telecommunication channel monitoring.

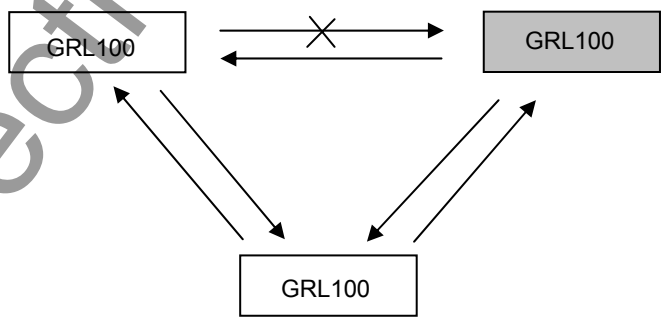



**Figure 2.2.5.1 Protection Disabled Terminal with Channel Failure**

The remote differential trip (RDIF) function enables the disabled terminal to trip by receiving a trip command from the sound terminal, which continues to perform current differential protection.

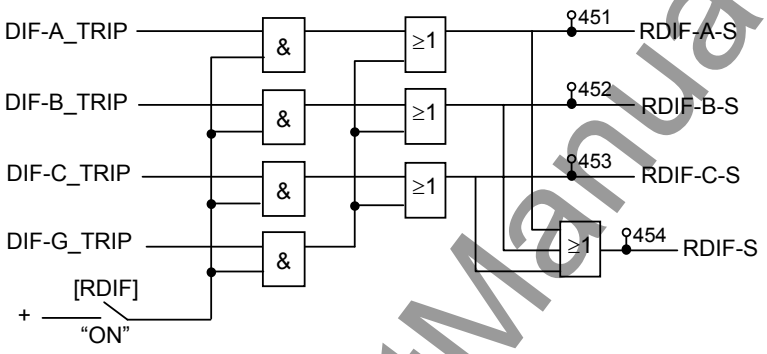
Figure 2.2.5.2(a) and (b) show the RDIF scheme logic at RDIF command sending terminal (= sound terminal) and command receiving terminal (= disabled terminal). The sound terminal

www . ElectricalPartManuals . com

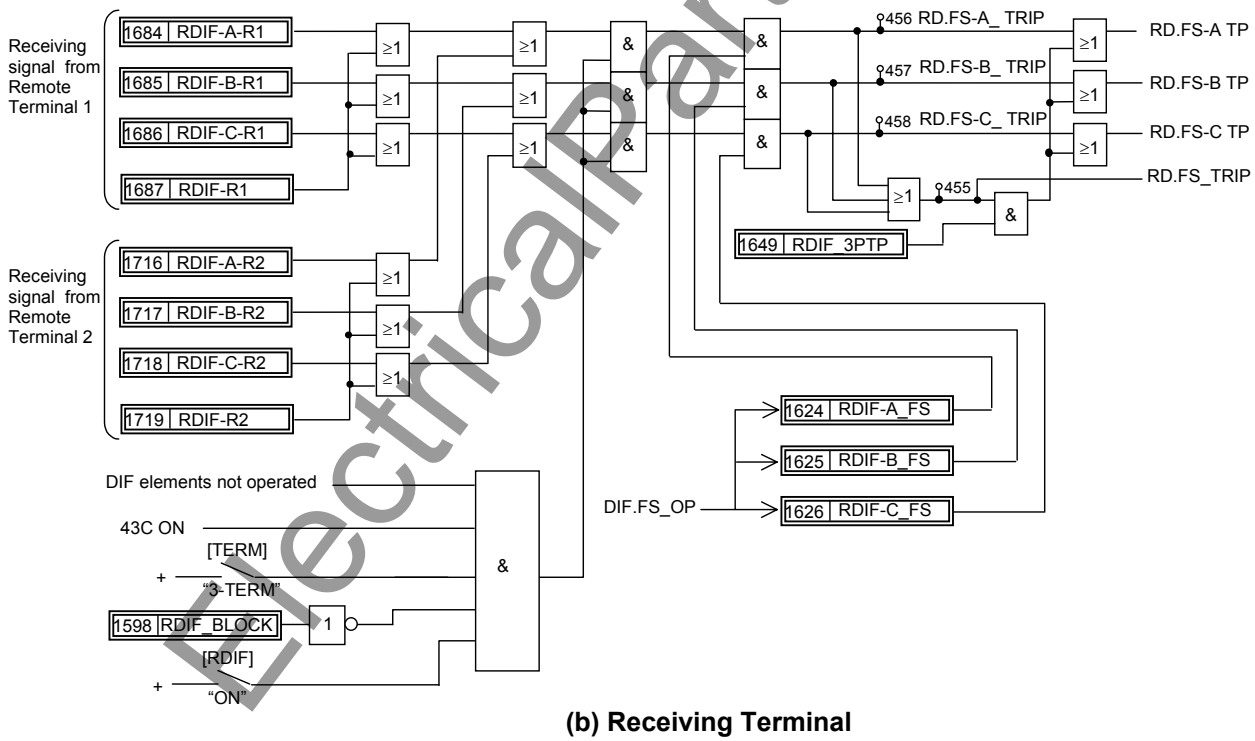
sends the command when the tripping signals RDIF-A-S, RDIF-B-S, RDIF-C-S or RDIF-S are output locally and the scheme switches [RDIF] and [TERM] are set to "ON" and "3-TERM" respectively. The RDIF command is sent to the remote terminal via the 64kb/s digital link together with other data and signals.

The receiving terminal outputs a local three-phase trip signal RDIF-TRIP under the conditions that when the command RDIF1 or RDIF2 is received from either of the remote terminals, local differential protection does not operate, the scheme switches [RDIF] and [TERM] are set to "ON" and "3-TERM" respectively and no communication channel failure exists in the channel which received the RDIF command.

When the RDIF function is applied, the command sending signals and receiving signals must be assigned by PLC function.




**(a) Sending terminal**




**(b) Receiving Terminal**

**Figure 2.2.5.2 Remote Differential Trip**

www.ElectricalPartManuals.com

### 2.2.6 Transmission Data

The following data are transmitted to the remote terminal via the 64kb/s digital link. The data depends on the communication mode and whether a function is used or not. The details are shown in Appendix N.

A-phase current

B-phase current

C-phase current

Residual current

Positive sequence voltage

A-phase differential element output signal

B-phase differential element output signal

C-phase differential element output signal

A-phase breaker and disconnector status

B-phase breaker and disconnector status

C-phase breaker and disconnector status

Scheme switch [LOCAL TEST] status

Scheme switch [TFC] status

Reclose block command

Sampling synchronization control signal

Synchronized test trigger signal

User configurable data

Current and voltage data are instantaneous values which are sampled every 30 electrical degrees (12 times per cycle) and consist of eleven data bits and one sign bit. This data is transmitted every sample to the remote terminal.

Three differential element outputs and the transfer trip command are related to remote terminal tripping and are transmitted every sampling interval.

Other data is transmitted once every power cycle.

The data transmission format and user configurable data are also shown in Appendix N.

A synchronized test trigger signal is used to test the differential protection simultaneously at all terminals. For details, see Section 6.5.3.

In addition to the above data, cyclic redundancy check bits and fixed check bits are transmitted to monitor the communication channel. If a channel failure is detected at the local terminal, all the local and remote current and voltage data at that instant are set to zero and outputs of the differential protection and out-of-step protection are blocked, and these protections of remote terminal are also blocked because the channel failure is also detected at the remote terminal.

### 2.2.7 Synchronized Sampling

The GRL100 performs synchronized simultaneous sampling at all terminals of the protected line. Two methods are applied for the sampling synchronization; intra-system synchronization and GPS-based synchronization. The former is applied to communication modes A-MODE and

www.ElectricalPartManuals.com

B-MODE, and the latter is applied to GPS-MODE.

The intra-system synchronization keeps the sampling timing error between the terminals within ±10μs or ±20μs and the GPS-based system keeps it within ±5μs or ±10μs for two- or three-terminal applications.

In both methods, the sampling synchronization is realized through timing synchronization control and sampling address synchronization control. These controls are performed once every two power cycles.

#### 2.2.7.1 Intra-system Synchronized Sampling for A-MODE and B-MODE

The synchronized sampling is realized using sampling synchronization control signals transmitted to other terminals together with the power system data. This synchronized sampling requires neither an external reference clock nor synchronization of the internal clocks of the relays at different terminals. The transmission delay of the channel is corrected automatically.

**Timing synchronization**

One of the terminals is selected as the time reference terminal and set as the master terminal. The other terminal is set as the slave terminal. The scheme switch [SP.SYN] is used for the settings.

**Note**: The master and slave terminals are set only for the convenience of the sampling timing synchronization. The GRL100s at all terminals perform identical protection functions and operate simultaneously.

To perform timing synchronization for the slave terminal, the sampling time difference between master and slave terminals is measured. The measurement principle of the sampling time difference ΔT is indicated in Figure 2.2.7.1. The master terminal and slave terminal perform their own sampling and send a signal that becomes the timing reference for the other terminal.

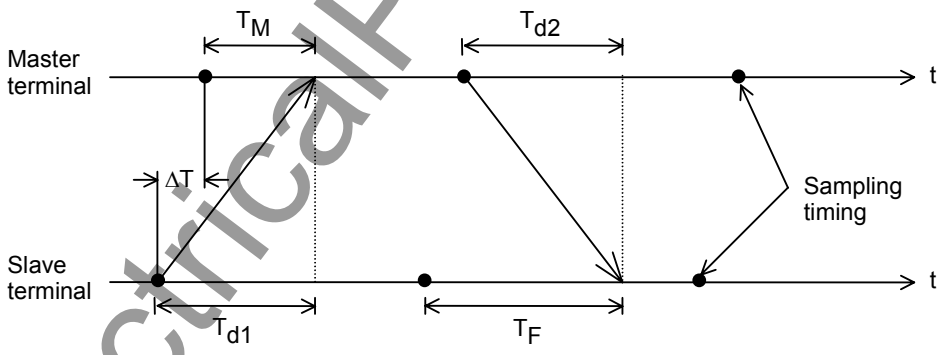



**Figure 2.2.7.1 Timing Synchronization**

Each terminal measures the time $T_M$ and $T_F$ from its own sampling instant to the arrival of the signal from the other terminal. As is evident from the figure, the times $T_M$ and $T_F$ can be obtained by equation (1) and (2) where $T_{d1}$ and $T_{d2}$ are the transmission delay of the channel in each direction. The sampling time difference ΔT can be obtained from the resulting equation (3).

$$T_M = T_{d1} - \Delta T \qquad (1)$$

$$T_F = T_{d2} + \Delta T \qquad (2)$$

$$\Delta T = \{(T_F - T_M) + (T_{d1} - T_{d2})\}/2 \qquad (3)$$

The slave terminal advances or retards its sampling timing based on the time ΔT calculated from equation (3), thereby reducing the sampling time difference with the master terminal to zero. This adjustment is performed by varying the interval of the sampling pulse generated by an

www.ElectricalPartManuals.com

oscillator in the slave terminal.

The difference of the transmission delay time $T_{dd}$ (= $T_{d1} - T_{d2}$) is set to zero when sending and receiving take the same route and exhibit equal delays. When the route is separate and the sending and receiving delays are different, $T_{dd}$ must be set at each terminal to be equal to the sending delay time minus the receiving delay time. The maximum $T_{dd}$ that can be set is 10ms. (For setting, see Section 4.2.6.7. The setting elements of transmission delay time difference are TCDT1 and TCDT2.)

The time $T_M$ measured at the master terminal is sent to the slave terminal together with the current data and is used to calculate the ΔT.

The permissible maximum transmission delay time of the channel is 10ms.

In case of the three-terminal line application, the communication ports of the GRL100 are interlinked with each other as shown in Figure 2.2.7.2, that is, port CH1 of one terminal and port CH2 of the other terminal are interlinked. For the setup of the communication system, see Section 2.2.13.3.

When terminal A is set as the master terminal by the scheme switch [SP.SYN], the synchronization control is performed between terminals A and B, and terminals B and C. The terminal B follows the terminal A and the terminal C follows the terminal B. The slave terminals perform the follow-up control at their communication port CH2.

When the master terminal is out-of-service in A-MODE, the slave terminal that is interlinked with port 1 of the master terminal takes the master terminal function. In the case shown in Figure 2.2.7.2, terminal B takes the master terminal function when the master terminal A is out-of-service. In B-MODE and GPS-MODE, even if the master terminal is out-of-service, the master terminal is not changed. If DC power supply of the out-of-service terminal is "OFF", differential elements at all terminals are blocked. Therefore, the [TERM] setting change from "3TERM" to "2TERM" is required.

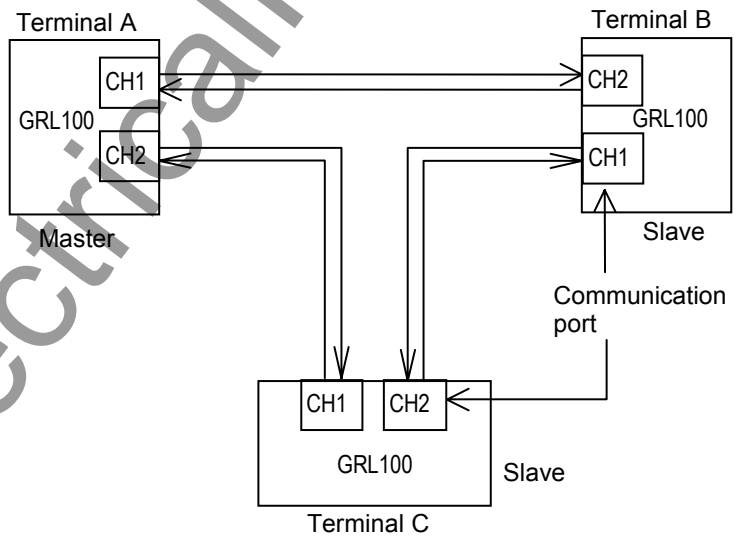



**Figure 2.2.7.2 Communication Link in Three-terminal Line**

**Sampling address synchronization**

The principle of sampling address synchronization control is indicated in Figure 2.2.7.3. After time synchronization has been established, the slave terminal measures the time from sending its own timing reference signal until it returns from the master terminal. The transmission delay time $T_{d1}$ from slave to master terminal can be calculated from equation (4).

www.ElectricalPartManuals.com

$$T_d = (\{T_o - (T - T_M)\}/2 + T_{dd})/2 \quad (4)$$

The calculated transmission delay time $T_{d1}$ is divided by the sampling interval T. The mantissa is truncated and the quotient is expressed as an integer. If the integer is set to P, the reception at the slave terminal of the signal sent from the master terminal occurs at P sampling intervals from the transmission. Accordingly, by performing control so that the sampling address of the slave terminal equals integer P when the sampling address = 0 signal is received from the master terminal, the sampling address of the slave terminal can be made the same as the master terminal.

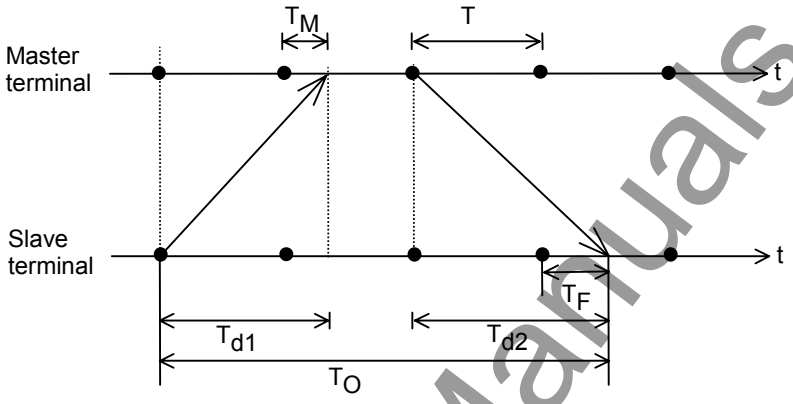



**Figure 2.2.7.3 Sampling Address Synchronization**

### 2.2.7.2 GPS-based Synchronized Sampling for GPS-MODE

The relays at all terminals simultaneously receive the GPS clock signal once every second. Figure 2.2.7.4 shows the GPS-based synchronized sampling circuit at one terminal. The GPS clock signal is received by the GPS receiver HHGP1 and input to a time difference measurement circuit in the GRL100. The circuit measures the time difference ΔT between the GPS clock and the internal clock generated from the crystal oscillator. The oscillator is controlled to synchronize with the GPS clock using the measured ΔT and outputs 2,400 Hz (50Hz rating) sampling signals to the current sampling circuit (analog to digital converter).

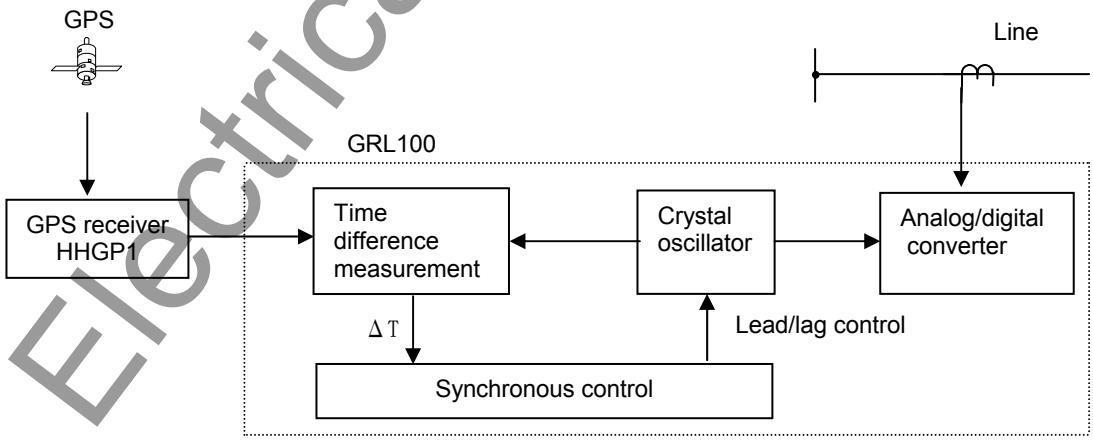



**Figure 2.2.7.4 GPS Clock-based Sampling**

www.ElectricalPartManuals.com

### Timing synchronization

When the GPS signal is received normally at every line terminal, the GRL100 performs synchronized sampling based on the received clock signal. The GRL100 can provide a backup synchronization system if the GPS signal is interrupted at one or more terminals, and perform synchronized sampling without any external reference clock. The backup system becomes valid by setting the scheme switch [GPSBAK] to "ON".

In the backup modes, the percentage restraint in the small current region can be increased from the normal 16.7% ((1/6)Ir in Figure 2.16.1.1) in accordance with the PDTD setting which is the probable transmission delay time difference between send and receive channels.

Backup modes, Mode 1, 2A and 2B are initialised when the backup system is set valid.

If the GPS signal interruption occurs when the backup is set invalid, the sampling runs based on the local clock. When the arrival time of the remote signal measured from local sampling instant deviates from a nominal time, the protection is blocked.

**Mode 0:** When the GPS signal is received normally, the sampling is performed synchronizing with the received clock signal thus realizing synchronized sampling at all terminals. Difference of the transmission delay time for the channel in each direction and fluctuation of the delay time can be permitted.

The GRL100 performs the protection based on the nominal current differential characteristics.

When the GPS signal has interrupted for more than ten seconds at any of the terminals, the mode changes to Mode 1 at all terminals.

**Mode 1:** The terminal which loses its GPS signal first functions as the slave terminal. If all terminals lose their signals simultaneously, then the scheme switch [SP.SYN] setting determines which terminal functions as the slave or master. The slave terminal adjusts the local sampling timing to synchronize the sampling with other terminal which is receiving the GPS signal regularly or with the master terminal.

> **Note**: When two terminals are receiving the GPS signal regularly, the slave terminal synchronizes with the terminal that is interlinked with port 2 of the slave terminal.

When the GPS signal has been restored, the mode shifts from Mode 1 back to Mode 0.

If, during Mode 1 operation, a failure occurs in the communication system, the sampling timing adjustment is disabled and each terminal runs free. If the free running continues over the time determined by the PDTD setting or the apparent phase difference exceeds the value determined by the PDTD setting, the mode shifts from Mode 1 to Mode 2A at all terminals.

**Mode 2A**: In this mode, the intra-system synchronization described in 2.2.7.1 is applied assuming that the transmission delay time for the channel in each direction is identical. Fluctuation of the delay time can be permitted.

The current differential protection is blocked in this mode.

When the GPS signal has been restored, the mode shifts from Mode 2A to Mode 0.

If the GPS signal interruption occurs a set period following energisation of the relay power supply or the mode returned to Mode 0 from Mode 1, 2A or 2B, then the transmission delay time measurement will not be completed in Mode 0, and the mode changes to Mode 2A.

When the apparent current phase difference has stayed within the value determined by the PDTD setting, the scheme switch [AUTO2B] for automatic mode change is set to "ON" and [TERM] is set to "2TERM", the mode changes from Mode 2A to Mode 2B at both terminals.

The mode can be changed to Mode 2B manually through a binary input signal "Mode 2B initiation" or user interface. Before this operation, it must be checked that the transmission delay

www.ElectricalPartManuals.com

time difference between send and receive terminals is less than the PDTD setting and the SYNC ALARM LED is off. If these conditions are not satisfied, the operation may cause a false tripping.

Note: The mode change with the binary input signal is performed by either way:

- If the binary input contact is such as to be open when the relay is in service, set the BI to "Inv" (inverted). The mode changes when the contact is closed more than 2 seconds and then open.
- If the binary input contact is such as to be closed when the relay is in service, set the BI to "Norm" (normal). The mode changes when the contact is open more than 2 seconds and then closed.
  For the BISW4, see Section 3.2.1.

  In the three-terminal application, the mode change to Mode 2B is available even when one of the three communication routes is failed.

**Mode 2B**: The same intra-system synchronization as in Mode 2A is applied.

When the GPS signal has been restored, the mode shifts from Mode 2B to Mode 0.

If a failure occurs in the communication system, the sampling timing adjustment is disabled and each terminal runs free.

The mode shifts from Mode 2B to Mode 2A, when the apparent load current phase difference exceeds the value determined by the PDTD setting for pre-determined time.

#### Checking the current phase difference (For two-terminal application setting only)

The current phase difference is checked using the following equations:

$I_{1A} \cdot \cos\theta < 0$

$I_{1A} \cdot I_{1B} \sin\theta < I_{1A} \cdot I_{1B} \sin\theta s$

$I_{1A} > OCCHK$

$I_{1B} > OCCHK$

Where,

$I_{1A}$ = Positive sequence component of load current at local terminal
$I_{1B}$ = Positive sequence component of load current at remote terminal
$\theta$ = Phase difference of $I_{1B}$ from $-I_{1A}$
$\theta s$ = Critical phase difference
= $CHK\theta - HYS\theta$

$$CHK\theta = \frac{PDTD(\mu s)}{2} \times \frac{360^\circ}{20000(\mu s)} + 8.5^\circ$$

$HYS\theta$ = Margin of phase difference checking

OCCHK = Minimum current for phase difference check

If the magnitude of $I_{1A}$ and $I_{1B}$ exceed the setting and the conditions for both equations above are established, then the sampling is regarded to be synchronized.

If the current phase difference exceeds a set value, the "SYNC ALARM" LED on the front panel is lit.

Checking the current phase difference is enabled by setting the scheme switches [TERM] to "2TERM" and [SRC$\theta$] to "I".

www.ElectricalPartManuals.com

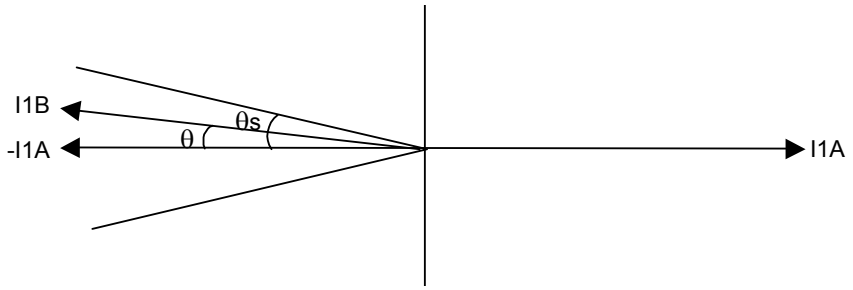



**Figure 2.2.7.5 Current Phase Difference Check**

**Sampling address synchronization**

The same method as described in section 2.2.7.1 is employed in Mode 0 and Mode 2A where the sampling synchronization must be established. It is not employed in Mode 1 and 2B because the sampling address synchronization has already been established in the previous mode.

### 2.2.7.3 Differential Current Calculation

Synchronized sampling allows correct calculation of differential current even in the presence of a transmission time delay. This processing is indicated in Figure 2.2.7.4. As indicated in the figure, sampling synchronization is established between terminals A and B, and both the sampling timing and sampling address match. The instantaneous current data and sampling address are both sent to the other terminal. The GRL100 refers to the sampling address affixed to the received data and uses local data with the same sampling address to calculate the differential current. This allows both terminals to use data sampled at the same instant to perform the differential current calculation, no matter how large the transmission time delay is.

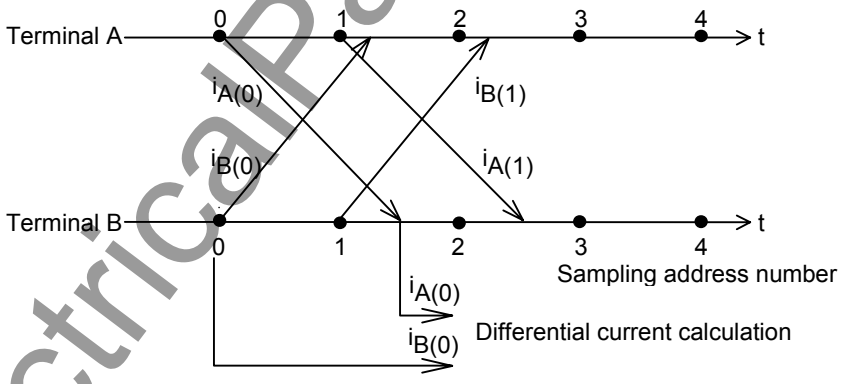



**Figure 2.2.7.4 Calculation of Differential Current with Transmission Delay Time**

**Protection in anomalous power system operation**

Even when any of the terminals is out-of-service, the GRL100 in-service terminal can still provide the differential protection using the out-of-service detection logic. For details of the out-of-service detection logic, see Section 2.2.2.

When one terminal is out-of-service in a two-terminal line, the other terminal continues the current differential protection using the local current irrespective of whether it is a master terminal or a slave terminal.

When one terminal is out-of-service in a three-terminal line, synchronized sampling is established between the remaining two terminals as follows and the differential protection is maintained.

- If the master terminal is out-of-service, one of the slave terminals takes over the master terminal synchronized sampling function and enables current differential protection

www.ElectricalPartManuals.com

between the remaining terminals to be performed.

- If the slave terminal is out-of-service, the master and another slave terminal maintain the differential protection.

When two terminals are out-of-service in a three-terminal line, the remaining terminal continues the current differential protection using the local current irrespective of whether it is a master terminal or a slave terminal.

### 2.2.8 Charging Current Compensation

When differential protection is applied to underground cables or long overhead transmission lines, the charging current which flows as a result of the capacitance of the line (see Figure 2.2.8.1) appears to the protection relay as an erroneous differential current.

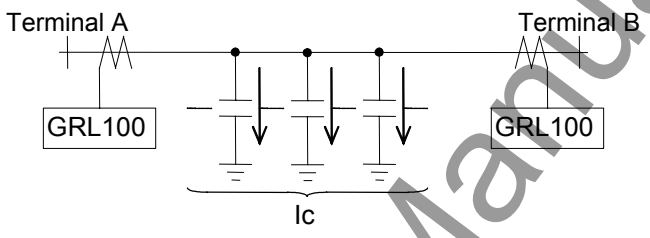



**Figure 2.2.8.1 Charging Current**

The charging current can be compensated for in the setting of the relay's differential protection sensitivity but only at the expense of reduced sensitivity to internal faults. In addition, the actual charging current varies with the running voltage of the line and this must be taken into account in the setting.

In order to suppress the effect of the charging current while maintaining the sensitivity of the differential protection, GRL100 is equipped with a charging current compensation function, which continuously re-calculates the charging current according to the running line voltage and compensates for it in its differential current calculation. The running line voltage is measured by VT inputs to GRL100.

The user enters values for line charging current and for the line voltage at which that charging current was determined in the settings [DIFIC] and [Vn], and these values are used by the relay to calculate the capacitance of the line. The relays at each line end share the line capacitance between them, that is they divide by two for a two-terminal line, and by three for a three-terminal line. In the case of a three-terminal line, if the relay at one terminal is out-of-service for testing (see out-of-service terminal detection), the other two terminals are automatically re-configured to divide the line capacitance by two.

Each terminal continuously calculates its share of the charging current at the running line voltage on a sample by sample basis as follows:

$$I_c = C \, dV / dt$$

where,

Ic = line charging current

C = line capacitance calculated from settings [DIFIC] and [Vn]

V = measured line voltage

The relay then calculates the line current compensated for the charging current on a sample by sample basis as follows:

www.ElectricalPartManuals.com

$$I = I' - I_C$$

where,

I = compensated current

I' = actual measured current

Note that since GRL100 calculates both the charging current and compensated line current on a sample by sample basis, all necessary phase information is inherently taken into account.

### 2.2.9 Blind Zone Protection

The GRL100 relay has "Out-of-Service Detection Logic" as described in Section 2.2.2. This logic functions automatically to detect the remote CB or DS (line disconnecting switch) opened condition as shown in Figure 2.2.9.1. If the remote CB or DS is opened, the received remote current data is set to "zero" Ampere at the local terminal, and the local relay can be operated with only local current like a simple over current relay. Therefore, this logic function is used for blind zone protection.

The zone between CB and CT at the remote terminal is the blind zone in Figure 2.2.9.1. If a fault occurs within this zone, the busbar protection should operate first and trip the CB at the remote terminal, but the fault remains and the fault current ($I_F$) is fed continuously from the local terminal. Since this phenomenon is an external fault for the current differential protection scheme, the blind zone fault cannot be cleared. The fault may be cleared by remote backup protection following a time delay, but there is a danger of damage being caused to power system plant. Fast tripping for this type of fault is highly desirable. The Out-of-Service Detection Logic is effective for a fault where a blind zone between CT and CB on the line exists as shown in Figure 2.2.9.1.

If the CB and DS condition are introduced at the remote terminal as shown in Figure 2.2.9.1, the GRL100 relay at the local terminal can operate with only local current and the fault can be cleared, because the remote current data is automatically cancelled as explained above.

Please note the "CB Close Command" signal must be connected to the GRL100 relay to prevent unwanted operation for a CB close operation (manual close and/or autoreclose). Unwanted operation may be caused if the close timing of the CB auxiliary contact is delayed relative to the CB main contact. Therefore, the CB close command signal resets forcibly the Out-of-Service Detection Logic before the CB main contact is closed.

CB and DS status signals are input by PLC. If the out-of-service detection is not used, its logic can be blocked by the scheme switch [OTD].

www . ElectricalPartManuals . com

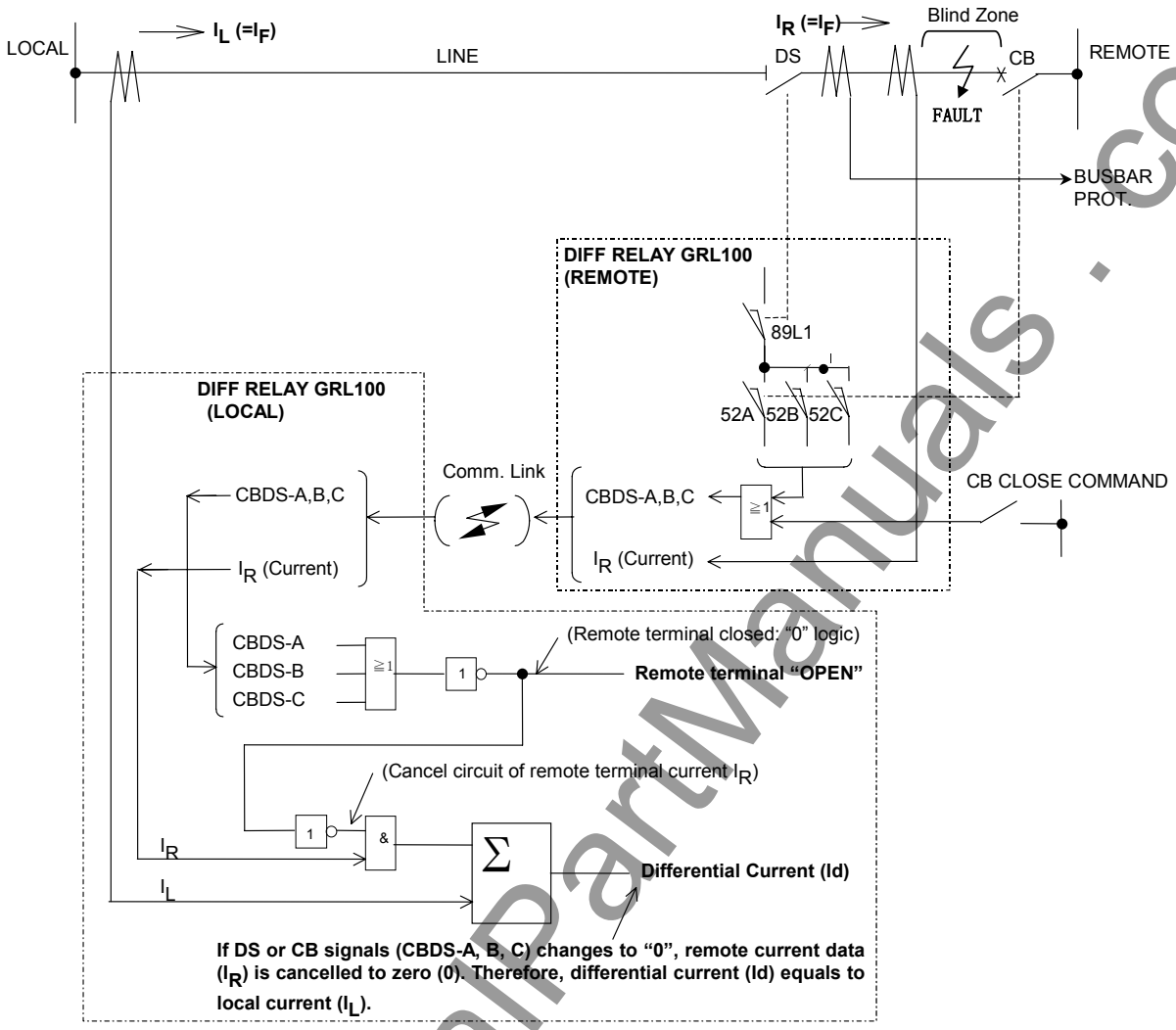



**Figure 2.2.9.1 Blind Zone Protection**

## 2.2.10 Application to Three-terminal Lines

When current differential protection is applied to a three-terminal line, special attention must be paid to the fault current flowing out of the line in the case of an internal fault and CT saturation at the outflowing terminal in case of an external fault.

### Fault current outflow in case of internal fault

In case of a two-terminal line, fault current never flows out from the terminals for an internal fault. But in case of a three-terminal line with an outer loop circuit, a partial fault current can flow out of one terminal and flow into another terminal depending on the fault location and magnitude of the power source behind each terminal.

Case 1 in Figure 2.2.10.1 shows a fault current outflow in a single circuit three-terminal line with outer loop circuit. J and F in the figure indicate the junction point and fault point. A part of the fault current flowing in from terminal A flows out once from terminal C and flows in again from terminal B through the outer loop.

Case 2 shows the outflow in a double-circuit three-terminal line. The outer loop is generated when one terminal is open in the parallel line. A part of the fault current flowing in from terminal A flows out from the fault line to the parallel line at terminal C and flows in again at terminal B through the parallel line.

www.ElectricalPartManuals.com

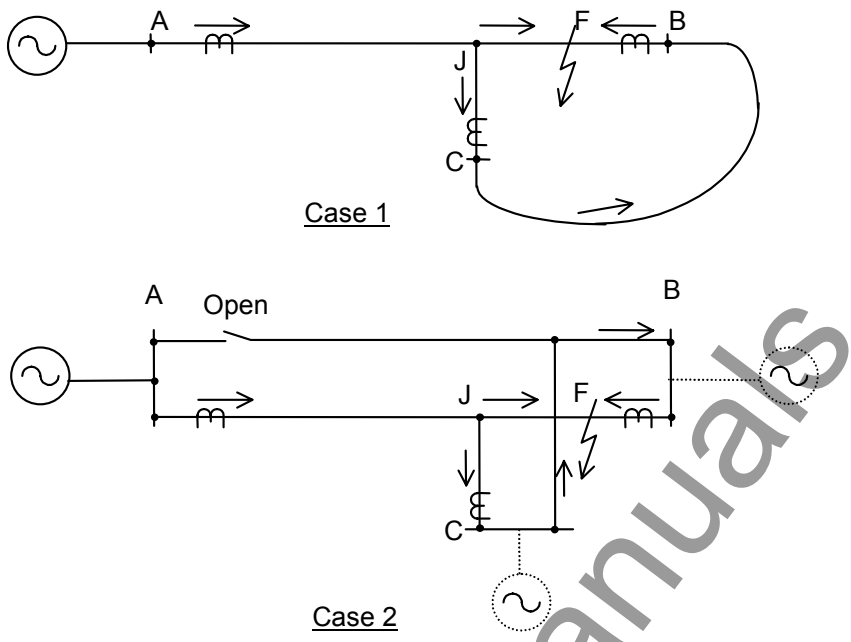



**Figure 2.2.10.1 Fault Current Outflow in Internal Fault**

The larger current outflows from terminal C when the fault location is closer to terminal B and the power source behind terminal C is weaker. In case of a double-circuit three-terminal line, 50% of the fault current flowing in from terminal A can flow out from terminal C if terminal C is very close to the junction and has no power source behind it.

These outflows must be considered when setting the differential element.

#### CT saturation for an external fault condition

In case of a two-terminal line, the magnitude of infeeding and outflowing currents to the external fault is almost the same. If the CTs have the same characteristics at the two terminals, the CT errors are offset in the differential current calculation.

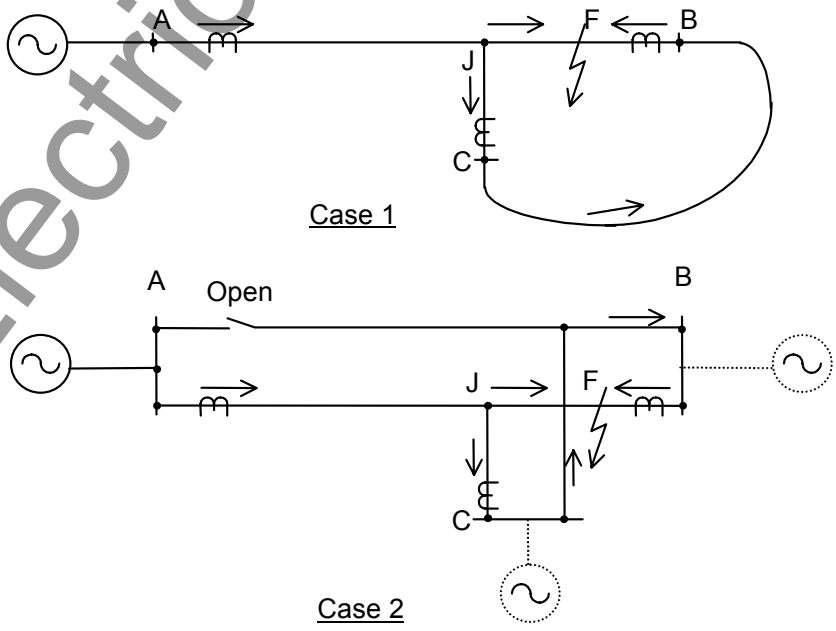



**Figure 2.2.10.2 Fault Current Distribution**

www . ElectricalPartManuals . com

But in case of a three-terminal line, the magnitude of the current varies between the terminals and the terminal closest to the external fault has the largest magnitude of outflowing fault current. Thus, the CT errors are not offset in the differential current calculation. Thus, it is necessary to check whether any fault causes CT saturation, particularly in the terminal with outflow, and the saturation must be accommodated utilising the DIFI2 setting of the DIF element.

### 2.2.11 Dual Communication Mode

Three-terminal application models have dual communication mode (GRL100-∗1∗). By connecting the remote terminal with dual communication routes, even if one of the routes fails, it is possible to continue sampling synchronization and protection by the current differential relay. To set dual communication mode, select "Dual" in the TERM setting. Other settings are the same as that of the two-terminal. In GPS-MODE setting, however, the dual communication mode cannot be applied.

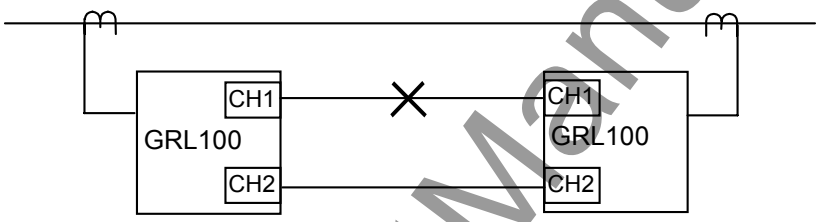



**Figure 2.2.11.1 Dual Communication Mode**

### 2.2.12 Application to One-and-a-half Breaker Busbar System

The GRL100-700 series can be used for lines connected via a one-and-a-half breaker busbar system, and have functions to protect against stub faults and through fault currents.

#### Stub fault

If a fault occurs at F1 or F2 when line disconnector DS of terminal A is open as shown in Figure 2.2.12.1, the differential protection operates and trips the breakers at both terminals without any countermeasures.

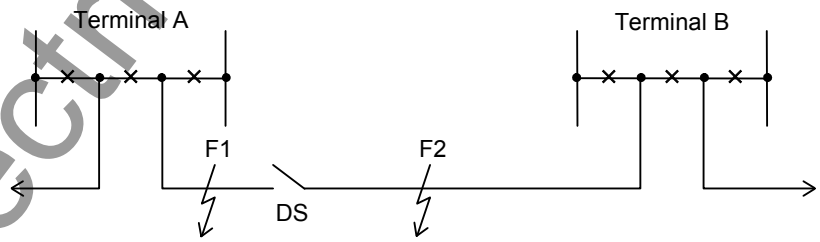



**Figure 2.2.12.1 Stub Fault**

GRL100 provides stub protection to avoid unnecessary tripping of the breakers in these cases. For the stub protection, see Section 2.13.

#### Fault current outflow in case of internal fault

As shown in Figure 2.2.12.2, the fault current may outflow in case of an internal fault of double-circuit lines. The outflow at terminal A increases as the fault location F approaches terminal B. When the fault is close to terminal B, 50% of the fault current flows out to the parallel line, though it depends on the power source conditions at terminals A and B.

This outflow must be considered when setting the differential element.

www.ElectricalPartManuals.com

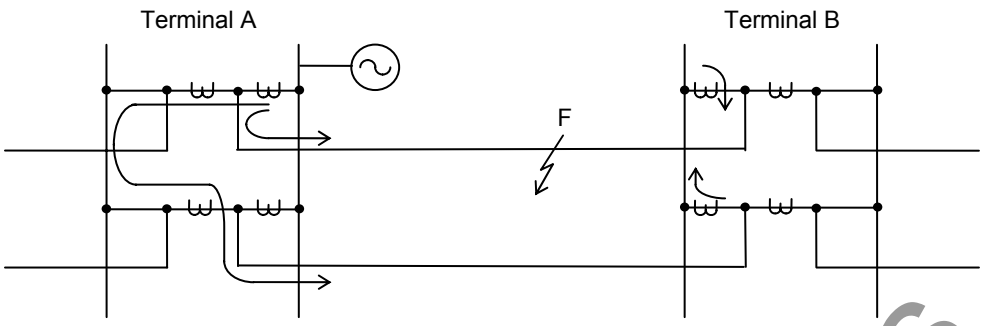


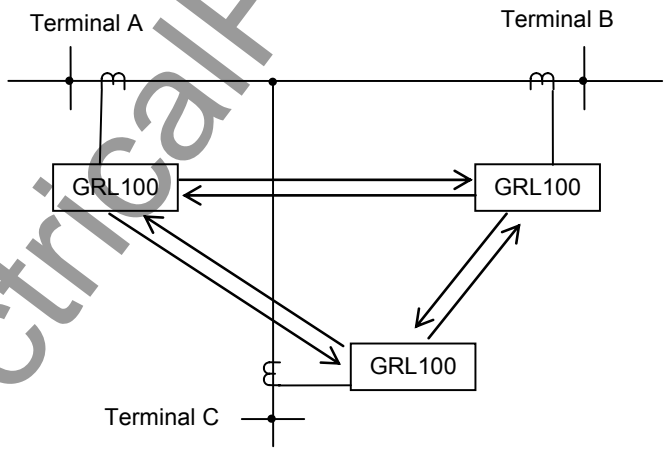

**Figure 2.2.12.2 Fault Current Outflow in Internal Fault**

## 2.2.13 Communication System

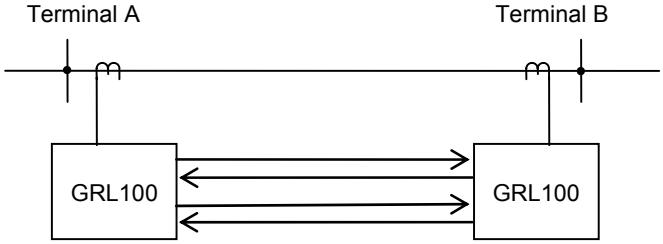
### 2.2.13.1 Signaling Channel

The GRL100 transmits all the local data to the remote terminal by coded serial messages. Two signaling channels are required for two-terminal line protection, six for three-terminal line protection and four for dual communication for two-terminal line as shown in Figure 2.2.13.1.

**(a) Two-terminal Line**




**(b) Three-terminal Line**




**(c) Dual Communication for Two-terminal Line**

**Figure 2.2.13.1 Signaling Channel**

www . ElectricalPartManuals . com

The variation of the channel delay time due to switching the route of the channel is automatically corrected in the relay and does not influence the synchronized sampling provided the sending and receiving channels take the same route. If the routes are separate, the transmission delay difference time must be set (see Section 2.2.7).

When the route is switched in A- or B-mode application, the synchronized sampling recovers within 4s in case of a two- terminal line and 6s in case of a three-terminal line after the switching. The differential element is blocked until the sampling synchronization is established.

In GPS-mode application (GPS-based synchronization), the sampling synchronization is not influenced by the route switch. The differential element is only blocked for the duration of the path switching.

#### 2.2.13.2 Linking to Communication Circuit

The GRL100 can be provided with one of the following interfaces by order type and linked to a dedicated optical fiber communication circuit or multiplexed communication circuit.

- Optical interface (1310nm, SM, 30km class)
- Optical interface (1550nm, DSF(Dispersion Shifted Fibre), 80km class) (*)
- Optical interface (820nm, GI, 2km class)
- Electrical interface in accordance with CCITT-G703-1.2.1
- Electrical interface in accordance with CCITT-G703-1.2.2 and 1.2.3
- Electrical interface in accordance with CCITT X.21
- Electrical interface in accordance with RS422, RS530

Note (*): When using the 80km class optical interface, it is necessary to ensure that the received optical power does not exceed −10dB, in order to avoid communication failure due to overloading of the receiver.

When testing in loop-back mode, for instance, the sending terminal should be connected to the receiving terminal via an optical attenuator with 10 dB or more attention.
Even if the sending terminal is directly connected to the receiving terminal, the optical transceiver will not damaged, but communication failures may occur.

- Fibre Coupled Power: −5 to 0dBm
- Input Power Range: −34 to −10dBm
- Optical Damage Input Level: 3dBm

Alternative links to the telecommunication circuit are shown in Figure 2.2.13.2 (a) to (c).

www . ElectricalPartManuals . com

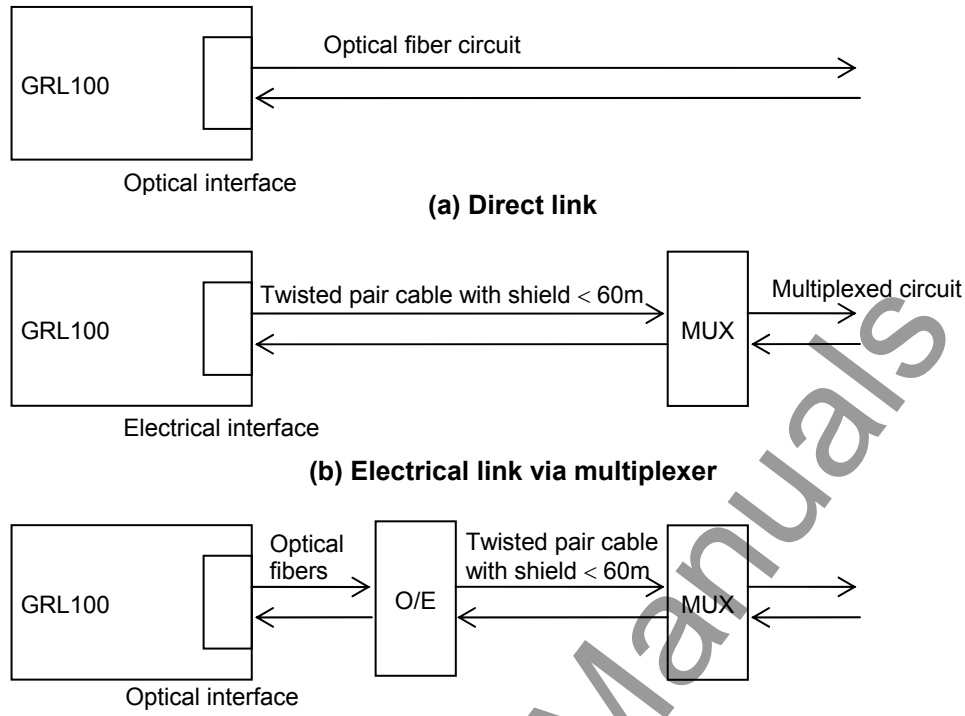



**Figure 2.2.13.2 Link to Communication Circuit**

### Direct link

When connected to single-mode (SM) 10/125μm type of dedicated optical fiber communication circuits and using Duplex LC type connector for 30km class, the optical transmitter is an LD with output power of more than –13dBm and the optical receiver is a PIN diode with a sensitivity of less than –30dBm. For 80km class, the optical transmitter is an LD with output power of more than –5dBm and the optical receiver is a PIN diode with a sensitivity of less than –34dBm.

When connected to graded-index (GI) multi-mode 50/125μm type or 62.5/125μm type of dedicated optical fiber telecommunication circuit and using an ST type connector, the optical transmitter is an LED with output power of more than –19dBm or –16dBm and the optical receiver is a PIN diode with a sensitivity of less than –24dBm.

For details, refer to Appendix K.

### Link via multiplexer

The GRL100 can be linked to a multiplexed communication circuit with an electrical or optical interface. The electrical interface supports CCITT G703-1.2.1, G703-1.2.2 and 1.2.3, X.21(RS530) or RS422. Twisted pair cable with shield (<60m) is used for connecting the relay and multiplexer.

In the optical interface, optical fibers of graded-index multi-mode 50/125μm or 62.5/125μm type are used and an optical to electrical converter is provided at the end of the multiplexer. The electrical interface between the converter and the multiplexer supports CCITT G703-1.2.1, G703-1.2.2 and 1.2.3, X.21(RS530) or RS422.

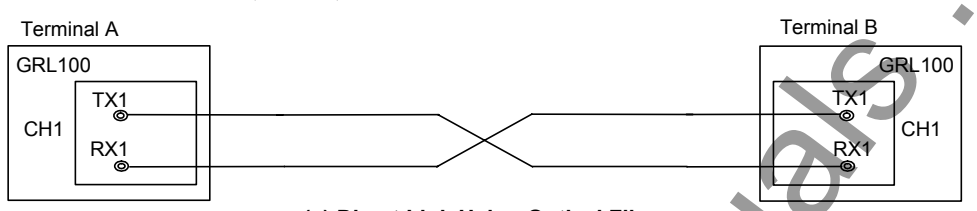
A D-sub connector (DB-25) or an ST connector is used for electrical linking and optical linking, respectively.

www.ElectricalPartManuals.com

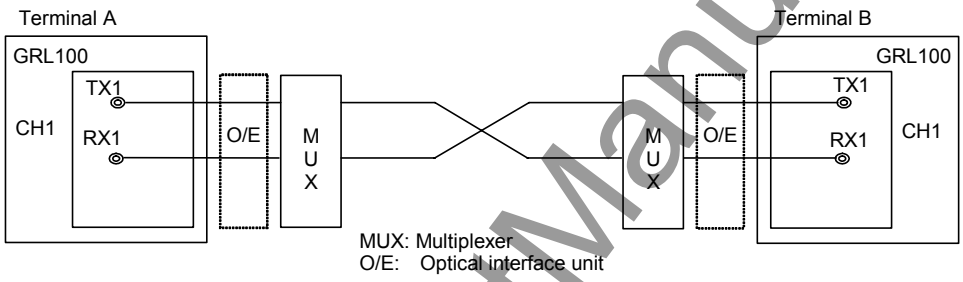
### 2.2.13.3 Setup of Communication Circuit

The GRL100 is provided with one set of transmit and receive signal terminals for two-terminal application models and two sets of signal terminals for three-terminal application models.

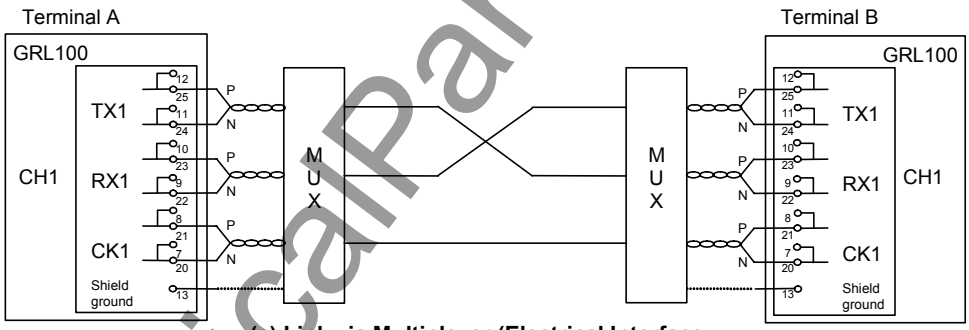
In case of two-terminal applications, the communication circuit is set as shown in Figure 2.2.13.3. In the figure, TX and RX are the transmit and receive signal terminals. CK is the receive terminal for the multiplexer clock signal and is used when the interface supports CCITT G703-1.2.2, 1.2.3 and X.21(RS530).



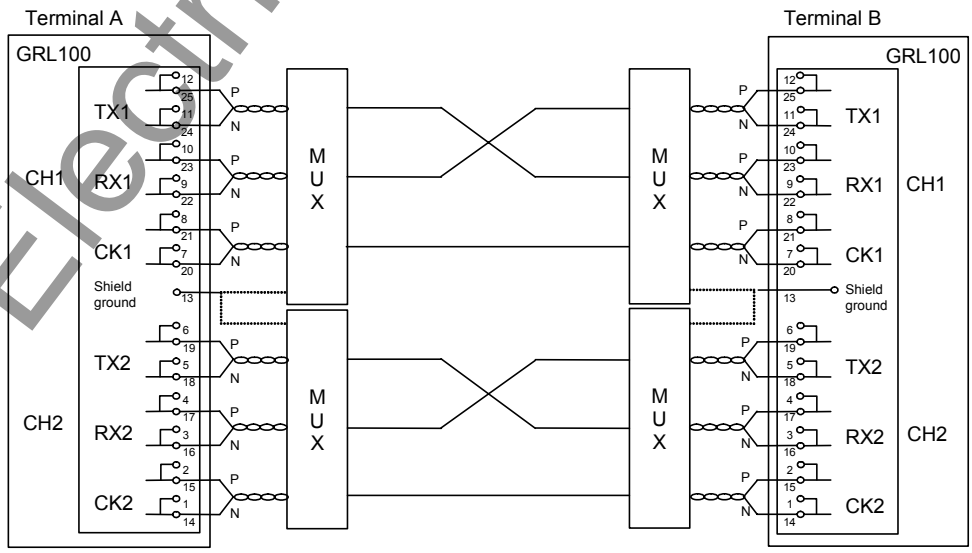

**(a) Direct Link Using Optical Fiber**




**(b) Link via Multiplexer (Optical Interface)**



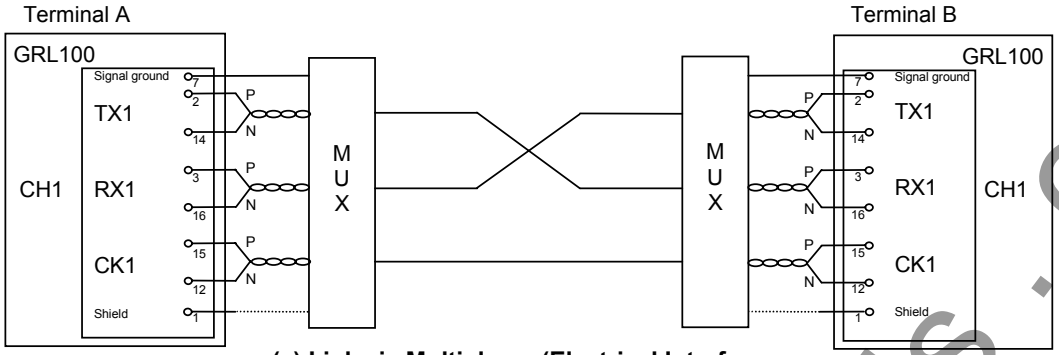

**(c) Link via Multiplexer (Electrical Interface in accordance with CCITT-G703)**



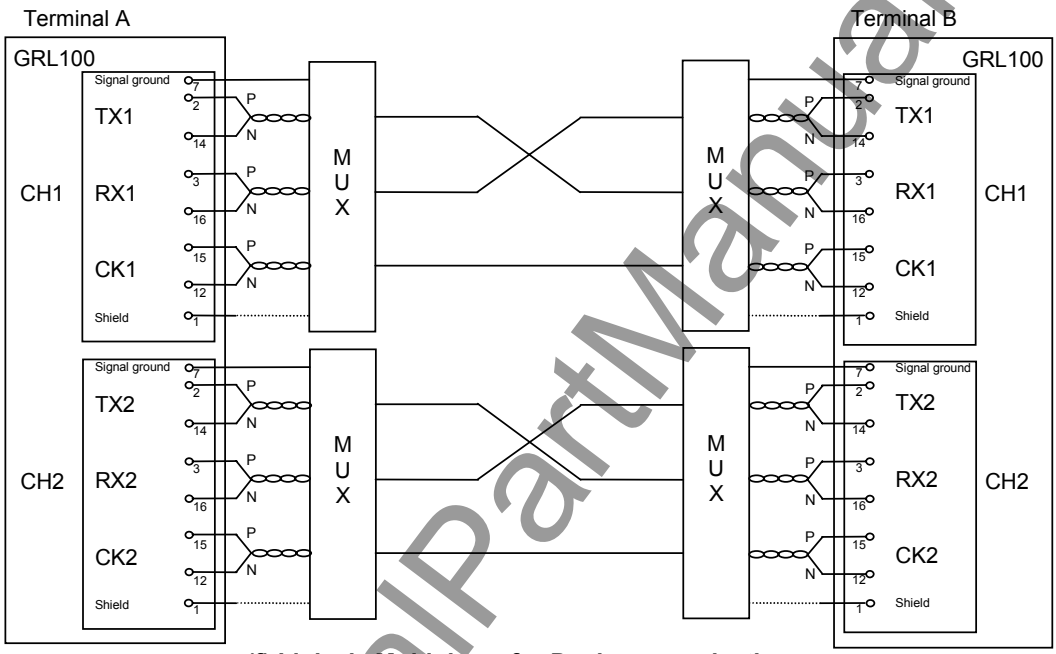

**(d) Link via Multiplexer for Dual communication (Electrical Interface in accordance with CCITT-G703)**

**Figure 2.2.13.3 Communication Circuit Setup in Two-terminal Application**

www . ElectricalPartManuals . com




**(e) Link via Multiplexer (Electrical Interface in accordance with X.21, RS530)**




**(f) Link via Multiplexer for Dual communication (Electrical Interface in accordance with X.21, RS530)**

**Figure 2.2.13.3 Communication Circuit Setup in Two-terminal Application (continued)**

In case of three-terminal applications, signal terminals CH1-TX1, -RX1 and -CK1 which have the same function as CH2-TX2, -RX2 and -CK2 are added.

Figure 2.2.13.4 shows the communication circuit arrangement for three-terminal applications. Note that the CH1 signal terminals TX1, RX1 and CK1 of one terminal are interlinked with the CH2 signal terminals TX2, RX2 and CK2 of another terminal and that the scheme switch [TERM] is set to "3-TERM". If the same channel is interlinked between both terminals such as the CH1 signal terminals of one terminal are interlinked with the CH1 signal terminals of another terminal, the scheme switch setting [CH. CON] should be set to “Exchange”.

The three-terminal line application models can be applied to a two-terminal line. In this case, same channel’s TX, RX and CK of both terminals are interlinked and scheme switch [TERM] is set to "2-TERM".

The three-terminal models also have dual communication mode as shown in Figure 2.2.13.5.

www.ElectricalPartManuals.com

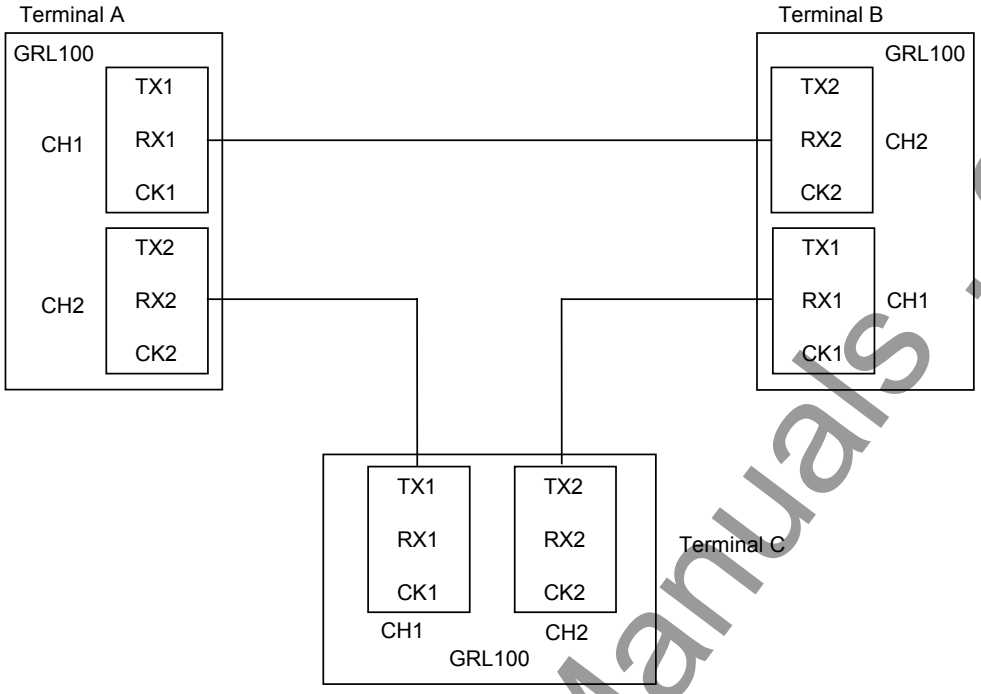



**Figure 2.2.13.4 Communication Circuit Setup for Three-terminal Applications**

**Note**: The corresponding channels are connected to each other.

**Figure 2.2.13.5 Dual Communication Mode**

### 2.2.13.4 Telecommunication Channel Monitoring

If a failure occurs or noise causes a disturbance in the telecommunication channel, this may interrupt the data transmission or generate erroneous data, thus causing the relay to operate incorrectly.

The GRL100 detects data failures by performing a cyclic redundancy check and a fixed bit check on the data. The checks are carried out for every sample.

If the failure lasts for ten seconds, a communication failure alarm is issued.

The output blocking ceases instantly when the failure recovers.

www.ElectricalPartManuals.com

### 2.2.14 Setting

The following shows the setting elements necessary for the current differential protection and their setting ranges. The settings can be made on the LCD screen or PC screen.

| Element | Range | Step | Default | Remarks | Communication Mode | | |
|---|---|---|---|---|---|---|---|
| | | | | | A | B | GPS |
| DIF | | | | Phase current | | | |
| DIFI1 | 0.50 – 10.00A | 0.01A | 5.00A | Small current region | x | x | x |
| | (0.10 – 2.00A | 0.01A | 1.00A)(*1) | | | | |
| DIFI2 | 3.0 – 120.0A | 0.1A | 15.0A | Large current region | x | x | x |
| | (0.6 – 24.0A | 0.1A | 3.0A) | | | | |
| DIFG | | | | Residual current | | | |
| DIFGI | 0.25 – 5.00A | 0.01A | 2.50A | | x | x | x |
| | (0.05 – 1.00A | 0.01A | 0.50A) | | | | |
| DIFIC | 0.00 – 5.00A | 0.01A | 0.00 A | Charging current compensation | x | x | x |
| | (0.00 – 1.00A | 0.01A | 0.00 A) | | | | |
| Vn | 100 - 120V | 1V | 110V | Rated line voltage | x | x | x |
| TDIFG | 0.00 – 10.00s | 0.01s | 0.50s | Delayed tripping timer | x | x | x |
| DIFSV | 0.25 – 10.00A | 0.01A | 0.50A | Differential current (Id) monitoring | x | x | x |
| | (0.05 – 2.00A | 0.01A | 0.10A) | | | | |
| TIDSV | 0 – 60s | 1s | 10s | Timer for Id detection | x | x | x |
| OCCHK (*4) | 0.5 – 5.0A | 0.1A | 0.5A | Minimum current for phase difference check | -- | -- | x |
| | (0.10 – 1.00A | 0.01A | 0.10A) | | | | |
| HYSθ (*4) | 1 – 5 deg | 1 deg | 1 deg | Phase difference check margin | -- | -- | x |
| TDSV | 100 - 16000 | 1μs | 6000μs | Transmission delay time threshold setting for alarm (*7) | x | x | x |
| TCDT1 | –10000 – 10000 | 1μs | 0μs | Transmission delay time difference setting for channel 1 (*6) | x | x | x |
| TCDT2 | –10000 – 10000 | 1μs | 0μs | Transmission delay time difference setting for channel 2 (*6) | x | x | x |
| PDTD | 200 - 2000μs | 1μs | 1000μs | Transmission delay time difference between send and receive channels (GPS synchronization only) | -- | -- | x |
| RYID | 0-63 | | 0 | Local relay address | -- | x | x |
| RYID1 | 0-63 | | 0 | Remote 1 relay address | -- | x | x |
| RYID2 | 0-63 | | 0 | Remote 2 relay address | -- | x | x |
| [DIFG] | ON/OFF | | ON | High impedance earth fault protection | x | x | x |
| [STUB] | ON/OFF | | ON | Measure for stub fault | x | x | x |
| [RDIF] | ON/OFF | | ON | Remote differential protection | -- | x | x |
| [OTD] | ON/OFF | | OFF | Open terminal detection | x | x | x |
| [DIF-FS] | OFF/OC/OCD/Both | | OFF | Fail-safe function | x | x | x |
| [DIFG-FS] | ON/OFF | | OFF | Fail-safe function | x | x | x |
| [COMMODE] | A / B / GPS | | B | Communication mode | A | B | GPS |
| [TERM] | 2TERM/3TERM /Dual (*2) | | 3TERM | For three-terminal application models | x | x | x |

www.ElectricalPartManuals.com

| Element | Range | Step | Default | Remarks | Communication Mode | | |
|---|---|---|---|---|---|---|---|
| | | | | | A | B | GPS |
| [SP.SYN] | Master/Slave | | Master(*3) | Sampling synchronization | x | x | x |
| [CH. CON] | Normal/Exchange | | Normal | Telecommunication port exchanger | x | x | x |
| [T.SFT1] | ON/OFF | | OFF | Channel 1 bit shifting for multiplexer | x | x | x |
| [T.SFT2] | ON/OFF | | OFF | Channel 2 bit shifting for multiplexer | x | x | x |
| [B.SYN1] | ON/OFF | | ON | Channel 1 bit synchronising for multiplexer | x | x | x |
| [B.SYN2] | ON/OFF | | ON | Channel 2 bit synchronising for multiplexer | x | x | x |
| [LSSV] | ON/OFF | | OFF | Disconnector contacts discrepancy check | x | x | x |
| [GPSBAK] | OFF/ON | | ON | Backup synchronization | -- | -- | x |
| [AUTO2B](*6) | OFF/ON | | OFF | Automatic mode change | -- | -- | x |
| [SRCθ](*5) | Disable / I | | I | Sampling timing deviation monitoring with current | -- | -- | x |
| [IDSV] | OFF/ALM&BLK/ALM | | OFF | Id monitoring | x | x | x |
| [RYIDSV] | OFF/ON | | ON | Relay address monitoring | -- | x | x |

(*1) Current values shown in parentheses are in the case of 1A rating. Other current values are in the case of 5A rating.
(*2) This setting is valid for three-terminal application models of the GRL100.
(*3) In the actual setting, one terminal is set to "Master" and other terminal(s) to "Slave".
(*4) OCCHK, [SRCθ] and HYSθ are enabled by setting the [TERM] to "2TERM".
(*5) [AUTO2B] is enabled by setting the [TERM] to "2TERM" and [SRCθ] to "I".
(*6) This setting is only used when there is a fixed difference between the sending and receiving transmission delay time. When the delay times are equal, the default setting of 0μs must be used.
(*7) If the channel delay time of CH1 or CH2 exceeds the TDSV setting, then the alarm "Td1 over" or "Td2 over" is given respectively.

### CT Ratio matching

When the CT ratio is different between the local terminal and the remote terminal(s), the CT ratio matching can be done as follows:

The differential element settings are respectively set to the setting values so that the primary fault detecting current is the same value at all terminals. Figure 2.2.14.1 shows an example of CT ratio matching. The settings for DIFI2, DIFGI, DIFSV and DIFIC should also be set with relation to the primary current in the same manner of the DIFI1 setting.

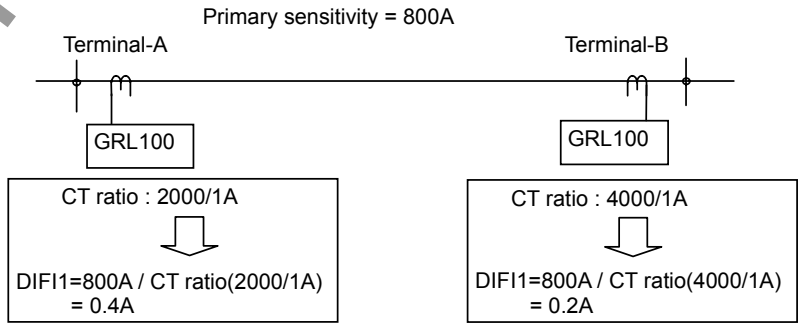



**Figure 2.2.14.1 Example of CT Ratio Matching**

www . ElectricalPartManuals . com

If the CT secondary ratings at the local and remote terminals are different, relay model suitable for the CT secondary rating is used at each terminal and then CT ratio matching can be applied the same as above. The differential element settings are respectively set to the setting values so that the primary fault detecting current is the same value at all terminals. Figure 2.2.14.2 shows an example of CT ratio matching. The settings for DIFI2, DIFGI, DIFSV and DIFC should also be set with relation to the primary current in the same manner of the DIFI1 setting.

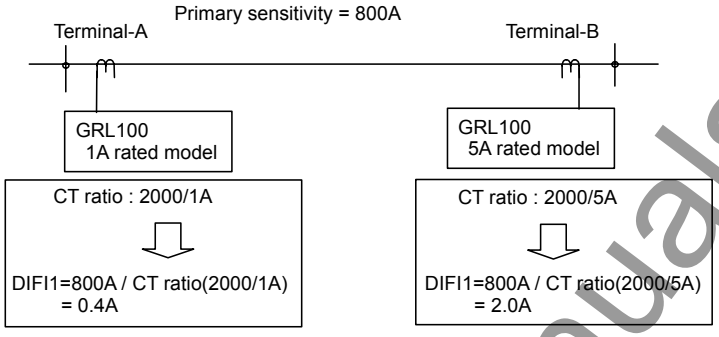



**Figure 2.2.14.2 Example of CT Ratio Matching incase of Different CT secondary Rating**

### Setting of DIFI1

The setting of DIFI1 is determined from the minimum internal fault current to operate and the maximum erroneous differential current (mainly the internal charging current) during normal service condition not to operate.

DIFI1 should therefore be set to satisfy the following equation:

$$K \cdot Ic < DIFI1 < I_f / K$$

where,

K: Setting margin (K = 1.2 to 1.5)

Ic: Internal charging current

$I_f$: Minimum internal fault current

For the GRL100 provided with the charging current compensation, the condition related to the charging current can be neglected.

The setting value of DIFI1 must be identical at all terminals. If the terminals have different CT ratios, then the settings for DIFI1 must be selected such that the primary settings are identical.

### Setting of DIFI2

The setting of DIFI2 is determined from the following two factors:

- Maximum erroneous current generated by CT saturation in case of an external fault
- Maximum load current
- Maximum outflow current in case of an internal fault

In the first factor, the DIFI2 should be set as small as possible so that unwanted operation is not caused by the maximum erroneous current generated by CT saturation on the primary side by a through current at an external fault. It is recommended normally to set DIFI2 to 2×In (In: secondary rated current) for this factor.

In the second factor, the DIFI2 should be set large enough such that it does not encroach on load current.

The third factor must be considered only when the GRL100 is applied to three-terminal

www.ElectricalPartManuals.com

double-circuit lines, lines with outer loop circuit, or double-circuit lines with one-and-a-half busbar system. DIFI2 should be set larger than the possible largest value of outflow current in case of an internal fault.

As the occurrence of current outflow depends on the power system configuration or operation, it is necessary to check whether it is possible for the fault current to flow out of the line. If so, the factor must be taken into consideration when making the setting.

In other applications, only the first and second factors need be considered.

#### Setting of DIFGI

The setting of DIFGI is determined from the high-impedance earth fault current.

The setting value of DIFGI must be identical at all terminals. If the terminals have different CT ratios, then the settings for DIFGI must be selected such that the primary settings are identical.

#### Setting of DIFSV

When using the differential current monitoring function, the setting of DIFSV is determined from the maximum erroneous differential current during normal service condition.

$$K \cdot Ierr < DIFSV < DIFI1 / (1.5 \text{ to } 2)$$

Ierr: maximum erroneous differential current

For the GRL100 provided with the charging current compensation, the condition related to the charging current can be neglected.

The setting value of DIFSV must be identical at all terminals. If the terminals have different CT ratios, then the settings for DIFSV must be selected such that the primary settings are identical.

#### Setting of DIFIC

The internal charging current under the rated power system voltage is set for DIFIC. The charging current is measured by energizing the protected line from one terminal and opening the other terminal.

If the measured power system voltage differs from the rated one, the measured charging current must be corrected.

The setting value of DIFIC must be identical at all terminals. If the terminals have different CT ratios, then the settings for DIFIC must be selected such that the primary settings are identical.

#### Setting of OCCHK

This setting is available for [COMMODE]='GPS-MODE' setting. The OCCHK must be set larger than any of the following three values, taking the errors due to charging current and measurement inaccuracy into consideration. If the differential current setting in the small current region DIFI1 differs between terminals due to different CT ratios, the larger DIFI1 is applied.

- 14 × charging current (A)
- 0.5 × DIFI1 setting (A)
- 0.5A (or 0.1A in case of 1A rating)

#### Setting of PDTD, [COMMODE], [GPSBAK], [AUTO2B], [TERM], [SRC θ] and [RYIDSV]

The setting of these items must be identical at all terminals.

COMMODE: generally set to 'B-MODE' which is standard operating mode. Set to 'A-MODE' if the opposite terminal relay is an old version of GRL100, that is GRL100-***A, -***N or -***Y. If the relay is applied to the GPS-based synchronization, set to



www.ElectricalPartManuals.com

'GPS-MODE'. The 'GPS-MODE' is only available for the relay provided with a GPS interface.

PDTD, GPSBAK, AUTO2B, SRCθ : Available for [COMMODE]='GPS-MODE' setting. See Section 2.2.7.

**Note**: Do not set [TERM] to "Dual" in GPS-mode.

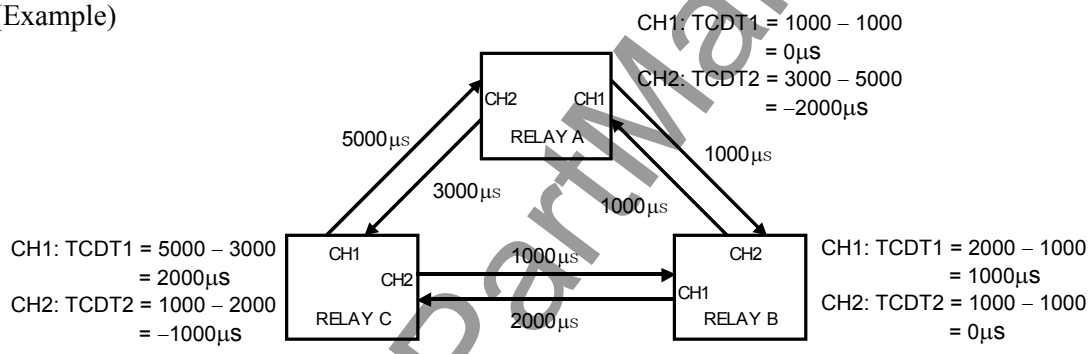
#### Setting of TDSV, TCDT1 and TCDT2

The TDSV is a transmission delay time threshold setting. GRL100 gives an alarm if the transmission delay time exceeds TDSV. The alarm messages are 'Td1 over' for CH1 and 'Td2 over' for CH2.

The TCDT1 and TCDT2 are transmission time delay difference settings for CH1 and CH2 respectively. If there is a permanent and constant difference of more than 100μs between the send and receive channel delay times, then the TCDT setting is used to compensate for that difference. The setting is calculated as follows:

TCDT = (Sending delay time) – (Receiving delay time)

(Example)




#### Setting of [SP.SYN]

One of terminals must be set to MASTER and others SLAVE.

If not, the synchronized sampling fails under the intra-system synchronized sampling or backup modes of the GPS-based synchronized sampling.

**Note**: As the simultaneous setting change at all terminals is not practical, it is not recommended to change the settings when the relay is in service.

#### Setting of [CH.CON]

In case of the two-terminal line application, the communication ports of the GRL100 are interlinked with port CH1 as shown in Figure 2.2.14.3(a) and (b). In case of three-terminal application, port CH1 of one terminal and port CH2 of the other terminal are linked as shown in Figure 2.2.14.3(c).

In these normal linkages, the communication port exchange switch [CH.CON] is set to "Normal".

#### Setting of [T.SFT1], [T.SFT2], [B.SYN1], and [B.SYN2]

T.SFT1: is used to synchronise the relay with multiplexer by shifting the send signal by a half-bit when the distance from the relay to the multiplexer is long. When electrical interface X.21, CCITT G.703-1.2.2 or -1.2.3 is applied and the distance (cable length from relay to multiplexer) is 300m or more, the setting is set to 'ON'. (for channel 1)

T.SFT2: same as above. (for channel 2)

www.ElectricalPartManuals.com

B.SYN1: is set to 'ON' when the relay is linked via multiplexer, and set to 'OFF' when direct link is applied. (for channel 1)
This setting is available for CCITT G703-1.2.1, 1.2.2, 1.2.3, X21 and optical interface (short distance: 2km class). In the case of optical interface 30km and 80km class, this setting is neglected.

B.SYN2: same as above. (for channel 2)

**Setting of RYID, RYID1 and RYID2**

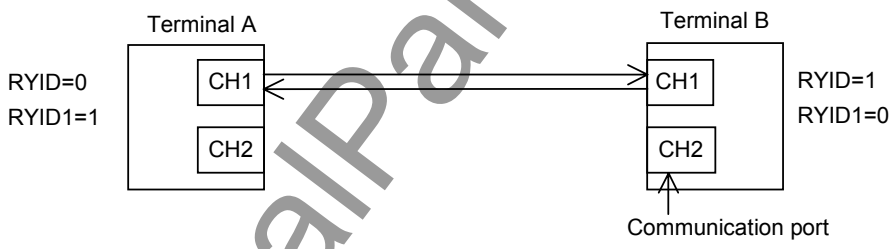
Relay address number RYID must take a different number at each terminal.

If the relay address monitoring switch [RYIDSV] is "OFF", their settings are ignored. The RYID2 setting is enabled by setting the [TERM] to "3TERM" or "Dual".

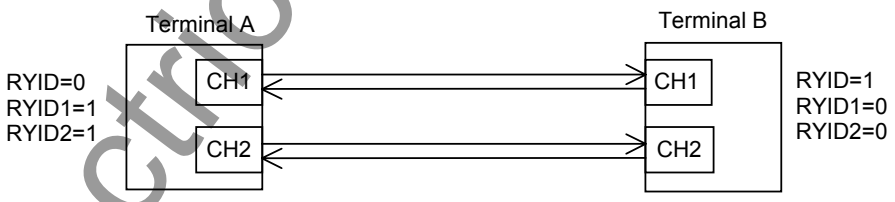
Two-terminal application: Set the local relay address number to RYID and the remote relay address number to RYID1. The RYID1 is equal to the RYID of the remote relay. See Figure 2.2.14.3.
In "Dual" setting, the RYID2 setting must be the same as the RYID1 setting.

Three-terminal application: Set the local relay address number to RYID and the remote relay 1 address number to RYID1 and the remote relay 2 address number to RYID2. The RYID1 is equal to the RYID of the remote 1 relay and the RYID2 equal to the RYID of the remote 2 relay. See Figure 2.2.14.3.

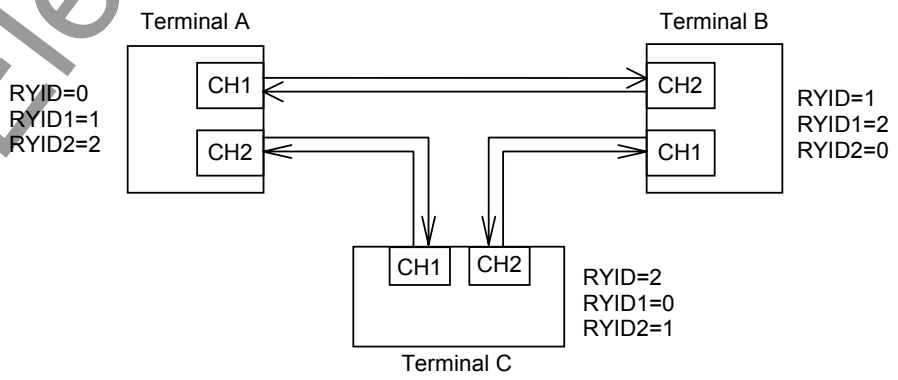
Note: The remote 1 relay is connected by CH1 and the remote 2 relay connected by CH2




**(a) Two-terminal Application**




**(b) Two-terminal Application (Dual)**




**(c) Three-terminal Application**

**Figure 2.2.14.3 Communication Link in Three-terminal Line**

www . ElectricalPartManuals . com

### Setting depending on communication mode

The setting depending on communication mode is shown in the following table.

| Setting | | A-MODE | B-MODE | GPS-MODE | Default setting | Remarks |
|---|---|---|---|---|---|---|
| Communication mode | COMMODE | Must select "A" of A/B/GPS | Must select "B" of A/B/GPS | Must select "GPS" of A/B/GPS | B | |
| GPS backup mode | GPSBAK | -- | -- | On/Off | On | |
| MODE2B shifted automatically | AUTO2B | -- | -- | On/Off | Off | |
| Phase difference check | SRCθ | -- | -- | Disable/I | I | Available for only 2TERM setting |
| Terminal application | TERM | 2TERM/3TERM/ DUAL | 2TERM/3TERM/ DUAL | 2TERM/3TERM | 2TERM | For 3 terminal application model |
| Relay address monitoring | RYIDSV | -- | On/Off | On/Off | On | |
| Multi-phase autoreclosing | Autoreclose mode | MPAR2/MPAR3 | MPAR2/MPAR3 | MPAR2/MPAR3 | SPAR&TPAR | RYIDSV=Off is required |
| Open terminal detection | OTD | On/Off | On/Off | On/Off | Off | |
| Zero-phase current differential | DIFG | On/Off | On/Off | On/Off | On | |
| Out-of-step tripping | OST | Trip/BO/Off | Trip/BO/Off | Trip/BO/Off | Off | |
| Fault locator | FL | On/Off | On/Off | On/Off | On | |
| Remote differential trip | RDIF | -- | On/Off | On/Off | On | Available for 3TERM application |

--: don't care.

### Terminal application

In A-MODE and B-MODE, anyone of 2TERM, 3TERM or DUAL can be selected. In GPS-MODE, however, DUAL cannot be selected.

### Multi-phase autoreclosing

To apply the multi-phase autoreclosing with MPAR2 or MPAR3, the relay address monitoring RYIDSV in B-MODE and GPS-MODE must be set to "OFF". When the RYIDSV=OFF, CBLS (CBDS) condition is sent.

If shared with the relay address monitoring, the bits for CBLS condition can be assigned instead of the bits for DIFG or OST/FL by PLC function when DIFG or OST/FL is not used.

### Automatic open terminal detection OTD

In B-MODE and GPS-MODE, the RYIDSV=OFF setting for relay address monitoring is required to use the open terminal detection function (OTD=On).

If shared with the relay address monitoring, the following methods can be applied:

(1) Only one bit with open terminal condition instead of CBLS condition can be sent by sub-communication bit.

(2) If DIFG or OST/FL is not used, the bits for CBLS condition can be assigned instead of the bits for DIFG or OST/FL by PLC function.

The open terminal detection in B-MODE and GPS-MODE do not automatically change

www.ElectricalPartManuals.com

"Master" or Slave" in SP.SYN. If the master terminal becomes out-of-service, therefore, the synchronization control of slave terminal follows that of the master terminal by ON/OFF at the master terminal and the current differential protection is blocked.

When putting a terminal into out-of-service in three-terminal operation, the following setting change method is recommended:

**(Example)**

When putting Terminal C into out-of-service to two-terminal operation, the following four setting are changed.

SP.SYN:

If the terminal C has been "Master", change the terminal A or B to "Master". If the terminal A or C has been "Master", do not change the setting.

TERM:

Change both the terminal A and B to "2TERM".

CH.CON:

It is defined that CH1 of both terminal relays is connected each other in two-terminal application and CH1 of local relay is connected to CH2 of remote relay in three-terminal application as shown in Figure 2.2.14.3. Therefore, the communication cable connection must be changed from CH2 to CH1.

[CH.CON] is to change CH1 or CH2 signal with CH2 or CH1 signal in the relay inside. If the [CH.CON] is set to "Exchange", CH2 data is dealt with as CH1 data or in reverse. In Figure 2.2.14.3, change the terminal B to "Exchange". However, note that the display or output such as a communication failure, etc. is expressed as CH1 because CH2 data is dealt with as CH1 data at the terminal B.

RYID1:

The remote terminal 1 seen from terminal B changes from terminal C to terminal A. Therefore, change the remote terminal 1 relay address setting RYID1 from "2" to "0" at terminal B.

If the relay address monitoring switch [RYIDSV] is "OFF", the setting is invalid and setting change is not required.

**Remote differential trip RDIF**

This function is not available for the A-MODE setting.

When this function is used, set [RDIF] and [TERM] are set to "ON" and "3-TERM" and the following must be configured by the PLC function.

Assign the remote DIF trip send signals RDIF-∗-S to user configurable data, and the receiving data from remote terminals to the trip command signals RDIF-∗-R1 and RDIF-∗-R2.

www . ElectricalPartManuals . com

## 2.3 Distance Protection

### 2.3.1 Time-Stepped Distance Protection

#### 2.3.1.1 Application

Using reach and tripping time settings coordinated with adjacent lines, the GRL100 provides three steps of distance protection for forward faults and one backup protection for reverse faults. These are used as the main protection when telecommunications are not available, or as backup protection for the protected line and adjacent lines.

The GRL100 has four distance measuring zones for both phase and earth faults, three zones for forward faults and one zone for reverse faults respectively. The zones can be defined with either mho-based characteristic or quadrilateral characteristic. The characteristic is selected by setting the scheme switch [ZS-C] for phase fault and [ZG-C] for earth fault to "Mho" or "Quad".

Figure 2.3.1.1 shows the mho-based characteristics. Zone 1 (Z1) and Zone 2 (Z2) have a complex characteristic combining the reactance element, mho element and blinder element, while Zone 3 (Z3), reverse Zone R (ZR) and reverse Zone 4 (Z4) elements have a complex characteristic combining the mho element and blinder element.

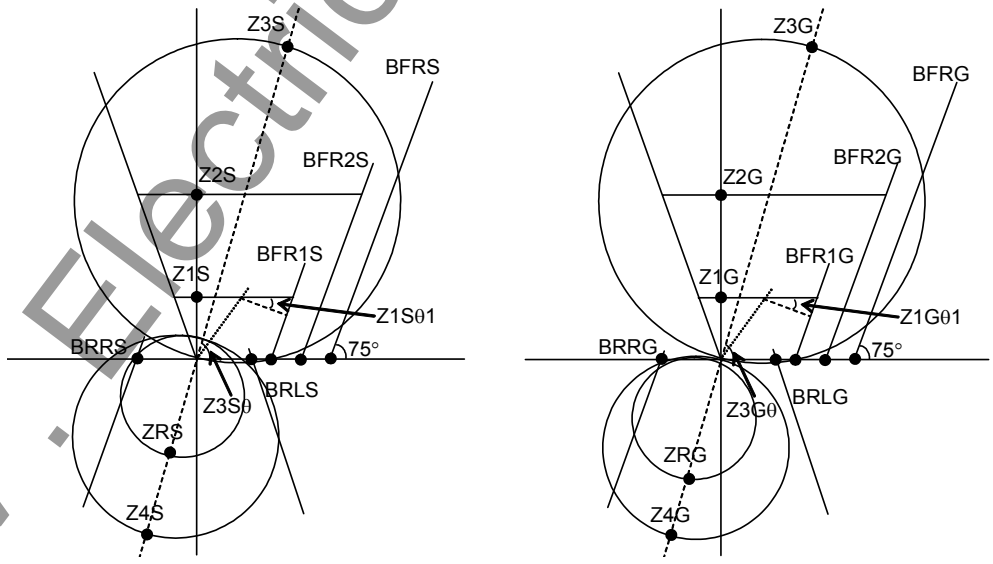
The blinder element (BFR) can be provided for each forward zone. The setting of blinder element can be set independently or set common to forward zones by the scheme switch [BLZONE]. Figures 2.3.1.1 and 2.3.1.2 show the characteristics with an independent setting.

Since the Z4 is used for detection of reverse faults in command protection, the Z4 for phase faults has an offset characteristic with an offset mho element which assures detection of close-up phase faults. The operation of Z4 for phase faults in the event of internal faults is inhibited by the operations of Z2 and Z3.

Figure 2.3.1.2 shows the quadrilateral characteristics. These have a complex characteristic combining the reactance element, directional element and blinder element.

The Z4 for phase faults has an offset characteristic with an offset directional element which assures detection of close-up phase faults.

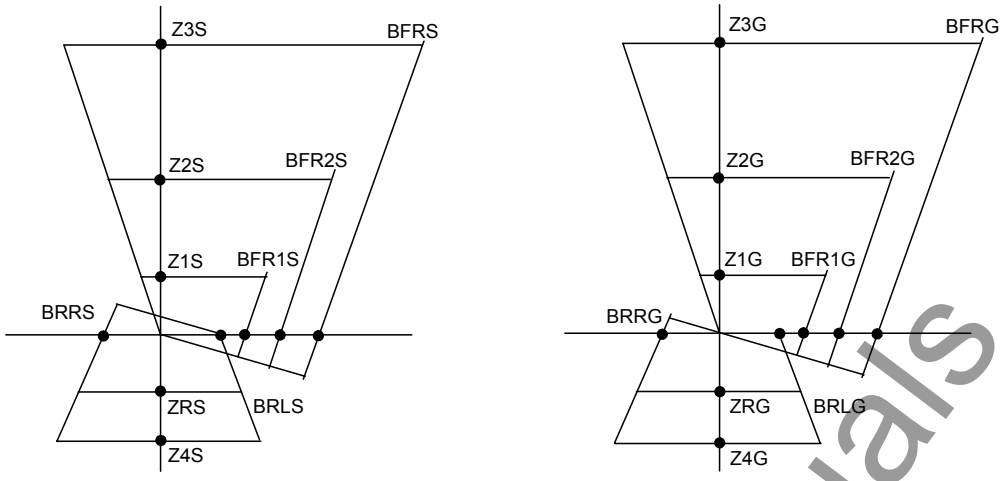
The operation is the same as the mho-based characteristics.




**(a) Phase fault element** **(b) Earth fault element**

**Figure 2.3.1.1 Mho-based Characteristics**

www.ElectricalPartManuals.com




**(a) Phase fault element** **(b) Earth fault element**

**Figure 2.3.1.2 Quadrilateral Characteristics**

Figure 2.3.1.3 shows typical time-distance characteristics of the time-stepped distance protection provided at terminal A.

Zone 1 is set to cover about 80% of the protected line. When GRL100 is used as the main protection, zone 1 generally provides instantaneous tripping but if used as a backup protection, time delayed tripping can be provided. With the GRL100, 6 types of zone 1 tripping modes can be set using the trip mode setting switch [Z1CNT].

Zone 2 is set to cover about 120% or more of the protected line, providing protection for the rest of the protected line not covered by zone 1 and backup protection of the remote end busbar. In order to coordinate the fault clearance time by the main protection, with the zone 1 protection of the adjacent lines or by the remote end busbar protection, zone 2 carries out time delayed tripping. Zone 2 trip can be disabled by the scheme switch [Z2TP].

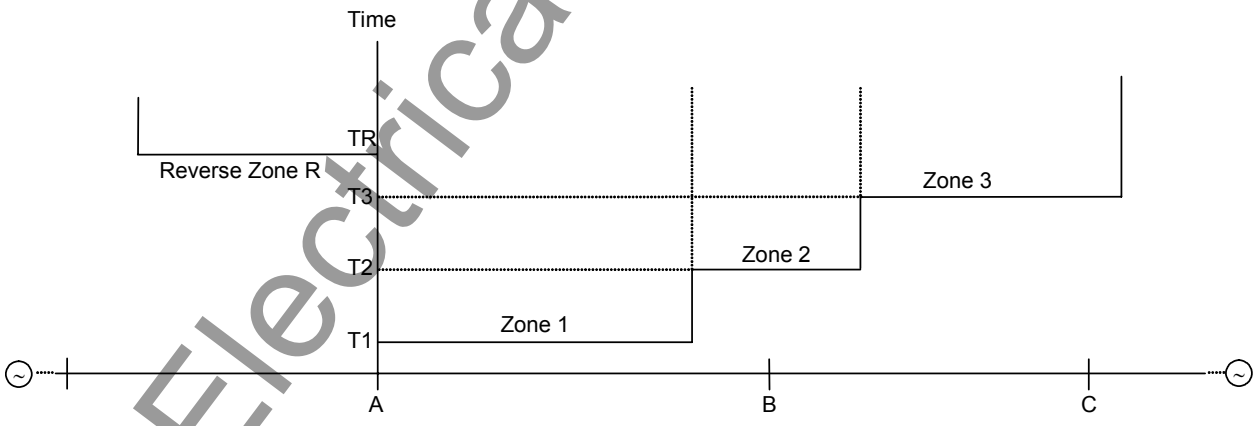



**Figure 2.3.1.3 Time/Distance Characteristics of Time-Stepped Distance Protection**

Zone 3 is mainly provided for remote backup protection of adjacent lines. Its reach is set to at least 1.2 times the sum of the impedance of the protected line and the longest adjacent line. The zone 3 time delay is set so that it coordinates with the fault clearance time provided by zone 2 of adjacent lines.

The reverse looking zone R element is used for time delayed local backup protection for busbar faults and transformer faults. Furthermore, when applied to multi-terminal lines, it is effective as the backup protection for adjacent lines behind the relaying point instead of the zone 3 protection

www.ElectricalPartManuals.com

at the remote terminal. This is because it is difficult for zone 3 at terminals A and C to provide remote backup protection for the fault shown in Figure 2.3.1.4 due to fault infeed from the other terminal, whereas reverse looking zone R of terminal B is not affected by this. Zone R trip can be disabled by the scheme switch [ZRTP].

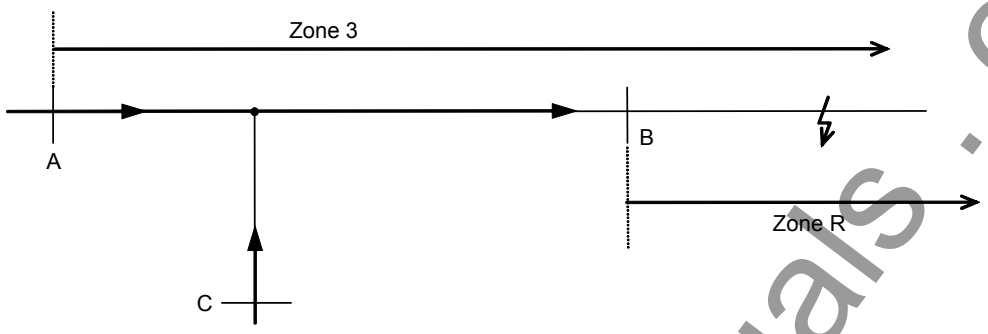



**Figure 2.3.1.4 Reverse Zone Protection**

To maintain stable operation for close-up three-phase faults which cause the voltages of all phases to drop to 0 or close to 0, zone 1 for phase faults, once operated, changes its element to a reverse offset element. This continues until the fault is cleared, and thus it is effective for time delayed protection.

The reactance element characteristics of zone 1 and zone 2 are parallel lines to the R axis and provide sufficient coverage for high-resistance faults. The reactance element characteristics of zone 1 can be transformed to a broken line depending on the load flow direction in order to avoid overreaching by the influence of load current. The characteristic in the resistive direction is limited by the mho characteristic of zone 3. The reactive reach setting is independent for each zone. It is also possible to have independent settings for each individual phase fault and earth fault elements.

With a long-distance line or heavily loaded line, it is possible for the load impedance to encroach on the operation zone of the mho element. Blinders are provided to limit the operation of the mho element in the load impedance area.

Zero-sequence current compensation is applied to zone 1 and zone 2 for earth fault protection. This compensates measuring errors caused by the earth return of zero-sequence current. This allows the faulted phase reactance element to precisely measure the positive-sequence impedance up to the fault point. Furthermore, in the case of double-circuit lines, zero-sequence current from the parallel line is introduced to compensate for influences from zero-sequence mutual coupling. Considering the case where the impedance angle of positive-sequence impedance and zero-sequence impedance differ which is the most common in cable circuits, GRL100 carries out vectorial zero-sequence current compensation.

The autoreclose schemes are utilised with instantaneous zone 1 tripping. When single-phase autoreclose or single- and three-phase autoreclose are selected, zone 1 executes single-phase tripping for a single-phase earth fault. In order to achieve reliable fault phase selection even for faults on heavily loaded long-distance lines or irrespective of variations in power source conditions behind the relaying point, an undervoltage element with current compensation is used as a phase selector. Other zones only execute three-phase tripping, and do not initiate autoreclose.

### 2.3.1.2 Scheme Logic

Figure 2.3.1.5 shows the scheme logic for the time-stepped distance protection. For zone 1 tripping, as described later, it is possible to select instantaneous tripping or time delayed tripping using the scheme switch [Z1CNT] in the trip mode control logic. (Detail of the [Z1CNT] is described after.) Zone 2, zone 3 and zone R give time delayed tripping. However, these zones can trip instantaneously by PLC signals Z∗_INST_TP. Timers TZ2, TZ3 and TZR with time delayed tripping can be set for earth faults and phase faults separately. Zone 1, zone 2, zone 3 and zone R

www.ElectricalPartManuals.com

tripping can be disabled by the scheme switches [Z1CNT] and [Z∗TP].

**Note:** For the symbols used in the scheme logic, see Appendix L.

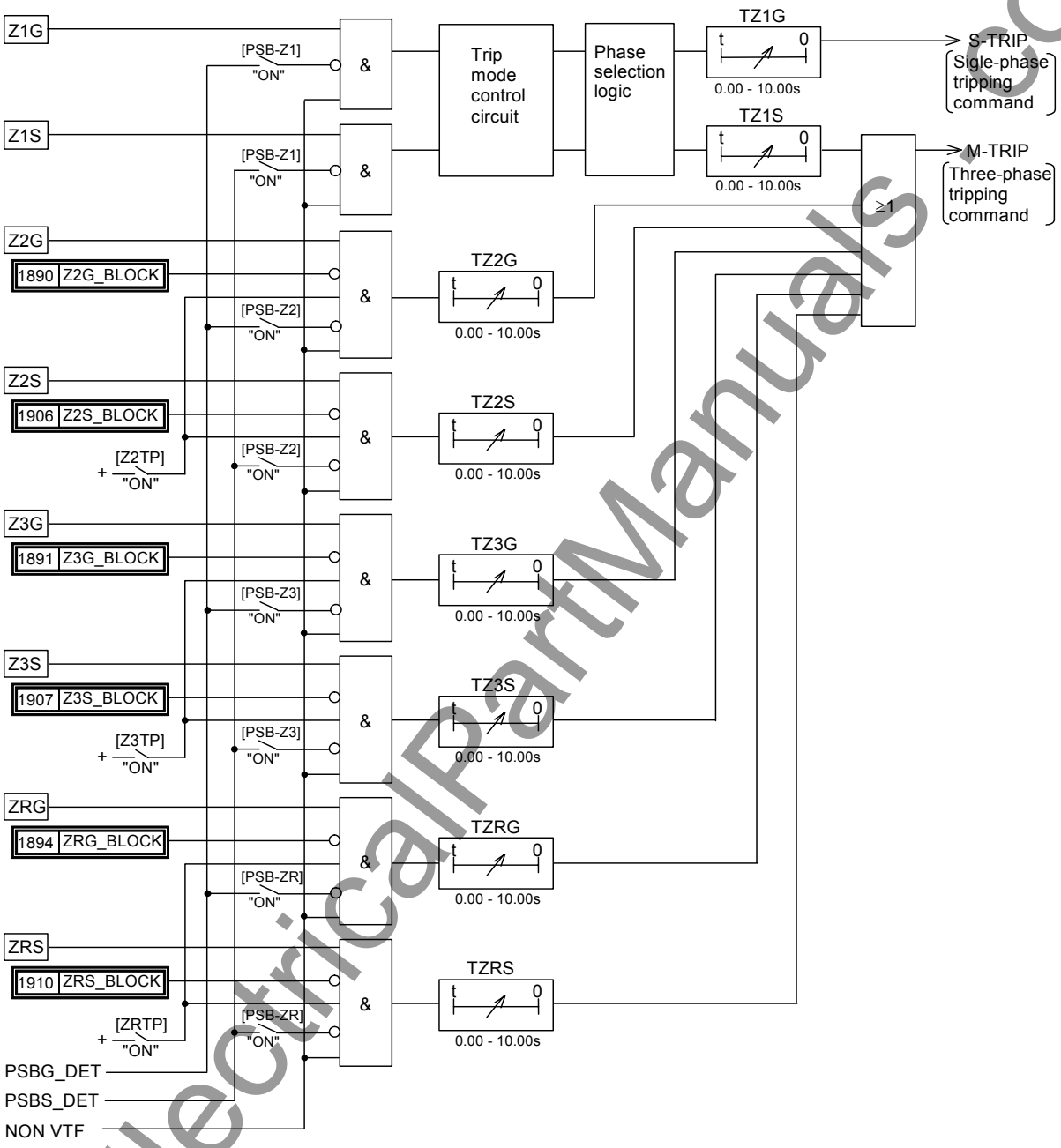



**Figure 2.3.1.5 Scheme Logic of Time-stepped Distance Protection**

Tripping by each zone can be blocked the PLC signal Z**_BLOCK. The tripping can be also blocked in the event of a failure of the secondary circuit of the voltage transformer or power swing. The former is detected by the VT failure detection function. The signal VTF becomes 1 when a failure is detected. The latter is detected by the power swing blocking function. The signal PSB becomes 1 when power swing is detected. The zone in which tripping will be blocked during a power swing can be set using the selection switches [PSB-Z1] to [PSB-ZR]. For the VTF and PSB, see Section 2.3.3 and Section 3.3.5, respectively.

By using the trip mode control logic, Zone 1 can implement different trip modes. The trip modes as shown in Table 2.3.1.1 can be selected according to the position of the scheme switch [Z1CNT] and whether or not the differential protection is in or out of service.

www.ElectricalPartManuals.com

**Table 2.3.1.1 Zone 1 Trip Mode Control**

| Z1CNT Position | CURRENT DIFFERENTIAL PROTECTION USE OR NOT | |
|---|---|---|
| | USE | NO USE (*) |
| 1 | SINGLE-PHASE TRIP & AUTO-REC | SINGLE-PHASE INST. TRIP & AUTO-REC |
| 2 | THREE-PHASE TRIP | SINGLE-PHASE INST. TRIP & AUTO-REC |
| 3 | THREE-PHASE TRIP | THREE-PHASE INST. TRIP |
| 4 | SINGLE-PHASE TRIP & AUTO-REC | |
| 5 | THREE-PHASE TRIP | |
| 6 | Z1 TRIP BLOCK | |

(*): during a communication failure or when the [DIF] setting is "No use".

The zone 1 tripping mode at each position of the switch [Z1CNT] is as follows:

Position 1: When the current differential protection is in service, zone 1 executes time tripping with a time delay using timer TZ1 and starts autoreclose. Zone 1 performs single-phase tripping and reclosing or three-phase tripping and reclosing depending on the reclose mode of the autoreclose function and the type of faults (single-phase faults or multi-phase faults). If the autoreclose is out of service, zone 1 performs three-phase final tripping for all faults.

When the current differential protection is out of service, zone 1 executes performs instantaneous single-phase tripping and reclosing or three-phase tripping and reclosing depending on the reclose mode of the autoreclose function and the type of faults (single-phase faults or multi-phase faults). If the autoreclose is out of service, zone 1 performs instantaneous three-phase final tripping for all faults.

Position 2: When the current differential protection is in service, zone 1 performs three-phase tripping with a time delay using timer TZ1 and does not start autoreclose. The zone 1 performs instantaneous single-phase tripping and reclosing or three-phase tripping and reclosing depending on the reclose mode of the autoreclose function and the type of faults (single-phase faults or multi-phase faults), if the current differential protection is out of service. If the autoreclose is out of service, zone 1 performs three-phase final tripping for all faults.

Position 3: When the current differential protection is in service, zone 1 performs three-phase tripping with a time delay using timer TZ1 and does not start autoreclose. The zone 1 performs three-phase tripping instantaneously and does not start autoreclose if the current differential protection is out of service.

Position 4: Though the current differential protection is in service or out of service, zone 1 executes time tripping with a time delay using timer TZ1 and starts autoreclose. Zone 1 performs single-phase tripping and reclosing or three-phase tripping and reclosing depending on the reclose mode of the autoreclose function and the type of faults (single-phase faults or multi-phase faults). If the autoreclose is out of service, zone 1 performs three-phase final tripping for all faults.

Position 5: Though the current differential protection is in service or out of service, zone 1 performs three-phase tripping with a time delay using timer TZ1 and does not start autoreclose.

Position 6: Zone 1 tripping is blocked though the current differential protection is in service or out of service.

Zone 1 Trip Mode Control is performed using PLC default function as shown in Figure 2.3.1.6. By changing the PLC default setting, the Z1 trip can be controlled independently of the [Z1CNT] setting.

www.ElectricalPartManuals.com

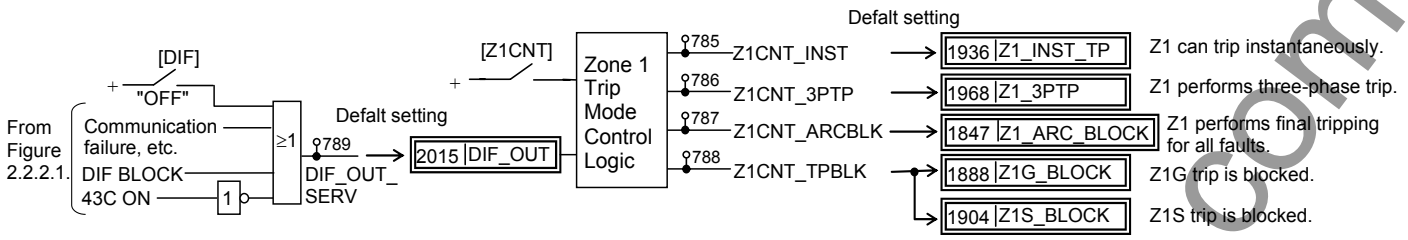



**Figure 2.3.1.6 Zone 1 Trip Mode Control Circuit**

If the distance protection is active only when communication failure in the GRL100, it is achieved by the PLC function. See Appendix S.

Zone 1 tripping is provided with an additional phase selection element UVC and phase selection logic to make sure the faulted phase is selected for the single-phase earth fault.

Figure 2.3.1.7 gives details of the phase selection logic in Figure 2.3.1.5. In case of single-phase earth fault, the earth fault measuring zone 1 element Z1G with a certain phase and the phase selection element UVC with the same phase operate together, and a single-phase tripping command S-TRIP can be output to the phase.

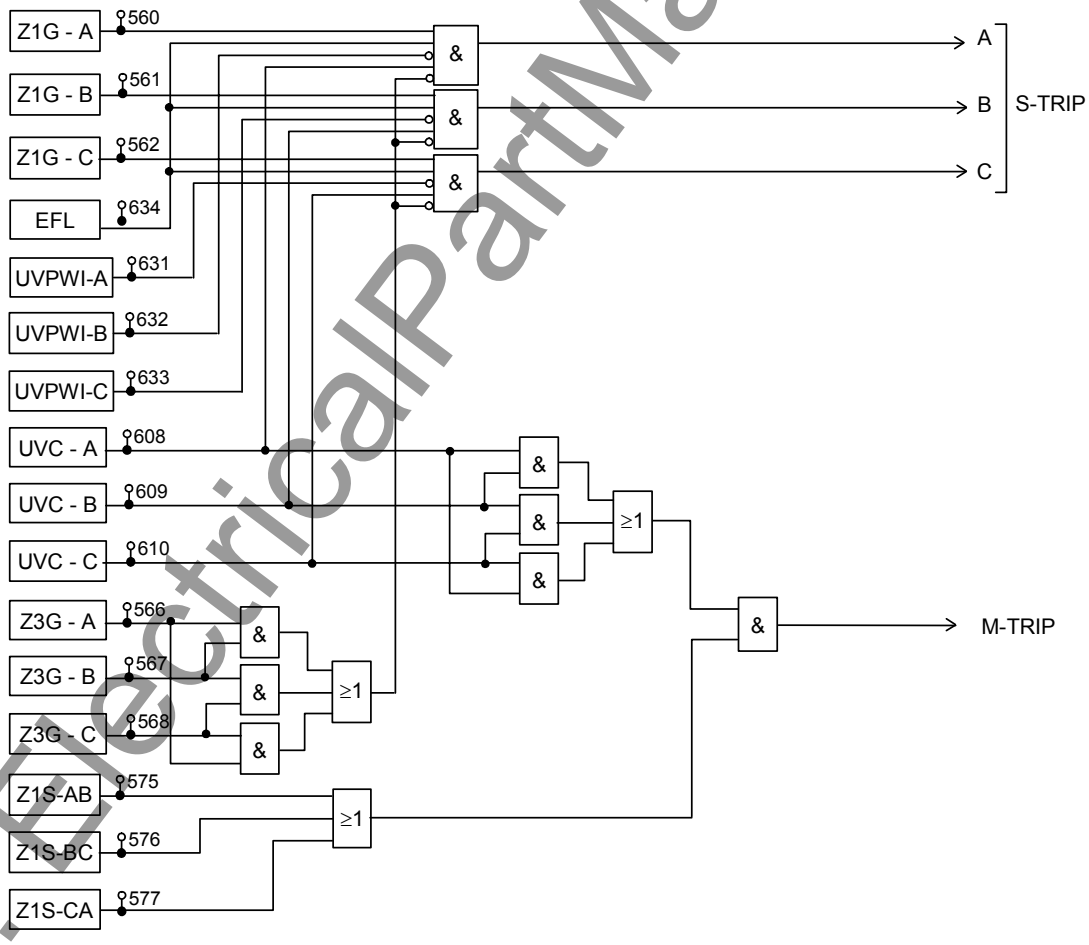



**Figure 2.3.1.7 Phase Selection Logic for Zone 1 Protection**

Depending on the setting of the scheme switch [Z1CNT] or [ARC-M] which selects reclosing mode, single-phase tripping may be converted to a three-phase tripping command. This is not shown in the figure.

In case of multi-phase fault, the phase fault measuring zone 1 element Z1S and the two phases of the UVC operate together, the Z1G trip is blocked and the three-phase tripping command M-TRIP

www.ElectricalPartManuals.com

is always output. The condition for the UVC two-phase operation is to inhibit the Z1S from overreaching in the event of a single-phase earth fault.

The UVC element is applied to the zone 1 distance elements.

EFL is an earth fault detection element, and UVPWI is a phase undervoltage relay to provide countermeasures for overreaching of a leading-phase distance element at positive phase weak infeed condition. These elements are applied to all earth fault distance elements. (Refer to Appendix A.) The UVPWI can be disabled by the scheme switch [UVPWIEN].

#### 2.3.1.3 Setting

The following shows the necessary distance protection elements and their setting ranges.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| Phase fault protection | | | | |
| ZS-C | Mho - Quad | | Mho | Characteristic selection |
| Z1S | 0.01 - 50.00Ω | 0.01Ω | 1.60Ω | Z1 reach |
| | (0.10 - 250.00Ω | 0.01Ω | 8.00Ω) (*1) | |
| Z1S θ1 | 0° - 45° | 1° | 0° | Gradient of reactance element |
| Z1S θ2 | 45° - 90° | 1° | 90° | |
| BFR1S | 0.10 - 20.00Ω | 0.01Ω | 5.10Ω | Forward right blinder reach for Z1 |
| | (0.5 - 100.0Ω | 0.1Ω | 25.5Ω) | |
| Z2S | 0.01 - 50.00Ω | 0.01Ω | 3.00Ω | Z2 reach |
| | (0.10 - 250.00Ω | 0.01Ω | 15.00Ω) | |
| BFR2S | 0.10 - 20.00Ω | 0.01Ω | 5.10Ω | Forward right blinder reach for Z2 |
| | (0.5 - 100.0Ω | 0.1Ω | 25.5Ω) | |
| Z3S | 0.01 - 50.00Ω | 0.01Ω | 6.00Ω | Z3 reach |
| | (0.1 – 250.0Ω | 0.1Ω | 30.0Ω) | |
| Z3S θ(*2) | 45 - 90° | 1° | 85° | Characteristic angle of mho element |
| ZBS θ(*3) | 0 - 45° | 1° | 5° | Angle of directional element |
| BFRS | 0.10 - 20.00Ω | 0.01Ω | 5.10Ω | Forward right blinder reach for Z3 |
| | (0.5 - 100.0Ω | 0.1Ω | 25.5Ω) | |
| BFLS θ | 90° - 135° | 1° | 120° | Forward left blinder angle |
| ZRS | 0.01 - 50.00Ω | 0.01Ω | 4.00Ω | ZR reach |
| | (0.1 – 250.0Ω | 0.1Ω | 20.0Ω) | |
| Z4S | 0.01 - 50.00Ω | 0.01Ω | 8.00Ω | Z4 reach |
| | (0.1 – 250.0Ω | 0.1Ω | 40.0Ω) | |
| BRRS | 0.10 - 20.00Ω | 0.01Ω | 5.10Ω | Reverse right blinder reach |
| | (0.5 - 100.0Ω | 0.1Ω | 25.5Ω) | |
| TZ1S | 0.00 - 10.00 s | 0.01 s | 0.00 s | Zone 1 timer |
| TZ2S | 0.00 - 10.00 s | 0.01 s | 0.30 s | Zone 2 timer |
| TZ3S | 0.00 - 10.00 s | 0.01 s | 0.40 s | Zone 3 timer |
| TZRS | 0.00 - 10.00 s | 0.01 s | 0.60 s | Zone R timer |
| | | | | |
| Earth fault protection | | | | |
| ZG-C | Mho - Quad | | Mho | Characteristic selection |
| Z1G | 0.01 - 50.00Ω | 0.01Ω | 1.60Ω | Z1 reach |
| | (0.10 - 250.00Ω | 0.01Ω | 8.00Ω) | |
| Z1G θ1 | 0° - 45° | 1° | 0° | Gradient of reactance element |
| Z1G θ2 | 45° - 90° | 1° | 90° | |
| BFR1G | 0.10 - 20.00Ω | 0.01Ω | 5.10Ω | Forward right blinder reach for Z1 |
| | (0.5 - 100.0Ω | 0.1Ω | 25.5Ω) | |

www.ElectricalPartManuals.com

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| Z2G | 0.01 - 50.00Ω | 0.01Ω | 4.00Ω | Z2 reach |
| | (0.10 - 250.00Ω | 0.01Ω | 20.00Ω) | |
| BFR2G | 0.10 - 20.00Ω | 0.01Ω | 5.10Ω | Forward right blinder reach for Z2 |
| | (0.5 - 100.0Ω | 0.1Ω | 25.5Ω) | |
| Z3G | 0.01 - 100.00Ω | 0.01Ω | 8.00Ω | Z3 reach |
| | (0.1 – 500.0Ω | 0.1Ω | 40.0Ω) | |
| Z3G θ(*2) | 45 - 90° | 1° | 85° | Characteristic angle of mho element |
| ZBGθ(*3) | 0° - 45° | 1° | 30° | Angle of directional element |
| BFRG | 0.10 - 20.00Ω | 0.01Ω | 5.10Ω | Forward right blinder reach for Z3 |
| | (0.5 - 100.0Ω | 0.1Ω | 25.5Ω) | |
| BFLG θ | 90° - 135° | 1° | 120° | Forward left blinder angle |
| ZRG | 0.01 - 100.00Ω | 0.01Ω | 4.00Ω | ZR reach |
| | (0.1 – 500.0Ω | 0.1Ω | 20.0Ω) | |
| Z4G | 0.01 - 100.00Ω | 0.01Ω | 8.00Ω | Z4 reach |
| | (0.1 – 500.0Ω | 0.1Ω | 40.0Ω) | |
| BRRG | 0.10 - 20.00Ω | 0.01Ω | 5.10Ω | Reverse right blinder reach |
| | (0.5 - 100.0Ω | 0.1Ω | 25.5Ω) | |
| Krs | 0 - 1000 % | 1% | 340% | Residual current compensation = R0/R1 |
| Kxs | 0 - 1000 % | 1% | 340% | Residual current compensation = X0/X1 |
| Krm | 0 - 1000 % | 1% | 300% | Mutual coupling compensation = ROM/R1 |
| Kxm | 0 - 1000 % | 1% | 300% | Mutual coupling compensation = XOM/X1 |
| KrsR | 0 - 1000 % | 1% | 100% | Residual current compensation for ZR = R0/R1 |
| KxsR | 0 - 1000 % | 1% | 100% | Residual current compensation for ZR = X0/X1 |
| TZ1G | 0.00 - 10.00 s | 0.01 s | 0.00 s | Zone 1 timer |
| TZ2G | 0.00 - 10.00 s | 0.01 s | 0.30 s | Zone 2 timer |
| TZ3G | 0.00 - 10.00 s | 0.01 s | 0.40 s | Zone 3 timer |
| TZRG | 0.00 - 10.00 s | 0.01 s | 0.60 s | Zone R timer |
| UVC | | | | Phase selection element |
| UVCV | 10 - 60 V | 1 V | 48 V | Voltage setting |
| UVCZ | 0.0 - 50.0Ω | 0.1Ω | 2.0Ω | Reach setting |
| | (0 - 250Ω | 1Ω | 10Ω) | |
| UVC θ | 45° - 90° | 1° | 85° | Characteristic angle |
| EFL | 0.5 – 5.0 A | 0.1 A | 1.0 A | Earth fault detection |
| | (0.10 – 1.00 A | 0.01 A | 0.20 A) | |
| UVPWI | 30 V fixed | | | UV for positive weak infeed |
| | | | | |
| Scheme switch | | | | |
| DISCR | OFF/ON | | OFF | Distance carrier protection enable |
| Z1CNT | 1/2/3/4/5/6 | | 2 | Zone 1 trip mode selection |
| BLZONE | COM/IND | | COM | Blinder setting mode |
| PSB - Z1 | OFF/ON | | ON | Z1 power swing blocking |
| PSB - Z2 | OFF/ON | | ON | Z2 power swing blocking |
| PSB - Z3 | OFF/ON | | OFF | Z3 power swing blocking |
| PSB - ZR | OFF/ON | | OFF | ZR power swing blocking |
| Z2TP | OFF/ON | | ON | Z2 trip enable |
| Z3TP | OFF/ON | | ON | Z3 trip enable |
| ZRTP | OFF/ON | | OFF | ZR trip enable |
| UVPWIEN | OFF/ON | | OFF | Countermeasures for overreaching of a leading-phase distance element at positive phase weak infeed condition |

www.ElectricalPartManuals.com

(*1) Ohmic values shown in the parentheses are in the case of 1 A rating. Other ohmic values are in the case of 5 A rating.
(*2) Valid only when mho-based characteristic is selected by ZS-C and ZG-C.
(*3) Valid only when quadrilateral characteristic is selected by ZS-C and ZG-C.

The following elements have fixed setting values or their settings are interlinked with other elements listed above. So no setting operation is required.

| Element | Setting | Remarks |
|---|---|---|
| Z1BS | Fixed to 1.5Ω (Fixed to 7.5Ω)(*1) | Z1 reverse offset reach |
| BFRS θ | Fixed to 75° | Angle of forward right blinder BFRS |
| Z4BS | Fixed to 1.5Ω (Fixed to 7.5Ω) | Z4 offset reach. This is also the offset reach for ZRS. However, in these cases the offset reach is limited by the Z1S setting when ZRS is used for backup tripping. |
| Z4S θ(*2) | Interlinked with Z3S θ | Characteristic angle of zone 4 mho element |
| Z4BS θ(*3) | Interlinked with ZBS θ | Angle of Z4 offset directional element |
| BRRS θ | Fixed to 75° | Angle of reverse right blinder BRRS |
| BRLS | Interlinked with BRRS | Reverse left blinder |
| BRLS θ | Interlinked with BFLS θ | Angle of reverse left blinder BRLS |
| BFRG θ | Fixed to 75° | Angle of forward right blinder BFRG |
| Z4G θ(*2) | Interlinked with Z3G θ | Characteristic angle of Z4 mho element |
| Z4BG θ(*3) | Interlinked with ZBG θ | Angle of offset directional element |
| BRRG θ | Fixed to 75° | Angle of reverse right blinder BRRG |
| BRLG | Interlinked with BRRG | Reverse left blinder |
| BRLG θ | Interlinked with BFLG θ | Angle of reverse left blinder BRLG |

(*1)Ohmic values shown in the parentheses are in the case of 1 A rating. Other ohmic values are in the case of 5 A rating.
(*2) Valid when mho-based characteristic is selected by ZS-C and ZG-C.
(*3) Valid when quadrilateral characteristic is selected by ZS-C and ZG-C.

In order to coordinate with the distance protection provided for adjacent lines, care is required in setting the reach and timer setting. Figure 2.3.1.8 shows an ideal zone and time coordination between terminals.

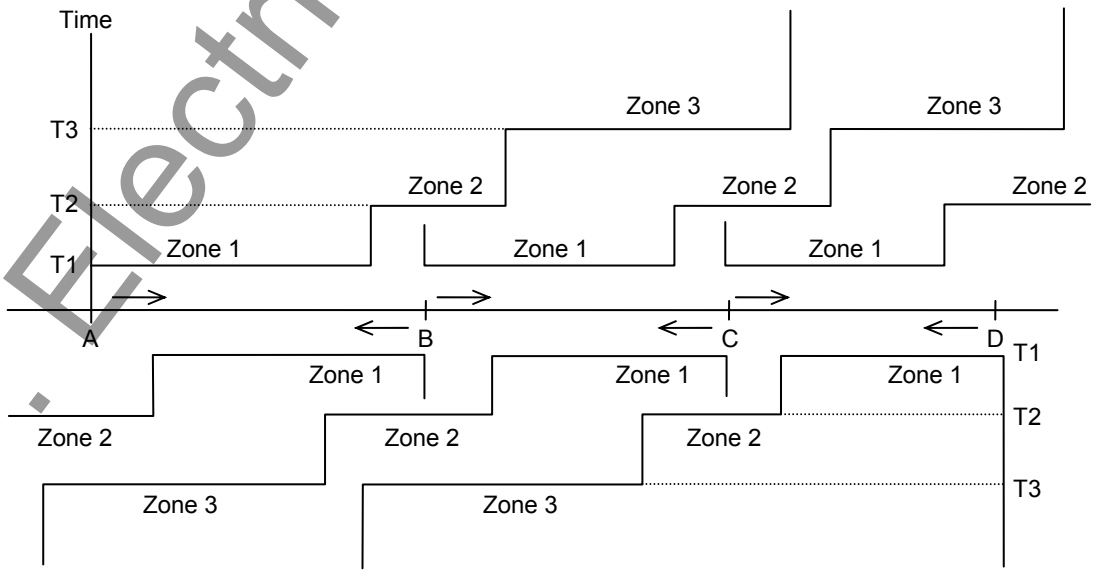



**Figure 2.3.1.8 Typical Zone/Time Coordination among A-D Terminals**

www.ElectricalPartManuals.com

**Zone 1 setting**

Since instantaneous tripping is allowed in zone 1, it is desirable to select a setting that will cover the widest possible range of the protected line. Conversely, zone 1 elements must not respond to faults further than the remote end. Therefore, the setting of the zone 1 reach is set to 80 to 90% of the impedance of the protected line taking account of VT and CT errors and measurement error. The reach is set on the X-axis.

In order to change the reactance element characteristic into a broken line, Z1S(G)θ1 and Z1S(G)θ2 in Figure 2.3.1.1 or Figure 2.3.1.2 must be set.

Time delayed tripping of zone 1 is selected when instantaneous tripping by another main protection is given priority. The time delay TZ1 is set to ensure that coordination is maintained with fault clearance by the main protection. Suppose that the maximum operating time of the main protection is Tp, the opening time of the circuit breaker is Tcb, the minimum operating time of zone 1 element is T1 and the reset time of the zone 1 element is Tzone 1, then TZ1 must satisfy the following condition:

$$TZ1 > Tp + Tcb + Tzone\ 1 - T1$$

**Zone 2 setting**

Zone 2 is required to cover 10 to 20% of the remote end zone not covered by zone 1. To assure this protection, it is set to 120% or greater of the protected line impedance. To maintain the selectivity with zone 1 of the adjacent lines, the zone 2 reach should not exceed the zone 1 reach of the shortest adjacent line. The reach is set on the X-axis.

Time delay TZ2 is set so that it may be coordinated with fault clearance afforded by the main protection of the adjacent lines. If time delayed tripping is selected for zone 1 of the protected line, coordination with the time delay should also be taken into account. Suppose that the main protection operating time on the adjacent lines is Tp', the opening time of the circuit breaker is Tcb', the minimum operating time of zone 2 element is T2 and the reset time of local terminal zone 2 element is Tzone 2, then TZ2 must satisfy the following two conditions:

$$TZ2 > Tp' + Tcb' + Tzone\ 2 - T2$$

$$TZ2 > TZ1$$

If the adjacent lines are too short for zone 2 to coordinate with zone 1 of the adjacent lines in reach setting, it is necessary to set a much greater time delay for zone 2 as shown in Figure 2.3.1.9.

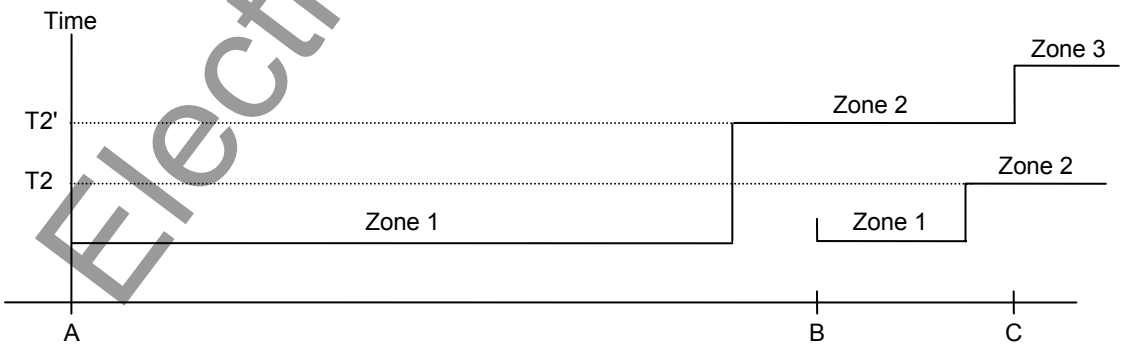



**Figure 2.3.1.9 Zone 2 Setting (When one of the adjacent lines is very short)**

Generally, in setting the zone 2, consideration should be given to ensure selectivity with even the slowest timer of the following protections:

- Remote end busbar protection
- Remote end transformer protection

www.ElectricalPartManuals.com

- Line protection of adjacent lines
- Remote end breaker failure protection

**Zone 3 setting**

Zone 3, in cooperation with zone 2, affords backup protection for faults that have occurred on adjacent lines. The reach should be set to exceed the remote end of the longest adjacent line whenever possible. It is also necessary to take into account the effect of fault infeed at the remote busbars. If an ideal reach setting as shown in Figure 2.3.1.8 is possible, the timer setting for zone 3 needs only to consider the coordination with the timer setting in zone 2 of the protected lines and adjacent lines.

However, as shown in Figure 2.3.1.10, if there are short-distance adjacent lines and it is impossible to establish coordination only by the reach setting, there may also be a case where the time delay for zone 3 will need to be set greater than that of the adjacent lines.

The zone 3 reach is set on the characteristic angle when the mho characteristic is selected or set on the X axis when the quadrilateral characteristic is selected.

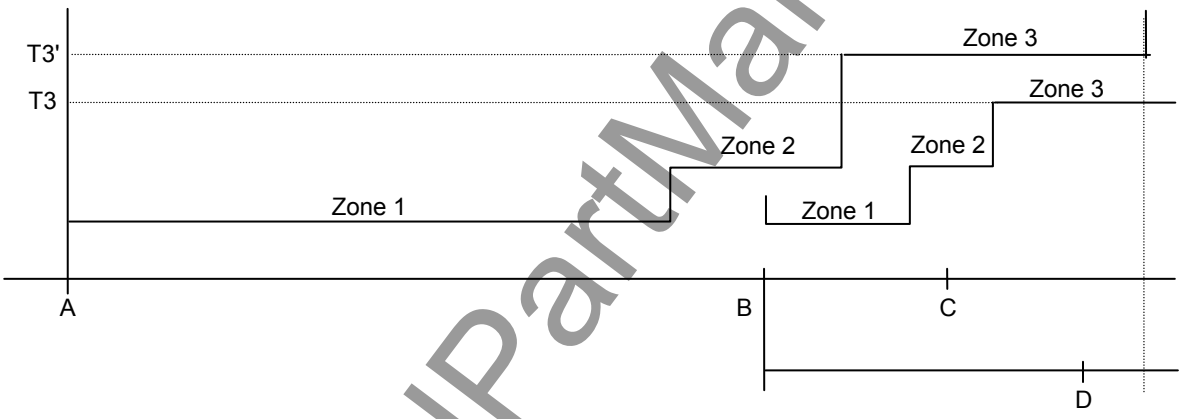



**Figure 2.3.1.10 Zone 3 Setting (When one of the adjacent lines is very short)**

**Zone R setting**

Zone R is used to provide local backup protection equivalent to that of zone 3 of the remote terminal. In such a case, the reach is set so as to exceed the remote end of the longest adjacent line behind the relaying point. The time delay is also set to be equivalent to that of the remote terminal.

the X axis when the quadrilateral characteristic is selected.

**Z4 setting**

Zone 4 is the reverse fault detection for the command protection. The reach setting of zone 4 should be greater than that of zone 2 or zone 3 whichever is used as a forward overreaching element at the remote terminal.

The zone 4 reach is set on the characteristic angle when the mho characteristic is selected or set on the X axis when the quadrilateral characteristic is selected.

**Blinder setting**

BFR and BRR reaches are set to the minimum load impedance with a margin. The minimum load impedance is calculated using the minimum operating voltage and the maximum load current.

The blinder element (BFR) can be provided for each forward zone. The setting of blinder element can be set independently or set common to forward zones by [BLZONE]=IND or [BLZONE]=COM setting. In the [BLZONE]=IND setting, the forward zone blinder setting should be set BFR1∗≤BFR2∗≤BFR∗. If BFR∗≤BFR1∗, for example, the reach of BFR1∗ is

www.ElectricalPartManuals.com

limited to the BFR∗ setting reach as shown in Figure 2.3.1.11(b).

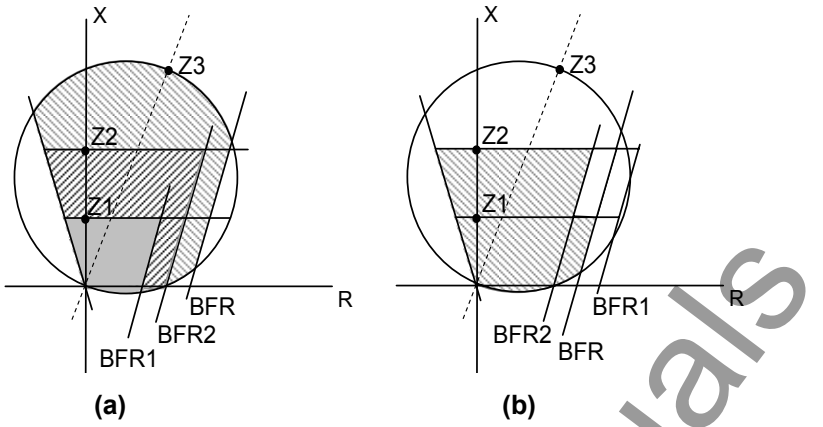



**Figure 2.3.1.11 BFR Reach**

The BFL angle can be set to 90 to 135° and is set to 120° as a default. The BRL angle is linked with the BFL angle.

Figure 2.3.1.12 shows an example of the blinder setting when the minimum load impedance is $Z_{Lmin}$ and $Z'_{Lmin}$ under the load transmitting and receiving conditions.

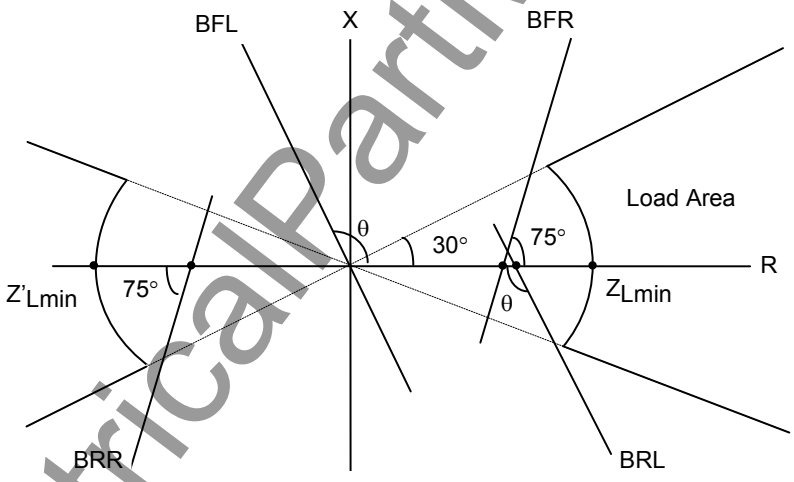



**Figure 2.3.1.12 Blinder Setting**

When Z4 is used for overreaching command protection ie. POP, UOP and BOP, it is necessary when setting BRR to take account of the setting of the remote end BFR to ensure coordination. That is, the BRR is set to a value greater than the set value of the remote end BFR (e.g., 120% of BFR). This ensures that a reverse fault that causes remote end zone 2 or zone 3 to operate is detected in local zone R and false tripping is blocked.

#### Setting of earth fault compensation factor (zero sequence compensation)

In order to correctly measure the positive-sequence impedance to the fault point, the current input to the earth fault measuring elements is compensated by the residual current ($3I_0$) of the protected line in the case of a single circuit line and by residual current ($3I_0$) of the protected line and residual current ($3I_0'$) of the parallel line in the case of a double circuit line.

Generally, the following equation is used to compensate the zero-sequence voltage drop in the case of phase “a”.

www.ElectricalPartManuals.com

$$V_a = (I_a - I_0)Z_1 + I_0 \times Z_0 + I_{om} \times Z_{om} \quad (1)$$

where,

$V_a$: Phase "a" voltage

$I_a$: Phase "a" current

$I_0$: Zero-sequence current of the protected line

$I_{0m}$: Zero-sequence current of the parallel line

$Z_1$: Positive-sequence impedance ($Z_1 = R_1 + jX_1$)

$Z_0$: Zero-sequence impedance ($Z_0 = R_0 + jX_0$)

$Z_{0m}$: Zero-sequence mutual impedance ($Z_{om} = R_{om} + jX_{om}$)

Equation (1) can be written as follows:

$$V_a = (R_1 + jX_1)I_a + \{(R_0 - R_1) + j(X_0 - X_1)\}I_0 + (R_{om} + jX_{om})I_{om}$$

$$= R_1(I_a + \frac{R_0 - R_1}{R_1}I_0 + \frac{R_{om}}{R_1}I_{om}) + jX_1(I_a + \frac{X_0 - X_1}{X_1}I_0 + \frac{X_{om}}{X_1}I_{om})$$

In the GRL100, the voltage is compensated independently for resistance and reactance components as shown in equation (2) in stead of general equation (1).

$$\begin{aligned} V_{aR} + jV_{aX} = \{&R_1( I_{aR} + \frac{\frac{K_{rs}}{100} - 1}{3} \times 3I_{0R} + \frac{\frac{K_{rm}}{100}}{3} \times 3I_{omR} ) \\ &- X_1( I_{aX} + \frac{\frac{K_{xs}}{100} - 1}{3} \times 3I_{0X} + \frac{\frac{K_{xm}}{100}}{3} \times 3I_{omX} )\} \\ &+ j\{R_1( I_{aX} + \frac{\frac{K_{rs}}{100} - 1}{3} \times 3I_{0X} + \frac{\frac{K_{rm}}{100}}{3} \times 3I_{omX} ) \\ &+ X_1( I_{aR} + \frac{\frac{K_{xs}}{100} - 1}{3} \times 3I_{0R} + \frac{\frac{K_{xm}}{100}}{3} \times 3I_{omR} )\} \end{aligned} \quad (2)$$

where,

$K_{xs}$: compensation factor ($K_{xs} = X_0/X_1 \times 100$)

$K_{rs}$: compensation factor ($K_{rs} = R_0/R_1 \times 100$)

$K_{xm}$: compensation factor ($K_{xm} = X_{om}/X_1 \times 100$)

$K_{rm}$: compensation factor ($K_{rm} = R_{om}/R_1 \times 100$)

X: imaginary part of the measured impedance

R: real part of the measured impedance

$V_{aX}$: imaginary part of phase "a" voltage

$V_{aR}$: real part of phase "a" voltage

$I_{aX}$:imaginary part of phase "a" current

$I_{aR}$: real part of phase "a" current

www.ElectricalPartManuals.com

$I_{0X}$: 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 parallel line

$I_{omR}$: real part of zero-sequence current of the parallel line

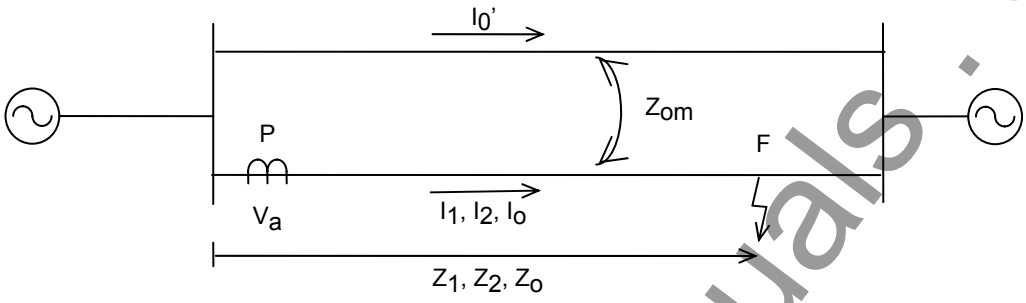



**Figure 2.3.1.13 Earth Fault Compensation**

The zero-sequence compensation factors are applied to the earth fault measuring elements as shown in the table below

| Element | Protected line | Parallel line |
|---|---|---|
| Z1G | Krs, Kxs | Krm, Kxm |
| Z2G | Krs, Kxs | Krm, Kxm |
| Z3G | – | – |
| ZRG | – | – |
| Z4G | – | – |

–: Compensation is not provided.

The zero-sequence compensation of the parallel line is controlled by the ZPCC (Zero-sequence Current Compensation) element.

When an earth fault occurs on the protected line, the ZPCC operates and parallel line compensation is performed to prevent underreach caused by the mutual zero-sequence current of the parallel line.

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

$$3I_0 / 3I_{om} \geq 0.8$$

**Charging current compensation**

When distance protection is applied to underground cables or long-distance overhead lines, the effect of charging current cannot be ignored. It appears as a distance measurement error in the fault.

To suppress the effect of the charging current and maintain the highly accurate distance measurement capability, the distance protection of GRL100 has a charging current compensation function.

The compensation is recommended if the minimum fault current can be less than three times the charging current.

The setting value of ZIC should be the charging current at the rated voltage Vn.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|

www.ElectricalPartManuals.com

| | | | | |
|---|---|---|---|---|
| ZIC | 0.00 - 5.00 A | 0.01 A | 0.0 0 | Charging current setting |
| | ( 0.00 - 1.00 A | 0.01 A | 0.00 A) (*) | |
| Vn | 100 - 120 | 1 V | 110 V | Rated line voltage |

(*) Current values shown in the parentheses are in the case of 1 A rating. Other current values are in the case of 5 A rating.

**Setting of phase selection element**

Phase selection is required only for faults on the protected line. Therefore, impedance reach setting UVCZ is set to 120% of the positive-sequence impedance of the protected line. Impedance angle setting UVC θ is set the same as the protected line angle.

Undervoltage setting UVCV is set higher than the estimated maximum fault voltage at the fault point for a single-phase earth fault.

www . ElectricalPartManuals . com

### 2.3.2 Command Protection

If operational information from the distance relays located at each end of the protected line is exchanged by means of telecommunication, it is possible to accurately determine whether or not the fault is internal or external to the protected line. Each terminal can provide high-speed protection for any fault along the whole length of the protected line. The GRL100 provides the following command (carrier) protection using the distance measuring elements.

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

Each command protection can initiate high-speed autoreclose. These protections perform single-phase or three-phase tripping depending on the setting of the reclosing mode and the fault type.

Each command protection includes the aforementioned time-stepped distance protection as backup protection.

#### 2.3.2.1 Permissive Underreach Protection

**Application**

In permissive underreach protection (PUP), the underreaching zone 1 protection operates and trips the local circuit breakers and at the same time sends a trip permission signal to the remote terminal. The terminal which receives this signal executes instantaneous tripping on condition that the local overreaching element has operated. The overreaching element can be selected as either zone 2 or zone 3.

Since the trip permission signal is sent only when it is sure that the fault exists in the operating zone of zone 1, the PUP provides excellent security. On the other hand, the PUP does not provide sufficient dependability for faults on lines that contain open terminals or weak infeed terminals for which zone 1 cannot operate. Faults near open terminals or weak infeed terminals are removed by delayed tripping of zone 2 elements at remote terminals.

Since only the operating signal of the underreaching element is transmitted, it is not necessary to distinguish a transmit signal from a receive signal. That is, the telecommunication channel can be shared by the terminals and a simplex channel can be used.

**Scheme Logic**

Figure 2.3.2.1 shows the scheme logic of the PUP. Once zone 1 starts to operate, it outputs a single-phase tripping signal S-TRIP or three-phase tripping signal M-TRIP to the local terminal instantaneously and at the same time sends a trip permission signal CS to the remote terminals. When the trip permission signal R1-CR or R2-CR or both is received from the remote terminals, PUP executes instantaneous tripping on condition that either zone 2 or zone 3 has operated. Whether or not zone 2 or zone 3 is used can be selected by the scheme switch [ZONESEL].

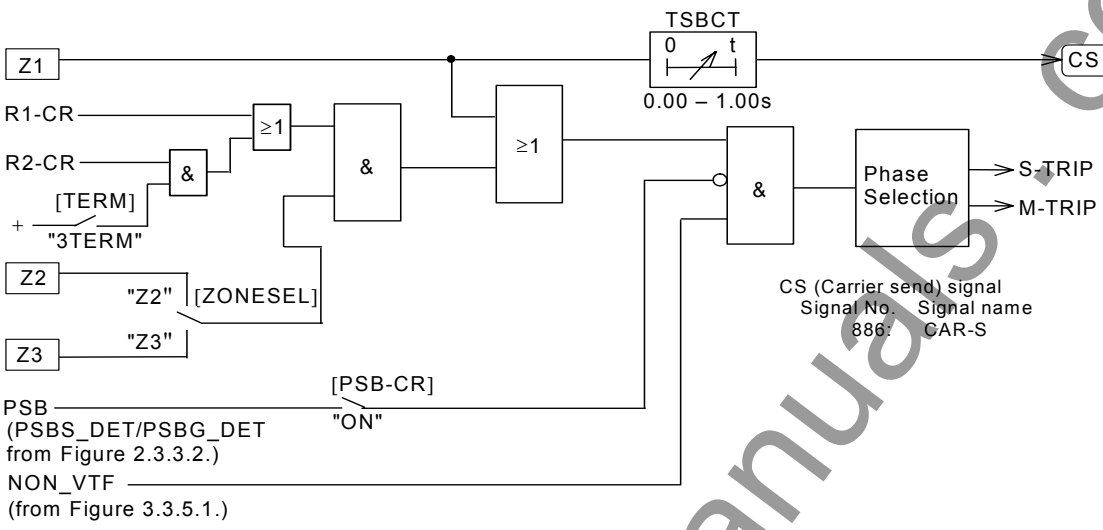
To select the faulted phases reliably, phase selection is performed using the phase selection element UVC. Phase selection logic in zone 1 tripping is shown in Figure 2.3.1.7 and its operation is described in Section 2.3.1. Phase selection logic in command tripping is shown in Figure 2.3.2.9. Refer to Section 2.3.2.7.

Off-delay timer TSBCT is provided for the following purpose:

In many cases, most of the overreaching elements at both ends operate almost simultaneously. However, there may be some cases where they cannot operate simultaneously due to unbalanced distribution of fault currents. Non-operation of the overreaching elements can occur at a terminal

www.ElectricalPartManuals.com

far from the fault, but they can operate if the other terminal trips. Transmission of the trip permission signal continues for the setting time of TSBCT after reset of zone 1, and thus even the terminal for which the overreaching element has delayed-picked up can also trip.




R1-CR: Trip permission signal from the remote terminal 1 in 3 terminal application, or
Trip permission signal from remote terminal in 2 terminal application.

| Signal No. | Signal name | Description |
|---|---|---|
| 1856: | CAR.R1-1 | Trip carrier signal for CH1 |

R2-CR: Trip permission signal from the remote terminal 2 in 3 terminal application.

| Signal No. | Signal name | Description |
|---|---|---|
| 1864: | CAR.R2-1 | Trip carrier signal for CH1 |

**Figure 2.3.2.1 PUP Scheme Logic**

### Setting

The following shows the setting elements necessary for the PUP and their setting ranges. For the settings of Z1, Z2, Z3 and UVC, refer to Section 2.3.1.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| TSBCT | 0.00 – 1.00s | 0.01s | 0.10s | |
| CRSCM | PUP/POP/UOP/BOP | | POP | Carrier protection mode |
| DISCR | OFF/ON | | OFF | Distance carrier protection enable |
| ZONESEL | Z2/Z3 | | Z2 | Overreaching element selection |
| PSB - CR | OFF/ON | | ON | Power swing blocking |

## 2.3.2.2 Permissive Overreach Protection

### Application

In permissive overreach protection (POP), the terminal on which the forward overreaching element operates transmits a trip permission signal to the other terminal. The circuit breaker at the local terminal is tripped on condition that the overreaching element of the local terminal has operated and that a trip permission signal has been received from the remote terminal. That is, POP determines that the fault exists inside the protected line based on the overlapping operation of the forward overreaching elements at both terminals. It is possible to use zone 2 or zone 3, as the forward overreaching element.

The POP is provided with an echo function and weak infeed trip function so that even when the protection is applied to a line with open terminal or weak infeed terminal, it enables fast tripping of both terminals for any fault along the whole length of the protected line. An undervoltage element UVL is provided for weak infeed tripping. (See Section 2.3.2.5 for protection for weak infeed terminal.)

www.ElectricalPartManuals.com

When a sequential fault clearance occurs for a fault on a parallel line, the direction of the current on the healthy line is reversed. The status of the forward overreaching element changes from an operating to a reset state at the terminal where the current is reversed from an inward to an outward direction, and from a non-operating status to operating status at the other terminal. In this process, if the operating periods of the forward overreaching element of both terminals overlap, the healthy line may be tripped erroneously. To prevent this, current reversal logic (CRL) is provided. (See Section 2.3.2.6 for current reversal.)

Since the POP transmits a trip permission signal with the operation of the overreaching element, it requires multiplex signaling channels or one channel for each direction. This ensures that the transmitting terminal does not trip erroneously due to reception of its own transmit signal during an external fault in the overreaching zone.

#### Scheme Logic

Figure 2.3.2.2 shows the scheme logic for the POP. The POP transmits a trip permission signal to the other terminal for any of the following conditions.

- The forward overreaching zone 2 or zone 3 selected by scheme switch [ZONESEL] operates and the current reversal logic (CRL) has not picked up.
- The circuit breaker is opened and a trip permission signal CR is received from the other terminal.
- The forward overreaching zone 2 or zone 3 and reverse looking Z4 have not operated and a trip permission signal is received from the other terminal.

The last two are implemented when an echo function (ECH) is selected. (Refer to Section 2.3.2.5 for echo function.)

Transmission of the trip permission signal continues for the TSBCT setting even after the local terminal is tripped by the delayed drop-off timer TSBCT. This is to ensure that command tripping is executed at the remote terminal.

The POP outputs single-phase tripping signal S-TRIP or three-phase tripping signal M-TRIP to the local terminal when the trip permission signal R1-CR and R2-CR are received from the remote terminals, the current reversal logic (CRL) is not picked up and one of the following conditions is established.

- The forward overreaching element operates.
- The undervoltage element UVL (UVLS or UVLG) operates and the forward overreaching and the reverse looking elements do not operate.

The latter is implemented when the weak infeed trip function is selected. (Refer to Section 2.3.2.5 for weak infeed trip function.)

To select the faulted phase reliably, phase selection is performed using the phase selection element UVC. Phase selection logic is described in Section 2.3.2.7.

www . ElectricalPartManuals . com

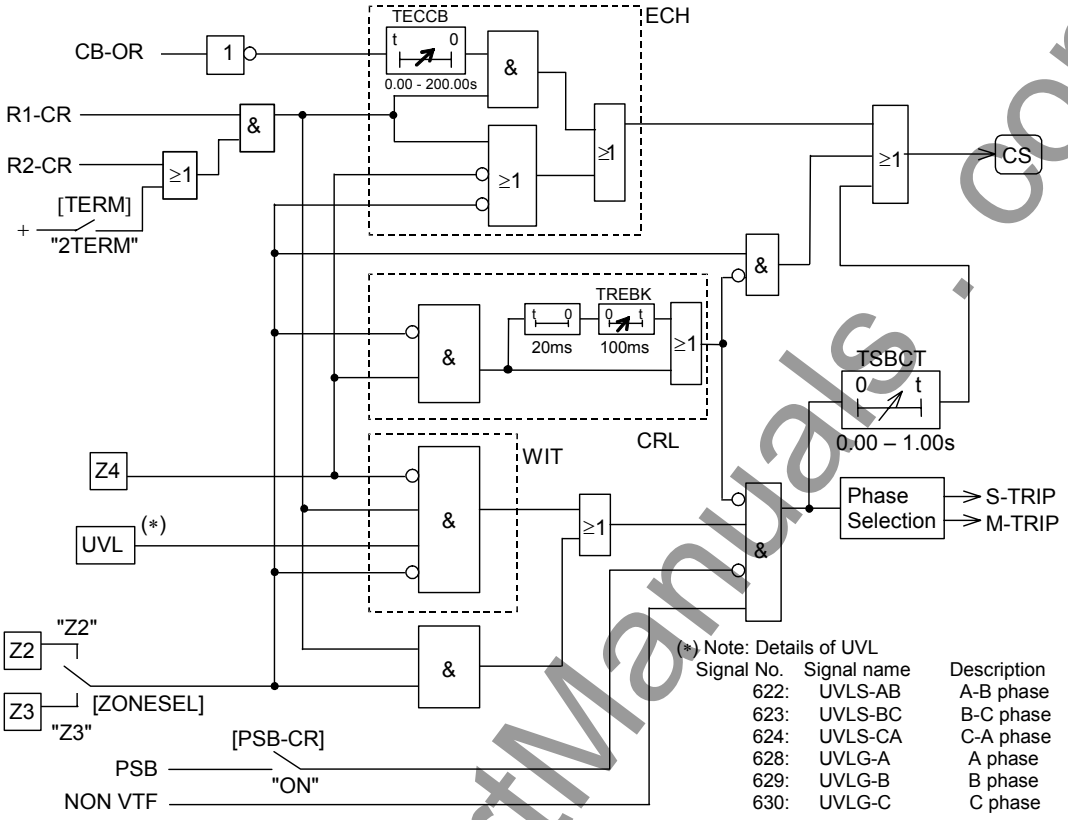



**Figure 2.3.2.2 POP Scheme Logic**

### Setting

The following shows the setting elements necessary for the POP and their setting ranges. For the settings of Z2, Z3 and UVC, refer to Section 2.3.1.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| UVL | | | | Weak infeed trip element |
| UVLS | 50 - 100 V | 1V | 77V | Undervoltage detection (phase fault) |
| UVLG | 10 - 60 V | 1V | 45V | Undervoltage detection (earth fault) |
| Z4S | 0.01 - 50.00Ω | 0.01Ω | 8.00Ω | Z4 reach |
| | (0.1 – 250.0Ω | 0.1Ω | 40.0Ω) (*) | |
| BRRS | 0.10 - 20.00Ω | 0.01Ω | 5.10Ω | Reverse right blinder reach |
| | (0.5 - 100.0Ω | 0.1Ω | 25.5Ω) | |
| Z4G | 0.01 – 100.00Ω | 0.01Ω | 8.00Ω | Z4 reach |
| | (0.1 – 500.0Ω | 0.1Ω | 40.0Ω) | |
| BRRG | 0.10 - 20.00Ω | 0.01Ω | 5.10Ω | Reverse right blinder reach |
| | (0.5 - 100.0Ω | 0.1Ω | 25.5Ω) | |
| TREBK | 0.00 - 10.00s | 0.01s | 0.10s | Current reversal block time |
| TSBCT | 0.00 – 1.00s | 0.01s | 0.10s | |
| CRSCM | PUP/POP/UOP/BOP | | POP | Carrier protection mode |
| DISCR | OFF/ON | | OFF | Distance carrier protection enable |
| ZONESEL | Z2/Z3 | | Z2 | Overreaching element selection |
| PSB - CR | OFF/ON | | ON | Power swing blocking |
| ECHO | OFF/ON | | ON | Echo function |
| WKIT | OFF/ON | | ON | Weak infeed trip function |

(*) Ohmic values shown in the parentheses are in the case of 1 A rating. Other ohmic values are in the case of 5 A rating.

www.ElectricalPartManuals.com

The following elements have fixed setting values or their settings are interlinked with other elements listed above. So no setting operation is required.

| Element | Setting | Remarks |
|---|---|---|
| Z4BS | Fixed to 1.5Ω | Z4 reverse offset reach |
| | (Fixed to 7.5Ω) (*1) | |
| Z4S θ(*2) | Interlinked with Z3S θ | Characteristic angle of Z4 mho element |
| Z4BS θ(*3) | Interlinked with ZBS θ | Angle of Z4 directional element |
| BRRS θ | Fixed to 75° | Angle of reverse right blinder BRRS |
| BRLS | Interlinked with BRRS | Reverse left blinder |
| BRLS θ | Interlinked with BFLS θ | Angle of reverse left blinder BRLS |
| Z4G θ(*2) | Interlinked with Z3G θ | Characteristic angle of Z4 mho element |
| Z4BG θ(*3) | Interlinked with ZBG θ | Angle of Z4 directional element |
| BRRG θ | Fixed to 75° | Angle of reverse right blinder BRRG |
| BRLG | Interlinked with BRRG | Reverse left blinder |
| BRLG θ | Interlinked with BFLG θ | Angle of reverse left blinder BRLG |

(*1)Ohmic values shown in the parentheses are in the case of 1 A rating. Other ohmic values are in the case of 5 A rating.

(*2) Valid only when mho-based characteristic is selected by ZS-C and ZG-C.

(*3) Valid only when quadrilateral characteristic is selected by ZS-C and ZG-C.

The reverse looking Z4 (G,S), BRR (G,S) and BRL (G,S) must always operate for reverse faults for which the forward overreaching element of the remote end operates. The following setting coordination is required.

When zone 2 is selected as the forward looking element:

Z4 setting = 1.2 × (Zone 2 setting at remote end)

When zone 3 is selected:

Z4 setting = 1.2 × (Zone 3 setting at remote end)

In both cases:

BRR setting = 1.2 × (BFR setting at remote end)

#### 2.3.2.3 Unblocking Overreach Protection

**Application**

If a power line carrier is used as the telecommunication media, there is a possibility that the dependability of the PUP and POP could be reduced. This is because the trip permission signal must be transmitted through the fault point and the attenuation of the signal may cause the PUP and POP to fail to operate. To solve this problem, unblocking overreach protection (UOP) is applied.

The signal transmitted under the UOP is a trip block signal and this is transmitted continuously during non-fault conditions. When the forward overreaching element operates, transmission is stopped. At the remote end, the non-receipt of a trip block signal is recognized as an actual trip permission signal and tripping is executed on condition that the local forward overreaching element operates.

In this system, the transmitted signal is a trip block signal, and transmission of that signal is required only in the case of external faults. Therefore, even if power line carrier is used, a failure to operate or false operation due to attenuation of the signal would not be experienced.

If the modulation method of the telecommunication circuits is a frequency shift method, frequencies f1 and f2 are assigned to the trip block signal and trip permission signal, respectively. The receive end recognizes signals CR1 and CR2 as corresponding to respective frequencies as

www.ElectricalPartManuals.com

the actual trip permission signals when either one of the following conditions is established and executes tripping on condition that the overreaching element should operate.

- CR1 is lost and only CR2 is received.
- Both CR1 and CR2 are lost.

The latter is also applicable if there is a telecommunication circuit failure in addition to attenuation of the signal at the fault point. Therefore, when the latter condition continues for a certain period or longer, the UOP is blocked and a telecommunication circuit failure alarm is output.

The UOP is provided with an echo function and weak infeed trip function and even when applied to a line with open terminals or weak infeed terminals, it allows fast tripping of both terminals for any fault along the whole length of the protected line. An undervoltage element UVL is provided for weak infeed tripping. (See Section 2.3.2.5 for protection for weak infeed terminal.)

When a sequential fault clearance occurs for a fault on a parallel line, the direction of the current on the healthy line is reversed. The status of the forward overreaching element changes from an operating to a reset state at the terminal where the current is reversed from an inward to an outward direction, and from a non-operating status to an operating status at the other terminal. In this process, if the operating periods of the forward overreaching element of both terminals overlap, the healthy line may be tripped erroneously. To prevent this, current reversal logic is provided. (See Section 2.3.2.6 for current reversal.)

For the communication channel, a single channel shared by different terminals or multiplex channels, one channel for each direction can be used.

#### Scheme Logic

Figure 2.3.2.3 shows the scheme logic of the UOP. The logic level of transmit signal CS and receive signal R1-CR and R2-CR is "1" for a trip block signal and "0" for a trip permission signal.

The UOP changes its transmit signal CS from a trip block signal to trip permission signal under one of the following conditions. The logic level of CS changes from 1 to 0.

- The forward overreaching zone 2 or zone 3 selected by the scheme switch [ZONESEL] operates and the current reversal logic (CRL) is not picked up.
- The circuit breaker is open and the trip permission signal (R1-CR=0, R2-CR=0) is received from the other terminal.
- The forward overreaching zone 2 or zone 3 and reverse looking Z4 are not operating and a trip permission signal is received from the other terminal.

The last two are implemented when an echo function (ECH) is selected. (Refer to Section 2.3 2.5 for echo function.)

Transmission of a trip permission signal continues for the TSBCT setting even after the local terminal is tripped. This is to ensure that command tripping is executed at the remote terminal.

The UOP outputs single-phase tripping signal S-TRIP or three-phase tripping signal M-TRIP to the local terminal when the trip permission signal (R1-CR=0, R2-CR=0) is received from the remote terminal, the current reversal logic (CRL) is not picked up and one of the following conditions is established.

- The forward overreaching element operates.
- The undervoltage element UVL (UVLS or UVLG) operates and the forward overreaching and the reverse looking elements do not operate.

The latter is implemented when the weak infeed trip function is selected.

To select the faulted phase reliably, phase selection is performed using the phase selection element

www.ElectricalPartManuals.com

UVC. Phase selection logic is described in Section 2.3.2.7.

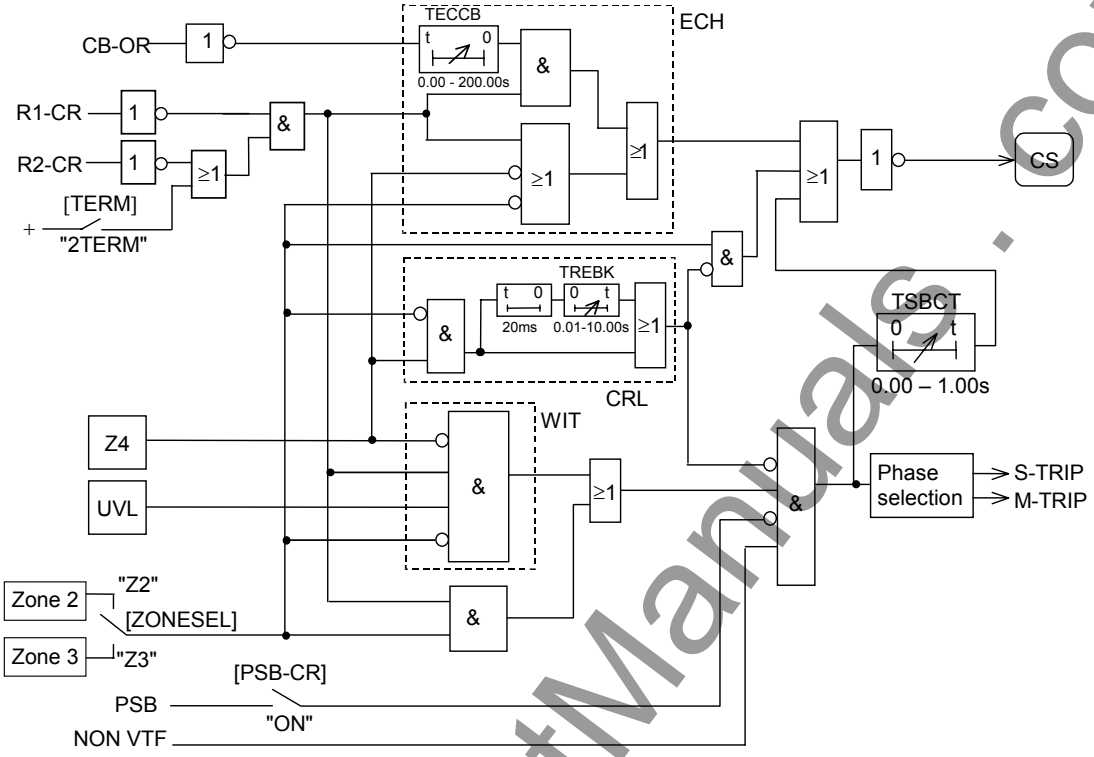



**Figure 2.3.2.3 UOP Scheme Logic**

### Setting

The following shows the setting elements necessary for the UOP and their setting ranges. For the settings of Z2, Z3, and UVC, refer to Section 2.3.1.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| UVL | | | | Weak infeed trip element |
| UVLS | 50 - 100 V | 1V | 77V | Undervoltage detection (phase fault) |
| UVLG | 10 - 60 V | 1V | 45V | Undervoltage detection (earth fault) |
| Z4S | 0.01 - 50.00Ω | 0.01Ω | 8.00Ω | Z4 reach |
| | (0.1 – 250.0Ω | 0.1Ω | 40.0Ω) (*) | |
| BRRS | 0.10 - 20.00Ω | 0.01Ω | 5.10Ω | Reverse right blinder reach |
| | (0.5 - 100.0Ω | 0.1Ω | 25.5Ω) | |
| Z4G | 0.01 - 100.00Ω | 0.01Ω | 8.00Ω | Z4 reach |
| | (0.1 – 500.0Ω | 0.1Ω | 40.0Ω) | |
| BRRG | 0.10 - 20.00Ω | 0.01Ω | 5.10Ω | Reverse right blinder reach |
| | (0.5 - 100.0Ω | 0.1Ω | 25.5Ω) | |
| TREBK | 0.00 - 10.00s | 0.01s | 0.10s | Current reversal block time |
| TSBCT | 0.00 – 1.00s | 0.01s | 0.10s | |
| CRSCM | PUP/POP/UOP/BOP | | POP | Carrier protection mode |
| DISCR | OFF/ON | | OFF | Distance carrier protection enable |
| ZONESEL | Z2/Z3 | | Z2 | Overreaching element selection |
| PSB - CR | OFF/ON | | ON | Power swing blocking |
| ECHO | OFF/ON | | ON | Echo function |
| WKIT | OFF/ON | | ON | Weak infeed trip function |

(*) Ohmic values shown in the parentheses are in the case of 1 A rating. Other ohmic values are in the case of 5 A rating.

www.ElectricalPartManuals.com

The following elements have fixed setting values or their settings are interlinked with other elements listed above. So no setting operation is required.

| Element | Setting | Remarks |
|---|---|---|
| Z4BS | Fixed to 1.5Ω | Z4 reverse offset reach |
| | (Fixed to 7.5Ω) (*1) | |
| Z4S θ(*2) | Interlinked with Z3S θ | Characteristic angle of Z4 mho element |
| Z4BS θ(*3) | Interlinked with ZBS θ | Angle of Z4 directional element |
| BRRS θ | Fixed to 75° | Angle of reverse right blinder BRRS |
| BRLS | Interlinked with BRRS | Reverse left blinder |
| BRLS θ | Interlinked with BFLS θ | Angle of reverse left blinder BRLS |
| Z4G θ(*2) | Interlinked with Z3G θ | Characteristic angle of Z4 mho element |
| Z4BG θ(*3) | Interlinked with ZBG θ | Angle of Z4 directional element |
| BRRG θ | Fixed to 75° | Angle of reverse right blinder BRRG |
| BRLG | Interlinked with BRRG | Reverse left blinder |
| BRLG θ | Interlinked with BFLG θ | Angle of reverse left blinder BRLG |

(*1) Ohmic values shown in the parentheses are in the case of 1 A rating. Other ohmic values are in the case of 5 A rating.

(*2) Valid only when mho-based characteristic is selected by ZS-C and ZG-C.

(*3) Valid only when quadrilateral characteristic is selected by ZS-C and ZG-C.

The reverse looking elements Z4 (G,S), BRR (G,S) and BRL (G,S) must always operate for reverse faults for which the forward overreaching element of the remote end operates. The following setting coordination is required.

When zone 2 is selected as the forward-looking element,

$$\text{Z4 setting} = 1.2 \times (\text{Zone 2 setting at remote end})$$

When zone 3 is selected,

$$\text{Z4 setting} = 1.2 \times (\text{Zone 3 setting at remote end})$$

In both cases,

$$\text{BRR setting} = 1.2 \times (\text{BFR setting at remote end})$$

#### 2.3.2.4 Blocking Overreach Protection

**Application**

In blocking overreach protection (BOP), each terminal normally transmits a trip permission signal, and transmits a trip block signal if the reverse looking Z4 operates and the forward overreaching element does not operate. Tripping of the local circuit breaker is performed on condition that the forward overreaching element has operated and a trip permission signal has been received. As the forward overreaching element, it is possible to use zone 2 or zone 3.

If signal modulation is performed by an ON/OFF method, the signal is not normally transmitted and a trip block signal is transmitted only when the reverse looking element operates. Tripping is performed on condition that the forward overreaching element has operated and no signal has been received. In this signaling system, the signal transmitted is a trip block signal and transmission of this signal is only required in the event of an external fault. Therefore, even if power line carrier is used, there will be no failure to operate or false operation due to attenuation of signals caused by signal transmission through the fault.

The BOP receives a trip permission signal all the time. Therefore, when a forward external fault occurs, the infeed terminal on which the forward overreaching element has operated attempts to perform instantaneous tripping. At this time, at the remote outfeed terminal, the reverse looking element operates and transmits a trip block signal. This signal is received at the infeed terminal after a channel delay time. Therefore, a short delay is required for the tripping to check for the reception of a trip block signal.

www.ElectricalPartManuals.com

The BOP performs fast tripping 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, no echo function is required. However, since no weak infeed logic is applicable to the BOP, the weak infeed terminal cannot operate.

When a sequential fault clearance occurs for a fault on a parallel line, the direction of the current on the healthy line is reversed. The status of the forward overreaching element changes from an operating to a reset state at the terminal where the current is reversed from the inward direction to outward direction, and from a non-operating status to an operating status at the other terminal. In this process, if the operating periods of the forward overreaching element of both terminals overlap, the healthy line may be tripped erroneously. To prevent this, current reversal logic is provided. (See Section 2.3.2.6 for current reversal.)

### Scheme Logic

Figure 2.3.2.4 shows the scheme logic of the BOP. The logic level of transmit signal CS and receive signal R1-CR or R2-CR is "1" for a trip block signal and "0" for a trip permission signal.

The transmit signal is controlled in the BOP as follows:

In the normal state, the logic level of transmit signal CS is 0, and a trip permission signal is transmitted. If the reverse looking Z4 operates and at the same time the forward overreaching element zone 2 or zone 3 selected by the scheme switch [ZONESEL] does not operate, CS becomes 1 and a trip block signal is transmitted. When this condition continues for 20 ms or more, current reversal logic is picked up and a drop-off delay time of TREBK setting is given to reset the transmission of the trip block signal.

Transmission of a trip permission signal continues for the TSBCT setting even after the local terminal is tripped, assuring command tripping of the remote terminal.

The BOP outputs single-phase tripping signal S-TRIP or three-phase tripping signal M-TRIP to the local terminal when zone 3 or zone 2 operates and at the same time the trip permission signal is received (R1-CR=0). The delayed pick-up timer TCHD 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.

To select the faulted phase reliably, phase selection is performed using the phase selection element UVC. The phase selection logic is described in Section 2.3.2.7.

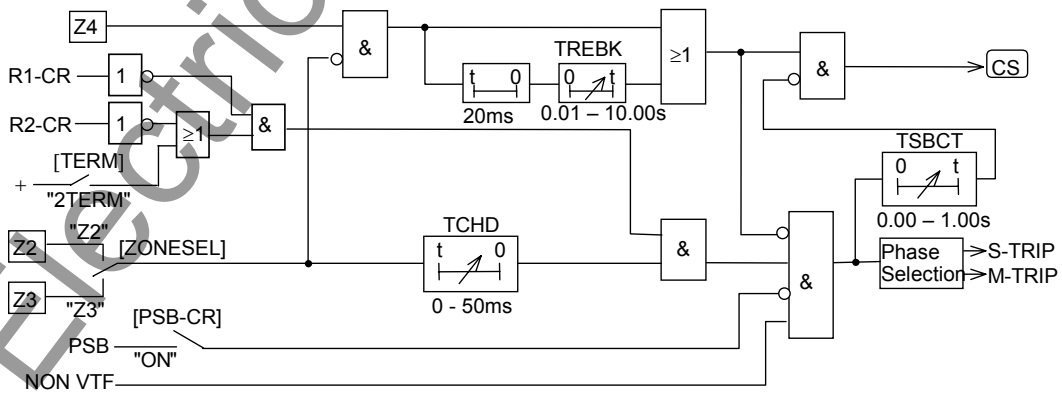



**Figure 2.3.2.4 BOP Scheme Logic**

### Setting

The following shows the setting elements necessary for the BOP and their setting ranges. For the settings of Z2, Z3 and UVC, refer to Section 2.3.1.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| Z4S | 0.01 - 50.00Ω | 0.01Ω | 8.00Ω | Z4 reach |
| | (0.1 – 250.0Ω | 0.1Ω | 40.0Ω) (*) | |

www.ElectricalPartManuals.com

| | | | | |
|---|---|---|---|---|
| BRRS | 0.10 - 20.00Ω | 0.01Ω | 5.10Ω | Reverse right blinder reach |
| | (0.5 - 100.0Ω | 0.1Ω | 25.5Ω) | |
| Z4G | 0.01 - 100.00Ω | 0.01Ω | 8.00Ω | Z4 reach |
| | (0.1 – 500.0Ω | 0.1Ω | 40.0Ω) | |
| BRRG | 0.10 - 20.00Ω | 0.01Ω | 5.10Ω | Reverse right blinder reach |
| | (0.5 - 100.0Ω | 0.1Ω | 25.5Ω) | |
| TCHD | 0 - 50 ms | 1 ms | 12 ms | Channel delay time |
| TREBK | 0.00 - 10.00s | 0.01s | 0.10s | Current reversal block time |
| TSBCT | 0.00 – 1.00s | 0.01s | 0.10s | |
| CRSCM | PUP/POP/UOP/BOP | | POP | Carrier protection mode |
| DISCR | OFF/ON | | OFF | Distance carrier protection enable |
| ZONESEL | Z2/Z3 | | Z2 | Overreaching element selection |
| PSB - CR | OFF/ON | | ON | Power swing blocking |

(*) Ohmic values shown in the parentheses are in the case of 1 A rating. Other ohmic values are in the case of 5 A rating.

The following elements have fixed setting values or their settings are interlinked with other elements listed above. So no setting operation is required.

| Element | Setting | Remarks |
|---|---|---|
| Z4BS | Fixed to 1.5Ω | Z4 reverse offset reach |
| | (Fixed to 7.5Ω) (*1) | |
| Z4S θ(*2) | Interlinked with Z3S θ | Characteristic angle of Z4 mho element |
| Z4BS θ(*3) | Interlinked with ZBS θ | Angle of Z4 directional element |
| BRRS θ | Fixed to 75° | Angle of reverse right blinder BRRS |
| BRLS | Interlinked with BRRS | Reverse left blinder |
| BRLS θ | Interlinked with BFLS θ | Angle of reverse left blinder BRLS |
| Z4G θ(*2) | Interlinked with Z3G θ | Characteristic angle of Z4 mho element |
| Z4BG θ(*3) | Interlinked with ZBG θ | Angle of Z4 directional element |
| BRRG θ | Fixed to 75° | Angle of reverse right blinder BRRG |
| BRLG | Interlinked with BRRG | Reverse left blinder |
| BRLG θ | Interlinked with BFLG θ | Angle of reverse left blinder BRLG |

(*1)Ohmic values shown in the parentheses are in the case of 1 A rating. Other ohmic values are in the case of 5 A rating.

(*2) Valid only when mho-based characteristic is selected by ZS-C and ZG-C.

(*3) Valid only when quadrilateral characteristic is selected by ZS-C and ZG-C.

The reverse looking elements Z4 (G,S), BRR (G,S) and BRL (G,S) must always operate for reverse faults for which the forward overreaching element of the remote end operates. The following setting coordination is required.

When zone 2 is selected as the forward-looking element,

Z4 setting = 1.2 × (Zone 3 setting at remote end)

or

Z4 setting = α × (Zone 2 setting at remote end)

Note: α should be determined in consideration of the extension of zone 2 by zero-sequence compensation.

When zone 3 is selected,

Z4 setting = 1.2 × (Zone 3 setting at remote end)

In both cases,

www.ElectricalPartManuals.com

BRR setting = 1.2 × (BFR setting at remote end)

The delayed pick-up timer TCHD is set as follows taking into account the transmission delay time of the blocking signal and a safety margin of 5 ms.

TCHD setting = maximum signal transmission delay time(*) + 5ms

(*) includes delay time of binary output and binary input for the blocking signal.

#### 2.3.2.5 Protection for Weak Infeed Terminal

The POP and UOP are provided with an echo function and weak infeed trip function. Both functions are used for lines with weak infeed terminals.

Figure 2.3.2.5 shows the scheme logic for the echo function.

With the POP, when a trip permission signal is received (R1-CR=1, R2-CR=1) if neither forward overreaching zone 2 or zone 3 nor reverse looking Z4 have operated, the echo function sends back the received signal to the remote terminal. With the UOP, when reception of a blocking signal is stopped (R1-CR=0, R2-CR=0) if neither forward overreaching zone 2 (or zone 3) nor reverse looking Z4 have operated, the echo function stops sending the blocking signal to the remote terminal. When the circuit breaker is open (CB-OR = 1), too, the echo function sends back the trip permission signal or stops sending the blocking signal. Timer TECCB is used to set the time from CB opened to the echo logic enabled.

The terminal on which the forward overreaching element has operated can be tripped at high speed by this echoed signal.

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 they have reset.

In order 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.

The echo function can be disabled by the scheme switch [ECHO].

The setting element necessary for the echo function and its setting range is as follows:

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| TECCB | 0.00 – 200.00 s | 0.01 s | 0.10 s | Echo enable timer |
| ECHO | OFF/ON | | ON | Echo function |

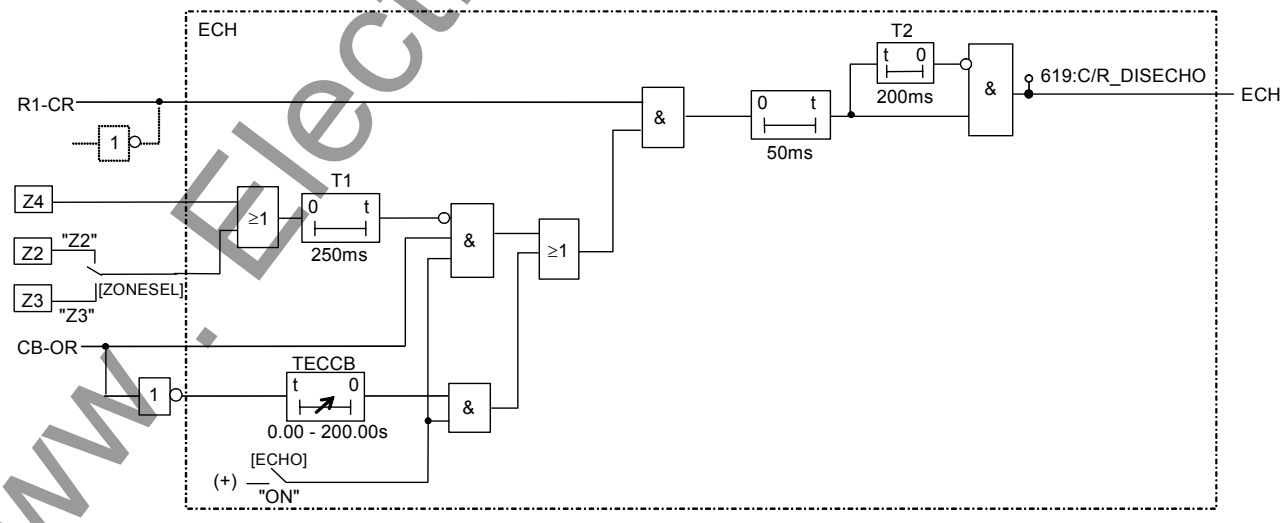



**Figure 2.3.2.5 Echo Logic**

www.ElectricalPartManuals.com

Figure 2.3.2.6 shows the scheme logic of the weak infeed trip function. Weak infeed tripping is executed on condition that a trip permission signal has been received (R1-CR=1, R2-CR=1) for the POP, and reception of a trip block signal has stopped (R1-CR=0, R2-CR=0) for the UOP, the undervoltage element UVL (UVLS or UVLG) operates and neither forward overreaching zone 2 or zone 3 nor reverse looking Z4 operates.

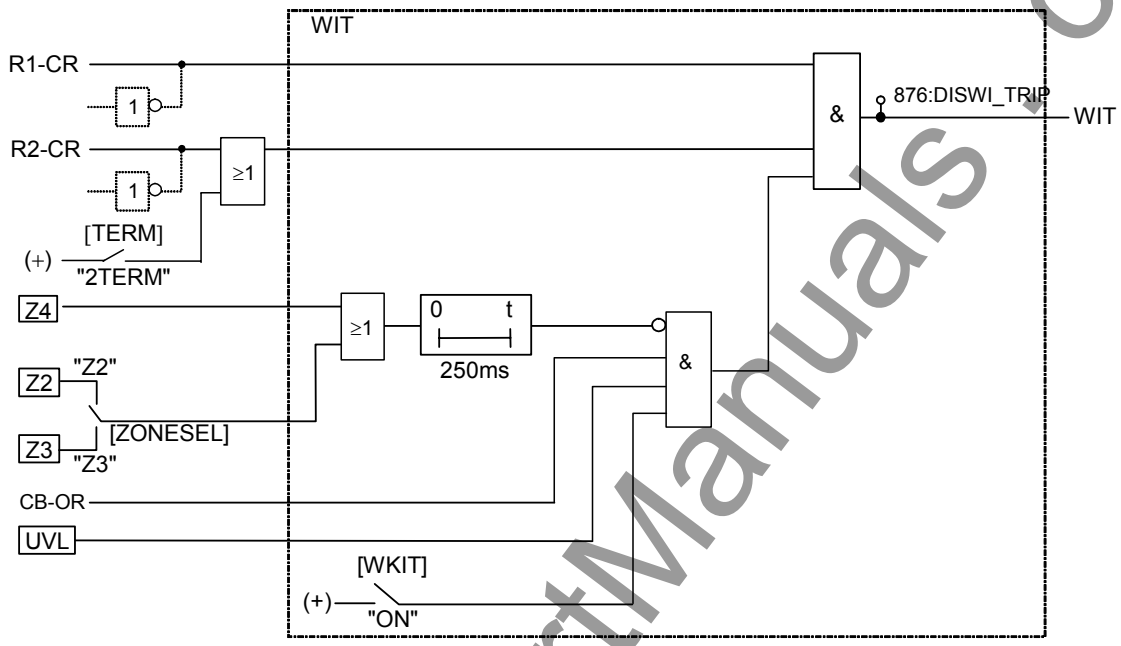



**Figure 2.3.2.6 Weak Infeed Trip Logic**

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

Single-phase tripping or three-phase tripping is also applicable to weak infeed tripping according to the reclosing mode of the autoreclose function.

The weak infeed trip function can be disabled by the scheme switch [WKIT].

### 2.3.2.6 Measure for Current Reversal

In response to faults on parallel lines, sequential opening of the circuit breaker may cause a fault current reversal on healthy lines. This phenomenon may cause false operation of the POP, UOP and BOP schemes in the worst case. To prevent this, the POP, UOP and BOP are provided with current reversal logic.

With the parallel line arrangement as shown in Figure 2.3.2.7 (a), suppose that a fault occurs at time t1 at point F of line L1, A1 trips at time t2 first and then B1 trips at time t3. The direction of the current that flows in healthy line L2 can be reversed at time t2. That is, the current flows from terminal B to terminal A as indicated by a solid line in the period from time t1 to t2, and from terminal A to terminal B as indicated by a broken line in the period from time t2 to t3. This current reversal phenomenon may occur with the presence of an external looped circuit if not for parallel lines.

Figure 2.3.2.7 (b) shows a sequence diagram of Z3 and Z4 and the current reversal logic CRL on healthy line L2 before and after the occurrence of a current reversal. When the current is reversed, Z3 operation and Z4 reset are seen at terminal A, while reset of Z3 and operation of Z4 are seen at terminal B. If at this time, Z3 of A2 operates before Z3 of B2 is reset, this may cause false operation of the POP, UOP and BOP on line L2.

www.ElectricalPartManuals.com

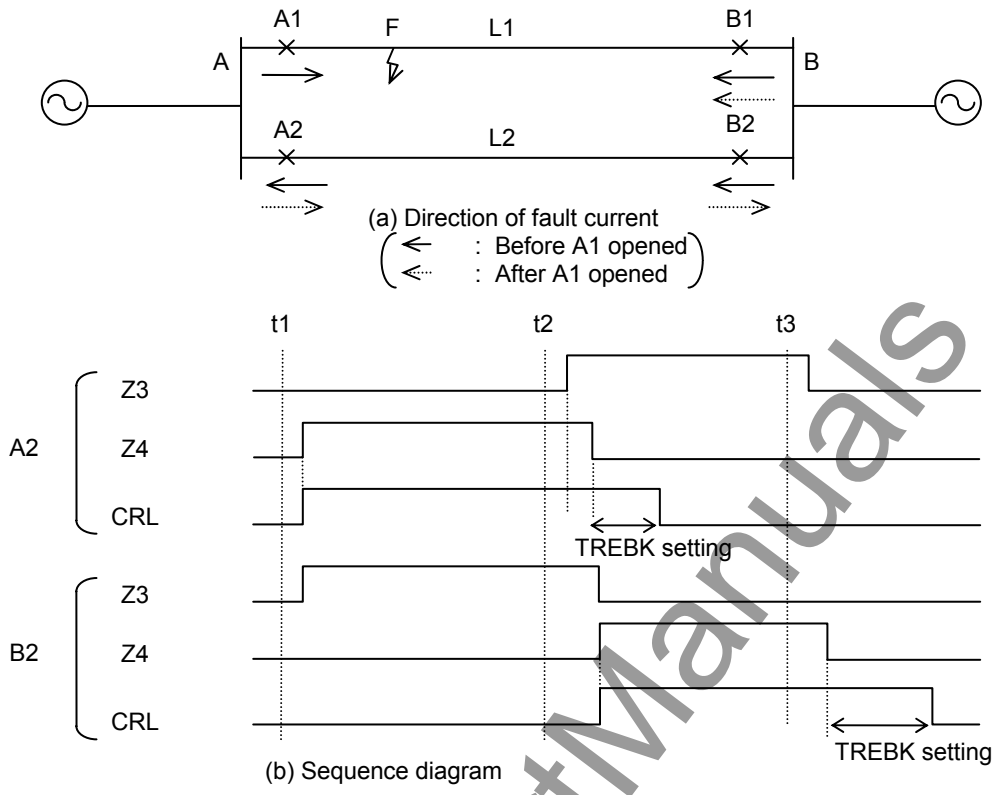



**Figure 2.3.2.7 Current Reversal Phenomenon**

Figure 2.3.2.8 shows the current reversal logic. The current reversal logic is picked up on condition that reverse looking Z4 has operated and forward overreaching zone 2 or zone 3 have not operated, and the output CRL immediately controls the send signal to a trip block signal and at the same time blocks local tripping. If the condition above continues longer than 20ms, the output CRL will last for the TREBK setting even after the condition above ceases to exist.

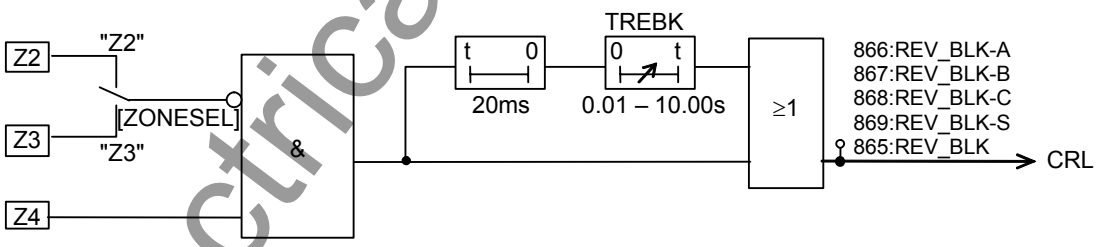



**Figure 2.3.2.8 Current Reversal Logic**

The operation of the current reversal logic and its effect in the event of a fault shown in Figure 2.3.2.7 (a) are as follows. As shown in Figure 2.3.2.7 (b), the current reversal logic of terminal A2 operates (CRL = 1) immediately after the fault occurs. This operation lasts for TREBK setting even after the current is reversed and Z3 operates, continuously blocking the local tripping and transmitting a trip block signal to the terminal B2.

Even if overlap arises due to current reversal on the operation of Z3 at terminal A2 and terminal B2, it will disappear while the current reversal logic is operating, thus avoiding false tripping of the healthy line of parallel lines. When a current reversal occurs in the direction opposite to the above, the current reversal logic at terminal B2 will respond similarly.

Current reversal logic is not picked up for internal faults, thus not obstructing high-speed operation of any protection scheme.

www.ElectricalPartManuals.com

### 2.3.2.7 Phase Selection Logic

Every command protection has phase selection logic for single-phase tripping. Figure 2.3.2.9 gives details of the phase selection logic displayed in blocks in Figures 2.3.2.1 to 2.3.2.4.

Tripping command signal TRIP of each command protection can be classified by the phase selection logic as a single-phase tripping command or a three-phase tripping command. If the distance measuring element for earth fault Z3G (or Z2G depending on the setting of the scheme switch [ZONESEL]) is operating when a TRIP is input, a single-phase tripping command S-TRIP is output to the phase in which the phase selection element UVC is operating. If the UVC is operating with two or more phases, a three-phase tripping command M-TRIP is output.

The undervoltage detection element UVLS, not shown in Figure 2.3.2.9, is used for the phase selection logic as phase fault detector. The UVLS is also used for fault location.

If the distance measuring element for phase fault Z3S (or Z2S) is operating when a TRIP is input, a three-phase tripping command M-TRIP is output.

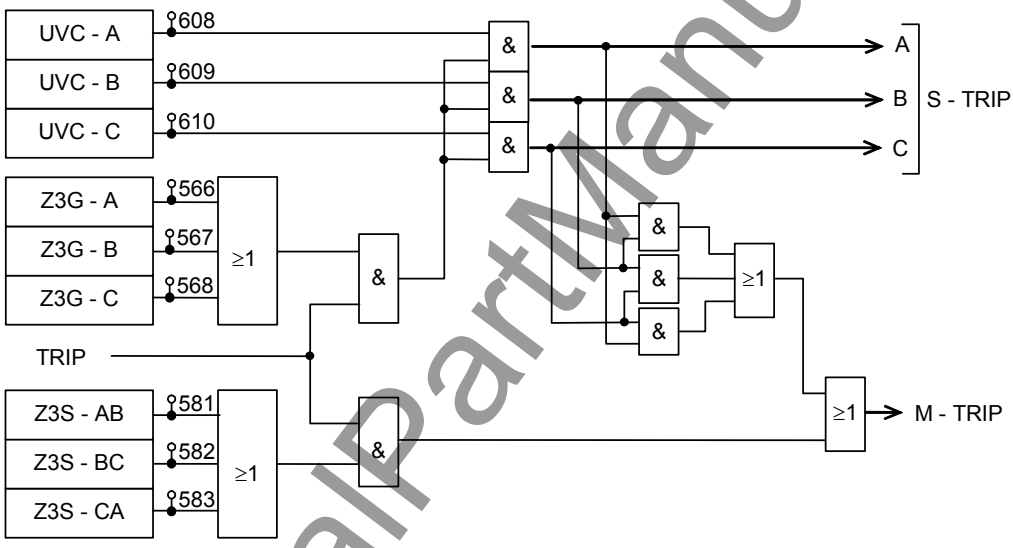



**Figure 2.3.2.9 Phase Selection Logic for Command Protection**

### 2.3.2.8 Interface with Signaling Equipment

GRL100 interfaces with protection signaling equipment through binary input and output circuits as shown in Figure 2.3.2.10.
Receiving command signals for remote terminal from the signaling equipment are input to photo-coupler circuits BIn and BIm. BIn and BIm output signals R1-CR1 and R1-CR2 through logic level inversion (NOT logic) circuit by PLC function (refer to Section 3.2.3).

A sending command signal CS to the signaling equipment should be output to the auxiliary relay BOn through a logic level inversion circuit.

www . ElectricalPartManuals . com

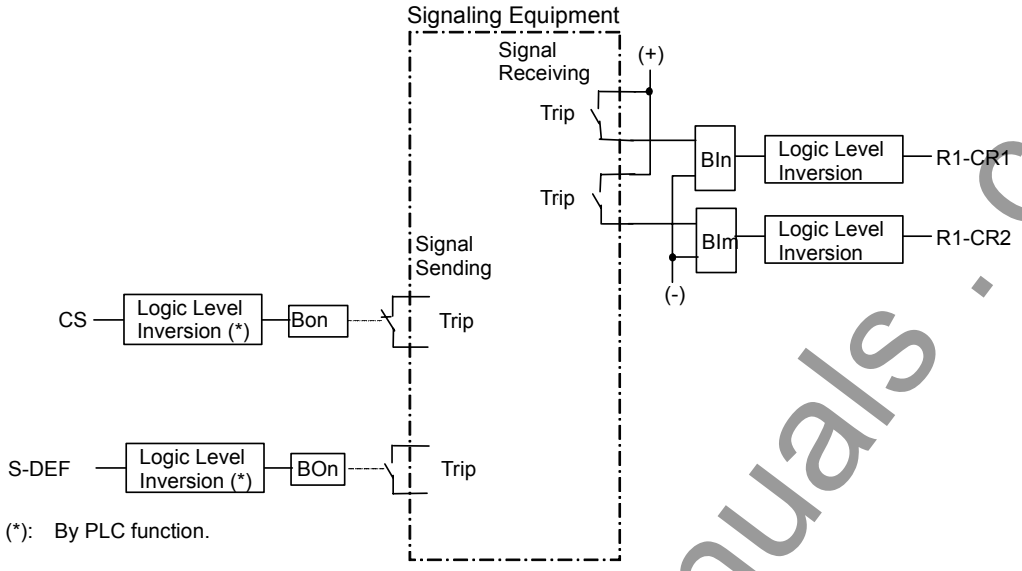



**Figure 2.3.2.10 Interface with Signaling Equipment**

### 2.3.2.9 Signaling Channel

When directional earth fault command protection (see Section 2.4.1) is used with POP, UOP or BOP scheme of distance protection and two channels are available, signal channel can be separated from distance protection by setting the scheme switch [CH-DEF] to "CH2". In this case, signals CH1 and CH2 are used for distance protection and directional earth protection respectively. If the scheme switch [CH-DEF] is set to "CH1", the signal CH1 is shared by the both protections.

When directional earth fault command protection is used with PUP scheme, signal channel is separated irrespective of [CH-DEF] setting.

Following table shows the scheme switch settings and usable signals:

| Scheme | CH-DEF setting | Use of signal | |
|---|---|---|---|
| | | CH1 | CH2 |
| PUP | CH1 | PUP | DEF |
| | CH2 | PUP | DEF |
| POP | CH1 | POP and DEF (*) | -- |
| | CH2 | POP | DEF |
| UOP | CH1 | UOP and DEF (*) | -- |
| | CH2 | UOP | DEF |
| BOP | CH1 | BOP and DEF (*) | -- |
| | CH2 | BOP | DEF |

(*) CH1 is shared by the distance and directional earth fault command protections.

**Setting**

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| CH-DEF | CH1/CH2 | | CH1 | Channel separation |

www.ElectricalPartManuals.com

### 2.3.3 Power Swing Blocking

When a power swing occurs on the power system, the impedance seen by the distance measuring element moves away from the load impedance area into the operating zone of the distance measuring element. The operation of the distance measuring element due to the power swing occurs in many points of interconnected power systems. Therefore, tripping due to the operation of the distance measuring element during a power swing is generally not allowed. The power swing blocking function (PSB) of the GRL100 detects the power swing and blocks tripping by the distance measuring element. The GRL100 provides PSBSZ and PSBGZ for phase fault measuring elements and earth fault measuring elements. Their functions and characteristics are same.

Once the PSB is in operation, tripping of zone 1 to zone 3 of the time-stepped distance protection, backup protection zone R for reverse faults and command protection using distance measuring elements can be blocked. These tripping blocks can be disabled by setting the scheme switches.

If a zero-phase current has been detected, the PSB is inhibited. This allows tripping in the event of an earth fault during a power swing or high resistance earth fault by which the resistance at the fault point changes gradually.

GRL100 can provide a high-speed protection for one- and two-phase faults which occur during a power swing by using negative sequence directional element and any of the command protection PUP, POP, UOP and BOP.

Three-phase faults during a power swing are eliminated by distance and overcurrent backup protection.

#### Scheme logic

A power swing is detected by using two PSB elements PSBIN and PSBOUT. They are composed of blinder elements and reactance elements as shown in Figure 2.3.3.1. PSBOUT encloses PSBIN with a settable width of PSBZ.

Figure 2.3.3.2 shows the power swing detection logic. During a power swing, the impedance viewed from the PSB elements passes through the area between the PSBOUT and PSBIN in a certain time. In the event of a system fault, the impedance passes through this area instantaneously. Therefore, a power swing is detected in a time which commences on operation of the PSBOUT until PSBIN starts to operate, if longer than the set value of delayed pick-up timer TPSB. If the residual overcurrent element EFL operates, detection of the power swing is inhibited.

The trip block signal PSB generated as a result of the detection of a power swing is reset 500 ms after the PSBOUT is reset by delayed timer T2.

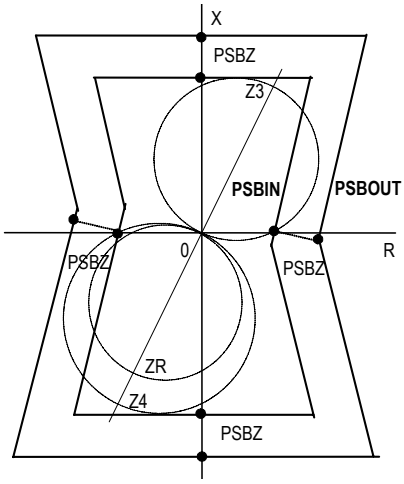



**Figure 2.3.3.1 Power Swing Blocking Element**

www . ElectricalPartManuals .com

PSBSZ and PSBGZ have same functions and characteristics as shown in Figures 2.3.3.1 and 2.3.3.2, and block tripping of phase and earth fault elements respectively.

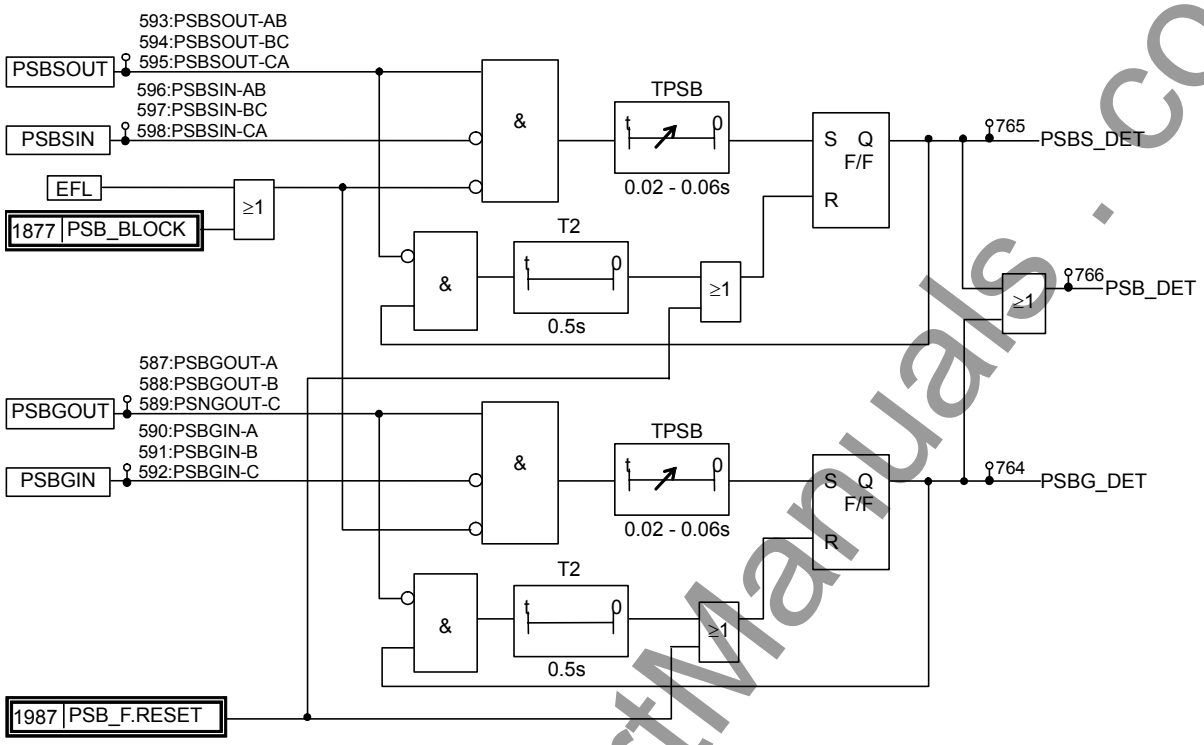



**Figure 2.3.3.2 Power Swing Detection Logic**

One- and two-phase faults can be protected with the command protection even during a power swing.

The PSB can be disabled or reset by the PLC signal PSB_BLOCK or PSB_F.RESET.

www . ElectricalPartManuals . com

### Setting

The setting elements necessary for the PSB and their setting ranges are as shown in the table below.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| PSBSZ | 0.50 - 15.00Ω | 0.01Ω | 2.00Ω | PSBS detection zone |
| | ( 2.5 - 75.0Ω | 0.1Ω | 10.0Ω) (*) | |
| PSBGZ | 0.50 - 15.00Ω | 0.01Ω | 2.00Ω | PSBG detection zone |
| | ( 2.5 - 75.0Ω | 0.1Ω | 10.0Ω) (*) | |
| EFL | 0.5 - 5.0 A | 0.1 A | 1.0 A | Residual overcurrent |
| | ( 0.10 - 1.00 A | 0.01 A | 0.20 A) | |
| TPSB | 20 - 60 | 1 ms | 40 ms | Power swing timer |
| PSB-Z1 | OFF/ON | | ON | Z1 blocked under power swing |
| PSB-Z2 | OFF/ON | | ON | Z2 blocked under power swing |
| PSB-Z3 | OFF/ON | | OFF | Z3 blocked under power swing |
| PSB-CR | OFF/ON | | ON | Carrier trip blocked under power swing |
| PSB-ZR | OFF/ON | | OFF | ZR blocked under power swing |

(*) Values shown in the parentheses are in the case of 1A rating. Other values are in the case of 5A rating.

Residual overcurrent element EFL is used in common with the following functions.

- VT failure detection
- Earth fault distance protection

The PSBIN reach is set automatically to coordinate with the Z3 and Z4 settings.

Note: In the case of the quadrilateral characteristic, if the ZR reach is larger than the Z4, the PEB-IN reach depends on the ZR reach. Therefore, the ZR must be set less than the Z4 whether the ZR used or not.

The right side forward and reverse blinders for PSBIN are shared with the right side forward and reverse blinders of the distance protection characteristic, BFRS/BFRG and BRRS/BRRG respectively, ensuring that the PSB element coordinates properly with the protection, for both mho and quadrilateral characteristics.

The positive reactive reach setting is fixed so that the setting makes the reactance element tangential to the Z3 distance element when the Z3 is mho-based or takes the same value as the Z3 reactive reach setting when the Z3 is quadrilateral-based.

The negative resistive reach takes the same value as that of the positive reach. The negative reactive reach setting is fixed so that the setting makes the reactance element tangential to the Z4 distance element when the Z4 is mho-based or takes the same value as the Z4 reactive reach setting when the Z4 is quadrilateral-based.

PSBOUT encloses PSBIN and the margin between the two is determined by the user-settable power swing detection zone width, PSBSZ and PSBGZ, for phase and earth fault characteristics respectively.

www . ElectricalPartManuals . com

## 2.4 Directional Earth Fault Protection

For a high-resistance earth fault for which the impedance measuring elements cannot operate, the GRL100 uses a directional earth fault element (DEF) to provide the following protections.

- Directional earth fault command protection
- Directional inverse or definite time earth fault backup protection

Figure 2.4.1 shows the scheme logic for the directional earth fault protection. The two kinds of protection above can be enabled or disabled by the scheme switches [DEFCR], [CRSCM], [DEFFEN] and [DEFREN]. The DEF command protection or DEF backup protection can be blocked by the binary input signal (PLC signal) DEF∗_BLOCK or DEFCRT_BLOCK.

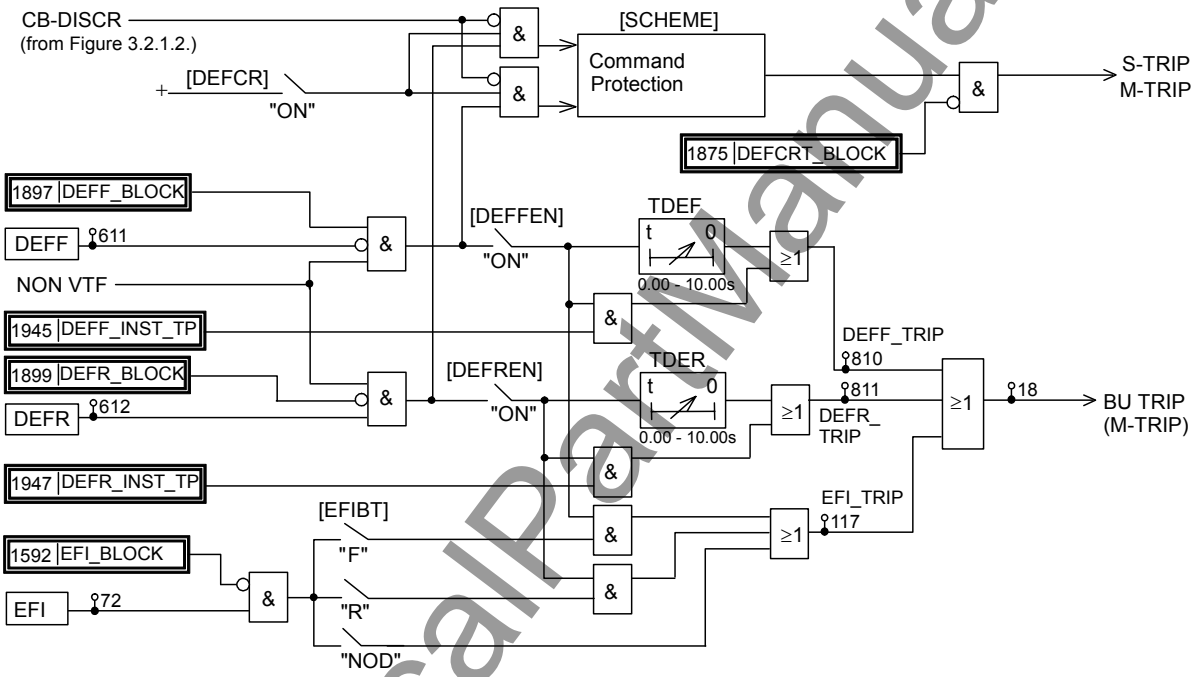



**Figure 2.4.1 Directional Earth Fault Protection**

The directional earth fault command protection provides the POP, UOP and BOP schemes using forward looking DEFF and reverse looking DEFR elements. All schemes execute three-phase tripping and autoreclose.

The command protection is disabled during a single-phase autoreclosing period (CB-DISCR=1).

The directional earth fault protection as backup protection is described in Section 2.4.2.

The directional earth fault element DEF provides selective protection against a high-resistance earth fault. The direction of earth fault is determined by the lagging angle (θ) of the residual current ($3I_0$) with respect to the residual voltage ($-3V_0$). The residual voltage and residual current are derived from the vector summation of the three-phase voltages and three-phase currents inside the relay.

The phase angle θ in the event of an internal fault is equal to the angle of the zero-sequence impedance of the system and in the directly-earthed system this value ranges approximately from 50° to 90°. θ of the DEF can be set from 0° to 90°. The minimum voltage necessary to maintain directionality can be set from 1.7 to 21.0 V.

www.ElectricalPartManuals.com

### 2.4.1 Directional Earth Fault Command Protection

High-speed directional earth fault command protection is provided using the forward looking directional earth fault element DEFF and reverse looking directional earth fault element DEFR. The signaling channel of DEF command protection can be shared with or separated from distance protection by the scheme switch [CH-DEF].

Figure 2.4.1.1 shows the scheme logic for the DEF command protection.

The DEF command protections are applied in combination with the distance command protection POP, UOP, BOP and PUP and enabled when the scheme switch [CRSCM] is set to "POP", "UOP", "BOP" or "PUP". These protections are called as the DEF POP, DEF UOP, DEF BOP and DEF PUP hereafter. The POP, UOP or BOP schemes can be selected as a common scheme. However, in the DEF PUP, distance protection takes the PUP scheme but DEF command protection takes the POP scheme and signaling channels of distance and DEF command protections are always separated (CH1: distance, CH2: DEF, see Section 2.3.2.9.).

The DEF command protection can select fast tripping or delayed tripping by a timer setting. Delayed tripping is used when it is desired to give priority to distance protection.

The DEF command protection is blocked during a single-phase autoreclose period by the distance protection (CB-DISCR=1). The signal CB-DISCR is generated with the binary input signals (PLC signals) of circuit breaker auxiliary contact (refer to Section 3.2.1).

The DEF command protection provides the phase selection logic for single-phase tripping. The details are shown in Figure 2.4.1.2. The current change detection element separated (OCD1) is used as the phase selection element. In addition, it is possible to input the output of external phase selection relay in PLC input DEF_PHSEL-A, DEF_PHSEL-B and DEF_PHSEL-C.

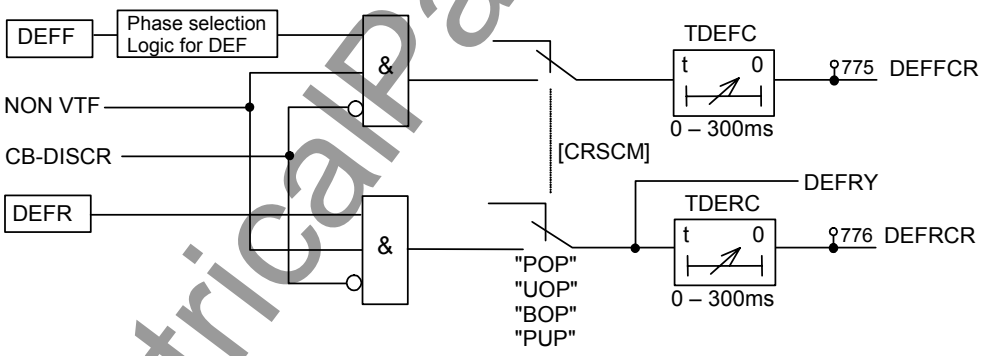



**Figure 2.4.1.1 DEF Command Protection**

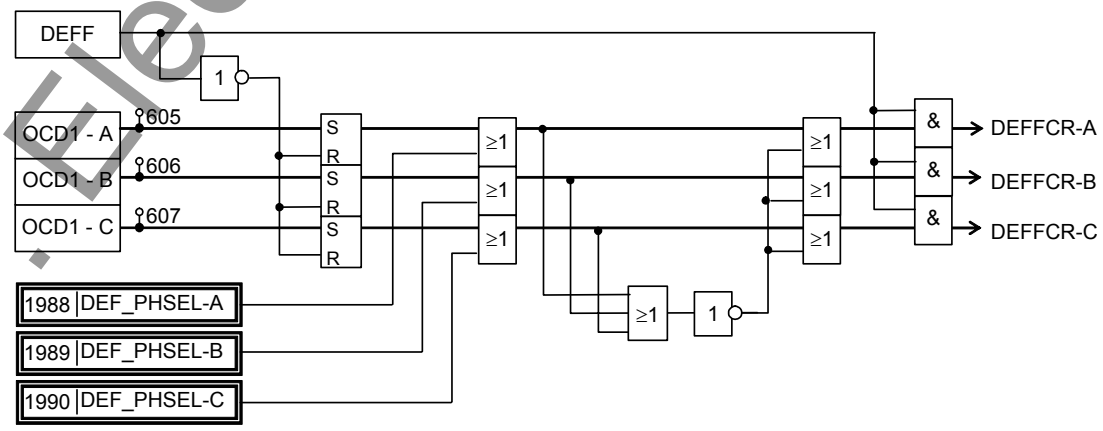



**Figure 2.4.1.2 Phase Selection Logic for DEFF**

www.ElectricalPartManuals.com

**DEF POP, DEF UOP and DEF PUP scheme logic**

Figure 2.4.1.3 shows the scheme logic of the DEF POP and DEF UOP.

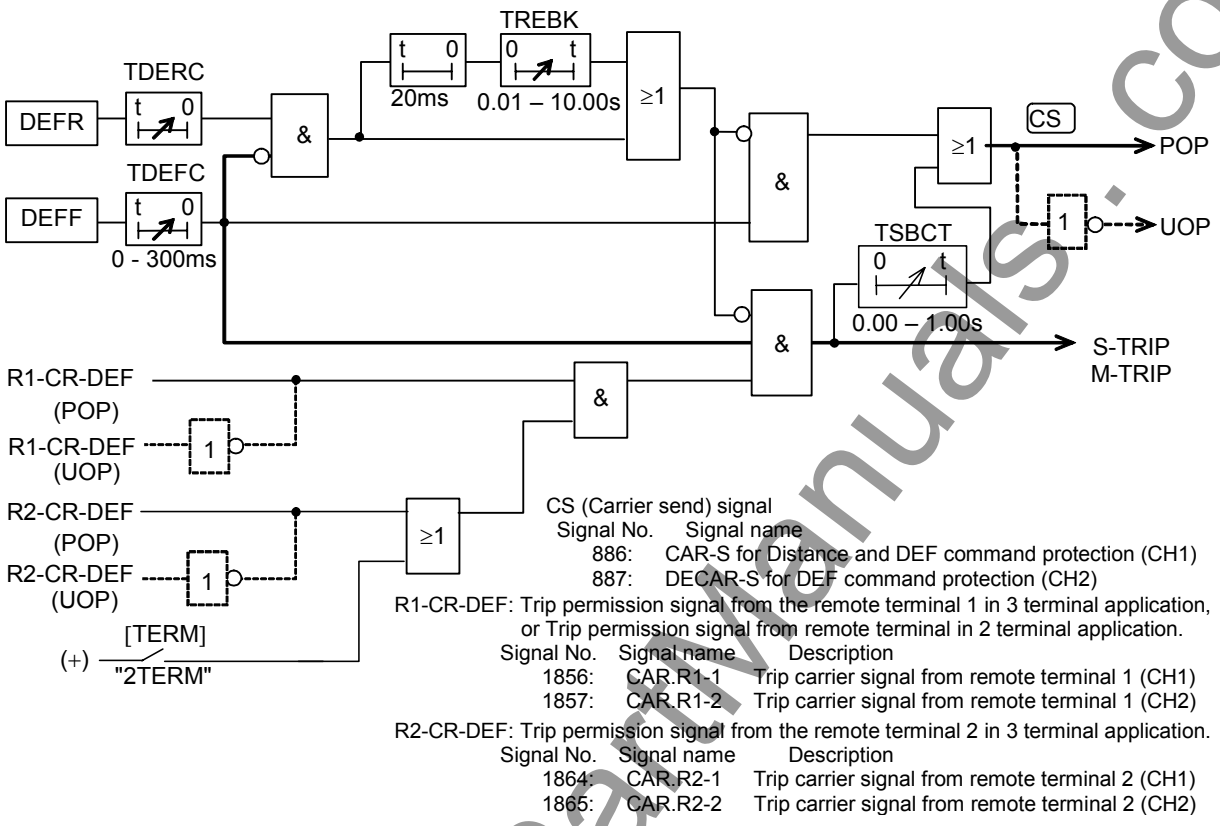



**Figure 2.4.1.3 DEF POP and DEF UOP Scheme Logic**

When the PUP+DEF scheme logic is selected, the DEF scheme logic is constructed same as the DEF POP scheme logic in Figure 2.4.1.3.

The signal transmitted is a trip permission signal for the POP and a trip block signal for the UOP. In the event of an internal fault, the POP transmits a signal, while the UOP stops transmission. In Figure 2.4.1.3, a signal is transmitted when CS becomes 1, and when the signal is received CR-DEF becomes 1.

When the DEFF operates, CS becomes 1 for the POP and a signal (that is, a trip permission signal) is transmitted. For the UOP, CS becomes 0 and transmission of the signal (that is, a trip block signal) is stopped.

When a signal is received in the POP, or no signal is received in the UOP, tripping is executed on condition that the DEFF has operated. In order to assure tripping of the remote terminal, transmission of a trip permission signal or stoppage of a trip block signal continues for the TSBCT setting time even after the DEFF reset.

The DEFR is used for the current reversal logic in the same manner as reverse looking Z4 in the distance protection (for the current reversal, refer to Section 2.3.2.6).

When operation of the DEFR and no-operation of the DEFF continue for 20 ms or more, even if the DEFF operates or the DEFR is reset later, tripping of the local terminal or transmission of the trip permission signal is blocked for the TREBK setting time.

The POP or UOP can be set for instantaneous operation or delayed operation by setting on-delay timer TDEFC and TDERC.

The DEF command protection is provided with an echo function and weak infeed trip function.

www.ElectricalPartManuals.com

Both functions are used for lines with weak infeed terminals.

The echo function allows fast tripping of the terminal on which the DEFF has operated when applied to a line with an open terminal or a weak infeed earth fault current terminal. The scheme logic is shown in Figure 2.4.1.4.

With the POP, when a trip permission signal is received (R1-CR-DEF = 1, R2-CR-DEF = 1) if neither the forward looking DEFF nor the reverse looking DEFR operates, the echo function sends back the received signal to the remote terminal. With the UOP, when reception of a blocking signal is stopped (R1-CR-DEF = 0, R2-CR-DEF = 0), if the DEFF and DEFR do not operate, the echo function stops transmission of the blocking signal likewise. When the circuit breaker is open, the echo function also sends back the trip permission signal or stops transmission of the blocking signal.

Once the DEFF or the DEFR operates, transmission of the echo signal is inhibited for 250 ms by delayed drop-off timer T1 even after they are reset.

In order to prevent any spurious echo signal from looping round between terminals in a healthy state, the echo signal is restricted to last 200 ms by delayed pick-up timer T2.

The echo function can be disabled by the scheme switch [ECHO].

When a signaling channel is shared by the distance protection and DEF protection, it is necessary to unite the scheme logic of both echo functions so that the echo function may not be picked up in the event of an external fault. The echo function at this time is blocked by Z2 (or Z3) and Z4 indicated by a dotted line in Figure 2.4.1.4.

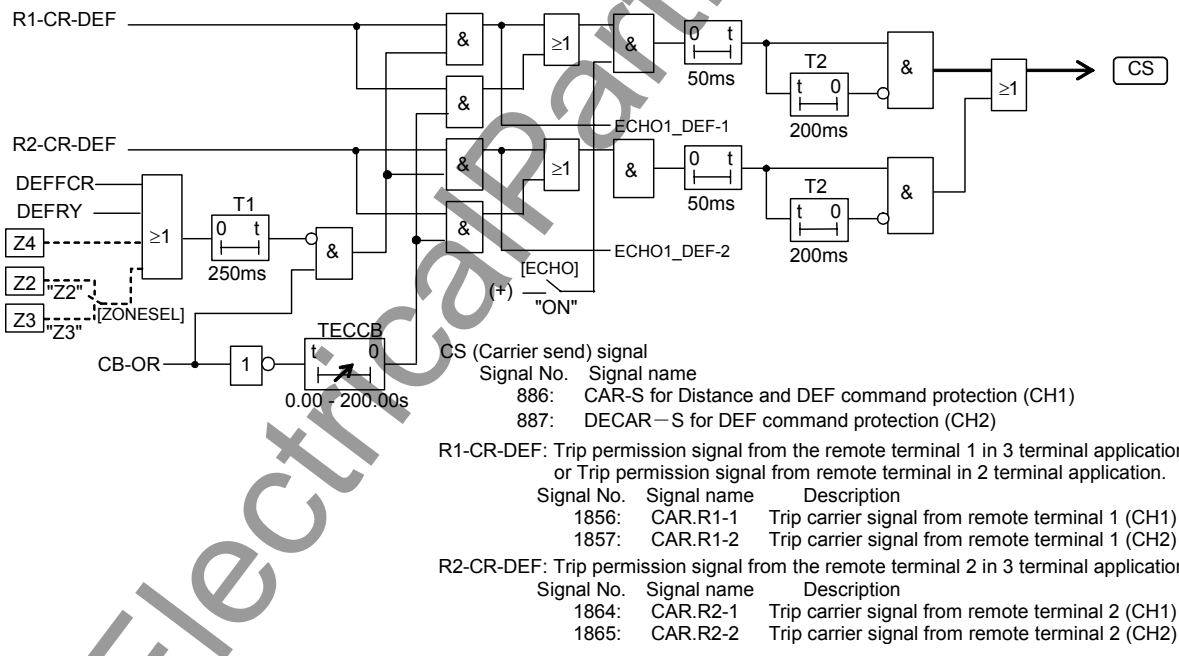



**Figure 2.4.1.4 Echo Function in DEF Scheme Logic**

Figure 2.4.1.5 shows the scheme logic of the weak infeed trip function. Weak infeed tripping is executed on condition that a trip permission signal has been received (ECHO1_DEF-1=1 or ECHO1_DEF-2=1), the undervoltage element UVL (UVLS or UVLG) operates.

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

Single-phase tripping or three-phase tripping is also applicable to weak infeed tripping according to the reclosing mode of the autoreclose function.

www.ElectricalPartManuals.com

The weak infeed trip function can be disabled by the scheme switch [WKIT].

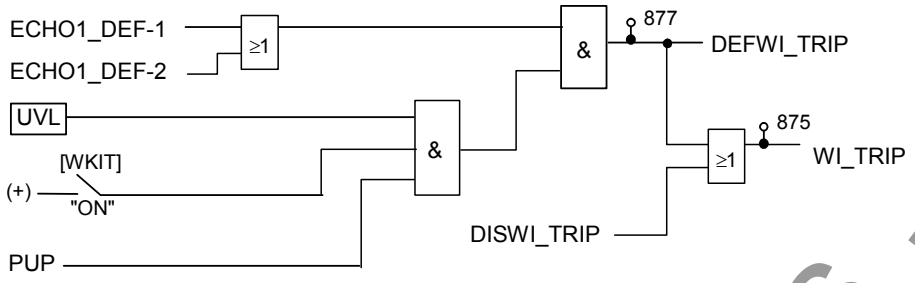
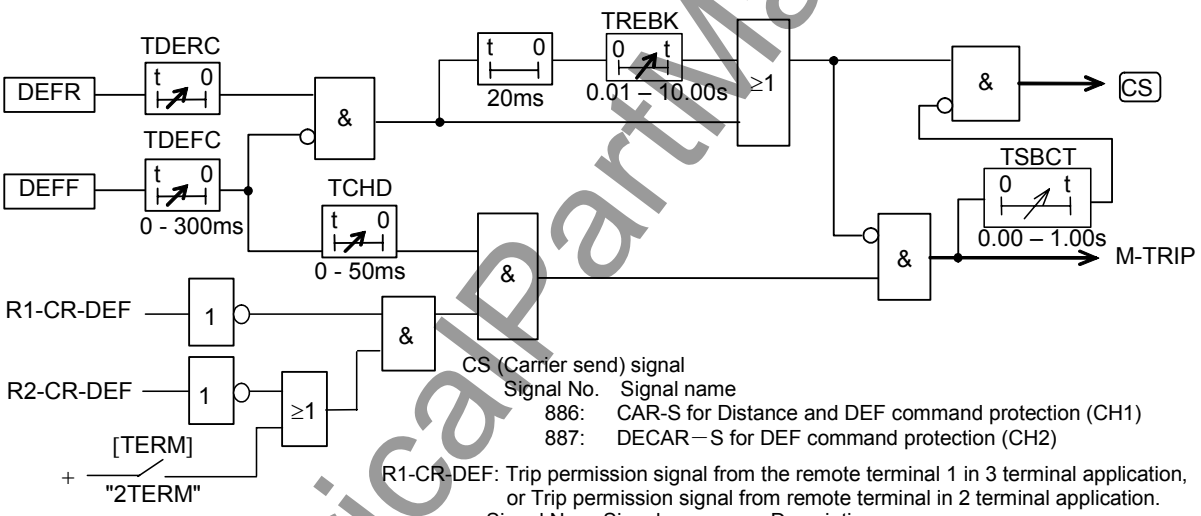



**Figure 2.4.1.5 Weak Infeed Trip Logic**

When the signaling channel of DEF POP or DEF UOP is separated from that of distance command protection, the signal S-DEF2 is used for CS and assigned to a user configurable binary output relay (see Section 3.2.2.).

### DEF BOP scheme logic

Figure 2.4.1.6 shows the scheme logic of the DEF BOP.




CS (Carrier send) signal

| Signal No. | Signal name |
|---|---|
| 886: | CAR-S for Distance and DEF command protection (CH1) |
| 887: | DECAR－S for DEF command protection (CH2) |

R1-CR-DEF: Trip permission signal from the remote terminal 1 in 3 terminal application, or Trip permission signal from remote terminal in 2 terminal application.

| Signal No. | Signal name | Description |
|---|---|---|
| 1856: | CAR.R1-1 | Trip carrier signal from remote terminal 1 (CH1) |
| 1857: | CAR.R1-2 | Trip carrier signal from remote terminal 1 (CH2) |

R2-CR-DEF: Trip permission signal from the remote terminal 2 in 3 terminal application.

| Signal No. | Signal name | Description |
|---|---|---|
| 1864: | CAR.R2-1 | Trip carrier signal from remote terminal 2 (CH1) |
| 1865: | CAR.R2-2 | Trip carrier signal from remote terminal 2 (CH2) |

**Figure 2.4.1.6 DEF BOP Scheme Logic**

With the BOP, the signal transmitted is a trip block signal. When the reverse looking DEFR operates, the logic level of the transmit signal CS becomes 1 and a trip block signal is transmitted. When the trip block signal is received, R1-CR-DEF and R2-CR-DEF becomes 1.

When the forward looking DEFF operates, it executes tripping on condition that no trip blocking signal should be received.

The delayed pick-up timer TCHD is provided to allow for the transmission delay of the trip block signal from the remote terminal. Therefore, the time is set depending on the channel delay time.

TCHD setting = maximum signal transmission delay time(*) + 5ms

(*) includes delay time of binary output and binary input for the blocking signal.

The DEFR is also used for the current reversal logic (for current reversal, see Section 2.3.2.6).

www.ElectricalPartManuals.com

When operation of the DEFR and non-operation of the DEFF last for 20 ms or more, even if the DEFF operates or the DEFR is reset later, tripping of the local terminal is blocked for the TREBK setting time and transmission of the trip block signal continues for the TSBCT setting time.

When the signaling channel of DEF BOP is separated from that of distance command protection, the signal S-DEFBOP2 is used for CS and assigned to a user configurable binary output relay (see Section 3.2.2.).

**Setting**

The following setting is required for the DEF command protection:

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| DEFF | | | | Forward looking DEF |
| DEFFI | 0.5 - 5.0 A | 0.1 A | 1.0 A | Residual current |
| | (0.10 - 1.00 A | 0.01 A | 0.2 A) (*) | |
| DEFFV | 1.7 – 21.0 V | 0.1 V | 2.0 V | Residual voltage |
| TDEFC | 0.00 - 0.30 s | 0.01 s | 0.15 s | DEF carrier trip delay timer |
| DEFR | | | | Reverse looking DEF |
| DEFRI | 0.5 - 5.0 A | 0.1 A | 1.0 A | Residual current |
| | (0.10 - 1.00 A | 0.01 A | 0.20 A) | |
| DEFRV | 1.7 – 21.0 V | 0.1 V | 2.0 V | Residual voltage |
| TDERC | 0.00 - 0.30 s | 0.01 s | 0.15 s | DEF carrier trip delay timer |
| DEF θ | 0 - 90° | 1° | 85° | Characteristic angle |
| TCHD | 0-50 ms | 1 ms | 12 ms | Coordination timer |
| TREBK | 0.00 - 10.00s | 0.01s | 0.10s | Current reversal blocking timer |
| TSBCT | 0.00 - 1.00s | 0.01s | 0.10s | SBCNT timer |
| TECCB | 0.00 – 200.00s | 0.01s | 0.10 | ECHO enable timer from CB opened |
| CRSCM | PUP/POP/UOP/ BOP | | POP | Scheme selection |
| DISCR | OFF/ON | | OFF | Distance carrier protection enable |
| DEFCR | OFF/ON | | OFF | DEF carrier protection enable |
| ZONESEL | Z2/Z3 | | Z2 | Carrier control element |
| ECHO | OFF/ON | | OFF | ECHO carrier send |
| WKIT | OFF/ON | | OFF | Weak infeed carrier trip |
| CH-DEF | CH1/CH2 | | CH1 | DEF carrier channel setting |

(*) Current values shown in the parentheses are in the case of 1 A rating. Other current values are in the case of 5 A rating.

When the DEFF at the remote end operates, the local DEFR must always operate for reverse faults. The setting levels of the residual current and residual voltage for the DEFR must be lower than that for the DEFF.

### 2.4.2 Directional Earth Fault Protection

The scheme logic is shown in Figure 2.4.1.

The directional inverse or definite time earth fault protection as backup protection executes three-phase final tripping. The forward looking DEFF or reverse looking DEFR can be selected. The directional inverse and definite time earth fault protections are available to trip instantaneously by binary input DEF∗_INST-TRIP except for [DEF∗EN]= “OFF” setting.

In order to give priority to the distance protection, the directional earth fault protection enables inverse time or definite time delayed tripping by the scheme switch [DEF∗EN].

www.ElectricalPartManuals.com

### Setting

The settings necessary for the directional earth fault protection are as follows:

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| DEFF | | | | Forward looking DEF |
| DEFFI | 0.5 - 5.0 A | 0.1 A | 1.0 A | Residual current |
| | (0.10 - 1.00 A | 0.01 A | 0.2 A) (*) | |
| DEFFV | 1.7 – 21.0 V | 0.1 V | 2.0 V | Residual voltage |
| TDEF | 0.0 – 10.0 s | 0.1 s | 0.0 s | Definite time setting |
| DEFR | | | | Reverse looking DEF |
| DEFRI | 0.5 - 5.0 A | 0.1 A | 1.0 A | Residual current |
| | (0.10 - 1.00 A | 0.01 A | 0.2 A) (*) | |
| DEFRV | 1.7 – 21.0 V | 0.1 V | 2.0 V | Residual voltage |
| TDER | 0.0 – 10.0 s | 0.1 s | 0.0 s | Definite time setting |
| DEF θ | 0 - 90° | 1° | 85° | Characteristic angle |
| DEFFEN | OFF/ON | | OFF | Forward DEF backup trip enable |
| DEFREN | OFF/ON | | OFF | Reverse DEF backup trip enable |
| EFIBT | OFF/NOD/F/R | | NOD | EFI directional control |

(*) Current values shown in the parentheses are in the case of 1 A rating. Other current values are in the case of 5 A rating.

The DEF element is shared with the command protection.

The EFIBT is the scheme switch for directional control selection and if NOD is selected, the inverse time overcurrent protection executes non-directional operation. If F or R is selected, it executes forward operation or reverse operation in combination with the DEFF or DEFR. If OFF is selected, the inverse time overcurrent protection is blocked.

www . ElectricalPartManuals . com

## 2.5 Overcurrent Backup Protection

Inverse time and definite time overcurrent protections are provided for phase faults and earth faults respectively.

### Scheme logic

The scheme logic of the overcurrent backup protection is shown in Figures 2.5.1 and 2.5.2. The overcurrent protection issues single-phase tripping signals in the operation of OC and OCI, and issues a three-phase tripping signal BU-TRIP in the operation of EF or EFI element. Three-phase tripping of OC and OCI is available by PLC signals OC_3PTP and OCI_3PTP. Tripping by each element can be disabled by the scheme switches [OCBT], [OCIBT], [EFBT] and [EFIBT]. The EF element issues an alarm for the backup trip for earth fault. The alarm can be disabled by the scheme switch [EFBTAL].

The overcurrent backup protection can be blocked by the binary input signal BUT_BLOCK. Tripping by each protection can be blocked by PLC signals OC_BLOCK, OCI_BLOCK, EF_BLOCK and EFI_BLOCK. The OC and EF can trip instantaneously by PLC signals OC_INST_TP and EF_INST_TP.

The OC and OCI protections can connect to the Fail-safe elements by PLC. Then the outputs of Fail-safe elements are connected to OC-A_FS, OC-B_FS, OC-C_FS, OCI-A_FS, OCI-B_FS and OCI-C_FS.

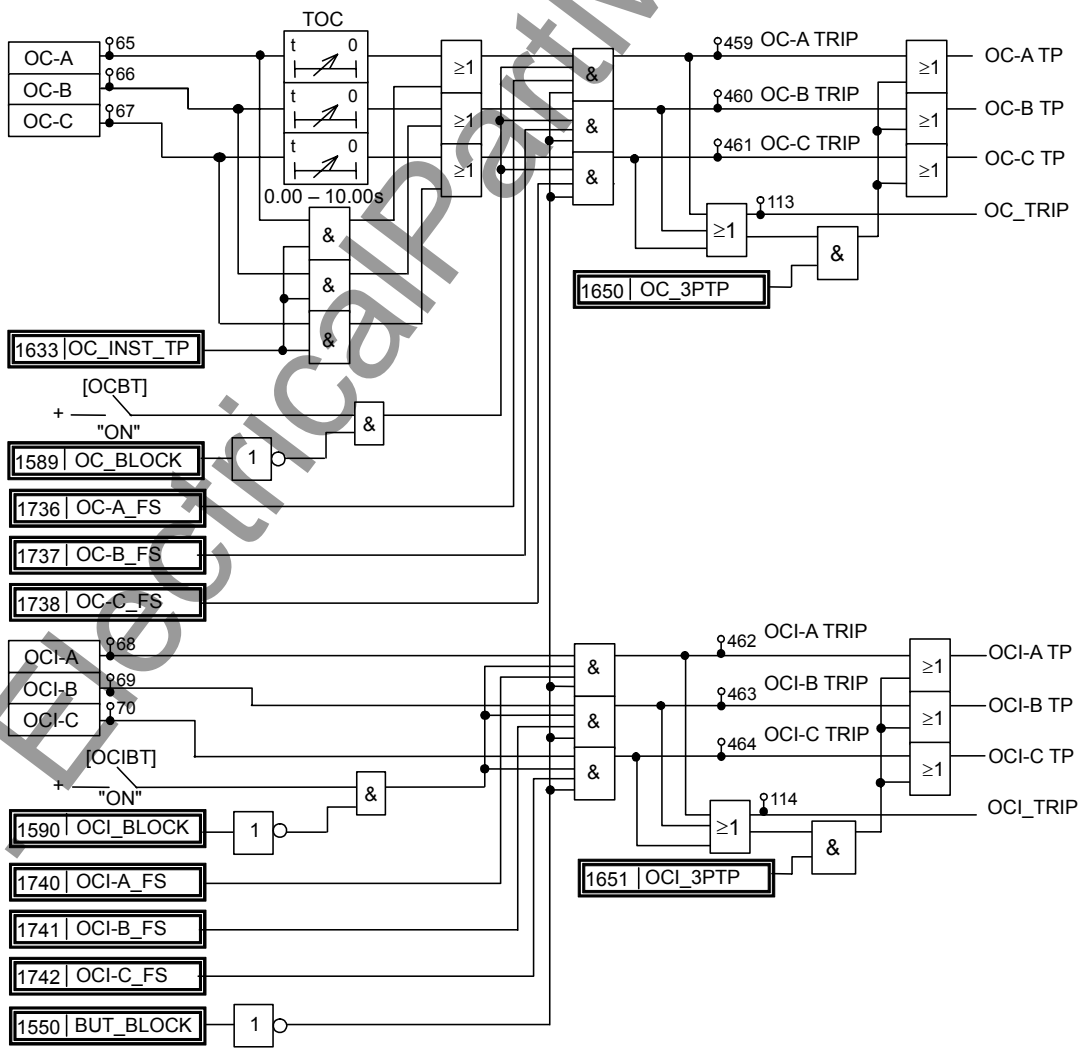



**Figure 2.5.1 Overcurrent Backup Protection OC and OCI**

www.ElectricalPartManuals.com

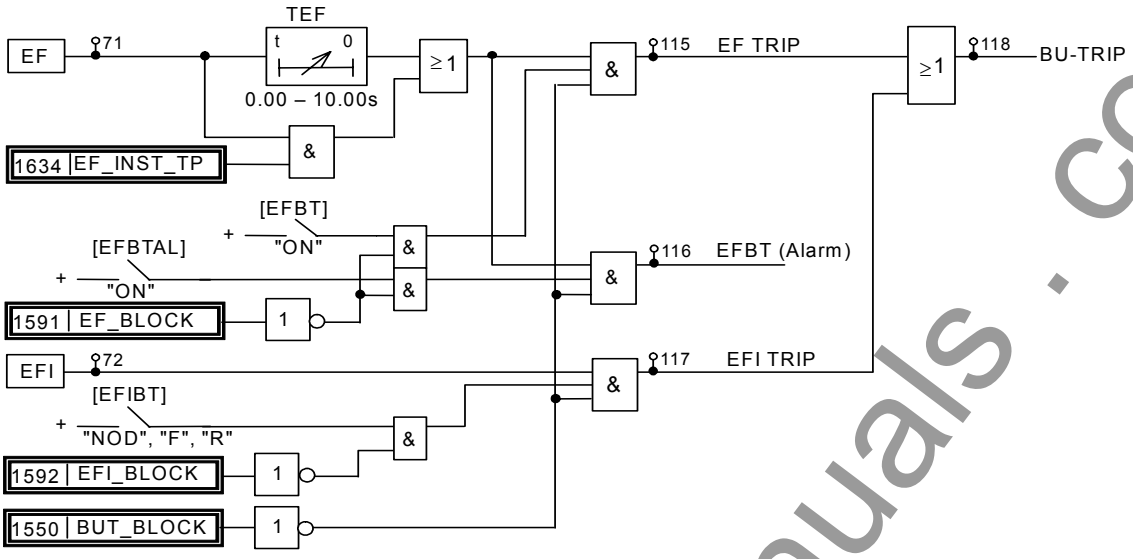



**Figure 2.5.2 Overcurrent Backup Protection EF and EFI**

### 2.5.1 Inverse Time Overcurrent Protection

In a system in which the fault current is mostly determined by the fault location, without being greatly affected by changes in the power source impedance, it is advantageous to use the inverse definite minimum time (IDMT) overcurrent protection. Reasonably fast tripping should be obtained even at a terminal close to the power supply by using the inverse time characteristics. In the IDMT overcurrent protection function, one of the following three IEC-standard-compliant inverse time characteristics and one long time inverse characteristic is available.

- standard inverse IEC 60255-3
- very inverse IEC 60255-3
- extremely inverse IEC 60255-3

The IDMT element has a reset feature with definite time reset.

If the reset time is set to instantaneous, then no intentional delay is added. As soon as the energising current falls below the reset threshold, the element returns to its reset condition.

If the reset time is set to some value in seconds, then an intentional delay is added to the reset period. If the energising current exceeds the setting for a transient period without causing tripping, then resetting is delayed for a user-definable period. When the energising current falls below the reset threshold, the integral state (the point towards operation that it has travelled) of the timing function (IDMT) is held for that period.

This does not apply following a trip operation, in which case resetting is always instantaneous.

#### Setting

The following table shows the setting elements necessary for the inverse time overcurrent protection and their setting ranges.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| OCI | 0.5 - 25.0 A | 0.1 A | 10.0 A | |
| | ( 0.10 - 5.00 A | 0.01 A | 2.00 A) (*) | |
| TOCI | 0.05 - 1.00 | 0.01 | 0.50 | OCI time setting |
| TOCIR | 0.0 – 10.0 s | 0.1 s | 0.0 s | OCI definite time reset delay |
| [MOCI] | Long/Std/Very/Ext | | Std | OCI inverse characteristic selection |
| [OCIBT] | ON/OFF | | ON | OCI backup protection |

www.ElectricalPartManuals.com

| | | | | |
|---|---|---|---|---|
| EFI | 0.5 - 5.0 A | 0.1 A | 5.0 A | Earth fault EFI setting |
| | ( 0.10 - 1.00 A | 0.01 A | 1.00 A) (*) | |
| TEFI | 0.05 - 1.00 | 0.01 | 0.50 | EFI time setting |
| TEFIR | 0.0 – 10.0 s | 0.1 s | 0.0 s | EFI definite time reset delay |
| [MEFI] | Long/Std/Very/Ext | | Std | EFI inverse characteristic selection |
| [EFIBT] | OFF/NOD/F/R | | NOD | EFI backup protection |

(*) Current values shown in the parentheses are in the case of 1 A rating. Other current values are in the case of 5 A rating.

The scheme switches [MOCI] and [MEFI] are used to select one of the four inverse time characteristics.

### Current setting

In Figure 2.5.1.1, the current setting at terminal A is set lower than the minimum fault current in the event of a fault at remote end F1. Furthermore, when considering also backup protection of a fault within the adjacent lines, it is set lower than the minimum fault current in the event of a fault at remote end F3. For grading of the current settings, the terminal furthest from the power source is set to the lowest value and the terminals closer to the power source are set to a higher value.

The minimum setting is restricted so as not to operate on false zero-sequence currents caused by an unbalance in the load current, errors in the current transformer circuits or zero-sequence mutual coupling of parallel lines.

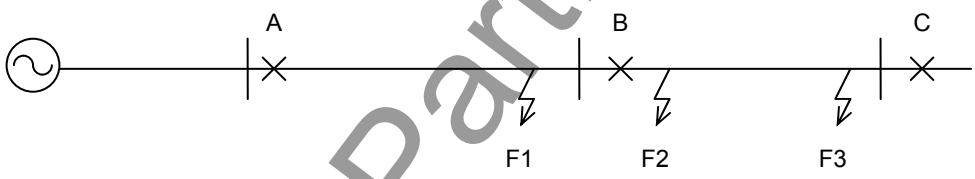



**Figure 2.5.1.1 Current Settings in Radial System**

### Time setting

Time setting is performed to provide selectivity in relation with the relays on the adjacent lines. Suppose a minimum source impedance when the current flowing in the relay becomes the maximum. In Figure 2.5.1.1, in the event of a fault at near end F2 of the adjacent line, the operating time is set so that terminal A may operate by time grading Tc behind terminal B. The current flowing in the relays may sometimes be greater when the remote end of the adjacent line is open. At this time, time coordination must also be kept.

The reason why the operating time is set when the fault current reaches the maximum is that if time coordination is obtained for large fault current, then time coordination can also be obtained for small fault current as long as relays with the same operating characteristic are used for each terminal.

The grading margin Tc of terminal A and terminal B is given by the following expression for a fault at point F2 in Figure 2.5.1.1.

$$Tc = T1 + T2 + M$$

where, T1: circuit breaker clearance time at B
T2: relay reset time at A
M: margin

When single-phase autoreclose is used, the minimum time of the earth fault overcurrent protection must be set longer than the time from fault occurrence to reclosing of the circuit breaker. This is to prevent three-phase final tripping from being executed by the overcurrent protection during a single-phase autoreclose cycle.

www.ElectricalPartManuals.com

### 2.5.2 Definite Time Overcurrent Protection

In a system in which fault current does not change greatly with the position of the fault, the advantages of the IDMT characteristics are not fully realised. In this case, the definite time overcurrent protection is applied. The operating time can be set irrespective of the magnitude of the fault current.

The definite time overcurrent protection consists of instantaneous overcurrent elements and on-delay timers started by them.

Identical current values can be set for terminals, but graded settings are better than identical settings in order to provide a margin for current sensitivity. The farther from the power source the terminal is located, the higher sensitivity (i.e. the lower setting) is required.

The operating time of the overcurrent element of each terminal is constant irrespective of the magnitude of the fault current and selective protection is implemented by graded settings of the on-delay timer. As a result, the circuit breaker of the terminal most remote from the power source is tripped in the shortest time.

When setting the on-delay timers, time grading margin Tc is obtained in the same way as explained in Section 2.5.1.

#### Setting

The setting elements necessary for the definite time overcurrent protection and their setting ranges are shown below.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| OC | 0.5 - 100.0 A | 0.1 A | 10.0 A | Phase overcurrent |
| | ( 0.1 - 20.0 A | 0.1 A | 2.0 A) (*) | |
| TOC | 0.00 - 10.00 s | 0.01 s | 3.00 s | OC delayed tripping |
| OCBT | ON/OFF | | ON | OC backup protection |
| EF | 0.5 - 5.0 A | 0.1 A | 5.0 A | Residual overcurrent |
| | ( 0.10 - 1.00 A | 0.01 A | 1.00 A) (*) | |
| TEF | 0.00 - 10.00 s | 0.01 s | 3.00 s | EF delayed tripping |
| [EFBT] | ON/OFF | | ON | EF backup protection |
| [EFBTAL] | ON/OFF | | ON | EF backup trip alarm |

(*) Current values shown in the parentheses are in the case of 1 A rating. Other current values are in the case of 5 A rating.

www . ElectricalPartManuals . com

## 2.6 Transfer Trip Function

The GRL100 provides the transfer trip function which receives a trip signal from the remote terminal and outputs a trip command. Two transfer trip commands are provided. The scheme logic is shown in Figure 2.6.1. When the scheme switch [TTSW∗] is set to "TRIP", the binary output for tripping is driven. When set to "BO", the binary output for tripping is not driven and only user-configurable binary output is driven.

The sending signal is configured by PLC function. If the sending signal is assigned on a per phase basis by PLC, a single-phase tripping is available.

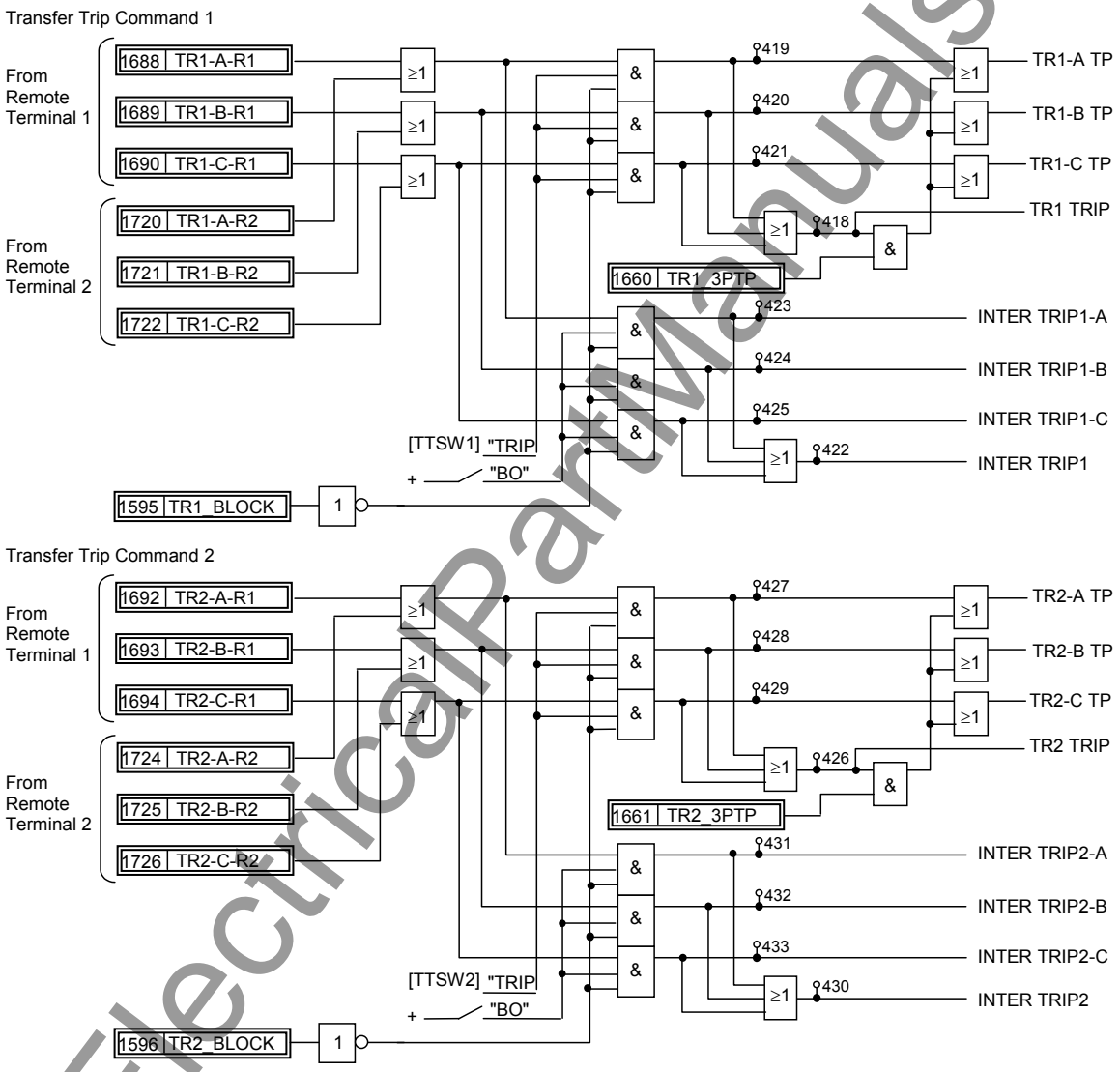



**Figure 2.6.1 Transfer Trip Scheme Logic**

www . ElectricalPartManuals . com

## 2.7 Out-of-step Protection

The GRL100 out-of-step protection (OST) operates only when the out-of-step loci cross the protected line and provides optimal power system separation in case of power system step out.

The OST compares the phase of the local and remote positive sequence voltages and detects the out-of-step when the difference in the phase angle exceeds 180°. The OST can detect any of the out-of-steps with slow or fast slip cycles.

Figure 2.7.1 show the loci of the voltage vectors measured at terminals A and B when an out-of-step occurs on the power system. P and Q are equivalent power source locations. Loci 1 and 2 are the cases when the locus crosses the protected line, and passes outside the protected line, respectively.

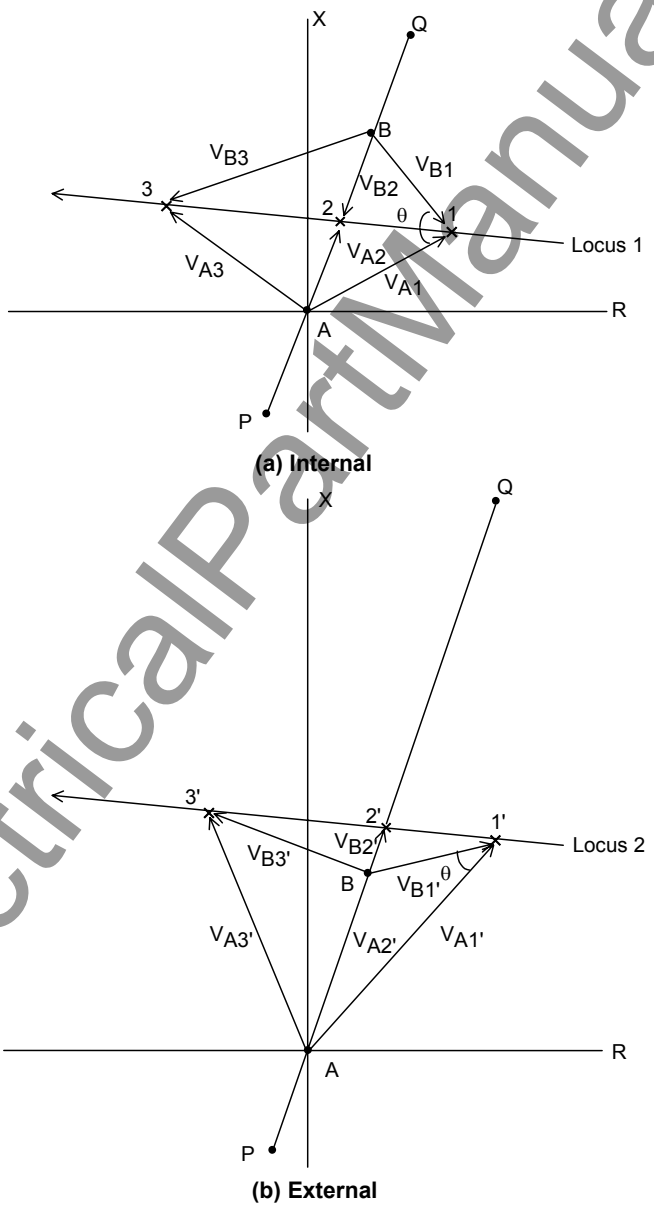



**Figure 2.7.1 Out-of-step Loci**

Voltage phase angle differs by θ between terminals A and B. In case of Locus 1, θ gets larger as the voltage locus approaches the protected line and becomes 180° when the locus crosses the line. In case of Locus 2, θ becomes 0° when the locus crosses the power system impedance outside the protected line.

www . ElectricalPartManuals . com

At terminal A, the terminal voltage $V_A$ is taken as a reference voltage. Then, the phase angle of the remote terminal voltage $V_B$ changes as shown in Figure 2.7.2. Out-of-step is detected when $V_B$ moves from the second quadrant to the third quadrant or vice versa.

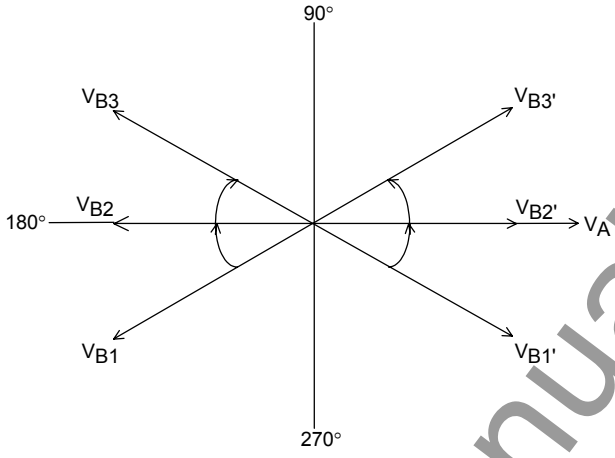
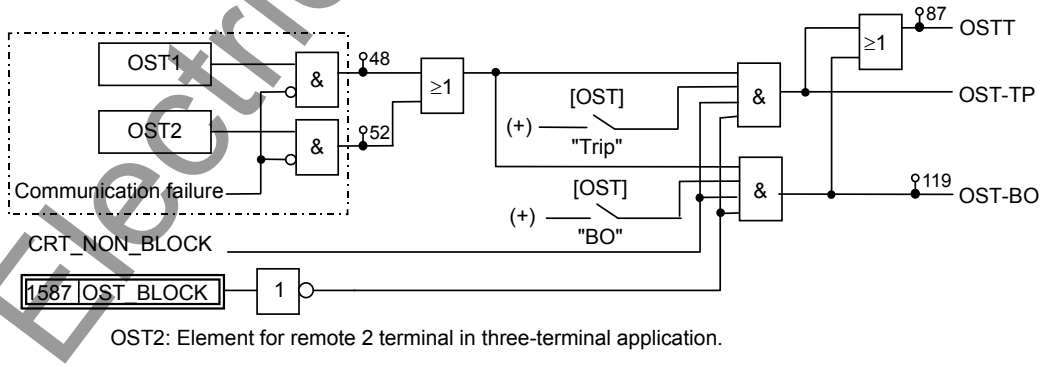



**Figure 2.7.2 Voltage Phase Comparison**

In the case of a three-terminal line, this phase comparison is performed between each pair of terminals. All the terminals can detect any out-of-step provided its locus crosses the protected line.

Figure 2.7.3 shows a scheme logic for the out-of-step protection. The output signal of the out-of-step element OST1 performs three-phase final tripping. The output signal is blocked when the scheme switch [OST] is set to "OFF" or binary signal OST_BLOCK is input. The tripping signal of the out-of-step protection can be separated from other protection tripping signals by the switch [OST]. In this case, the switch [OST] is set to "BO" and the tripping signal OST-BO is assigned to a desired binary output number (for details, see Section 4.2.6.9). When the tripping signal of the out-of-step protection is not separated from other protection tripping signals, the switch [OST] is set to "Trip".

The voltage of the out-of-service terminal is set to zero at the receiving terminal and the OST does not function with the out-of-service terminal.




OST2: Element for remote 2 terminal in three-terminal application.

**Figure 2.7.3 Scheme Logic for Out-of-step Protection**

### Setting

The OST measuring element has no setting items. Only the scheme switch [OST] setting is necessary for the out-of-step protection.

| Element | Range | Step | Default |
|---|---|---|---|
| [OST] | OFF/Trip/BO | | OFF |

www.ElectricalPartManuals.com

## 2.8 Thermal Overload Protection

The temperature of electrical plant rises according to an $I^2t$ function and the thermal overload protection in GRL100 provides a good protection against damage caused by sustained overloading. The protection simulates the changing thermal state in the plant using a thermal model.

The thermal state of the electrical system can be shown by equation (1).

$$\theta = \frac{I^2}{I_{AOL}^2}\left(1 - e^{-t/\tau}\right) \times 100\% \qquad (1)$$

where:

$\theta$ = thermal state of the system as a percentage of allowable thermal capacity,

I = applied load current,

$I_{AOL}$ = allowable overload current of the system,

$\tau$ = thermal time constant of the system.

The thermal state 0% represents the cold state and 100% represents the thermal limit, which is the point at which no further temperature rise can be safely tolerated and the system should be disconnected. The thermal limit for any given system is fixed by the thermal setting $I_{AOL}$. The relay gives a trip output when $\theta$ = 100%.

The thermal overload protection measures the largest of the three phase currents and operates according to the characteristics defined in IEC60255-8. (Refer to Appendix P for the implementation of the thermal model for IEC60255-8.)

Time to trip depends not only on the level of overload, but also on the level of load current prior to the overload - that is, on whether the overload was applied from 'cold' or from 'hot'.

Independent thresholds for trip and alarm are available.

The characteristic of the thermal overload element is defined by equation (2) and equation (3) for 'cold' and 'hot'. The cold curve is a special case of the hot curve where prior load current Ip is zero, catering to the situation where a cold system is switched on to an immediate overload.

$$t = \tau \cdot Ln\left[\frac{I^2}{I^2 - I_{AOL}^2}\right] \qquad (2)$$

$$t = \tau \cdot Ln\left[\frac{I^2 - I_P^2}{I^2 - I_{AOL}^2}\right] \qquad (3)$$

where:

t = time to trip for constant overload current I (seconds)

I = overload current (largest phase current) (amps)

$I_{AOL}$ = allowable overload current (amps)

$I_P$ = previous load current (amps)

$\tau$ = thermal time constant (seconds)

*Ln* = natural logarithm

Figure 2.8.1 illustrates the IEC60255-8 curves for a range of time constant settings. The left-hand chart shows the 'cold' condition where an overload has been switched onto a previously un-loaded system. The right-hand chart shows the 'hot' condition where an overload

www.ElectricalPartManuals.com

is switched onto a system that has previously been loaded to 90% of its capacity.

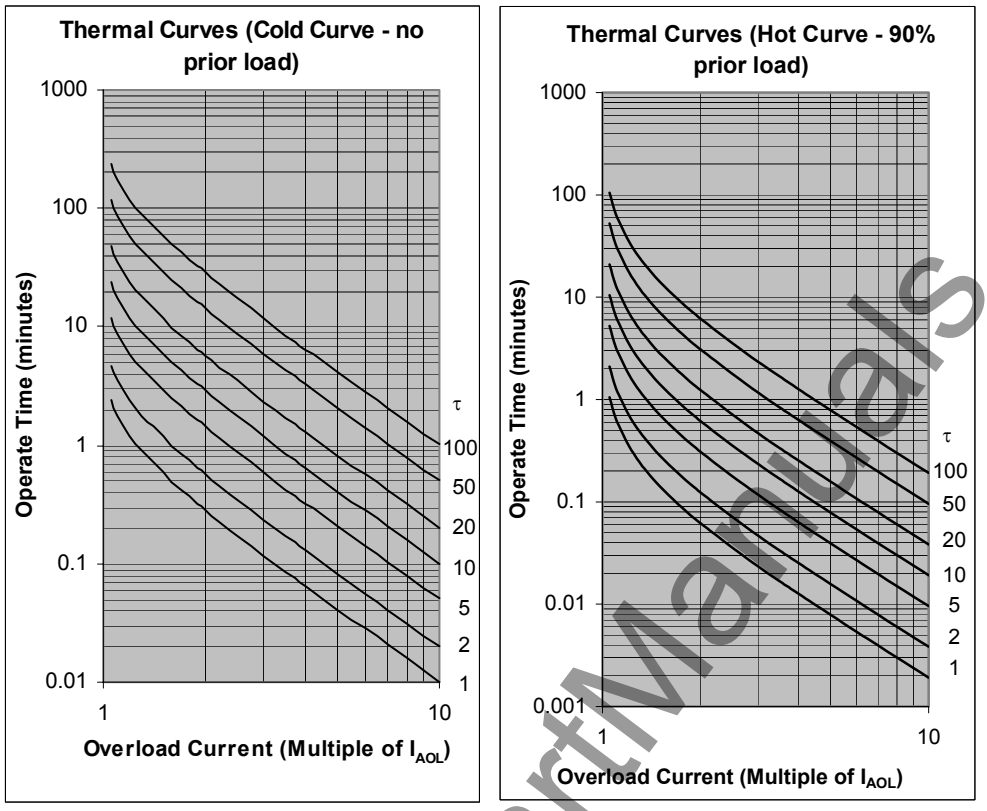



**Figure 2.8.1 Thermal Curves**

### Scheme Logic

Figure 2.8.2 shows the scheme logic of the thermal overload protection.

The thermal overload element THM has independent thresholds for alarm and trip, and outputs alarm signal THM ALARM and trip signal THM TRIP. The alarming threshold level is set as a percentage of the tripping threshold.

The alarming and tripping can be disabled by the scheme switches [THMAL] and [THMT] respectively or binary input signals THMA BLOCK and THM BLOCK.

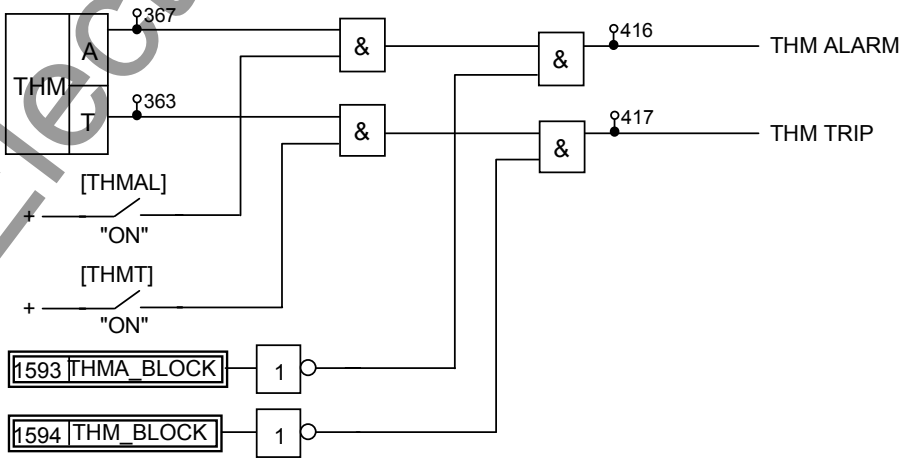



**Figure 2.8.2 Thermal Overload Protection Scheme Logic**

www . ElectricalPartManuals . com

### Setting

The table below shows the setting elements necessary for the thermal overload protection and their setting ranges.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| THM | 2.0 – 10.0 A<br>(0.40 – 2.00 A)(*) | 0.1 A<br>(0.01 A) | 5.0 A<br>(1.00 A) | Thermal overload setting.<br>(THM = $I_{AOL}$: allowable overload current) |
| THMIP | 0.0 – 5.0 A<br>(0.00 – 1.00 A)(*) | 0.1 A<br>(0.01 A) | 0.0 A<br>(0.00 A) | Previous load current |
| TTHM | 0.5 - 300.0 min | 0.1 min | 10.0 min | Thermal time constant |
| THMA | 50 – 99 % | 1 % | 80 % | Thermal alarm setting.<br>(Percentage of THM setting.) |
| [THMT] | Off / On | | Off | Thermal OL enable |
| [THMAL] | Off / On | | Off | Thermal alarm enable |

(*) Current values shown in the parenthesis are in the case of a 1 A rating. Other current values are in the case of a 5 A rating.

Note: THMIP sets a minimum level of previous load current to be used by the thermal element, and is typically used when testing the element. For the majority of applications, THMIP should be set to its default value of zero, in which case the previous load current, Ip, is calculated internally by the thermal model, providing memory of conditions occurring before an overload.

www . ElectricalPartManuals . com

## 2.9 Overvoltage and Undervoltage Protection

### 2.9.1 Overvoltage Protection

GRL100 provides four independent undervoltage elements with programmable dropoff/pickup(DO/PU) ratio for phase-to-phase voltage input and phase voltage input. OVS1 and OVS2 are used for phase-to-phase voltage input, and OVG1 and OVG2 for phase voltage input. OVS1 and OVG1 are programmable for inverse time (IDMT) or definite time (DT) operation. OVS2 and OVG2 have definite time characteristic only.

OVS1 and OVG1 overvoltage protection elements have an IDMT characteristic defined by equation (1):

$$t = TMS \times \left[ \frac{1}{\left( V / V_S \right) - 1} \right] \qquad (1)$$

where:

t = operating time for constant voltage V (seconds),

V = energising voltage (V),

Vs = overvoltage setting (V),

TMS = time multiplier setting.

The IDMT characteristic is illustrated in Figure 2.9.1.1.

The OVS2 and OVG2 elements are used for definite time overvoltage protection.

#### Definite time reset

The definite time resetting characteristic is applied to the OVS1 and OVG1 elements when the inverse time delay is used.

If definite time resetting is selected, and the delay period is set to instantaneous, then no intentional delay is added. As soon as the energising voltage falls below the reset threshold, the element returns to its reset condition.

If the delay period is set to some value in seconds, then an intentional delay is added to the reset period. If the energising voltage exceeds the setting for a transient period without causing tripping, then resetting is delayed for a user-definable period. When the energising voltage falls below the reset threshold, the integral state (the point towards operation that it has travelled) of the timing function (IDMT) is held for that period.

This does not apply following a trip operation, in which case resetting is always instantaneous.

Overvoltage elements OVS1, OVS2, OVG1 and OVG2 have a programmable dropoff/pickup (DO/PU) ratio.

www . ElectricalPartManuals . com

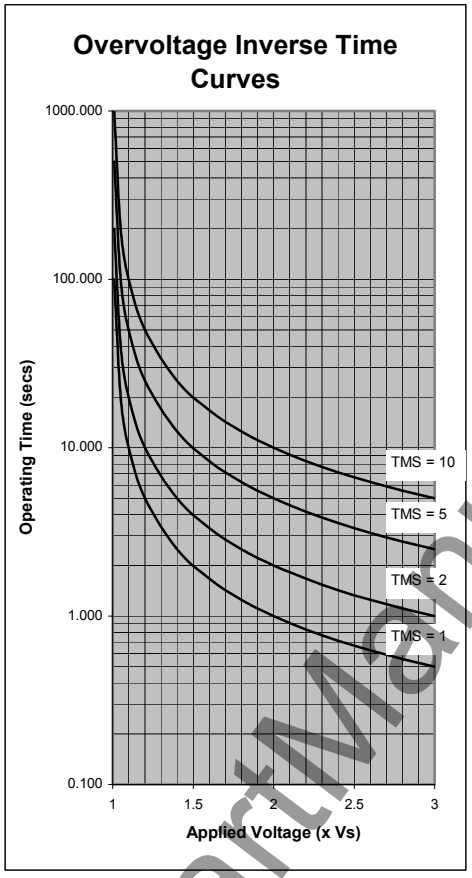



**Figure 2.9.1.1 IDMT Characteristic**

### Scheme Logic

Figures 2.9.1.2 (a) and 2.9.1.3 (a) show the scheme logic of the OVS1 and OVG1 overvoltage protection with selective definite time or inverse time characteristic.

The definite time protection is selected by setting [OV∗1EN] to "DT", and trip signal OV∗1_TRIP is given through the delayed pick-up timer TO∗1. The inverse time protection is selected by setting [OV∗1EN] to "IDMT", and trip signal OV∗1_TRIP is given.

The OVS1 and OVG1 protections can be disabled by the scheme switch [OV∗1EN] or the PLC signal OV∗1_BLOCK.

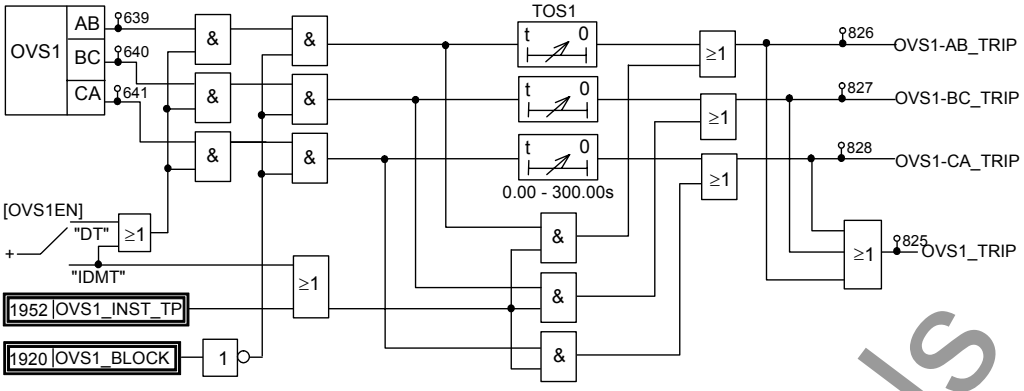
These protections are available to trip instantaneously by the PLC signal OV∗1_INST_TP except for [OV∗1EN]= "OFF" setting.

Figures 2.9.1.2 (b) and 2.9.1.3 (b) show the scheme logic of the OVS2 and OVG2 protection with definite time characteristic. The OV∗2 gives the signal OV∗2_ALARM through delayed pick-up timer TO∗2.

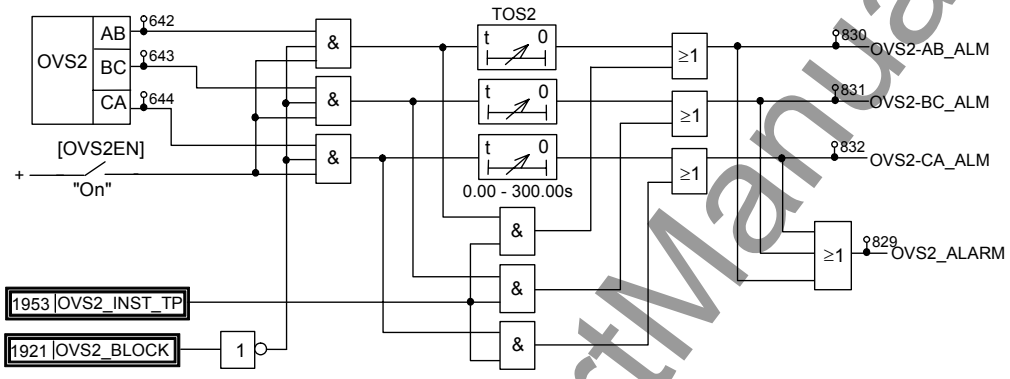
The OV∗2_ALARM can be blocked by incorporated scheme switch [OV∗2EN] and the binary input signal OV∗2_BLOCK.

These protections are also available to alarm instantaneously by the PLC signal OV∗2_INST_TP.

www.ElectricalPartManuals.com

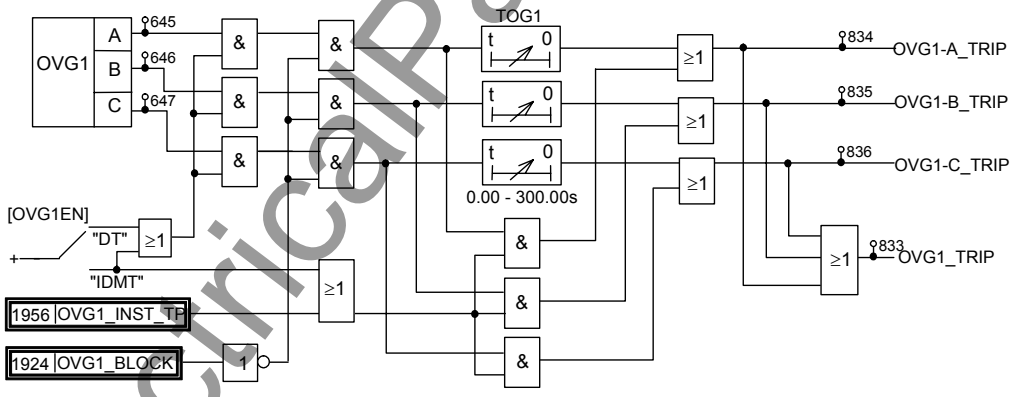



**(a) OVS1 Overvoltage Protection**

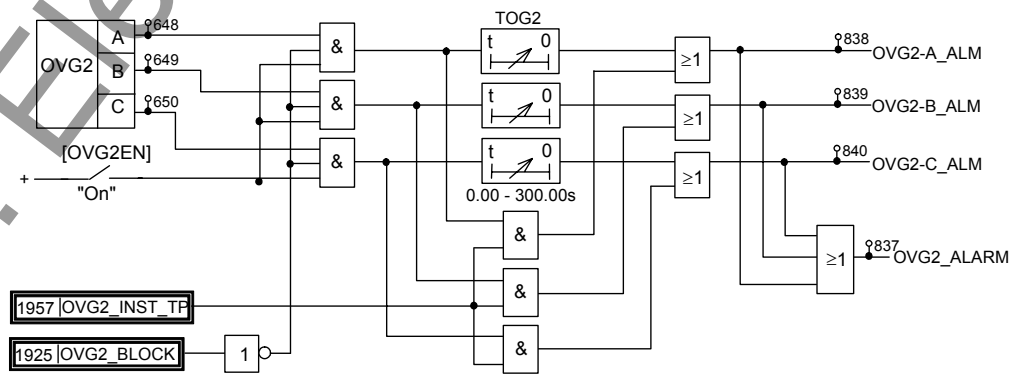



**(b) OVS2 Overvoltage Protection**

**Figure 2.9.1.2 OVS Overvoltage Protection**




**(a) OVG1 Overvoltage Protection**




**(b) OVG2 Overvoltage Protection**

**Figure 2.9.1.3 OVG Overvoltage Protection**

www . ElectricalPartManuals . com

### Setting

The table shows the setting elements necessary for the overvoltage protection and their setting ranges.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| OVS1 | 5.0 – 150.0 V | 0.1 V | 120.0 V | OVS1 threshold setting. |
| TOS1I | 0.05 – 100.00 | 0.01 | 10.00 | OVS1 time multiplier setting. Required if [OVS1EN] = IDMT. |
| TOS1 | 0.00 – 300.00 s | 0.01 s | 0.10 s | OVS1 definite time setting. Required if [OVS1EN] = DT. |
| TOS1R | 0.0 – 300.0 s | 0.1 s | 0.0 s | OVS1 definite time delayed reset. |
| OS1DP | 10 – 98 % | 1 % | 95 % | OVS1 DO/PU ratio setting. |
| OVS2 | 5.0 – 150.0 V | 0.1 V | 140.0 V | OVS2 threshold setting. |
| TOS2 | 0.00 – 300.00 s | 0.01 s | 0.10 s | OVS2 definite time setting. |
| OS2DP | 10 - 98 % | 1 % | 95 % | OVS2 DO/PU ratio setting. |
| OVG1 | 5.0 – 150.0 V | 0.1V | 70.0 V | OVG1 threshold setting. |
| TOG1I | 0.05 – 100.00 | 0.01 | 10.00 | OVG1 time multiplier setting. Required if [OVG1EN]=IDMT. |
| TOG1 | 0.00 – 300.00 s | 0.01 s | 0.10 s | OVG1 definite time setting. Required if [ZOV1EN]=DT. |
| TOG1R | 0.0 – 300.0 s | 0.1 s | 0.0 s | OVG1 definite time delayed reset. |
| OG1DP | 10 – 98 % | 1 % | 95 % | OVG1 DO/PU ratio |
| OVG2 | 5.0 – 150.0 V | 0.1V | 80.0 V | OVG2 threshold setting |
| TOG2 | 0.00 – 300.00 s | 0.01 s | 0.10 s | OVG2 definite time setting |
| OG2DP | 10 – 98 % | 1 % | 95 % | OVG2 DO/PU ratio |
| [OVS1EN] | Off / DT / IDMT | | Off | OVS1 Enable |
| [OVS2EN] | Off / On | | Off | OVS2 Enable |
| [OVG1EN] | Off / DT / IDMT | | Off | OVG1 Enable |
| [OVG2EN] | Off / On | | Off | OVG2 Enable |

www . ElectricalPartManuals . com

### 2.9.2 Undervoltage Protection

GRL100 provides four independent undervoltage elements for phase and earth fault protection. UVS1 and UVS2 are used for phase fault protection, and UVG1 and UVG2 for earth fault protection. UVS1 and UVG1 are programmable for inverse time (IDMT) or definite time (DT) operation. UVS2 and UVG2 have definite time characteristic only.

UVS1 and UVG1 undervoltage protection elements have an IDMT characteristic defined by equation (2):

$$t = TMS \times \left[ \frac{1}{1 - \left( V / Vs \right)} \right] \qquad (2)$$

where:

t = operating time for constant voltage V (seconds),

V = energising voltage (V),

Vs = undervoltage setting (V),

TMS = time multiplier setting.

The IDMT characteristic is illustrated in Figure 2.9.2.1.

The UVS2 and UVG2 elements are used for definite time undervoltage protection.

#### Definite time reset

The definite time resetting characteristic is applied to the UVS1 and UVG1 elements when the inverse time delay is used.

If definite time resetting is selected, and the delay period is set to instantaneous, then no intentional delay is added. As soon as the energising voltage rises above the reset threshold, the element returns to its reset condition.

If the delay period is set to some value in seconds, then an intentional delay is added to the reset period. If the energising voltage is below the undercurrent setting for a transient period without causing tripping, then resetting is delayed for a user-definable period. When the energising voltage rises above the reset threshold, the integral state (the point towards operation that it has travelled) of the timing function (IDMT) is held for that period.

This does not apply following a trip operation, in which case resetting is always instantaneous.

www . ElectricalPartManuals . com

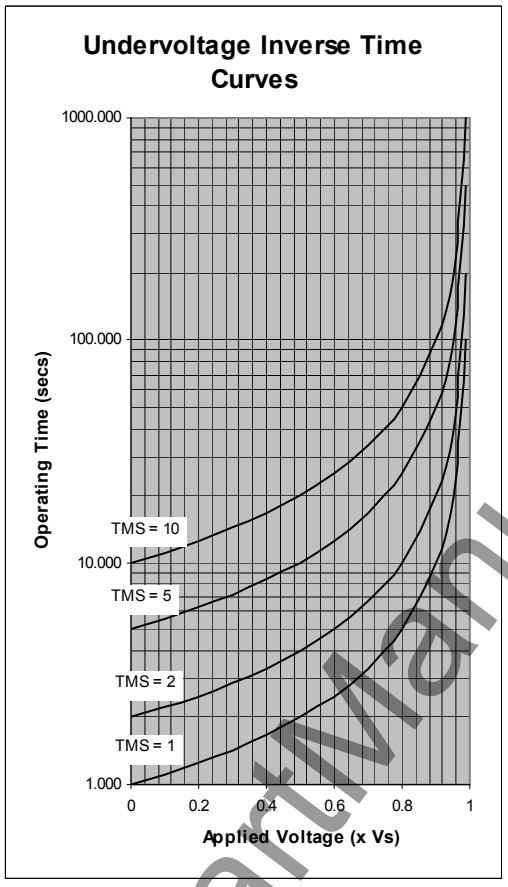



**Figure 2.9.2.1 IDMT Characteristic**

### Scheme Logic

Figures 2.9.2.2 (a) and 2.9.2.3 (a) show the scheme logic of the UVS1 and UVG1 undervoltage protection with selective definite time or inverse time characteristic.

The definite time protection is selected by setting [UV∗1EN] to "DT", and trip signal UV∗1_TRIP is given through the delayed pick-up timer TU∗1. The inverse time protection is selected by setting [UV∗1EN] to "IDMT", and trip signal UV∗1_TRIP is given.

The UVS1 and UVG1 protections can be disabled by the scheme switch [UV∗1EN] or the PLC signal UV∗1_BLOCK.

These protections are available to trip instantaneously by the PLC signal UV∗1_INST_TP except for [UV∗1EN]= "OFF" setting.

Figures 2.9.2.2 (b) and 2.9.2.3 (b) shows the scheme logic of the UVS2 and UVG2 protection with definite time characteristic. The UV∗2 gives the signal UV∗2_ALARM through delayed pick-up timer TU∗2.

The UV∗2_ALARM can be blocked by incorporated scheme switch [UV∗2EN] and the PLC signal UV∗2_BLOCK.

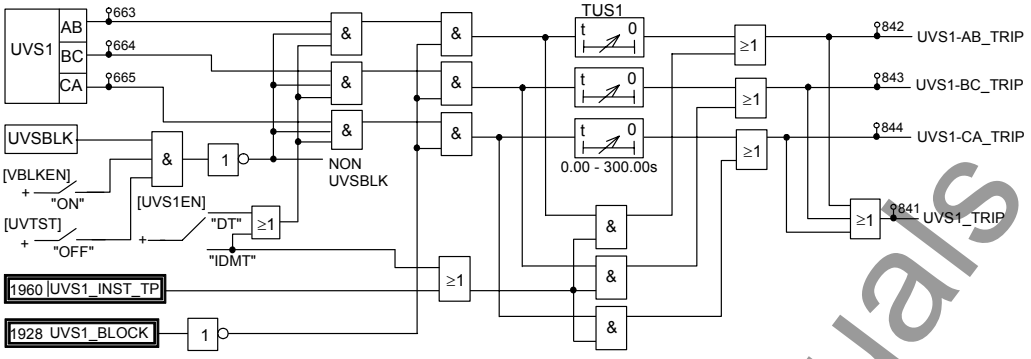
These protections are also available to alarm instantaneously by the PLC signal UV∗2_INST_TP except for [UV∗1EN]= "OFF" setting.

In addition, there is user programmable voltage threshold UVSBLK and UVGBLK. If all three phase voltages drop below this setting, then both UV∗1 and UV∗2 are prevented from operating. This function can be blocked by the scheme switch [VBLKEN]. The [VBLKEN] should be set to

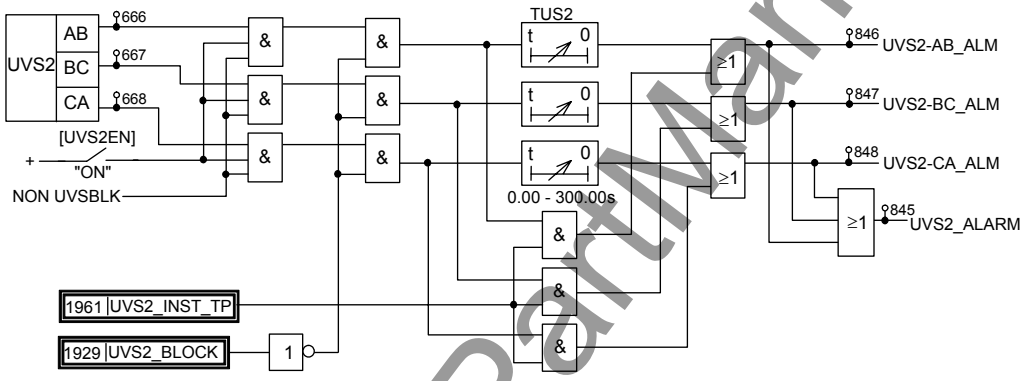
www.ElectricalPartManuals.com

"OFF" (not used) when the UV elements are used as fault detectors, and set to "ON" (used) when used for load shedding.

Note: The UVSBLK and UVGBLK must be set lower than any other UV setting values.

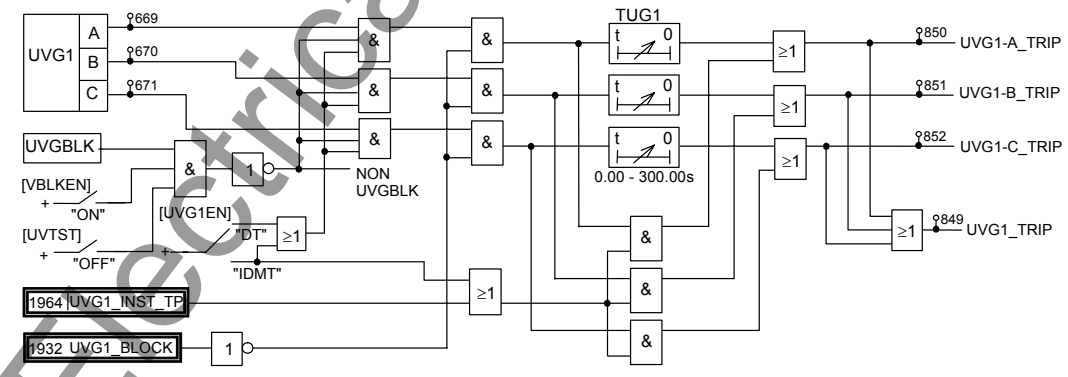



**(a) UVS1 Undervoltage Protection**




**(b) UVS2 Undervoltage Protection**

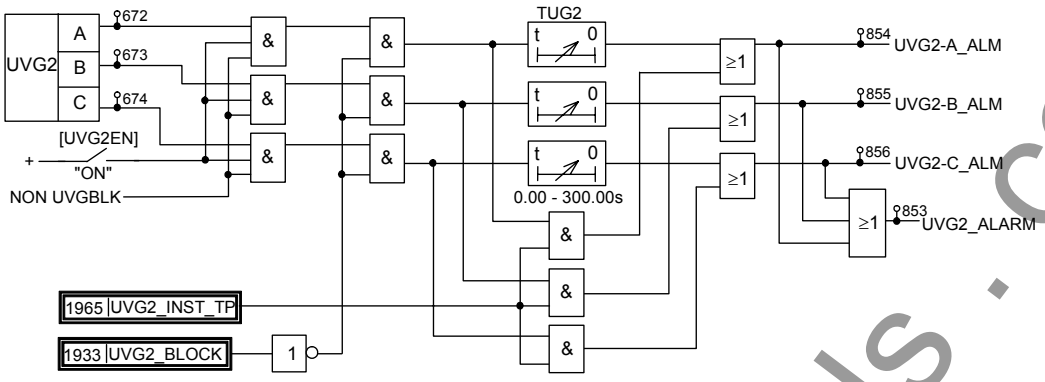
**Figure 2.9.2.2 UVS Undervoltage Protection**




**(a) UVG1 Undervoltage Protection**

**Figure 2.9.2.3 UVG Undervoltage Protection**

www.ElectricalPartManuals.com




**(b) UVG2 Undervoltage Protection**

**Figure 2.9.2.3 UVG Undervoltage Protection (continued)**

### Setting

The table shows the setting elements necessary for the undervoltage protection and their setting ranges.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| UVS1 | 5.0 – 150.0 V | 0.1 V | 60.0 V | UVS1 threshold setting |
| TUS1I | 0.05– 100.00 | 0.01 | 10.00 | UVSI time multiplier setting. Required if [UVS1EN] = IDMT. |
| TUS1 | 0.00 – 300.00 s | 0.01 s | 0.10 s | UVS1 definite time setting. Required if [UV1EN] = DT. |
| TUS1R | 0.0 – 300.0 s | 0.1 s | 0.0 s | UVS1 definite time delayed reset. |
| UVS2 | 5.0 – 150.0 V | 0.1 V | 40.0 V | UV2 threshold setting. |
| TUS2 | 0.00 – 300.00 s | 0.01 s | 0.10 s | UV2 definite time setting. |
| VSBLK | 5.0 – 20.0 V | 0.1 V | 10.0 V | Undervoltage block threshold setting. |
| UVG1 | 5.0 – 150.0 V | 0.1 V | 35.0 V | UVS1 threshold setting |
| TUG1I | 0.05– 100.00 | 0.01 | 10.00 | UVSI time multiplier setting. Required if [UVS1EN] = IDMT. |
| TUG1 | 0.00 – 300.00 s | 0.01 s | 0.10 s | UVS1 definite time setting. Required if [UV1EN] = DT. |
| TUG1R | 0.0 – 300.0 s | 0.1 s | 0.0 s | UVS1 definite time delayed reset. |
| UVG2 | 5.0 – 150.0 V | 0.1 V | 25.0 V | UV2 threshold setting. |
| TUG2 | 0.00 – 300.00 s | 0.01 s | 0.10 s | UV2 definite time setting. |
| VGBLK | 5.0 – 20.0 V | 0.1 V | 10.0 V | Undervoltage block threshold setting. |
| [UVS1EN] | Off / DT / IDMT | | Off | UVS1 Enable |
| [UVG1EN] | Off / DT / IDMT | | Off | UVG1 Enable |
| [UVS2EN] | Off / On | | Off | UVS2 Enable |
| [UVG2EN] | Off / On | | Off | UVG2 Enable |
| [VBLKEN] | Off / On | | Off | UV block Enable |

www . ElectricalPartManuals . com

## 2.10 Broken Conductor Protection

Series faults or open circuit faults which do not accompany any earth faults or phase faults are caused by broken conductors, breaker contact failure, operation of fuses, or false operation of single-phase switchgear.

Figure 2.10.1 shows the sequence network connection diagram in the case of a single-phase series fault assuming that the positive, negative and zero sequence impedance of the left and right side system of the fault location is in the ratio of $k_1$ to $(1 - k_1)$, $k_2$ to $(1 - k_2)$ and $k_0$ to $(1 - k_0)$.

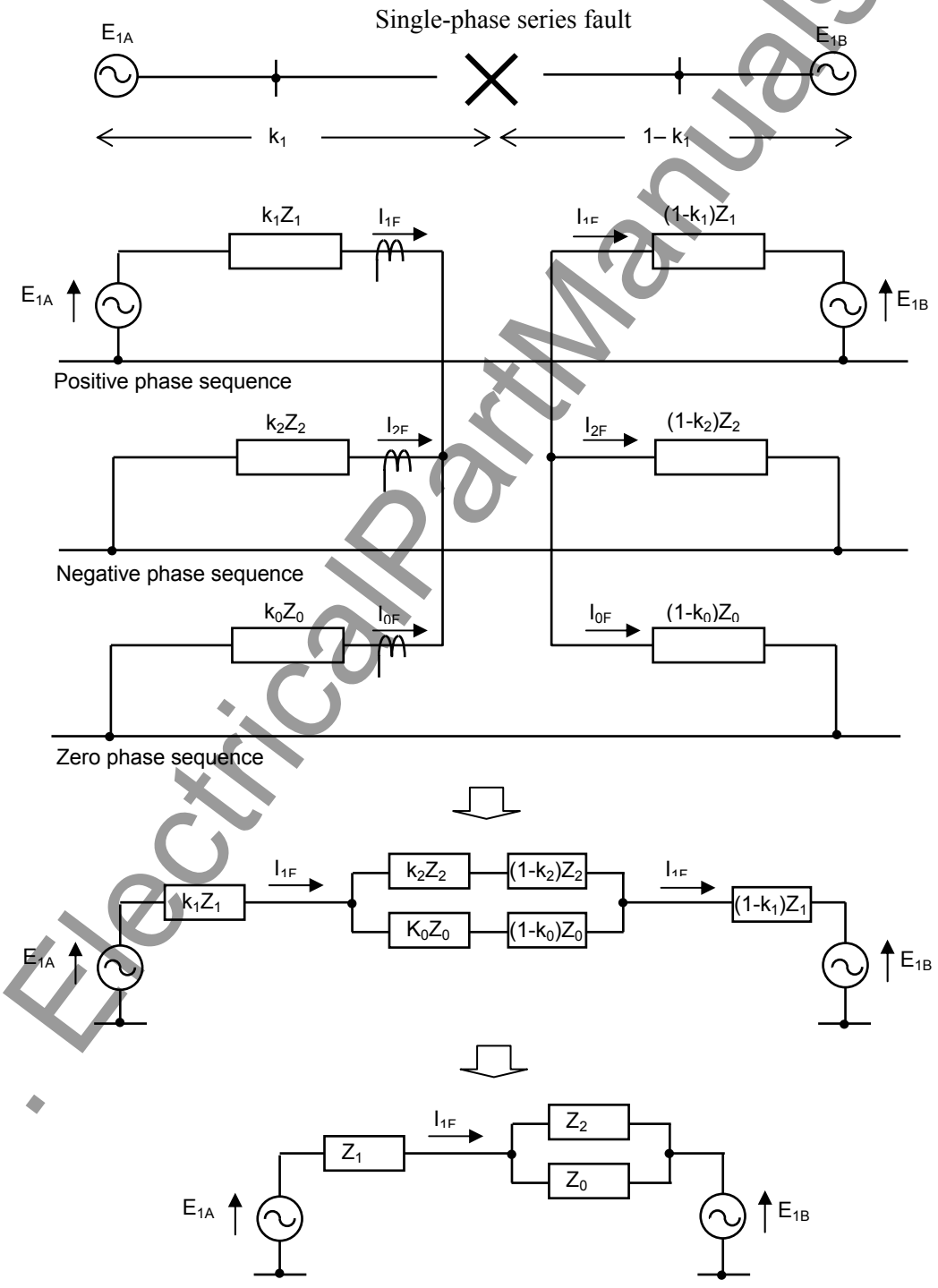



**Figure 2.10.1 Equivalent Circuit for a Single-phase Series Fault**

www . ElectricalPartManuals . com

Positive phase sequence current $I_{1F}$, negative phase sequence current $I_{2F}$ and zero phase sequence current $I_{0F}$ at fault location in a single-phase series fault are given by:

$$I_{1F} + I_{2F} + I_{0F} = 0 \quad (1)$$

$$Z_{2F}I_{2F} - Z_{0F}I_{0F} = 0 \quad (2)$$

$$E_{1A} - E_{1B} = Z_{1F}I_{1F} - Z_{2F}I_{2F} \quad (3)$$

where,

$E_{1A}$, $E_{1B}$: power source voltage

$Z_1$: positive sequence impedance

$Z_2$: negative sequence impedance

$Z_0$: zero sequence impedance

From the equations (1), (2) and (3), the following equations are derived.

$$I_{1F} = \frac{Z_2 + Z_0}{Z_1Z_2 + Z_1Z_0 + Z_2Z_0}(E_{1A} - E_{1B})$$

$$I_{2F} = \frac{-Z_0}{Z_1Z_2 + Z_1Z_0 + Z_2Z_0}(E_{1A} - E_{1B})$$

$$I_{0F} = \frac{-Z_2}{Z_1Z_2 + Z_1Z_0 + Z_2Z_0}(E_{1A} - E_{1B})$$

The magnitude of the fault current depends on the overall system impedance, difference in phase angle and magnitude between the power source voltages behind both ends.

Broken conductor protection element BCD detects series faults by measuring the ratio of negative to positive phase sequence currents ($I_{2F}$ / $I_{1F}$). This ratio is given with negative and zero sequence impedance of the system:

$$\frac{I_{2F}}{I_{1F}} = \frac{|I_{2F}|}{|I_{1F}|} = \frac{Z_0}{Z_2 + Z_0}$$

The ratio is higher than 0.5 in a system when the zero sequence impedance is larger than the negative sequence impedance. It will approach 1.0 in a high-impedance earthed or a one-end earthed system.

The characteristic of BCD element is shown in Figure 2.10.2 to obtain the stable operation.

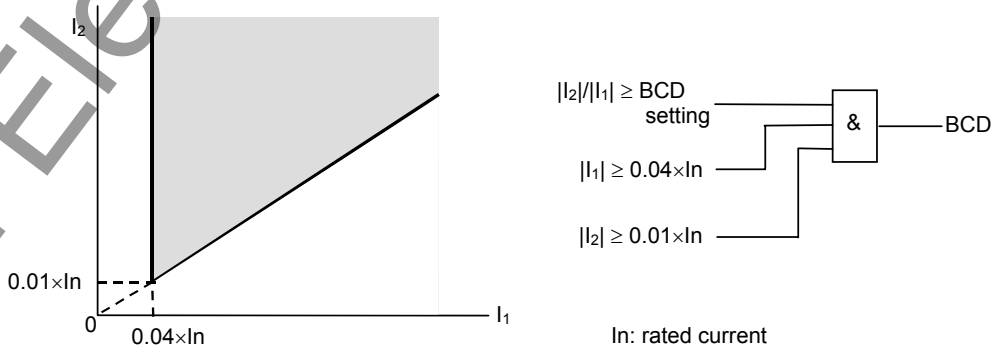



**Figure 2.10.2 BCD Element Characteristic**

www . ElectricalPartManuals . com

### Scheme Logic

Figure 2.10.3 shows the scheme logic of the broken conductor protection. BCD element outputs trip signals BCD TRIP through a delayed pick-up timer TBCD.

The tripping can be disabled by the scheme switch [BCDEN] or binary input signal BCD BLOCK.

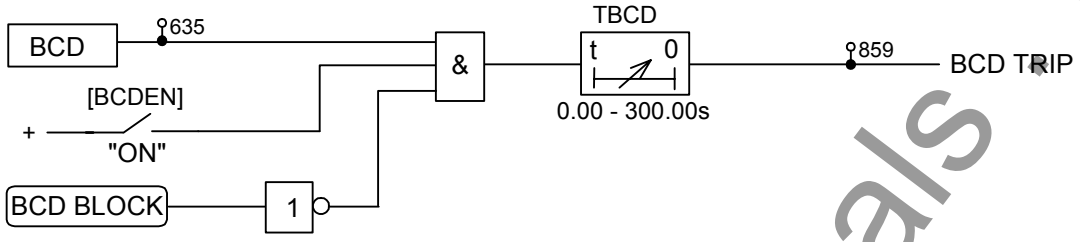



**Figure 2.10.3 Broken Conductor Protection Scheme Logic**

### Settings

The table below shows the setting elements necessary for the broken conductor protection and their setting ranges.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| BCD | 0.10 – 1.00 | 0.01 | 0.20 | $I_2 / I_1$ |
| TBCD | 0.00 – 300.00s | 0.01s | 1.00 s | BCD definite time setting |
| [BCDEN] | Off / On | | Off | BCD Enable |

Minimum setting of the BC threshold is restricted by the negative phase sequence current normally present on the system. The ratio $I_2$ / $I_1$ of the system is measured in the relay continuously and displayed on the metering screen of the relay front panel, along with the maximum value of the last 15 minutes $I_{21}$ max. It is recommended to check the display at the commissioning stage. The BCD setting should be 130 to 150% of $I_2 / I_1$ displayed.

Note: It must be noted that $I_2 / I_1$ is displayed only when the positive phase sequence current (or load current) in the secondary circuit is larger than 2 % of the rated secondary circuit current.

TBCD should be set to more than 1 cycle to prevent mal-operation caused by a transient operation such as CB closing.

www . ElectricalPartManuals com

## 2.11 Breaker Failure Protection

When a fault remains uncleared due to a breaker failure, the breaker failure protection (BFP) clears the fault by backtripping the adjacent breakers.

If the current continues to flow following the output of a trip command, the BFP judges it as a breaker failure. The existence of the current is detected by an overcurrent element provided for each phase. For high-speed operation of the BFP, a high-speed reset overcurrent element is used.

In order to prevent the BFP from starting by accident during maintenance work and testing and thus tripping the adjacent breakers, the BFP has the function of retripping the original breaker. To confirm that the breaker has failed, a trip command is issued to the original breaker again before tripping the adjacent breakers to prevent unnecessary tripping of the adjacent breakers in case of erroneous initiation of the BFP. It is possible to choose not to use retripping at all, or to use retripping with a backtrip command plus delayed pick-up timer, or retripping with a backtrip command plus overcurrent detection plus delayed pick-up timer.

Tripping by the BFP is three-phase final tripping and autoreclose is blocked.

An overcurrent element and on-delay timer are provided for each phase and they also operate correctly on the breaker failure in the event of an evolving fault.

### Scheme logic

The BFP is performed on an individual phase basis. Figure 2.11.1 shows the scheme logic for one phase. The BFP is initiated by a trip signal EXT_CBFIN from the external line protection or an internal trip signal TRIP. Starting with an external trip signal can be disabled by the scheme switch [BFEXT]. These trip signals must be present exist as long as the fault persists.

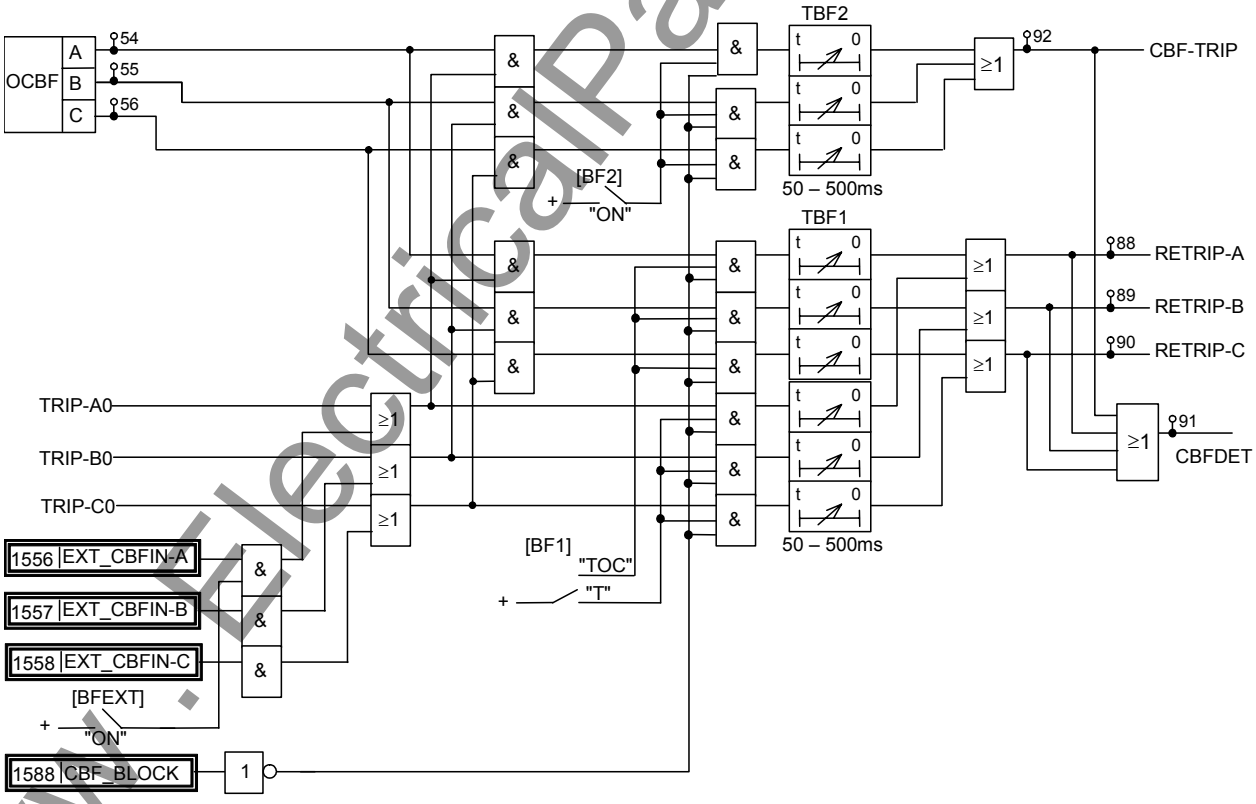



**Figure 2.11.1 BFP Scheme Logic**

The backtrip signal to the adjacent breakers CBF-TRIP is output if the overcurrent element OCBF operates continuously for the setting time of the delayed pick-up timer TBF2 after the

www.ElectricalPartManuals.com

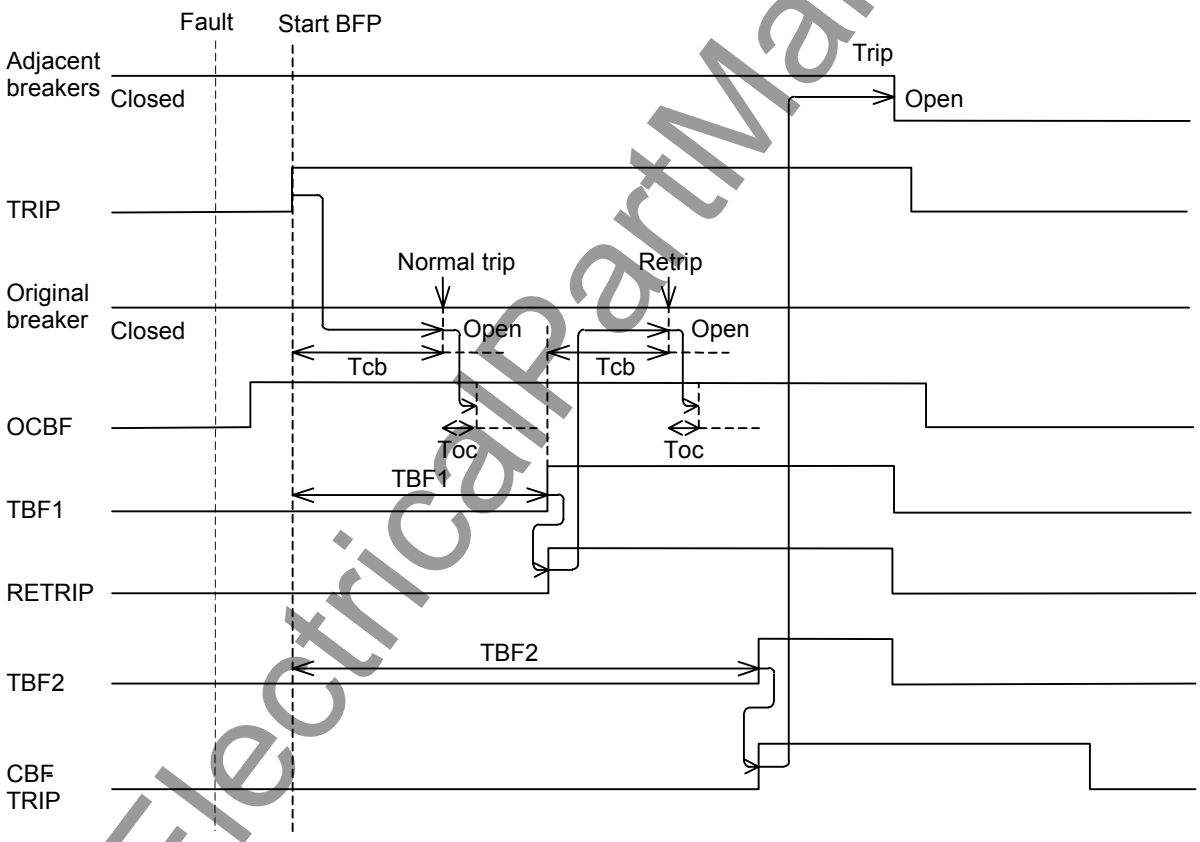
start-up. Tripping of the adjacent breakers can be blocked with the scheme switch [BF2].

There are two kinds of mode of the retrip signal to the original breaker RETRIP: the mode in which RETRIP is controlled by the overcurrent element OCBF, and the direct trip mode in which RETRIP is not controlled. The retrip mode together with the trip block can be selected with the scheme switch [BF1].

Figure 2.11.2 shows a sequence diagram of the BFP when a retrip and backtrip are used. If the breaker trips normally, the OCBF is reset before timer TBF1 or TBF2 is picked up and the BFP is reset.

If the OCBF continues operating, a retrip command is given to the original breaker after the setting time of TBF1. Unless the breaker fails, the OCBF is reset by the retrip. The TBF2 is not picked up and the BFP is reset. This may happen when the BFP is started by mistake and unnecessary tripping of the original breaker is unavoidable.

If the original breaker fails, retrip has no effect and the OCBF continues operating and the TBF2 is picked up finally. A trip command CBF-TRIP is issued to the adjacent breakers and the BFP is completed.




Tcb: operating time of the original breaker
Toc: reset time of the overcurrent element OCBF

**Figure 2.11.2 Sequence Diagram**

www . ElectricalPartManuals . com

**Setting**

The setting elements necessary for the breaker failure protection and its setting ranges are as follows:

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| OCBF | 0.5 – 10.0A | 0.1A | 4.0A | Overcurrent setting |
| | (0.1 – 2.0A | 0.1A | 0.8A) (*) | |
| TBF1 | 50 – 500ms | 1ms | 150ms | Retrip timer |
| TBF2 | 50 – 500ms | 1ms | 200ms | Adjacent breaker trip timer |
| [BFEXT] | ON/OFF | | OFF | External start |
| [BF1] | T/TOC/OFF | | OFF | Retrip mode |
| [BF2] | ON/OFF | | OFF | Adjacent breaker trip |

(*) Current values shown in parentheses are in the case of 1A rating. Other current values are in the case of 5A rating.

The overcurrent element OCBF checks that the breaker has opened and the current has disappeared. Therefore, since it is allowed to respond to the load current, it can be set from 10 to 200% of the rated current.

The settings of TBF1 and TBF2 are determined by the opening time of the original breaker (Tcb in Figure 2.11.2) and the reset time of the overcurrent element (Toc in Figure 2.11.2). The timer setting example when using retrip can be obtained as follows.

Setting of TBF1 = Breaker opening time + OCBF reset time + Margin
= 40ms + 10ms + 20ms
= 70ms

Setting of TBF2 = TBF1 + Output relay operating time + Breaker opening time + OCBF reset time + Margin
= 70ms + 10ms + 40ms + 10ms + 10ms
= 140ms

If retrip is not used, the setting of TBF2 can be the same as that of TBF1.

www . ElectricalPartManuals . com

## 2.12 Switch-Onto-Fault Protection

The current differential protection can trip against a switch-onto-fault. However, the distance protection cannot operate against a switch-onto-fault. Therefore, the switch-onto-fault protection should be applied when the current differential protection is out of service.

In order to quickly remove a fault which may occur when a faulted line or busbar is energized, the switch-onto-fault (SOTF) protection functions for a certain period after the circuit breaker is closed.

The SOTF protection is performed by a non-directional overcurrent element and distance measuring elements. The overcurrent protection is effective in detecting close-up three-phase faults on the line in particular when the voltage transformer is installed on the line side. This is because the voltage input to the distance measuring elements is absent continuously before and after the fault, and thus it is difficult for the distance measuring elements to detect the fault.

The distance measuring elements can operate for faults other than close-up three-phase faults. One of the zone 1 to zone R elements can be used for the SOTF protection.

### Scheme logic

The scheme logic for the SOTF protection is shown in Figure 2.12.1. The SOTF protection issues a three-phase tripping signal M-TRIP for the operation of an overcurrent element OCH or distance measuring elements Z1 to ZR for 500 ms after the circuit breaker is closed (CB-OR = 1) and/or for 500ms after the undervoltage dead line detector resets. The method of controlling the SOTF protection by CB closing and/or by undervoltage dead line detection is selected by scheme switch [SOTF-DL]. Elements UVFS and UVLG provide undervoltage dead line detection.

Tripping by each element can be disabled by the scheme switches [SOTF-OC] to [SOTF-R]. When a VT failure is detected (NON VTF = 0), tripping by the distance measuring elements is blocked.

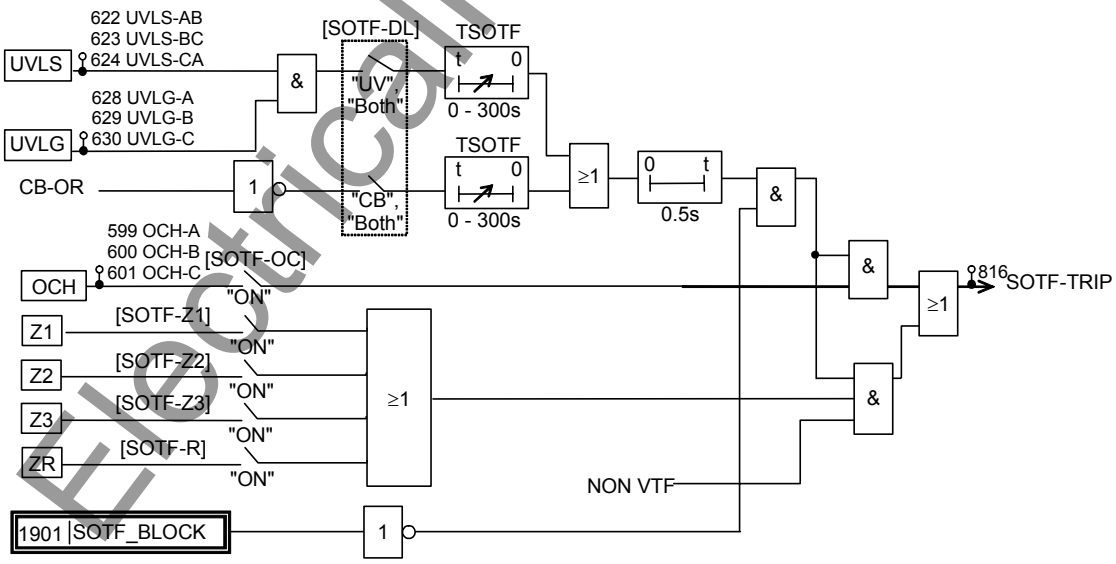



**Figure 2.12.1 SOTF Scheme Logic**

www.ElectricalPartManuals.com

### Setting

The setting elements necessary for the SOTF protection and their setting ranges are as follows:

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| OCH | 2.0 - 15.0 A | 0.1 A | 6.0 A | Overcurrent setting |
| | ( 0.4 - 3.0 A | 0.1 A | 1.2 A) (*) | |
| TSOTF | 0 – 300 s | 1 s | 5 s | SOTF check timer |
| SOTF - OC | OFF/ON | | ON | Overcurrent tripping |
| SOTF - Z1 | OFF/ON | | OFF | Zone 1 tripping |
| SOTF - Z2 | OFF/ON | | OFF | Zone 2 tripping |
| SOTF - Z3 | OFF/ON | | OFF | Zone 3 tripping |
| SOTF - R | OFF/ON | | OFF | Zone R tripping |
| SOTF-DL | CB/UV/BOTH | | CB | SOTF control |

(*) Current values shown in the parentheses are in the case of 1 A rating. Other current values are in the case of 5 A rating.

The OCH element and its setting are common with the stub protection.

www . ElectricalPartManuals . com

## 2.13 Stub Protection

In the case of a busbar with a one-and-a-half breaker arrangement as shown in Figure 2.13.1.1, the differential protection will operate and will trip the breakers at both terminals, and the distance protection will not operate.

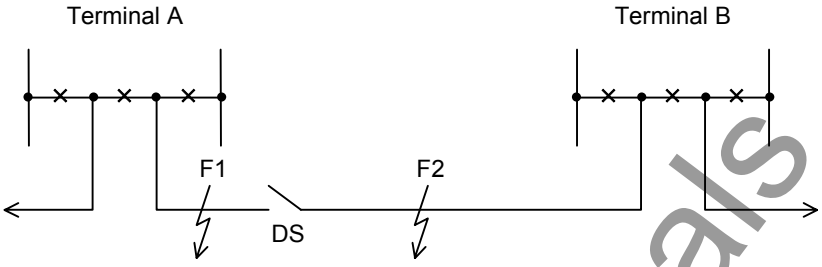



**Figure 2.13.1 Stub Fault**

GRL100-700 series provides the following two schemes of stub protection for such cases:

- STUB DIF
- STUB OC

### 2.13.1 STUB DIF Protection

If a fault occurs at F1 or F2 when line disconnector DS of terminal A is open as shown in Figure 2.13.1, the differential protection operates and trips the breakers at both terminals.

Figure 2.13.1.1 shows the stub fault protection logic of STUB DIF using the current differential principle.

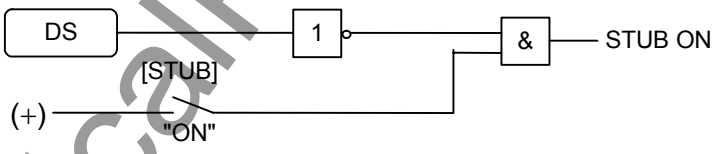



**Figure 2.13.1.1 STUB DIF Protection**

If the switch is set to "DIF" and the disconnector is open (DS = 0), the signal STUB ON is generated and used to reset the receiving current data from terminal B to zero. Thus, terminal A does not need to operate unnecessarily in response to fault F2.

Terminal B detects that terminal A is out-of-service with the out-of-service detection logic and resets the receiving current data from terminal A to zero, and so does not operate in response to fault F1.

The signal STUB ON brings the local tripping into three-phase final tripping.

### 2.13.2 STUB OC Protection

In the case of a busbar with a one-and-a-half breaker arrangement, the VT is generally installed on the line side. If the line is separated from the busbar, the distance protection does not cover to the "stub" area between the two CTs and line isolator. This is because the line VT cannot supply a correct voltage for a fault in the "stub" area. For a fault in the stub area under such conditions, fast overcurrent protection is applied.

www.ElectricalPartManuals.com

### Scheme logic

The scheme logic for the stub protection is shown in Figure 2.13.2.1. The stub protection performs three-phase tripping on the condition that the line disconnector is open (DS_N/O_CONT = 0) and the overcurrent element has operated (OCH = 1). CB condition (STUB_CB) can be added by using programmable BI function (PLC function). Tripping can be disabled by the scheme switch [STUB-OC].

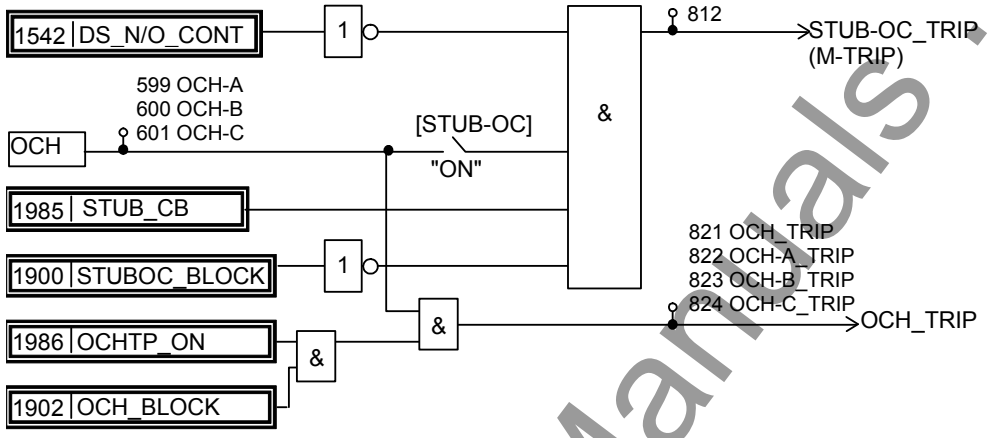



**Figure 2.13.2.1 Stub Protection Scheme Logic**

## 2.13.3 Setting

The setting elements necessary for the stub protection and their setting ranges are as follows:

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| STUB | OFF/ON | | OFF | STUB DIF protection |
| OCH | 2.0 - 10.0 A | 0.1 A | 6.0 A | Overcurrent setting for STUB OC |
| | (0.4 - 2.0 A | 0.1 A | 1.2 A) (*) | |
| STUB-OC | OFF/ON | | OFF | STUB OC protection |

(*) Current values shown in the parentheses are in the case of 1 A rating. Other current values are in the case of 5 A rating.

The OCH element and its setting are common with the SOTF protection.

www . ElectricalPartManuals . com

## 2.14 Tripping Output

Figure 2.14.1 shows the tripping logic. Segregated-phase differential protection outputs per-phase-based tripping signals such as DIF.FS-A_TP, DIF.FS-B_TP and DIF.FS-C_TP, etc. Zero-phase differential protection, thermal overload protection, earth fault backup protection and out-of-step protection output three-phase tripping signals DIFG.FS_TRIP, THM-T, BU-TRIP and OSTT.

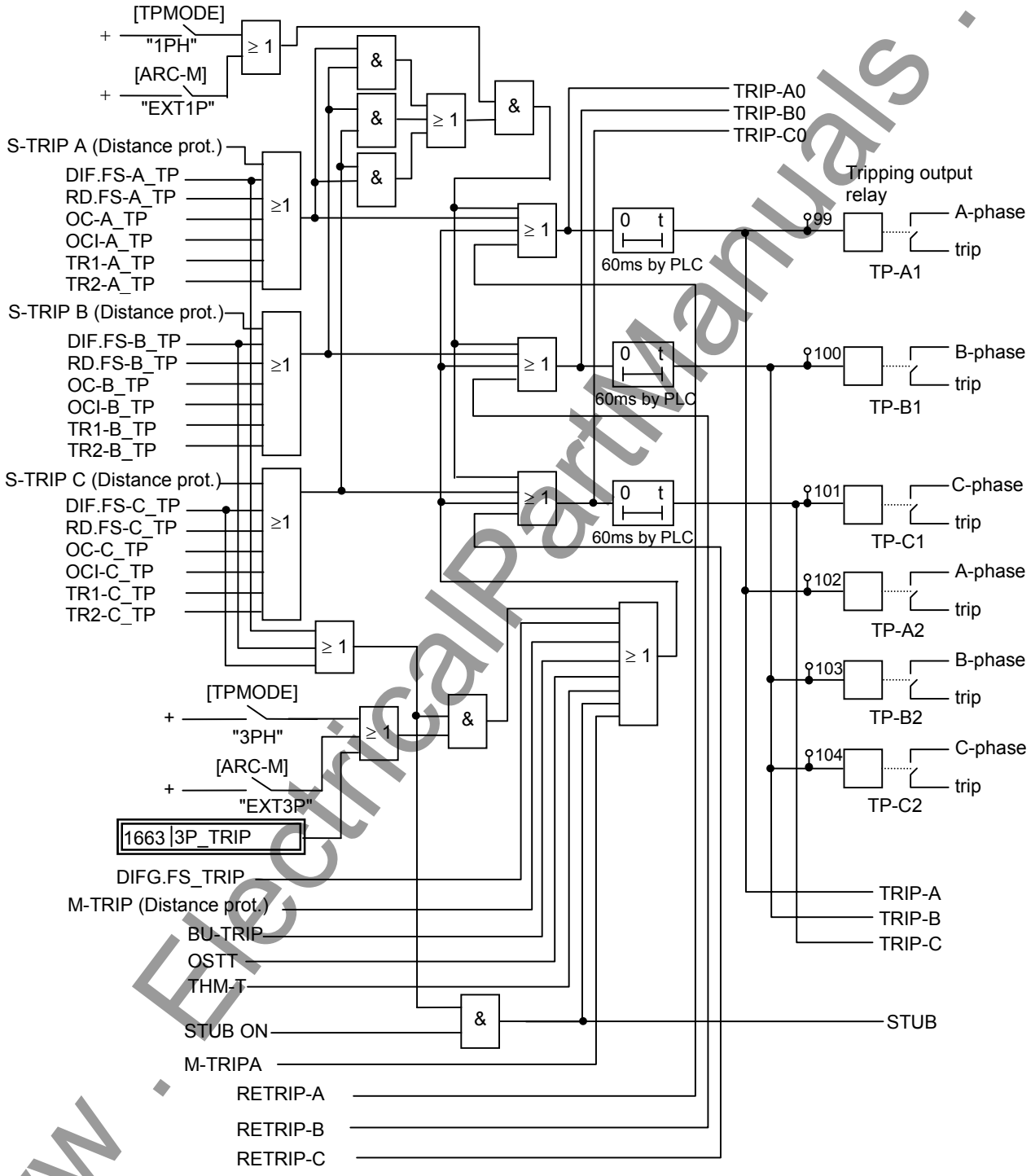



**Figure 2.14.1 Tripping Logic**

www.ElectricalPartManuals.com

In the following cases, per-phase-based tripping is converted to three-phase tripping.

- When autoreclose is prohibited by a binary input signal (ARC–BLK = 1)
- When the autoreclose mode selection switch [ARC-M] is set to "EXT3P"
- When the measure for stub fault is enabled (STUB ON = 1)
  (This applies to the one-and-a-half busbar system.)
- PLC command “3P_TRIP” is established.

In the following cases, two-phase tripping is converted to three-phase tripping.

- When the switch [ARC-M] is set to "EXT1P"

For the following trips, the logic level of M-TRIPA becomes 1, and per-phase-based tripping is converted to three-phase tripping. M-TRIPA is a logic signal in the autoreclose circuit (see Figure 2.15.2.1).

- Tripping within the reclaim time
- Tripping when reclosing and the mode selection switch [ARC-M] is set to "Disable" or "TPAR"

Signals RETRIP-A, RETRIP-B and RETRIP-C are the retripping signals of the breaker failure protection.

Tripping signals drive the high-speed tripping output relays. Two sets of output relays are provided for each phase and each relay has one normally open contact.

The tripping output relays reset 60ms(*) after the tripping signal disappears by clearing the fault. The tripping circuit must be opened with the auxiliary contact of the breaker prior to reset of the tripping relay to prevent the tripping relay from directly interrupting the tripping current of the breaker.

(*) Reset time is adjustable by PLC function. Default setting is 60ms.

A tripping output relay is user configurable for the adjacent breakers tripping signal CBF-TRIP in the breaker failure protection. For the default setting, see Appendix D. The relay is assigned to the signal number 92 with signal name CBF-TRIP.

The signals TRIP-A, TRIP-B and TRIP-C are used to start the autoreclose.

The signal TRIP-A0, TRIP-B0 and TRIP-C0 are used to start the breaker failure protection.

If the signal No.1663 “3P_TRIP”assigned by PLC is activated, GRL100 outputs a three-phase tripping command without regard to faulted phase.

www . ElectricalPartManuals . com

## 2.15 Autoreclose

### 2.15.1 Application

Most faults that occur on high-voltage or extra-high-voltage overhead lines are transient faults caused by lightning. If a transient fault occurs, the circuit breaker is tripped to isolate the fault, and then reclosed following a time delay to ensure that the hot gases caused by the fault arc have de-ionized. This makes it possible to recover power transmission.

The time between clearing the fault and reclosing the circuit breaker, that is, the dead time, should be made as short as possible to keep the power system stable. From the viewpoint of de-ionization of the fault arc, the fault arc is de-ionized more thoroughly as the period of this dead time is extended. The de-ionization commences when the circuit breakers for all terminals of the line are tripped. Therefore, the dead time can be set at its minimum level if all terminals of the line are tripped at the same time.

Autoreclose of the GRL100 is started by the current differential protection that ensures high-speed protection of all terminals.

The GRL100 provides two autoreclose systems, single-shot autoreclose and multi-shot autoreclose.

#### Single-shot autoreclose

Four types of single-shot autoreclose mode are provided: single-phase autoreclose, three-phase autoreclose, single- and three-phase autoreclose, and multi-phase autoreclose. An optimal mode is selected by the autoreclose mode selection switch [ARC-M]. In any case, autoreclose is performed only once. If the fault state still continues after reclosing, three-phase final tripping is activated.

Single-phase autoreclose:

In this mode, only the faulty phase is tripped, and then reclosed if a single-phase earth fault occurs. In the case of a multi-phase fault, three phases are tripped, but reclosing is not made. Since power can be transmitted through healthy phases even during the dead time, this 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 a three-phase autoreclose. As a result, a longer dead time is required.

It is essential to correctly determine the faulty phase. The GRL100 provides phase-segregated current differential protection to correctly determine the faulty phase(s).

For single-phase autoreclose, each phase of the circuit breaker must be segregated.

This reclosing mode is simply expressed as "SPAR" in the following descriptions.

Three-phase autoreclose:

In this autoreclose mode, three phases are tripped, and then reclosed regardless of the fault mode, whether single-phase fault or multi-phase fault. A shorter dead time can be set in this mode when compared to the single-phase autoreclose. For the three-phase autoreclose, synchronism check and voltage check between the busbar and the line are required.

This reclosing mode is simply expressed as "TPAR" in the following descriptions.

Single- and three-phase autoreclose:

In this autoreclose mode, single-phase tripping and reclosing are performed if a single-phase fault occurs, while three-phase tripping and reclosing are performed if a multi-phase fault occurs.

www.ElectricalPartManuals.com

This reclosing mode is simply expressed as "SPAR & TPAR" in the following descriptions.

Multi-phase autoreclose:

This autoreclose mode can be applied to double-circuit lines. In this mode, only the faulted phases are tripped and reclosed when the terminals of double-circuit lines are interconnected during the dead time through at least two or three different phases.

This mode realizes high-speed reclosing for multi-phase faults without synchronism and voltage check and minimizes the possibility of outages in the case of double faults on double-circuit lines.

If the interlinking condition is not satisfied, all the phases are tripped and reclosing is not started.

This reclosing mode is simply expressed as "MPAR2" for two-phase interconnection and "MPAR3" for three-phase interconnection in the following descriptions.

For the detailed performance of the multi-phase autoreclose, see Appendix M.

In B-mode and GPS-mode, the multi-phase autoreclose can be applied if the RYIDSV function is not applied.

Single-shot autoreclose can be applied to one-breaker reclosing and two-breaker reclosing in the one-and-a-half breaker busbar system.

#### Multi-shot autoreclose

In the multi-shot autoreclose, any of two- to four-shot reclosing can be selected. In any case, the first shot is selected from four types of autoreclose mode as described in the above single-shot autoreclose. All successive shots (up to three times), which are applied if the first shot fails, are three-phase tripping and reclosing.

Multi-shot autoreclose cannot be applied to two-breaker reclosing in the one-and-a-half breaker busbar system.

The autoreclose can also be activated from an external line protection. At this time, all autoreclose modes described above are effective.

If a fault occurs under the following conditions, three-phase final tripping is performed and autoreclose is blocked:

- Reclosing block signal is received from an external unit locally or remotely.
- Throughout the reclaim time.

For evolving faults that occur during the dead time between single-phase tripping and reclosing, "SPAR & TPAR" functions are as follows.

For evolving faults that occur within the period of time set from the first fault, the reclosing mode enters the three-phase autoreclose mode. At this time, the total dead time becomes the dead time for three-phase autoreclose added to the dead time for single-phase autoreclose which has expired up to the point at which the evolving fault occurs.

For evolving faults that occurred after the set time, three-phase final tripping is performed, and reclosing is not performed.

If an evolving fault occurs when "SPAR" is selected, three-phase final tripping is performed, and reclosing is not performed.

If an evolving fault occurs when "MPAR2" or "MPAR3" is selected, the dead time is recounted provided the network conditions defined for linked circuits are satisfied.

www.ElectricalPartManuals.com

## 2.15.2 Scheme Logic

### 2.15.2.1 One-breaker Autoreclose

Figure 2.15.2.1 shows the simplified scheme logic for the single-shot autoreclose. Autoreclose for a further fault incident is available when the circuit breaker is closed and ready for autoreclose (CB-RDY=1), the reclosing mode selection switch [ARC-M] is set to "SPAR", "TPAR", "SPAR & TPAR", "MPAR2" or "MPAR3" and the on-delay timer TRDY1 is picked up. TRDY1 is used to determine the reclaim time.

If the autoreclose is ready, the internal tripping signal TRIP-A, B, C or external tripping signal EXT_TRIP-A, B, C for each phase of the breaker activates the autoreclose. Whether or not the external trip signals are used to activate the reclosing is selected by the scheme switch [ARC-EXT].

Once this autoreclose is activated, it is kept by the flip-flop circuit until one reclosing cycle is completed.

Autoreclose is not activated in the following conditions and all the phases are tripped (M-TRIPA=1).

- When tripping is performed by the high-impedance earth fault protection (DIFGT=1) and the autoreclose selection switch [ARC-DIFG] is set to "OFF".
- When tripping is performed by the backup protection (BU-TRIP=1) and the autoreclose selection switch [ARC-BU] is set to "OFF".
- When tripping is performed by the out-of-step protection (OSTT=1), breaker failure protection (RETRIP=1) or stub fault protection (STUB=1).
- When an autoreclose prohibiting binary input signal is applied at either the local or remote terminal (ARC_BLOCK=1).
- When tripping is performed by the DEF command protection and the autoreclose selection switch [ARC-DEFC] is set to "OFF".

If autoreclosing is not ready, a three-phase tripping command M-TRIPA is output for all tripping modes. At this time, autoreclose is not activated.

#### Autoreclose for single-phase fault

If the switch [ARC-M] is set to "SPAR", "SPAR & TPAR" or "MPAR2", single-phase tripping is performed. If it is set to "MPAR3", single-phase tripping is performed only when the adjacent parallel line is healthy.

The dead time counter TSPR or TMPR for single-phase reclosing is started by any of the tripping signals TRIP-A to C. After the dead time has elapsed, reclosing command ARC is output. The voltage check condition can be configured by the PLC function, if the voltage check and others are required for the reclosing condition.

If [ARC-M] is set to "TPAR", three-phase tripping is performed and the dead time counter TTPR1 for three-phase reclosing is started. After the dead time has elapsed, reclosing command ARC is output based on the operating conditions of the voltage and synchronism check elements output signal SYN-OP. (The SYN-OP is assigned by the PLC as a default setting.)

If [ARC-M] is set to "Disable", three-phase tripping is performed and autoreclose is not started.

www.ElectricalPartManuals.com

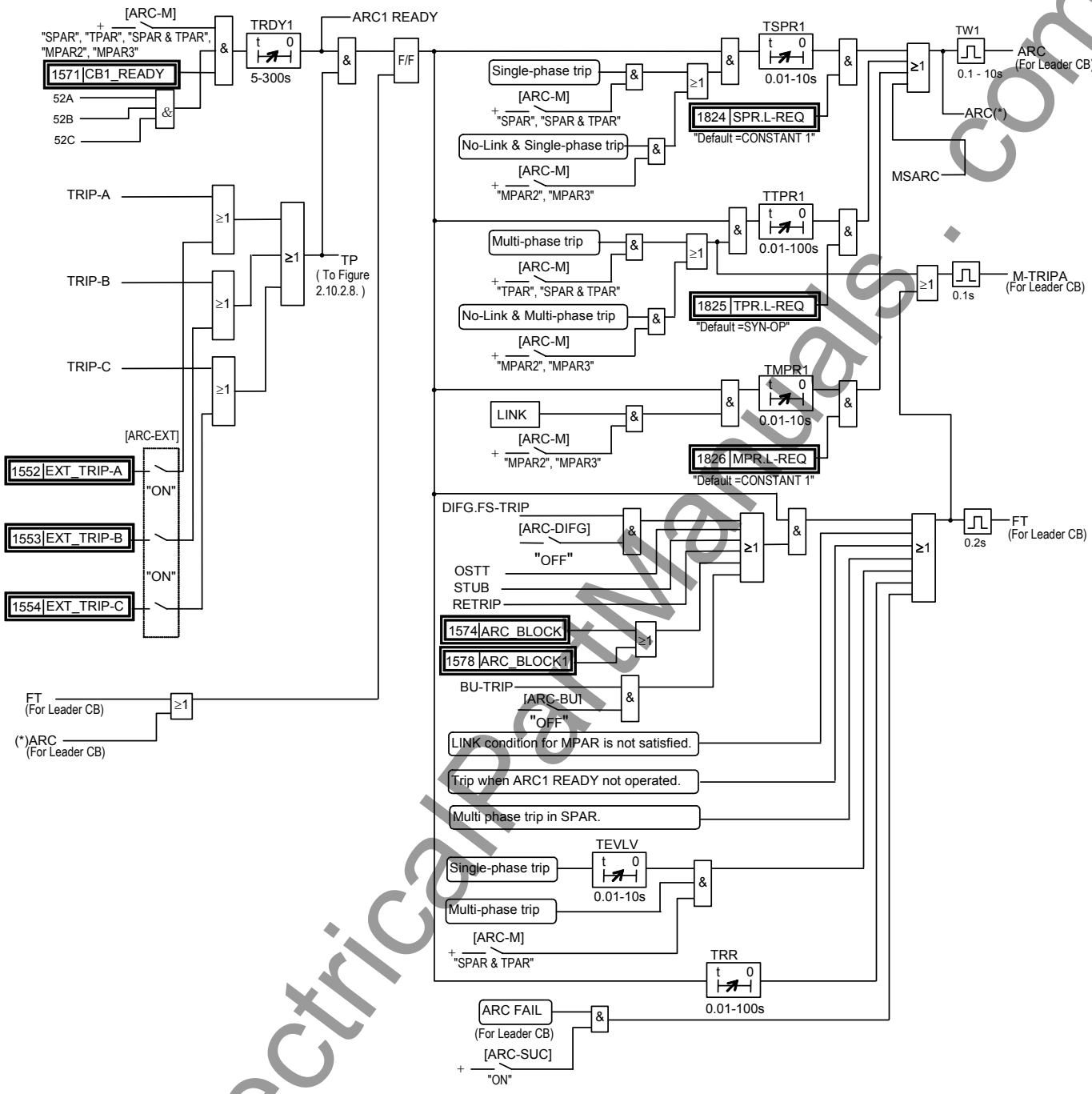



**Figure 2.15.2.1 Autoreclose Scheme**

### Autoreclose for multi-phase fault

If [ARC-M] is set to "MPAR2" or "MPAR3", only the faulted phases are tripped and the dead time counter TMPR is started by any of the tripping signals TRIP-A to C. After the dead time has elapsed, reclosing command ARC is output, based on the status of the linked circuits check output signal LINK. The voltage check condition can be configured by the PLC function, if the voltage check and others are required for the reclosing condition.

In other reclosing modes, three-phase tripping is performed and all of TRIP-A to C are activated. If [ARC-M] is set to "TPAR" or "SPAR & TPAR", the dead time counter TTPR1 for three-phase reclosing is started. After the dead time has elapsed, reclosing command ARC is output based on the status of the voltage and synchronism check elements output signal SYN-OP. (The SYN-OP

www.ElectricalPartManuals.com

is assigned by the PLC as a default setting.)

If [ARC-M] is set to "SPAR" or "Disable", autoreclose is not activated.

In "SPAR & TPAR" or "TPAR", if the operating conditions of the voltage and synchronism check elements assigned by the PLC as default are not satisfied during three-phase reclosing, the TRR is then picked up and reclosing is reset. In "MPAR2" or "MPAR3", if the operating condition of interlinking is not satisfied, autoreclosing is not activated and three-phase final tripping is performed in case of setting [MA-NOLK] to “FT”. In case of setting [MA-NOLK] to "S" or "S+T", it is shifted to other reclose modes and three-phase final tripping is not performed.

#### Autoreclose for an evolving fault

Figure 2.15.2.2 shows the sequence diagram of autoreclose for an evolving fault when "SPAR & TPAR" is selected. If single-phase tripping (1φtrip) is performed, the evolving fault detection timer TEVLV is started at the same as the TSPR is started. If no evolving faults occur, single-phase reclosing is performed when the TSPR is picked up.

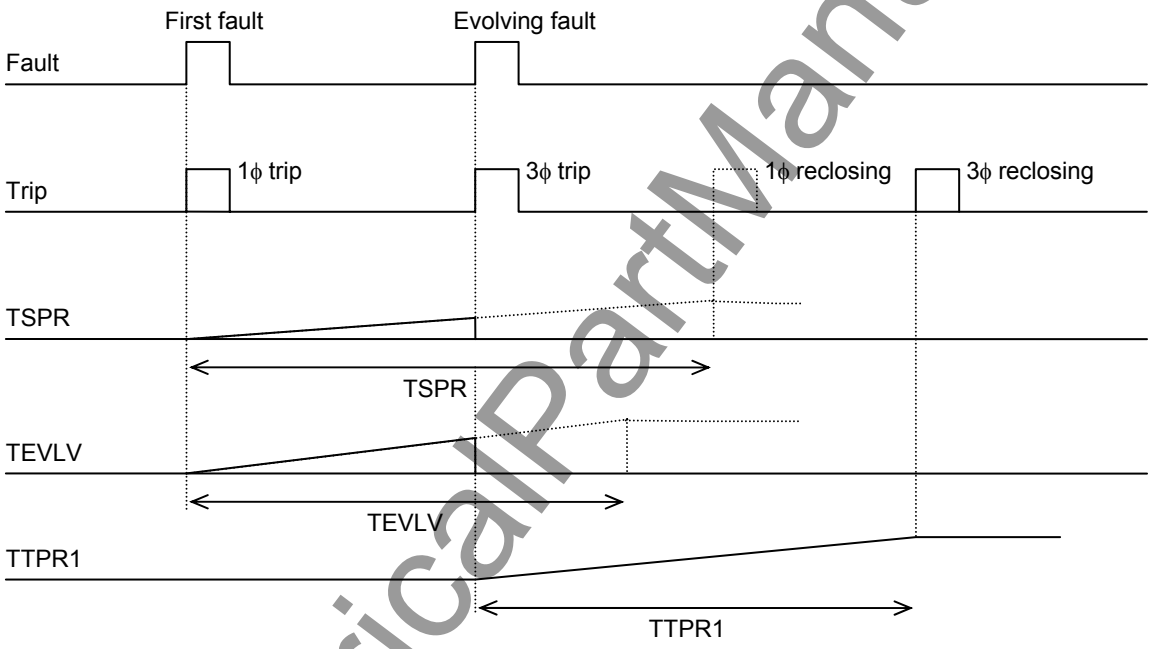



**Figure 2.15.2.2 Autoreclose for Evolving Fault**

As shown in the figure, if an evoving fault occurs before the TEVLV is picked up, three-phase tripping (3φtrip) is performed. If this occurs, the TSPR and TEVLV are reset, and the TTPR1 is now started.

After the TTPR1 is picked up, three-phase reclosing is performed based on the status of the voltage and synchronism check elements output signal SYN-OP. If an evolving fault occurs after the TEVLV has picked up, autoreclose is reset and reclosing is not performed.

In "MPAR2" or "MPAR3", an evolving fault only resets and restarts the dead time counter TSPR provided the network conditions defined for linked circuits are satisfied, though not shown in Figure 2.15.2.1.

#### Voltage and synchronism check

There are four voltage modes as shown below when all three phases of the circuit breaker are open. The voltage and synchronism check is applicable to voltage modes 1 to 3 and controls the energizing process of the lines and busbars in the three-phase autoreclose mode.

www.ElectricalPartManuals.com

| Voltage Mode | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Busbar voltage ($V_B$) | live | live | dead | dead |
| Line voltage ($V_L$) | live | dead | live | dead |

The synchronism check is performed for voltage mode 1 while the voltage check is performed for voltage modes 2 and 3.

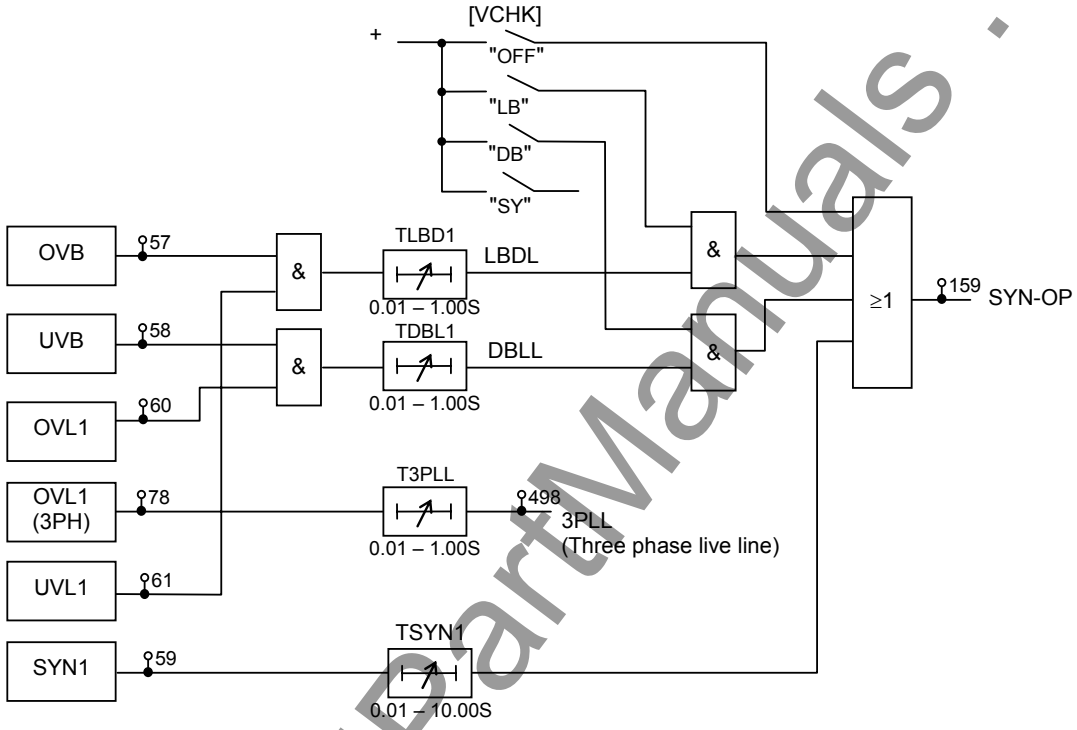



**Figure 2.15.2.3 Energizing Control Scheme**

Figure 2.15.2.3 shows the energizing control scheme. The voltage and synchronism check output signal SYN-OP is generated when the following conditions have been established:

- Synchronism check element SYN1 operates and on-delay timer TSYN1 is picked up.
- Busbar overvoltage detector OVB and line undervoltage detector UVL1 operate, and on-delay timer TLBD1 is picked up. (This detects the live bus and dead line condition.)
- Busbar undervoltage detector UVB and line overvoltage detector OVL1 operate, and on-delay timer TDBL1 is picked up. (This detects the dead bus and live line condition.)

Using the scheme switch [VCHK], the energizing direction can be selected.

| Setting of [VCHK] | Energizing control |
|---|---|
| LB | Reclosed under the "live bus and dead line" condition or with synchronism check. |
| DB | Reclosed under the "dead bus and live line" condition or with synchronism check. |
| SYN | Reclosed with synchronism check only. |
| OFF | Reclosed without voltage and synchronism check. |

When [VCHK] is set to "LB", the line is energized in the direction from the busbar to line under the "live bus and dead line" condition. When [VCHK] is set to "DB", the lines are energized in the direction from the line to busbar under the "dead bus and live line" condition.

When the synchronism check output exists, autoreclose is executed regardless of the position of

www.ElectricalPartManuals.com

the scheme switch.

When [VCHK] is set to "SYN", three-phase autoreclose is performed only with the synchronism check.

When [VCHK] is set to "OFF", three-phase autoreclose is performed without the voltage and synchronism check.

The voltage and synchronism check requires a single-phase reference voltage from the busbar or line. If three-phase voltages used by the current differential protection are supplied from the line voltage transformer, the reference voltage will need to be supplied from the busbar voltage transformer. On the contrary, if three-phase voltages used by the current differential protection are supplied from the busbar voltage transformer, the reference voltage will need to be supplied from the line voltage transformer.

Additionally, it is not necessary to fix the phase of the reference voltage.

To match the busbar voltage and line voltage for the voltage and synchronism check option described above, the GRL100 has the following three switches as shown in Figure 2.15.2.4:

[VTPSEL]: This switch is used to match the voltage phases. If the A-phase voltage or A-phase to B-phase voltage is used as a reference voltage, "A" is selected.

[VT-RATE]: This switch is used to match the magnitude and phase angle. "PH/G" is selected when the reference voltage is a single-phase voltage while "PH/PH" is selected when it is a phase-to-phase voltage.

[3PH-VT]: "Bus" is selected when the three-phase voltages are busbar voltages while "Line" is selected when they are line voltages.

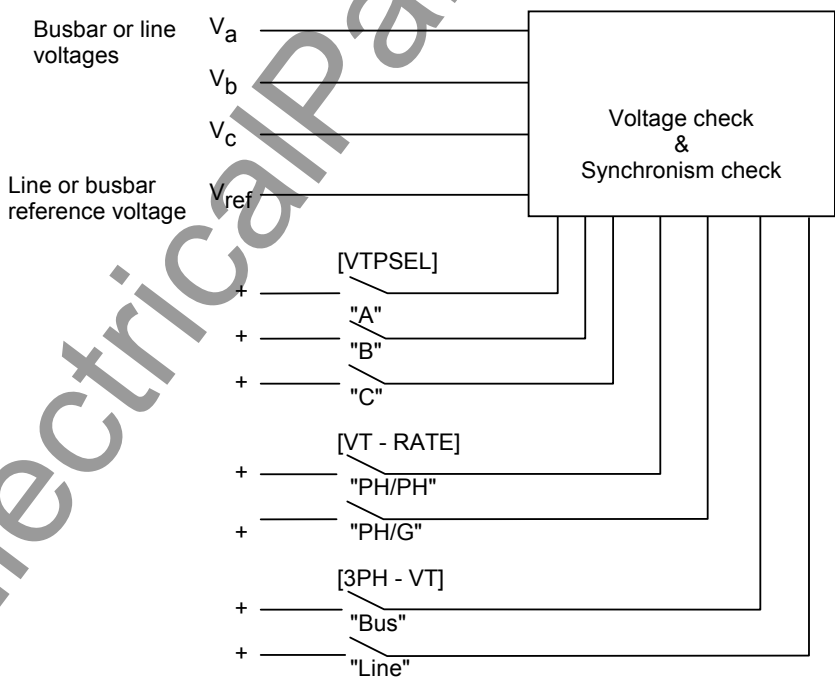



**Figure 2.15.2.4 Matching of Busbar Voltage and Line Voltage**

The signal 3PLL shown in Figure 2.15.2.3 is output when all three phase voltages are live, and it is available by the [3PH-VT] = LINE setting.

www.ElectricalPartManuals.com

#### Autoreclosing requirement

Using PLC function, various reclose requirements can be designed. In Figure 2.15.2.1, a reclose requirement for "SPAR", "TPAR", "SPAR&TPAR" or "MPAR" can be respectively assigned to the following signals by PLC:

"SPAR": [SPR.L-REQ]

"TPAR": [TPR.L-REQ]

"SPAR&TPAR": [SPR.L-REQ], [TPR.L-REQ]

"MPAR": [MPR.L-REQ]

The default setting is as follows:

| Reclose requirement | Default setting | Remarks |
|---|---|---|
| "SPAR" | [SPR.L-REQ] = CONSTANT_1 | No condition |
| "TPAR" | [TPR.L-REQ] = SYP-ON | Voltage and synchronism check |
| "MPAR" | [MPR.L-REQ] = CONSTANT_1 | No condition |

The setting example is shown in Appendix S.

#### Interconnection check for multi-phase autoreclose

MPAR is performed when the terminals of double-circuit lines remain interconnected during the dead time through two or three different phases. Interconnection is checked as follows.

Figure 2.15.2.5 shows the interconnection check scheme in a two-terminal line application. Each terminal originates a local interconnection check signals CBDS-A, -B and -C when disconnector DS and the circuit breaker for each phase CB1A, CB1B and CB1C are closed. These signals are transmitted to the remote terminals as well as used locally.

Interconnection signal LINK-A, -B or -C is established when both the local and remote interconnection check signals are established for their respective phases.

Interconnection through two or three different phases is checked employing signals LINK-A, -B or –C of the line and the parallel line. When [ARC-M] is set to "MPAR2", interconnection signal LINK is output if any two of LINK-A, -B and -C are established. When [ARC-M] is set to "MPAR3", LINK is output if all of LINK-A, -B and -C are established.

The interconnection signals LINK-A, -B or -C for parallel line are assigned to the binary output relays as shown in Appendix D.

In the three-terminal line application, the interconnection check is performed with two remote terminals independently.

When the interconnection check signal CBDS-A, -B, or -C is established at both the local terminal and remote terminal 1, interconnection signal LINK-A1, -B1, -C1 is established. When it is established at both the local and remote terminal 2, interconnection signal LINK-A2, -B2 or -C2 is established. Those signals are assigned to the binary output relays and output to the parallel line.

**Note:** In the three-terminal line application, remote terminal 1 and 2 are designated automatically through the communication circuit setup. The remote terminal 1 is a terminal to which the local communication port 1 is linked and remote terminal 2 is the terminal to which local communication port 2 is linked.

When the interconnection with either of the two remote terminals is confirmed employing the interconnection signals from the line and the parallel line, multi-phase autoreclose can be performed.

In case the interconnection condition LINK is not satisfied, the following operations can be

www.ElectricalPartManuals.com

selected by the scheme switch [MA-NOLK] setting.

| Setting of [MA-NOLK] | Operation |
|---|---|
| FT | Final Trip |
| T | Three-phase autoreclose |
| S+T | Single- and Three-phase autoreclose |

If "FT" is selected and the LINK is not satisfied, the final trip FT is performed. If "T" selected, the three-phase autoreclose is performed. If "S+T" selected, the single-phase or three-phase autoreclose is performed depending on the faulted phase(s).

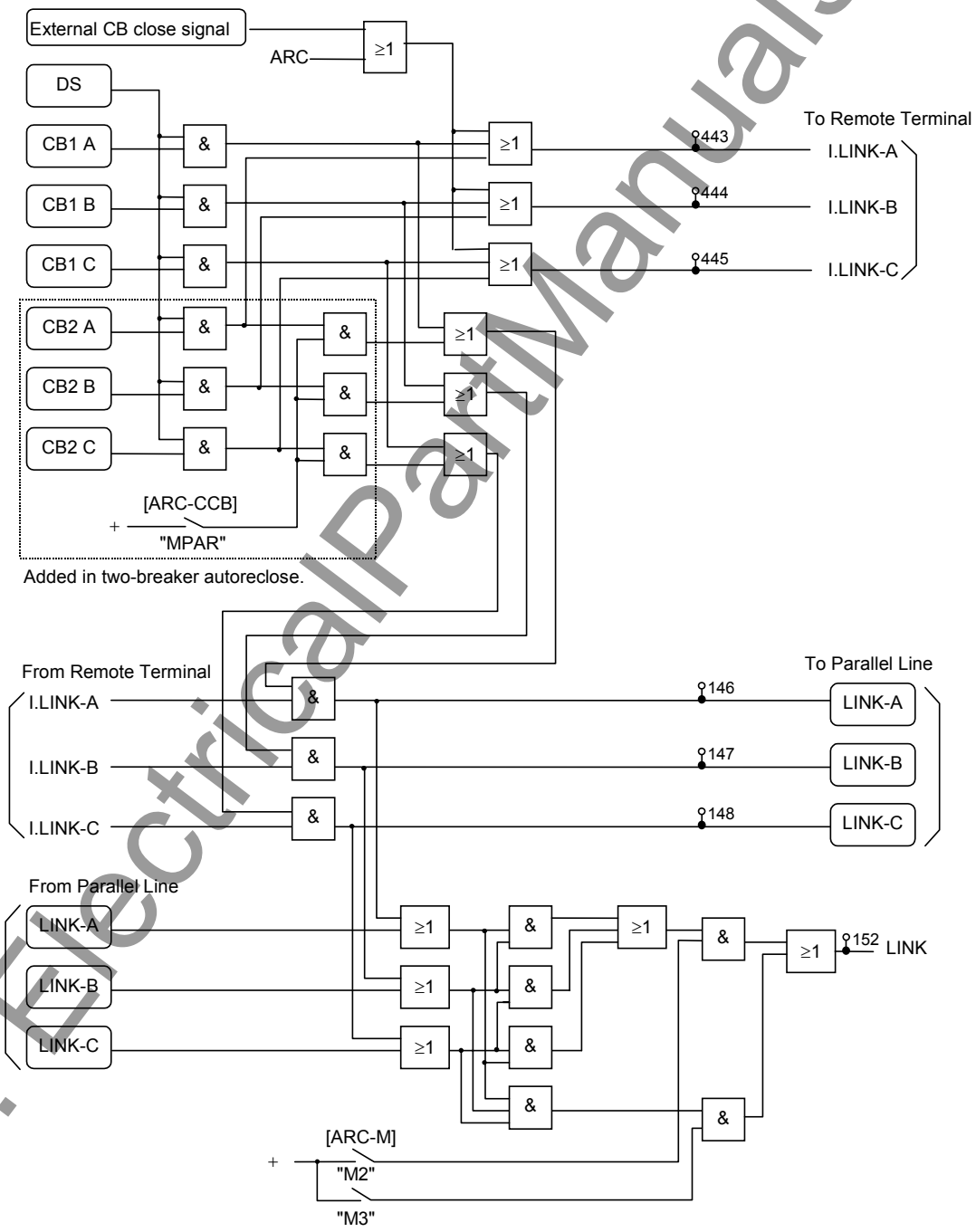



**Figure 2.15.2.5 Interconnection Check Scheme**

www.ElectricalPartManuals.com

### Permanent fault

When reclose-onto-a-fault is activated when a permanent fault exists, three-phase final tripping is performed. However, this operation is performed only in the single-shot autoreclose mode. In the multi-shot autoreclose mode, reclosing is retried as shown below, for multi-shot autoreclosing.

### Multi-shot autoreclose

In a multi-shot autoreclose, low-speed autoreclose is executed up to three times after high-speed autoreclose fails. The first shot is high-speed autoreclose that functions in the same manner as described for single-shot autoreclose. Figure 2.15.2.6 shows the simplified scheme logic for the low-speed autoreclose of the second to fourth shot.

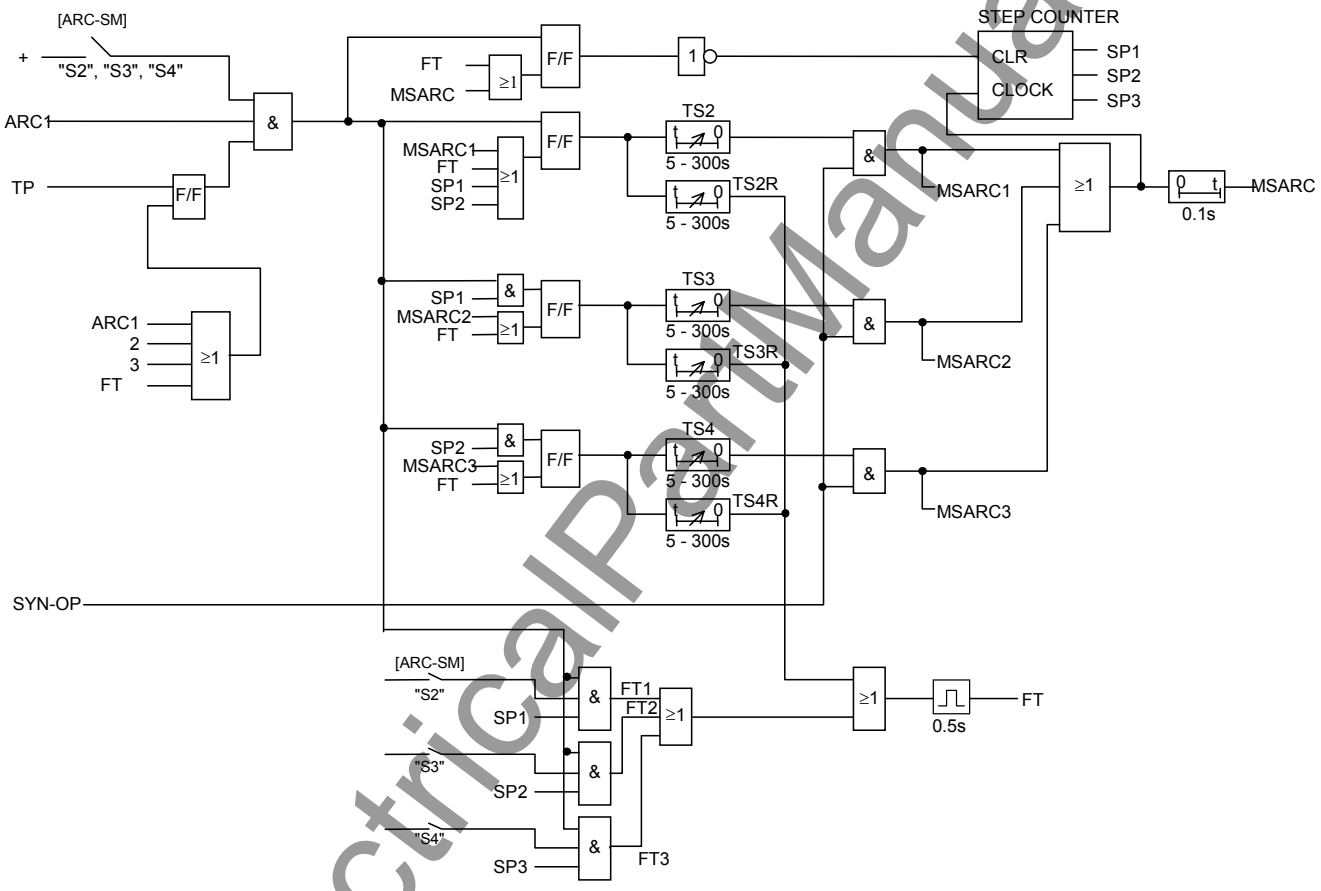



**Figure 2.15.2.6 Scheme Logic for Multi-Shot Autoreclose**

The multi-shot mode, two shots to four shots, is set with the scheme switch [ARC-SM].

In low-speed autoreclose, the dead time counter TS2 for the second shot is activated if high-speed autoreclose is performed (ARC = 1), but tripping occurs again (TP = 1). Second shot autoreclose is performed only when the voltage and synchronism check element operates (SYN-OP = 1) after the period of time set on TS2 has elapsed. At this time, outputs of the step counter are: SP1 = 1, SP2 = 0, and SP3 = 0.

Autoreclose is completed at this step if the two-shot mode is selected for the multi-shot mode. Therefore, the tripping following the "reclose-onto-a-fault" becomes the final tripping (FT = 1).

If the voltage and synchronism check element does not operate within the period of time set on the timer TS2R which is started at the same time as TS2 is started, the multi-shot autoreclose is cancelled (FT = 1).

www.ElectricalPartManuals.com

When the three-shot mode is selected for the multi-shot mode, autoreclose is retried again after the above tripping occurs. At this time, the TS3 and TS3R are started. The third shot autoreclose is performed only when the voltage and synchronism check element operates after the period of time set on the TS3 has elapsed. At this time, outputs of the step counter are: SP1 = 0, SP2 = 1, and SP3 = 0.

The three-shot mode of autoreclose is then completed. Therefore, the tripping following the ““reclose-onto-a-fault”” becomes the final tripping (FT = 1).

If the voltage and synchronism check element does not function within the period of time set on the TS3R, the multi-shot autoreclose is cancelled.

When the four-shot autoreclose is selected, low-speed autoreclose is retried once again for tripping that occurs after the "reclose-onto-a-fault". This functions in the same manner as the three-shot autoreclose.

#### Use of external automatic reclosing equipment

To use external automatic reclosing equipment instead of the built-in autoreclose function of the GRL100, the autoreclose mode switch [ARC-M] is set to "EXT1P", "EXT3P" or "EXTMP".

When "EXT1P" is selected, the GRL100 performs single-phase tripping for a single-phase fault and three-phase tripping for a multi-phase fault. When "EXT3P" is selected, three-phase tripping is performed for all faults. When "EXTMP" is selected, fault phase tripping is performed for all faults.

One binary signal for each individual phase is output as an autoreclose start signal.

### 2.15.2.2 Two-breaker autoreclose

As shown in Figure 2.15.2.7, in the one-and-a-half breaker busbar arrangement, two circuit breakers, the busbar breaker and the center breaker, must be reclosed. The GRL100 are provided with the two-breaker autoreclose scheme.

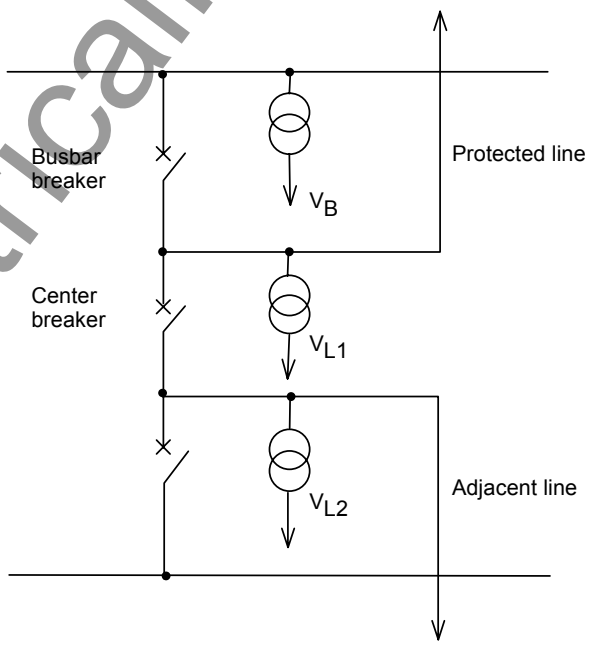



**Figure 2.15.2.7 One-and-a-Half Breaker Busbar Arrangement**

Multi-shot autoreclose is not applicable to two-breaker autoreclose; the scheme switch [ARC-SM] is set to "OFF" for a default setting.

www . ElectricalPartManuals . com

Autoreclose is not activated when an autoreclose prohibiting binary input signal is applied at the local or remote terminal.

- ARC_BLOCK signal common for leader and follower CB
- ARC_BLOCK1 signal for leader CB
- ARC_BLOCK2 signal for follower CB

The autoreclose scheme is different depending on the reclosing mode.

**Single-phase autoreclose and single- and three-phase autoreclose**

The breaker(s) to be reclosed and the reclosing order can be set by the scheme switch [ARC-CB] as follows:

| Setting of [ARC-CB] | Autoreclose mode |
|---|---|
| ONE | (Set when applied to a one-breaker system) |
| O1 | Only the busbar breaker is reclosed and the center breaker is subjected to final tripping. |
| O2 | Only the center breaker is reclosed and the busbar breaker is subjected to final tripping. |
| L1 | Single-phase autoreclose: Both breakers are reclosed simultaneously. (∗1) |
| | Three-phase autoreclose: The busbar breaker is reclosed first. If successful, then the center breaker is reclosed. |
| L2 | Single-phase autoreclose: Both breakers are reclosed simultaneously. (∗1) |
| | Three-phase autoreclose: The center breaker is reclosed first. If successful, then the busbar breaker is reclosed. |

**Note :** "ONE" is set only when the relay is applied to a one-breaker system. Trip and reclose commands are output only for CB1(bus CB).

(∗1): Sequential autoreclose can be applied by changing of the dead timer setting or the PLC setting.

(∗2): When [ARC-M] – MPAR is selected, the autoreclose mode depends on the [ARC-CCB] setting and the [ARC-CB] is not applied.

The autoreclose scheme logic for the two circuit breakers is independent of each other and are almost the same. The autoreclose scheme logic of the circuit breaker to be reclosed first (lead breaker) is the same as that shown in Figure 2.15.2.1. The scheme logic of the circuit breaker to be reclosed later (follower breaker) is shown in Figure 2.15.2.8.

The start of the dead time counter can be configured by the PLC. In the default setting, the single-phase autoreclose is started instantaneously after tripping, and the three-phase autoreclose is started after the ARC-SET condition is satisfied.

The "ARC-SET" is a scheme signal whose logical level becomes 1 when a leader breaker's autoreclose command is output.

In default setting, therefore, the dead time of the follower breaker is as follows:

- Three-phase autoreclose: equal to the sum of the dead time setting of the two breakers. (TTPR1 + TTPR2)
- Single-phase autoreclose: TSPR2

However, the dead time can be set that of the leader breaker by the PLC setting "RF.ST-REQ". The shortening of the dead time can be also applied when the leader breaker is final-tripped because it is no ready.

www.ElectricalPartManuals.com

**Autoreclose start requirement**

Using PLC function, various autoreclose start requirements can be designed. In Figure 2.15.2.8, a reclose start requirement for "SPAR", "TPAR", "SPAR&TPAR" or "MPAR" can be respectively assigned to the following signals by PLC:

"SPAR": [SPR.F-ST.REQ]

"TPAR": [TPR.F-ST.REQ]

"SPAR&TPAR": [SPR.F-ST.REQ], [TPR.F-ST.REQ]

"MPAR": [MPR.F-ST.REQ]

The default setting for the follower CB autoreclose start requirement is as follows:

| Reclose start requirement | Default setting | Remarks |
|---|---|---|
| "SPAR" | [SPR.F-ST.REQ] = CONSTANT_1 | No condition |
| "TPAR" | [TPR.F-ST.REQ] = ARC-SET or CCB-SET | ARC-SET becomes “1” when the leader CB is reclosed.<br>CCB-SET becomes “1” when [ARC-M]=M2 or M3 and [ARC-CCB]=TPAR setting. |
| "MPAR" | [MPR.F-ST.REQ] = CONSTANT_1 | No condition |

**Autoreclose requirement**

The autoreclose requirement can be designed by assigning a reclose requirement to the signals [SPR.F-REQ], [TPR.F-REQ] and [MPR.F-REQ] same as above.

The default setting for the follower CB autoreclose requirement is as follows:

| Reclose requirement | Default setting | Remarks |
|---|---|---|
| "SPAR" | [SPR.F-REQ] = CONSTANT_1 | No condition |
| "TPAR" | [TPR.F-REQ] = SYP-ON | Voltage and synchronism check |
| "MPAR" | [MPR.F-REQ] = CONSTANT_1 | No condition |

Others

If the autoreclose start requirement is designed such as starting the follower CB in no-ready condition of the leader CB, it is assigned to the signal [R.F-ST.REQ].

By assigning the autoreclose start requirement to the signal [R.F-ST.REQ], both the leader CB and the follower CB are set the same dead time. The reclose requirement is assigned to the signals [SPR.F2-ST.REQ], [TPR.F2-ST.REQ] and [MPR.F2-ST.REQ].

The default setting for the follower CB is as follows:

| Requirement | Default setting | |
|---|---|---|
| Reclose requirement | [R.F-ST.REQ] = CONSTANT_0 | (No used) |
| Reclose start requirement | | |
| "SPAR" | [SPR.F2-ST.REQ] = CONSTANT_0 | (No used) |
| "TPAR" | [TPR.F2-ST.REQ] = CONSTANT_0 | (No used) |
| "MPAR" | [MPR.F2-ST.REQ] = CONSTANT_0 | (No used) |

www . ElectricalPartManuals . com

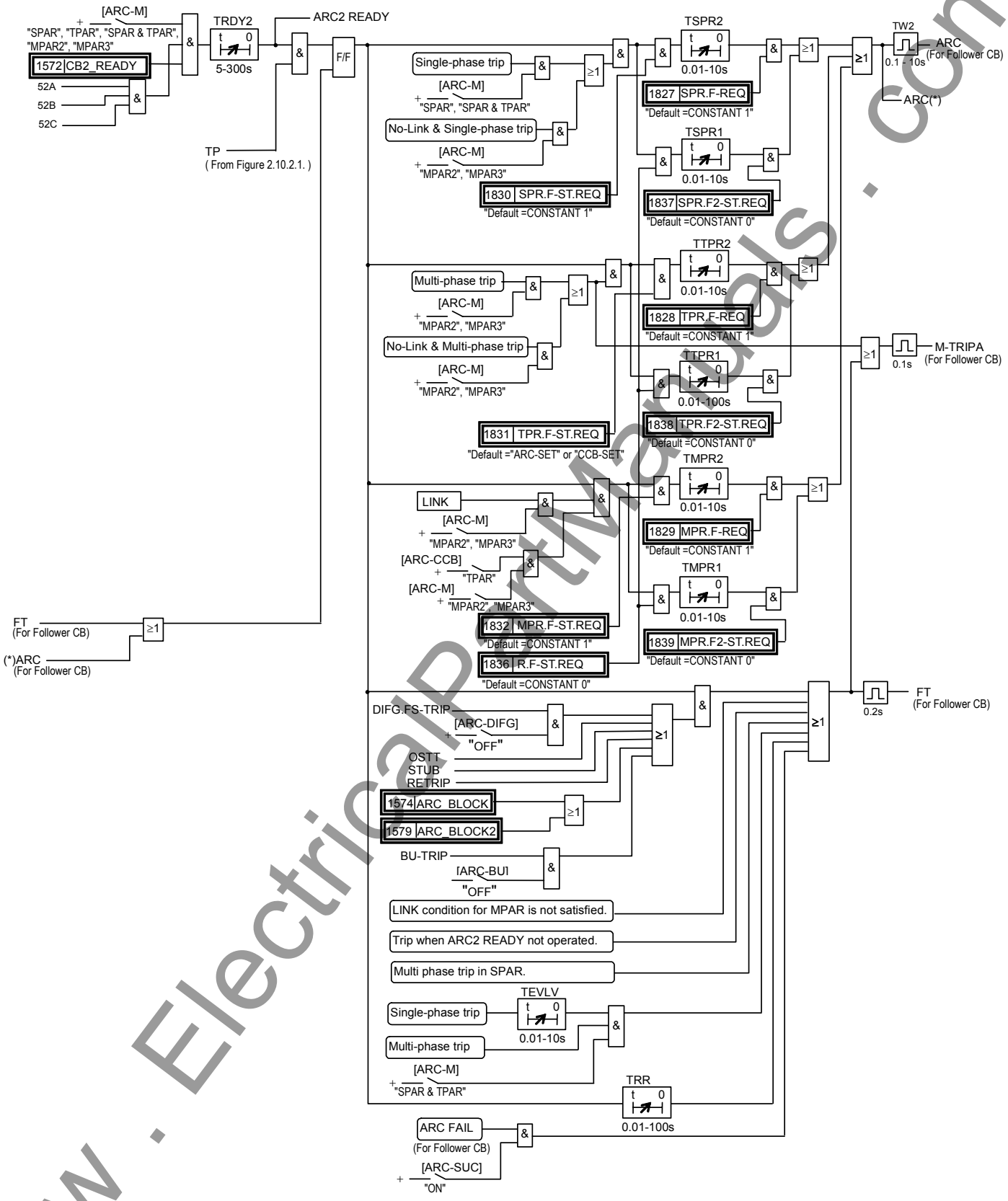


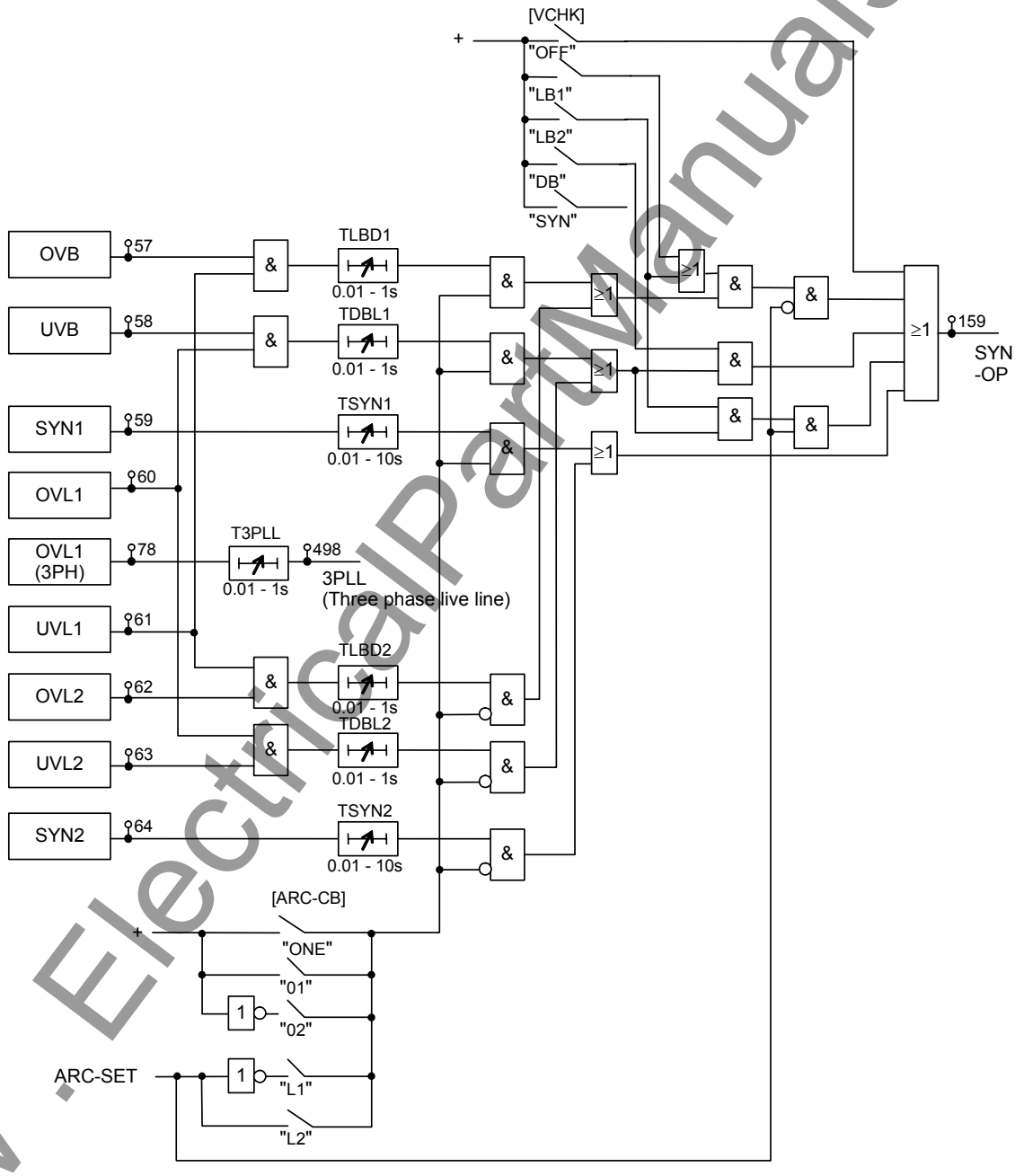

**Figure 2.15.2.8 Autoreclose Scheme for Follower Breaker**

www . ElectricalPartManuals . com

Figure 2.15.2.9 shows the energizing control scheme of the two circuit breakers in the three-phase autoreclose. OVB and UVB are the overvoltage and undervoltage detectors of busbar voltage $V_B$ in Figure 2.15.2.7. OVL1 and UVL1 are likewise the overvoltage and undervoltage detectors of line voltage $V_{L1}$.

OVL2 and UVL2 are likewise the overvoltage and undervoltage detectors of line voltage $V_{L2}$. $V_{L2}$ in the center breaker is equivalent to the busbar voltage $V_B$ in the busbar breaker.

SYN1 and SYN2 are the synchronism check elements to check synchronization between the two sides of the busbar and center breakers, respectively. SYN-OP is a voltage and synchronism check output.




**Note :** [ARC-CB] is set to "ONE" only when the relay is applied to one-breaker system. Trip and reclose commands are output only for CB1(bus CB).

**Figure 2.15.2.9 Energizing Control Scheme for Two Circuit Breakers**

www.ElectricalPartManuals.com

The voltage and synchronism check is performed as shown below according to the [ARC-CB] settings:

| Setting of [ARC-CB] | Voltage and synchronism check |
|---|---|
| ONE or O1 | A voltage and synchronism check is performed using voltages $V_B$ and $V_{L1}$. |
| O2 | A voltage and synchronism check is performed using voltages $V_{L1}$ and $V_{L2}$. |
| L1 | Since the logical level of ARC-SET is 0, a voltage and synchronism check is performed for the busbar breaker using voltages $V_B$ and $V_{L1}$. Then, the logical level of ARC-SET becomes 1 and a voltage and synchronism check is performed for the center breaker using voltages $V_{L1}$ and $V_{L2}$ and a reclosing command is output to the center breaker. |
| L2 | A voltage and synchronism check is performed for the center breaker using voltages $V_{L1}$ and $V_{L2}$. Then, the logical level of ARC-SET becomes 1 and a voltage and synchronism check is performed for the busbar breaker using voltages $V_B$ and $V_{L1}$. |

**Note :** "ONE" is set only when the relay is applied to one-breaker system. Trip and reclose commands are output only for CB1(bus CB).

The energizing control for the two circuit breakers can be set by the scheme switch [VCHK] as follows:

| Setting of [VCHK] | Energizing control |
|---|---|
| LB1 | The lead breaker is reclosed under the "live bus and dead line" condition or with synchronism check, and the follower breaker is reclosed with synchronism check only. |
| LB2 | The leader breaker is reclosed under the "live bus and dead line" condition or with synchronism check, and the follower breaker is reclosed under the "dead bus and live line" condition or with synchronism check. |
| DB | Both breakers are reclosed under the "dead bus and live line" condition or with synchronism check. |
| SYN | Both breakers are reclosed with synchronism check only. |
| OFF | Both breakers are reclosed without voltage and synchronism check. |

**Multi-phase autoreclose**

The scheme switch [ARC-M] is set to "MPAR2" or "MPAR3", then the busbar breaker is always reclosed in the multi-phase autoreclose mode.

The center breaker can select three-phase autoreclose, multi-phase autoreclose or three-phase final tripping by setting the scheme switch [ARC-CCB] shown in Figure 2.15.2.5.

When [ARC-CCB] is set to "TPAR", the logic level of CCB-SET signal becomes 1 and the center breaker is reclosed in the three-phase autoreclose mode only after the busbar breaker is successfully reclosed. If the voltage check condition is configured by the PLC, the energizing control for the center breaker is dependent on the setting of the scheme switch [VCHK] as follows.

| Setting of [VCHK] | Energizing control |
|---|---|
| LB | Reclosed under the "live bus and dead line" condition or with synchronism check. |
| DB | Reclosed under the "dead bus and live line" condition or with synchronism check. |
| SYN | Reclosed with synchronism check only. |
| OFF | Reclosed without voltage and synchronism check. |

Note: As this three-phase autoreclose is applied only to the center breaker, the settings of the [VCHK] is the same as that of one-breaker autoreclose.

www.ElectricalPartManuals.com

When [ARC-CCB] is set to "MPAR", the center breaker is also reclosed in the multi-phase autoreclose mode at the time of the TMPR2 setting.

When [ARC-CCB] is set to "OFF", autoreclose does not start for the center breaker.

The scheme switch [ARC-CCB] used in single-phase autoreclose and single- and three-phase autoreclose is invalid when multi-phase autoreclose is selected as a reclose mode.

The interlinking check scheme for two-breaker autoreclose is shown in Figure 2.15.2.5. Local interlink check signals CBDS-A, -B and –C are originated by ORing the busbar and center breaker conditions.

The scheme switch [ARC-SUC] is used to check the autoreclose succeeds. If all three phase CB contacts have been closed within TSUC time after ARC shot output, it is judged that the autoreclose has succeeded (AS). If not, it is judged that the autoreclose has failed (AF), and becomes the final tripping (FT).

The relay provides the user configurable switch [UARCSW] with three-positions (P1, P2, P3) to be programmed by using PLC function. Any position can be selected. If this switch is not used for the PLC setting, it is invalid. The setting example is shown in Appendix S.

### 2.15.2.3 Setting

The setting elements necessary for the autoreclose and their setting ranges are shown in the table below.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| VT | 1 - 20000 | 1 | 2000 | VT ratio for line differential protection |
| VTs1 | 1 - 20000 | 1 | 2000 | VT ratio for voltage and synchronism check |
| TSPR1 | 0.01 – 10.00s | 0.01s | 0.80s | Dead time for single-phase autoreclose and multi-phase autoreclose |
| TTPR1 | 0.01 – 100.00s | 0.01s | 0.60s | Dead time for three-phase autoreclose |
| TMPR1 | 0.01 – 100.00s | 0.01s | 0.80s | Dead time for multi-phase autoreclose |
| TRR | 0.01 – 100.00s | 0.01s | 2.00s | Autoreclose reset time |
| TEVLV | 0.01 – 10.00s | 0.01s | 0.30s | Dead time reset for evolving fault |
| TRDY1 | 5 – 300s | 1s | 60s | Reclaim time |
| SYN1 | | | | Synchronism check |
| SY1 θ | 5 – 75° | 1° | 30° | |
| SY1UV | 10 – 150V | 1V | 83V | |
| SY1OV | 10 – 150V | 1V | 51V | |
| OVB | 10 – 150V | 1V | 51V | Live bus check |
| UVB | 10 – 150V | 1V | 13 V | Dead bus check |
| OVL1 | 10 – 150V | 1V | 51V | Live line check |
| UVL1 | 10 – 150V | 1V | 13V | Dead line check |
| TSYN1 | 0.01 – 10.00s | 0.01s | 1.00s | Synchronism check time |
| TLBD1 | 0.01 – 1.00s | 0.01s | 0.05s | Voltage check time |
| TDBL1 | 0.01 – 1.00s | 0.01s | 0.05s | Voltage check time |
| T3PLL | 0.01 – 1.00s | 0.01s | 0.05s | Line three voltage check time |
| TW1 | 0.1 – 10.0s | 0.1s | 0.2s | Reclosing signal output time |
| TS2 | 5.0 – 300.0s | 0.1s | 20.0s | Second shot dead time |
| TS3 | 5.0 – 300.0s | 0.1s | 20.0s | Third shot dead time |
| TS4 | 5.0 – 300.0s | 0.1s | 20.0s | Fourth shot dead time |

www.ElectricalPartManuals.com

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| TS2R | 5.0 – 300.0s | 0.1s | 30.0s | Second shot reset time |
| TS3R | 5.0 – 300.0s | 0.1s | 30.0s | Third shot reset time |
| TS4R | 5.0 – 300.0s | 0.1s | 30.0s | Fourth shot reset time |
| TSUC | 0.1 – 10.0s | 0.1s | 3.0s | Autoreclose success check time |
| [ARC – M] | Disabled/SPAR/TPAR/ SPAR & TPAR/MPAR2/MPAR3/ EXT1P/EXT3P/EXTMP | | SPAR & TPAR | Autoreclose mode |
| [ARCDIFG] | OFF/ON | | OFF | High-resistance fault autoreclose |
| [ARC-BU] | OFF/ON | | OFF | Backup trip autoreclose |
| [ARC-EXT] | OFF/ON | | OFF | External start |
| [ARC – SM] | OFF/S2/S3/S4 | | OFF | Multi – shot autoreclose mode |
| [ARC-SUC] | OFF/ON | | OFF | Autoreclose success checking |
| [MA-NOLK] | FT/T/S+T | | FT | Control under NON-LINK in MPAR |
| [VCHK] | OFF/LB/DB/SYN | | LB | Energizing direction |
| [VTPHSEL] | A/B/C | | A | Phase of reference voltage |
| [VT – RATE] | PH/G / PH/PH | | PH/G | VT rating |
| [3PH – VT] | BUS/LINE | | LINE | Location of three – phase VTs |
| [UARCSW] | P1/P2/P3 | | (P1)(*) | User ARC switch for PLC |

(*) If this switch is not used for PLC setting, it is invalid.

"VT" is VT ratio setting of protection, and "VTs1" is VT ratio setting of a reference voltage input for voltage and synchronism check element as shown in Figure 2.16.9.1.

In a voltage setting, set "SY1UV", "SY1OV", "OVB", "UVB", "OVL1" and "UVL1" based on the VT rating for voltage and synchronism check. (When a voltage rating between line VT and busbar VT is different as shown in Figure 2.15.2.10, the voltage input from "VT" is matched to the rating of "VTs1" using the setting of "VT" and "VTs1".)

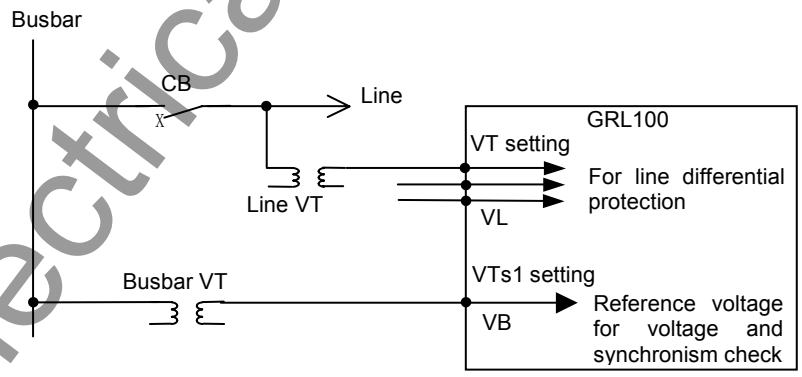



**Figure 2.15.2.10 VT and VTs1 Ratio Setting for Busbar or Line Voltage**

To determine the dead time, it is essential to find an optimal value while taking into consideration the de-ionization time and power system stability factors, which normally contradict each other.

Normally, a longer de-ionization time is required for a higher line voltage or larger fault current. For three-phase autoreclose, the dead time is generally 15 to 30 cycles. In single-phase autoreclose, the secondary arc current induced from the healthy phases may affect the de-ionization time. Therefore, it is necessary to set a longer dead time for single-phase autoreclose compared to that for three-phase autoreclose.

www.ElectricalPartManuals.com

In three-phase autoreclose, if the voltage and synchronism check does not operate within the period of time set on the on-delay timer TRR, which is started at the same time as the dead time counter TTPR1 is started, reclosing is not performed and three-phase autoreclose is reset to its initial state. Therefore, for example, the TRR is set to the time setting of the TTPR1 plus 100ms.

The TEVLV determines the possibility of three-phase reclosing for an evolving fault.

When the TEVLV is set to the same setting as the TSPR, three-phase reclosing is performed for all evolving faults. As the setting for the TEVLV is made shorter, the possibility of three-phase reclosing for an evolving fault becomes smaller and that of three-phase final tripping becomes larger.

For the two-breaker autoreclose, the following additional settings are required.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| VTs2 | 1 - 20000 | 1 | 2000 | VT ratio for voltage and synchronism checkSYN2 |
| TSPR2 | 0.1 – 10.0s | 0.1s | 0.1s | Dead time for single-phase autoreclode of follower breaker |
| TTPR2 | 0.1 – 10.0s | 0.1s | 0.1s | Dead time for three-phase autoreclode of follower breaker |
| TMPR2 | 0.1 – 10.0s | 0.1s | 0.1s | Dead time for multi-phase autoreclode of follower breaker |
| TRDY2 | 5 – 300s | 1s | 60s | Reclaim time of follower breaker |
| SYN2 | | | | Synchronism check |
| SY2 θ | 5 – 75° | 1° | 30° | |
| SY2UV | 10 – 150V | 1V | 83V | |
| SY2OV | 10 – 150V | 1V | 51V | |
| OVL2 | 10 – 150V | 1V | 51V | Live line check |
| UVL2 | 10 – 150V | 1V | 13V | Dead line check |
| TSYN2 | 0.01 – 10.00s | 0.01s | 1.00s | Synchronism check time |
| TLBD2 | 0.01 – 1.00s | 0.01s | 0.05s | Voltage check time |
| TDBL2 | 0.01 – 1.00s | 0.01s | 0.05s | Voltage check time |
| TW2 | 0.1 – 10.0s | 0.1s | 0.2s | Reclosing signal output time |
| [ARC-CB] | ONE/O1/O2/L1/L2 | | L1 | Two breaker autoreclose mode |
| [ARC-CCB] | TPAR/MPAR/OFF | | MPAR | Center breaker autoreclose mode |
| [VCHK] | OFF/LB1/LB2/DB/SYN | | LB1 | Energizing direction |

**Note :** [ARC-CB] is set to "ONE" only when the relay is applied to one-breaker system. Trip and reclose commands are output only for CB1(bus CB).

### 2.15.3 Autoreclose Output Signals

The autoreclose scheme logic has two output reclosing signals: ARC1 and ARC2. ARC1 is a reclosing signal for single breaker autoreclose or a reclosing signal for the busbar breaker in a two-breaker autoreclose scheme.

ARC2 is the reclosing signal for the center breaker of the two-breaker autoreclose scheme.

The assignment of these reclosing signals to the output relays can be configured, which is done using the setting menu. For details, see Section 3.2.2. For the default setting, see Appendix D.

www.ElectricalPartManuals.com

## 2.16 Characteristics of Measuring Elements

### 2.16.1 Segregated-phase Current Differential Element DIF and DIFSV

The segregated-phase current differential elements DIF have dual percentage restraint characteristics. Figure 2.16.1.1 shows the characteristics on the differential current (Id) and restraining current (Ir) plane. Id is a vector summation of the phase current of all terminals and Ir is a scalar summation of the phase current of all terminals. In these summations, charging current is eliminated from the phase currents by the charging current compensation function.

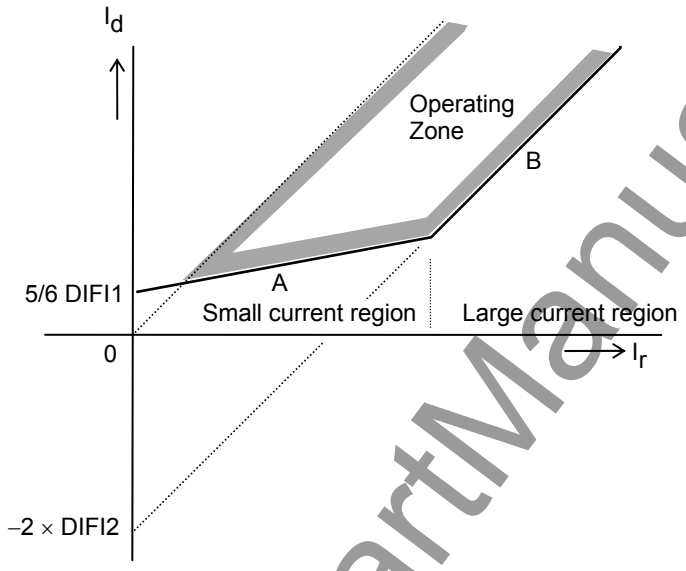



**Figure 2.16.1.1 Segregated-phase Current Differential Element ($I_r$-$I_d$ Plane)**

Characteristic A of the DIF element is expressed by the following equation:

$$I_d \geq (1/6)I_r + (5/6)DIFI1$$

where DIFI1 is a setting and defines the minimum internal fault current.

This characteristic has weaker restraint and ensures sensitivity to low-level faults.

Characteristic B is expressed by the following equation:

$$I_d \geq I_r - 2 \times DIFI2$$

where DIFI2 is a setting and its physical meaning is described later.

This characteristic has stronger restraint and prevents the element from operating falsely in response to the erroneous differential current which is caused by saturation or transient errors of the CT during an external fault. If the CT saturation occurs at the external fault in a small current region of the characteristics and continues, the element may operate falsely caused by increasing the erroneous differential current. The DIF prevents the false operation by enhancing the restraining quantity for the DIF calculation, depending on the magnitude of restraining current in the large current region characteristic B.

The figure shows how the operation sensitivity varies depending on the restraining current.

The same characteristic can be represented on the outflowing current ($I_{out}$) and infeeding current ($I_{in}$) plane as shown in Figure 2.16.1.2.

www.ElectricalPartManuals.com

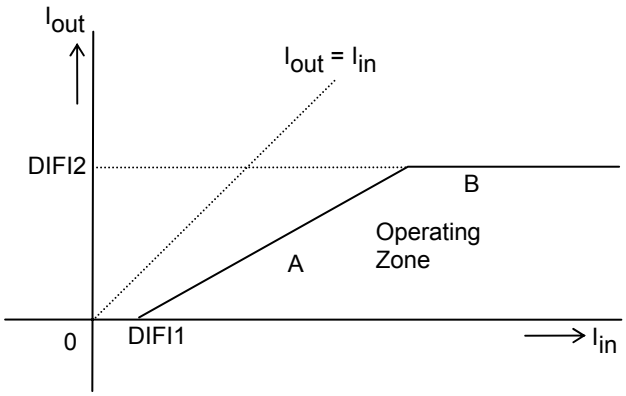



**Figure 2.16.1.2 Segregated-phase Current Differential Element (Iin-Iout Plane)**

Characteristic A is expressed by the following equation:

$$I_{out} \leq (5/7)(I_{in} - DIFI1)$$

Characteristic B is expressed by the following equation:

$$I_{out} \leq DIFI2$$

This figure shows the physical meaning of setting DIFI2, that is, DIFI2 defines the maximum outflowing current in case of an internal fault which can be detected by the relay. This outflowing current can be significant particularly in the case of a double-circuit three-terminal line or three-terminal line with outer loop circuit. Depending on the fault location, part of the fault current flows out from one terminal and flows in from another terminal. For details of the outflowing fault current, see Sections 2.2.10 and 2.2.12.

### 2.16.2 Zero-phase Current Differential Element DIFG

The DIF element is not too insensitive to detect a high-impedance earth fault, but to detect such faults under a heavy load current, the GRL100 is provided with a protection using a residual current.

Figure 2.16.2.1 represents the percentage restraining characteristic of the residual current differential element. Differential current ($I_d$) is a vector summation of the residual currents of all terminals and restraining current ($I_r$) is a scalar summation of the residual currents of all terminals.

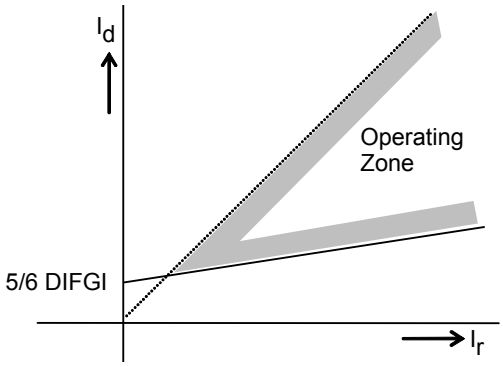



**Figure 2.16.2.1 Zero-phase Current Differential Element (Ir-Id Plane)**

The characteristic of the DIFG element is the same as that of the DIF element in the small current region and is expressed by the following equation:

www . ElectricalPartManuals . com

$$I_d \geq (1/6)I_r + (5/6)DIFGI$$

where DIFGI is a setting and defines the minimum residual fault current.

### 2.16.3 Distance Measuring Elements Z1, Z2, Z3, Z4, ZR and PSB

The GRL100 provides eight distance measuring zones with mho-based characteristics or quadrilateral characteristics.

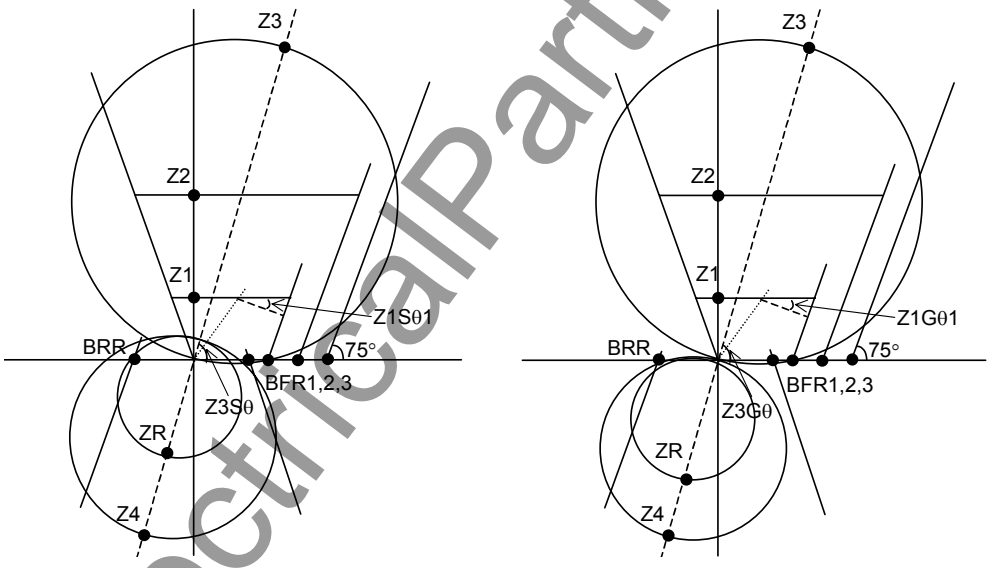
As shown in Figure 2.16.3.1, mho-based zone characteristics are composed of mho element, offset mho element, impedance element, reactance element, and blinder element for phase fault protection and earth fault protection.

Z1 (zone 1) and Z2 (zone 2) are a combination of the reactance element, mho element and blinder element.

Z3 (zone 3), ZR (reverse zone R) and Z4 use the mho element and blinder element, but Z4 for phase faults uses the offset mho element instead of mho element. This makes it possible to detect a reverse close-up fault at high speed if Z4 for phase faults is used for the command protection.

The blinder element is normally used to restrict the resistive reach of the mho or offset mho element if their operating range encroaches upon the load impedance.

The blinder element (BFR) can be provided for each forward zone. The setting of blinder element can be set independently or set common to forward zones by the scheme switch [BLZONE].



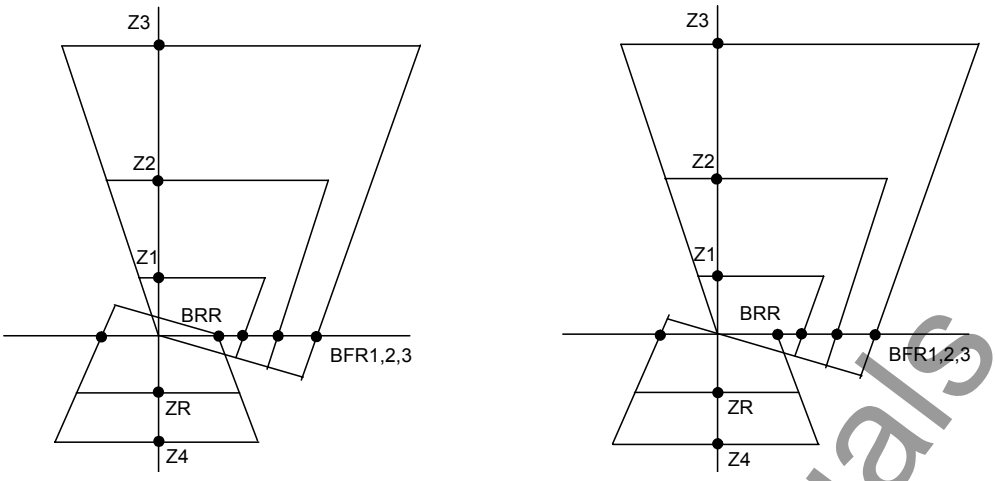

**(a) Phase fault element** **(b) Earth fault element**

**Figure 2.16.3.1 Mho-based Characteristics**

As shown in Figure 2.16.3.2, quadrilateral zone characteristics are composed of reactance element, directional element and blinder element. Z4 for phase faults uses the offset directional element to ensure a reverse close-up fault detection.

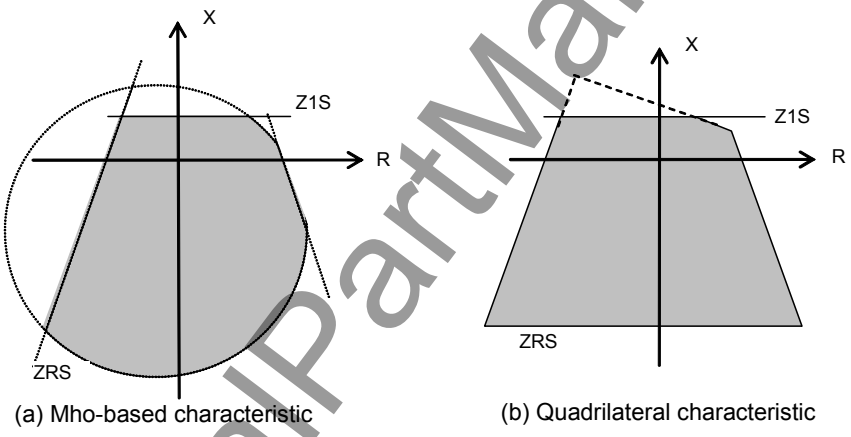
The forward offset reach of reverse zone ZR for both mho-based and quadrilateral characteristics is fixed as 7.5 ohms for 1A rating or 1.5 ohms for 5A rating. However, when they are used for back-up tripping ([ZRTP]= "ON"), the forward offset reach is limited to the zone 1 reach setting, as shown in Figure 2.16.3.3. Z4, on the other hand, is normally used to provide blocking in the command schemes, and its offset is not limited by the zone 1 reach setting. It is fixed at 7.5Ω (or 1.5Ω) in order to give reliable, fast blocking for a close-up reverse fault.

www.ElectricalPartManuals.com




**(a) Phase fault element** **(b) Earth fault element**

**Figure 2.16.3.2 Quadrilateral Four Zone Characteristics**




(a) Mho-based characteristic (b) Quadrilateral characteristic

**Figure 2.16.3.3 ZRS Characteristic Offset Reach for Backup Tripping**

Zone 1 and zone 2 can trip on condition that zone 3 has operated, in both characteristics.

The power swing blocking elements (PSBS and PSBG) are a combination of the reactance element and blinder element as shown in Figure 2.16.3.4. The outer element PSBOUT encloses the inner element PSBIN with a settable width of PSBZ.

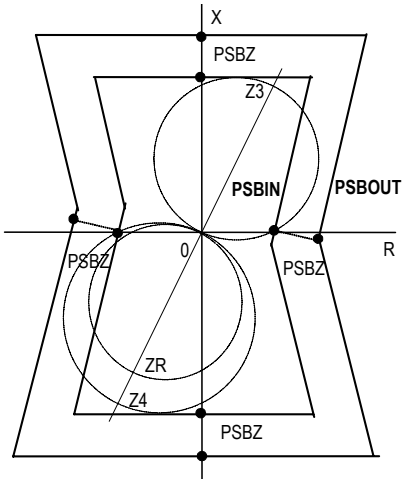



**Figure 2.16.3.4 Power Swing Blocking Element**

www . ElectricalPartManuals . com

**Mho element**

The characteristic of the mho element is obtained by comparing the phases between signals S1 and S2. If the angle between these signals is 90° or more, it means that the fault is within the mho characteristic, and the mho element will operate.

$S1 = V - IZs$

$S2 = Vp$

where,

V = fault voltage

I = fault current

Zs = zone reach setting

Vp = polarizing voltage

Figure 2.16.3.5 is a voltage diagram, which shows that the mho characteristic is obtained by the phase comparison if V and Vp are in-phase.

The mho characteristic on the impedance plane is obtained by dividing the voltage in Figure 2.16.3.5 by current I.

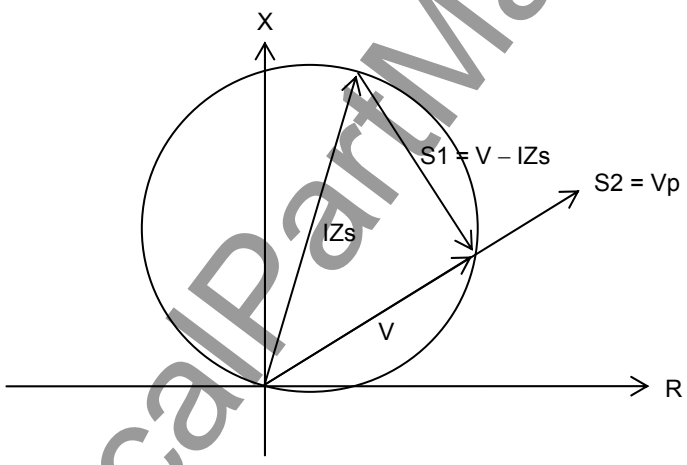



**Figure 2.16.3.5 Mho Element**

Both the phase fault mho element and earth fault mho element of the GRL100 employ a dual polarization (self-polarization plus cross-polarization). Its polarizing voltage Vp is expressed by the following equations.

For B-to-C-phase phase fault element

$$V_{pbc} = \sqrt{3}\,(V_a - V_0) \angle -90° + V_{bc}$$

For an A-phase earth fault element

$$V_{pa} = \sqrt{3}\,(V_a - V_0) + V_{bc} \angle 90°$$

where,

$V_a$ = A-phase voltage

$V_0$ = zero-sequence voltage

$V_{bc}$ = B-to-C-phase voltage

The dual-polarization improves the directional security when applied to heavily loaded lines or weak infeed terminals.

www.ElectricalPartManuals.com

The polarizing voltage for the phase fault mho element has a memory action for the close-up three-phase fault. $V_a$ and $V_{bc}$ mentioned above are the memorized pre-fault voltages. This memory is retained for two cycles after a fault occurs. The polarizing voltage for the earth fault mho element has no memory action.

When a three-phase fault occurs within zone 1, the phase fault mho element for zone 1 is modified to an offset mho characteristic as shown in Figure 2.16.3.6. This, together with voltage memory action, enables zone 1 to perform tripping with a time delay as well as instantaneous tripping for the close-up three-phase fault.

The Z2 and Z3 do not have the modifying function mentioned above.

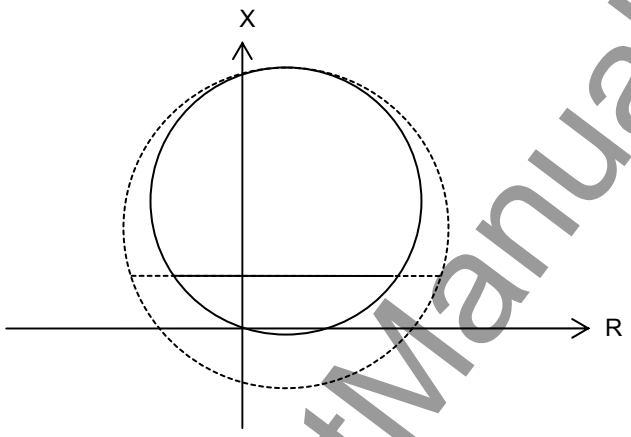



**Figure 2.16.3.6 Offset of Z1 in Three-phase Fault**

#### Offset mho element

Three independent offset mho elements are used for Z1 for phase faults, reverse zone ZR2 and Z4 for phase faults.

The characteristics of each offset mho element are obtained by comparing the phases between signals S1 and S2.

If the angle between these signals is 90° or more, the offset mho element operates.

$$S1 = V - IZs$$

$$S2 = V + IZso$$

where,

V = fault voltage

I = fault current

Zs = zone reach setting

Zso = offset zone reach setting

Figure 2.16.3.7 is a voltage diagram showing the offset mho characteristics obtained by the phase comparison between S1 and S2.

The offset mho characteristic on the impedance plane is obtained by dividing the voltage in Figure 2.16.3.7 by current I.

www.ElectricalPartManuals.com

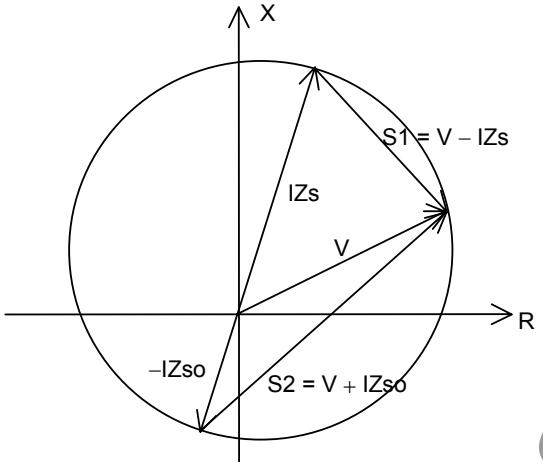



**Figure 2.16.3.7 Offset Mho Element**

**Reactance element**

The reactance element of Z1 has a composite characteristic with the two straight lines, one is parallel and the other is gradual descent toward the R-axis as shown in Figure 2.16.3.8.

The characteristic is defined by the reach setting Xs and the angle settings θ1 and θ2. This composite characteristic is obtained only when the load current is transmitted from local to remote terminal. When the load current flows from remote to local terminal or the load current does not flow or θ1 is set to 0°, the reactance element characteristic is a horizontal line which is parallel to the R-axis.

The characteristic is expressed by the following equations.

For horizontal characteristic

$$X \leq Xs$$

For gradient characteristic

$$R \leq Xs \tan ( 90° - \theta 2 ) + ( Xs - X ) \tan ( 90° - \theta 1 )$$

where,

R = resistance component of measured impedance

X = reactance component of measured impedance

Xs = reach setting

The reactance element characteristic of Z2 and ZR is given by a parallel line to the R axis.

R and X are calculated using an integration approximation algorithm. The reactance element provides high measurement accuracy even in the presence of power system frequency fluctuations and distorted transient waveforms containing low-frequency spectral components.

A decision to operate is made 6 times in each power frequency cycle using the above-mentioned equation. The reactance element operates when two consecutive measurements are made if the distance to a fault is within 90% of the reach setting. If the distance to a fault is more than 90%, the reactance element operates when four consecutive measurements are made.

This decision method prevents transient overreaching occurring for faults close to the element boundary.

www.ElectricalPartManuals.com

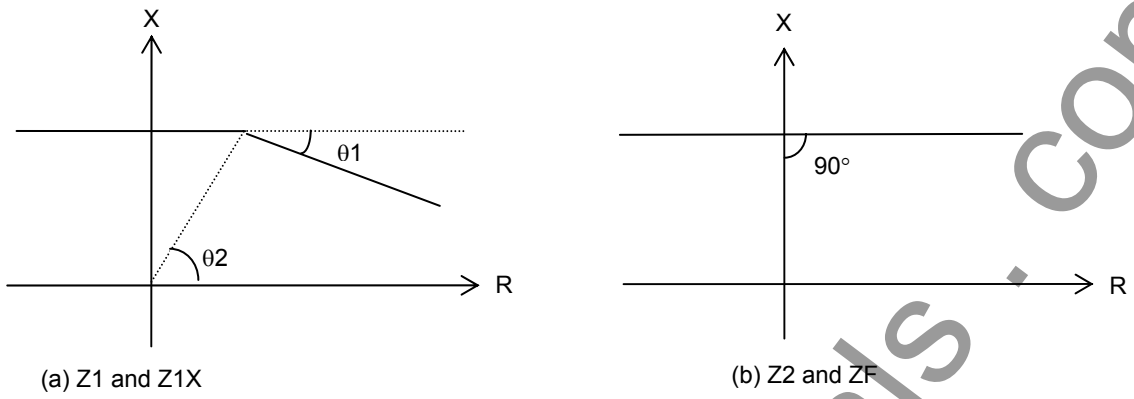



**Figure 2.16.3.8 Reactance Element**

The setting of θ1(Z1θ1) and θ2(Z1θ2) are set to the following:

$Z1\theta2 < \tan^{-1}( X / R_F )$

Where,

X = reactance component

$R_F$ = fault resistance

$Z1\theta1 < \tan^{-1}\{I_{Lmax} / (I_{Lmax} + I_{Fmin})\}$

$I_{Lmax}$ = maximum load current

$I_{Fmin}$ = minimum fault current

**Blinder element**

The blinder element is commonly applicable to Z1, Z2, Z3, ZR and Z4. As shown in Figure 2.16.3.9, the blinder element provides the forward blinder and the reverse blinder. The operating area of the forward blinder is the zone enclosed by the lines BFR and BFL, and that of the reverse blinder is the zone enclosed by the lines BRR and BRL. The BFR has an angle θ of 75° to the R-axis and BFL 90° to 135°. The angle of BRL is linked with that of BFL.

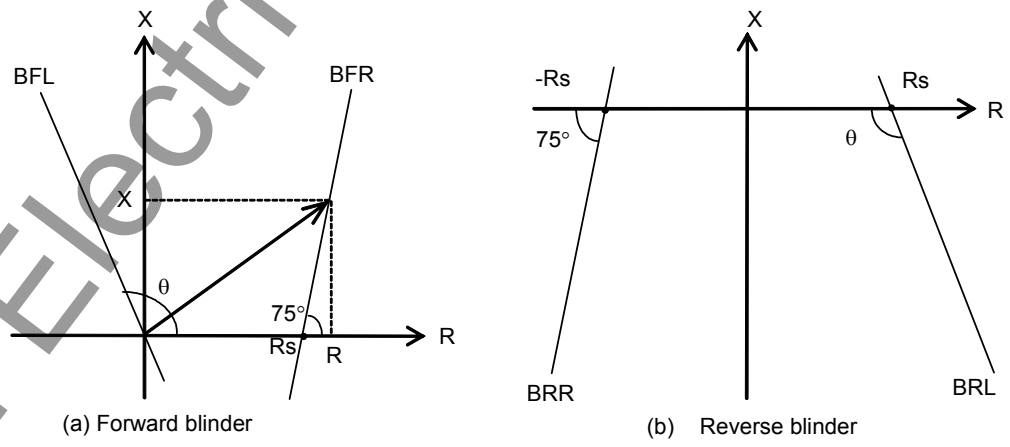



**Figure 2.16.3.9 Blinder element**

The characteristic of the BFR is obtained by the following equation.

$X \geq (R - Rs) \tan 75°$

where,

www.ElectricalPartManuals.com

R = resistance component of measured impedance

X = reactance component of measured impedance

Rs = reach setting

The characteristic BFL is obtained by the following equation. Polarizing voltage employed is the same as employed for mho element.

$$Vp\ I \cos ( \phi + \theta - 90° ) > 0$$

where,

Vp = polarizing voltage

I = fault current

$\phi$ = lagging angle of I to Vp

$\theta$ = angle setting

A blinder applicable to the offset mho element for the power swing blocking also has the same characteristics as BFR.

The characteristics of BRR and BRL are expressed by the following equations.

For BRR

$$X \leq (R + Rs) \tan 75°$$

For BRL

$$X \leq (R - Rs) \tan (180° - \theta)$$

where,

R = resistance component of measured impedance

X = reactance component of measured impedance

Rs = reach setting

The reach settings of BFR and BRR are made on the R-axis. The BRL setting is interlinked with the BRR setting.

If the minimum load impedance is known, then assuming a worst case load angle of 30° and a margin of 80%, then the following equation can be used to calculate the blinder element resistive settings:

$$R_{set} < 0.8 \times Z_{Lmin} \times (\cos 30 - \frac{\sin 30}{\tan 75})$$

**Directional element**

The directional element is used for the quadrilateral four zone characteristics.

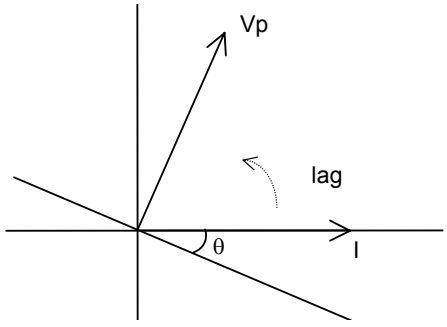



**Figure 2.16.3.10 Directional Element**

www . ElectricalPartManuals . com

The characteristic of the directional element is obtained by the following equation.

$$I \cdot Vp \cos ( \theta - \phi ) \geq 0$$

where,

I = fault current

Vp = polarizing voltage

$\phi$ = lagging angle of I to Vp

$\theta$ = directional angle setting

The polarizing voltage Vp is the same one as employed in the mho element.

For B-to-C-phase phase fault element

$$V_{pbc} = \sqrt{3} (V_a - V_0) \angle - 90° + V_{bc}$$

For an A-phase earth fault element

$$V_{pa} = \sqrt{3} (V_a - V_0) + V_{bc} \angle 90°$$

where,

$V_a$ = A-phase voltage

$V_0$ = zero-sequence voltage

$V_{bc}$ = B-to-C-phase voltage

The polarizing voltage for the phase fault element has a memory action for the close-up three-phase fault. $V_a$ and $V_{bc}$ mentioned above are the memorized pre-fault voltages. This memory is retained for two cycles after a fault occurs. The polarizing voltage for the earth fault element has no memory action.

When a three-phase fault occurs within zone 1, the phase fault element for zone 1 is modified to an offset characteristic as shown in Figure 2.16.3.11. This, together with voltage memory action, enables zone 1 to perform tripping with a time delay as well as instantaneous tripping for the close-up three-phase fault.

The Z2 and Z3 do not have the modifying function mentioned above.

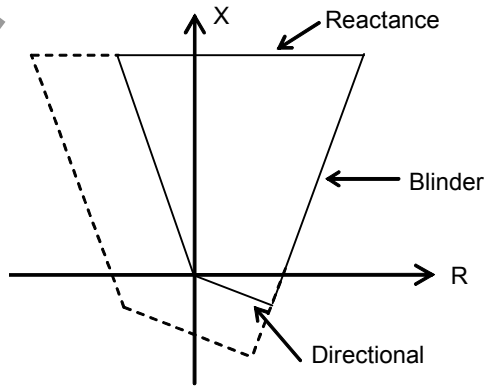



**Figure 2.16.3.11 Quadrilateral characteristic**

**Offset directional element**

The offset directional element is used only in Z4 for phase faults in the quadrilateral four zone characteristics.

www . ElectricalPartManuals . com

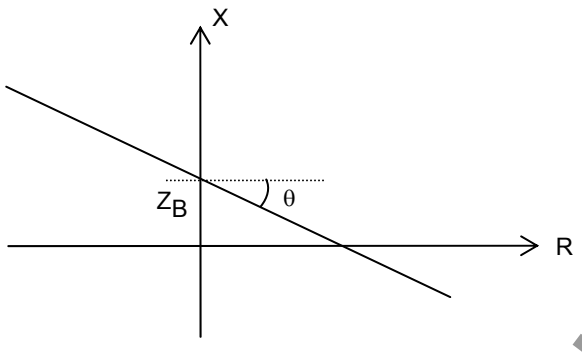



**Figure 2.16.3.12 Offset Directional Element**

The characteristic of the offset directional element is obtained by the following equation.

$$X + R \tan\theta \leqq Z_B$$

where,

X = reactance component of measured impedance

R = resistance component of measured impedance

θ = directional angle setting (interlinked with directional element angle setting)

$Z_B$ = offset reach setting (fixed to 1.5 Ω in 5A rating and 7.5 Ω in 1A rating)

### 2.16.4 Phase Selection Element UVC

The phase selection element has the undervoltage characteristic shown in Figure 2.16.4.1 and is used to select a faulty phase in case of a single-phase-to-earth fault.

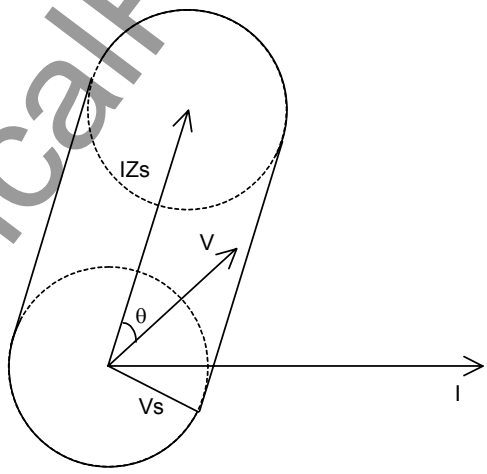



**Figure 2.16.4.1 Phase Selection Element**

The characteristic is obtained by a combination of the equations below. If equation (1) or equation (2), or both equations (3) and (4) are established, the UVC operates.

$$|V| \leq Vs \quad (1)$$

$$|V - IZs| \leq Vs \quad (2)$$

$$-Vs \leq V \sin\theta \leq Vs \quad (3)$$

$$0 \leq V \cos\theta \leq |IZs| \quad (4)$$

www.ElectricalPartManuals.com

where,

V = fault voltage

I = fault current

θ = angle difference between V and IZs

Zs = impedance setting

Vs = undervoltage setting

When the value and angle of Zs are set to those similar to the impedance of the protected line, the phase selection element will detect all single-phase earth faults that have occurred on the protected line even with a strong source and the voltage drop is small.

As a result of current compensation, the operating zone expands only in the direction leading the current by the line impedance angle. Therefore, the effect of current compensation is very small under load conditions where the current and voltage have almost the same phase angle.

### 2.16.5 Directional Earth Fault Elements DEFF and DEFR

There are two types of directional earth fault element, the forward looking element (DEFF) and reverse looking element (DEFR). Their characteristics are shown in Figure 2.16.5.1.

Both the DEFF and DEFR use a residual voltage as their polarizing voltage and determine the fault direction based on the phase relationship between the residual current and polarizing voltage.

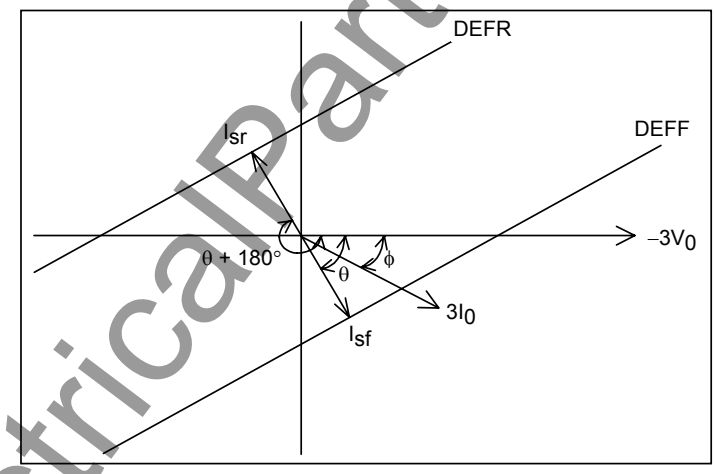



**Figure 2.16.5.1 Directional Earth Fault Element**

The operation decision is made using the following equation.

DEFF

$3I_0 \cdot \cos(\phi - \theta) \geq I_{sf}$

$3V_0 \geq V_{sf}$

DEFR

$3I_0 \cos(\phi - \theta - 180°) \geq I_{sr}$

$3V_0 \geq V_{sr}$

where,

$3I_0$ = residual current

www.ElectricalPartManuals.com

$3V_0$ = residual voltage

$-3V_0$ = polarizing voltage

$\phi$ = lagging angle of $(3I_0)$ to $(-3V_0)$

$\theta$ = characteristic angle setting (lagging to polarizing voltage)

$I_{sf}$, $I_{sr}$ = current setting

$V_{sf}$, $V_{sr}$ = voltage setting

### 2.16.6 Inverse Definite Minimum Time (IDMT) Overcurrent Element OCI and EFI

As shown in Figure 2.16.6.1, the IDMT element has one long time inverse characteristic and three inverse time characteristics in conformity with IEC 60255-3. One of these characteristics can be selected.

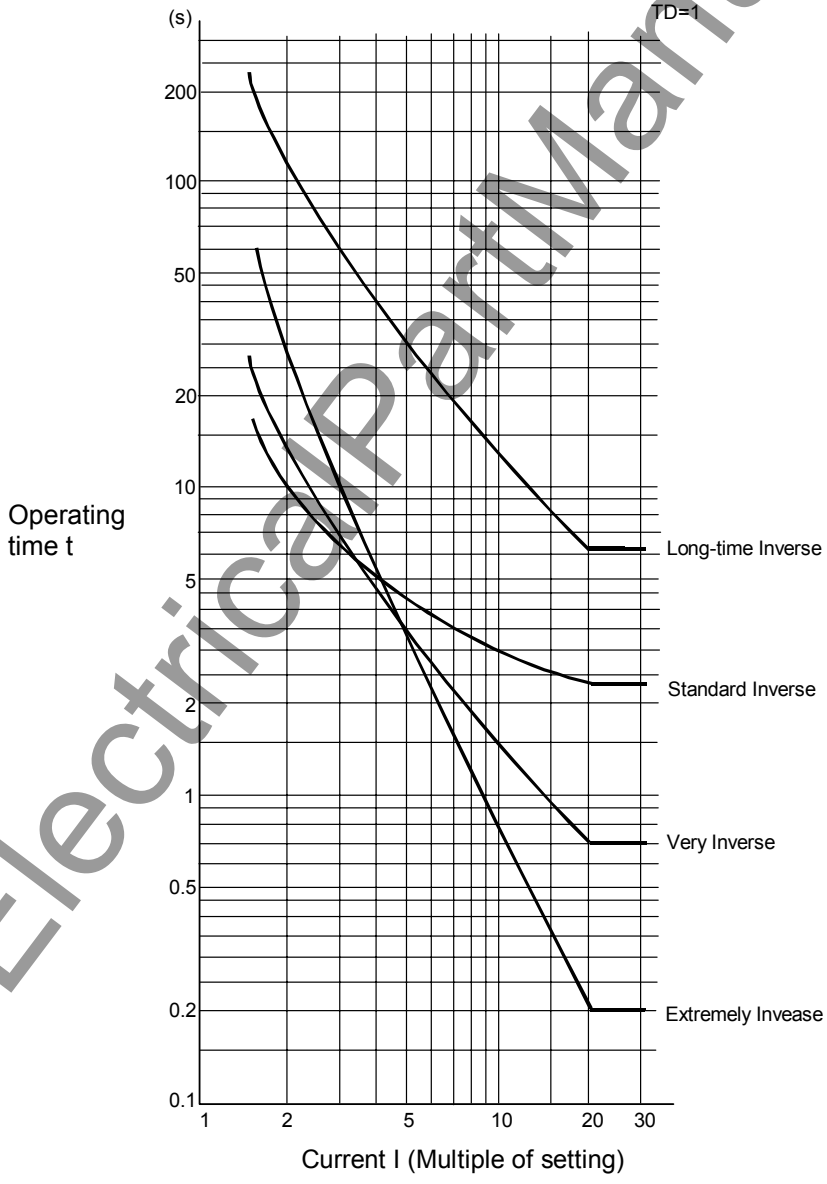



**Figure 2.16.6.1 IDMT Characteristics**

These characteristics are expressed by the following equations.

www . ElectricalPartManuals . com

Long Time Inverse

$$t = T \times \frac{120}{(I/Is)-1}$$

Standard Inverse

$$t = T \times \frac{0.14}{(I/Is)^{0.02} - 1}$$

Very Inverse

$$t = T \times \frac{13.5}{(I/Is) - 1}$$

Extremely Inverse

$$t = T \times \frac{80}{(I/Is)^{2} - 1}$$

where,

t = operating time
I = fault current
Is = current setting
T = time multiplier setting

### 2.16.7 Thermal Overload Element

Thermal overload element operates according to the characteristics defined in IEC60255-8. (Refer to Figure 2.6.1 and Appendix P.)

### 2.16.8 Out-of-Step Element OST

The OST element detects the out-of-step by checking that the voltage phasor $V_B$ of the remote terminal transits from the second quadrant (α-zone) to the third quadrant (β-zone) or vice versa when the voltage phasor $V_A$ of the local terminal is taken as a reference.

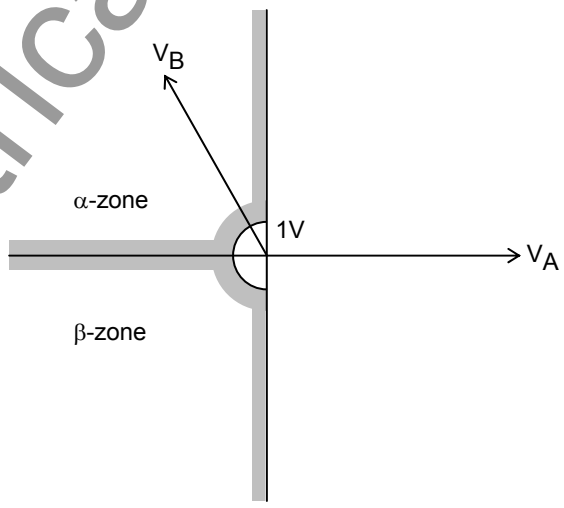



**Figure 2.16.8.1 Out-of-Step Element**

$V_B$ is further required to stay at each quadrant for a set time (1.5 cycles) to avoid the influence of any VT transient.

Positive phase voltages are used and valid for $V_A$ and $V_B$ when their amplitudes are larger than 1V.

www . ElectricalPartManuals . com

### 2.16.9 Voltage and Synchronism Check Elements OVL, UVL, OVB, UVB and SYN

The voltage check and synchronism check elements are used for autoreclose.

The output of the voltage check element is used to check whether the line and busbar are dead or live. The voltage check element has undervoltage detectors UVL and UVB, and overvoltage detectors OVL and OVB for the line voltage and busbar voltage check. The undervoltage detector checks that the line or busbar is dead while the overvoltage detector checks that it is live.

Figure 2.16.9.1 shows the characteristics of the synchronism check element used for the autoreclose if the line and busbar are live.

The synchronism check element operates if both the voltage difference and phase angle difference are within their setting values.

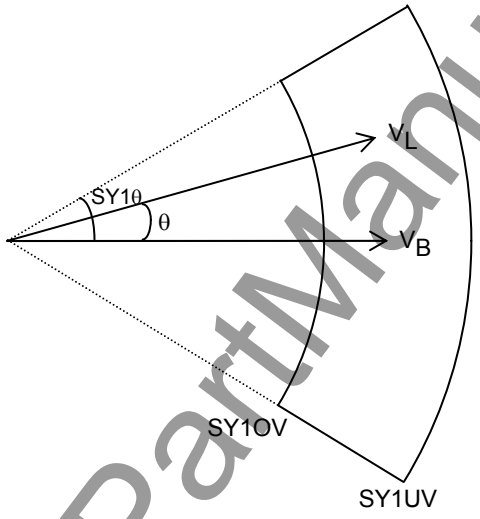



**Figure 2.16.9.1 Synchronism Check Element**

The voltage difference is checked by the following equations:

$$SY1OV \leq V_B \leq SY1UV$$

$$SY1OV \leq V_L \leq SY1UV$$

where,

$V_B$ = busbar voltage

$V_L$ = line voltage

SY1OV = lower voltage setting

SY1UV = upper voltage setting

The phase difference is checked by the following equations:

$$V_B \cdot V_L \cos\theta \geq 0$$

$$V_B \cdot V_L \sin(SY1\theta) \geq V_B \cdot V_L \sin\theta$$

where,

θ = phase difference between $V_B$ and $V_L$

SY1θ = phase difference setting

Note: When the phase difference setting and the synchronism check time setting are given, a

www.ElectricalPartManuals.com

detected maximum slip cycle is determined by the following equation:

$$f = \frac{SY1\theta}{180° \times T_{SYN1}}$$

where,

f = slip cycle

SY1θ = phase difference setting (degree)

$T_{SYN1}$ = setting of synchronism check timer (second)

### 2.16.10 Current change detection elements OCD, OCD1 and EFD

As shown in Figure 2.16.10.1, the current change detection element operates if the vectorial difference between currents $I_M$ and $I_N$ observed one cycle apart is larger than the fixed setting. Therefore, the operating sensitivity of this element is not affected by the quiescent load current and can detect a fault current with high sensitivity.

The OCD element is used for the VT failure supervision circuit.

The OCD1 and EFD are used as a fail-safe for current differential protection.

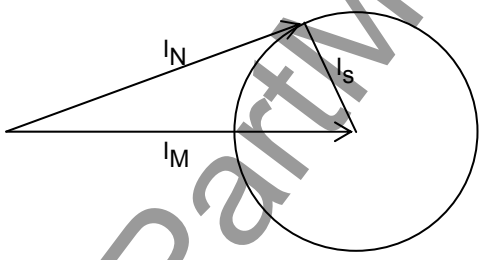



**Figure 2.16.10.1 Current Change Detection**

The operation decision is made by the following equation.

$$|I_M - I_N| > Is$$

where,

$I_M$ = present current

$I_N$ = current one cycle before

$I_S$ = fixed setting

### 2.16.11 Level Detectors

In addition to those explained above, GRL100 has overcurrent, overvoltage, and undervoltage level detectors described below.

All level detectors except for undervoltage level detectors UVFS and UVFG, and overcurrent level detector OCBF which require high-speed operation, operate in a similar manner.

That is, the operation decision is made by comparing the current or voltage amplitude with the relevant setting.

#### Overcurrent detector OCH, OC and OC1

This detector measures A, B, and C phase currents and its sensitivity can be set. The detector OCH is commonly used for the SOTF and stub protection. The detector OC is commonly used for backup protection. The OC1 is used as a fail-safe for current differential protection.

www.ElectricalPartManuals.com

#### Residual overcurrent detector EF and EFL

This detector measures a residual current and its sensitivity can be set. The EF is used for backup protection. The EFL is used for the earth fault detection of distance protection and VT failure supervision.

#### Overvoltage detector OVS1/OVS2/OVG1/OVG2 and undervoltage detector UVS1/UVS2/UVG1/UVG2

The OVS∗ and UVS∗ measure a phase-to-phase voltage while the OVG∗ and UVG∗ measure a phase-to-earth voltage. These detectors are used for overvoltage and undervoltage protection as described in Section 2.9.

#### Residual overvoltage detector OVG

This detector measures a residual voltage and its sensitivity is fixed at 20V. This detector is used for supervision of VT failure.

#### Undervoltage detector UVLS and UVLG

The UVLS measures a phase-to-phase voltage while the UVLG measures a phase-to-earth voltage. Their sensitivity can be set.

These detectors are used for weak infeed tripping.

The following two level detectors require high-speed operation or high-speed reset.

#### Undervoltage detector UVFS and UVFG

The UVFS measures a phase-to-phase voltage while the UVFG measures a phase-to-earth voltage. Their sensitivity can be set.

These detectors are commonly used for the VT failure supervision and signal channel test.

#### Undervoltage detector UVPWI

The UVPWI measures a phase-to-earth voltage and its sensitivity is 30V fixed. The UVPWI is used for countermeasures for overreaching of a leading-phase distance element at positive phase weak infeed condition.

#### Overcurrent detector OCBF

This detector measures A, B, and C phase currents and its sensitivity can be set. This detector is used for breaker failure protection and resets when the current falls below 80% of the operating value.

www . ElectricalPartManuals . com

## 2.17 Fault Locator

### 2.17.1 Application

GRL100 provides the following two type fault locators.

- Fault location using the local and remote end data (when current differential protection is applied.) (*)
- Fault location using the only local end data (when current differential protection is not applied.)

Note (*): The fault location using the local and remote end data is applied. In case of communication failure, however, the fault location using the only local end data is applied.

The measurement result is expressed as a percentage (%) of the line length and the distance (km) and is displayed on the LCD on the relay front panel. In three-terminal application, however, the measurement result is expressed as a fault section instead of a percentage. It is also output to a local PC or RSM (relay setting and monitoring) system.

To measure the distance to fault, the fault locator requires minimum 3 cycles as a fault duration time.

In distance to fault calculations, the change in the current before and after the fault has occurred is used as a reference current, alleviating influences of the load current and arc voltage. As a result, the location error in fault location using only local end data is a maximum of ±2.5 km for faults at a distance of up to 100 km, and a maximum of ±2.5% for faults at a distance between 100 km and 399.9 km. The location error in fault location using local and remote ends data is a maximum of ±2.0 km for faults at a distance of up to 100 km, and a maximum of ±2.0% for faults at a distance between 100 km and 399.9 km at the positive differential current more than In (rated current). If a fault current is more than 25×In, the location error is larger than above. (See Appendix K.)

Fault location is enabled or disabled by setting "Fault locator" to "ON" or "OFF" on the "Fault record" screen in the "Record" sub-menu.

### 2.17.2 Starting Calculation

Calculation of the fault location can be initiated by one of the following tripping signals.

- current differential protection trip
- carrier protection (command protection) trip
- zone 1 trip
- zone 2 trip
- zone 3 trip
- external protection trip

### 2.17.3 Displaying Location

The measurement result is stored in the "Fault record" and displayed on the LCD of the relay front panel or on the local or remote PC. For displaying on the LCD, see Section 4.2.3.1.

In the two-terminal line, the location is displayed as a distance (km) and a percentage (%) of the line length.

In the three-terminal line, the location is displayed as a distance (km). To discriminate faults in the second and the third section, the fault section is supplemented.

www.ElectricalPartManuals.com

"∗OB", "∗OJ", and "∗NC" and may display after the location result. These mean the followings:

∗OB: Fault point is over the boundary.

∗OJ: Fault point is over the junction in three-terminal line application.

∗NC: Fault calculation has not converged.

In case of a fault such as a fault duration time is too short, the fault location is not displayed and the "---" marked is displayed.

## 2.17.4 Distance to Fault Calculation

### 2.17.4.1 Fault location using the local and remote end data

**Calculation Principle**

In the case of a two-terminal line as shown in Figure 2.17.4.1, the relationship between the voltages at the local and remote terminals and the voltage at the fault point are expressed by Equations (1) and (2).

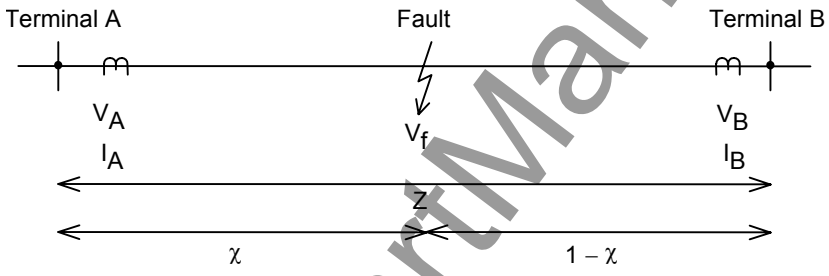



**Figure 2.17.4.1 Two-terminal Model**

$$V_A - \chi Z I_A = V_f \qquad (1)$$

$$V_B - (1 - \chi) Z I_B = V_f \qquad (2)$$

where,

$V_A$ = voltage at terminal A

$I_A$ = current at terminal A

$V_B$ = voltage at terminal B

$I_B$ = current at terminal B

$\chi$ = distance from terminal A to fault point as a ratio to line length

$V_f$ = voltage at fault point

$Z$ = line impedance

The distance $\chi$ is given by Equation (3) by eliminating $V_f$,

$$\chi = (V_A - V_B + ZI_B) / Z(I_A + I_B) \qquad (3)$$

As $(I_A + I_B)$ is equal to differential current Id, $\chi$ is calculated with the differential current obtained as follows:

$$\chi = (V_A - V_B + ZI_B) / ZI_d \qquad (4)$$

The distance calculation principle mentioned above can be applied to three-terminal lines. But in

www.ElectricalPartManuals.com

case of three-terminal application, the distance measurement equation varies according to which zone the fault is in, this side or beyond the junction. Terminal A measures the distance using Equations (5), (6) or (7).

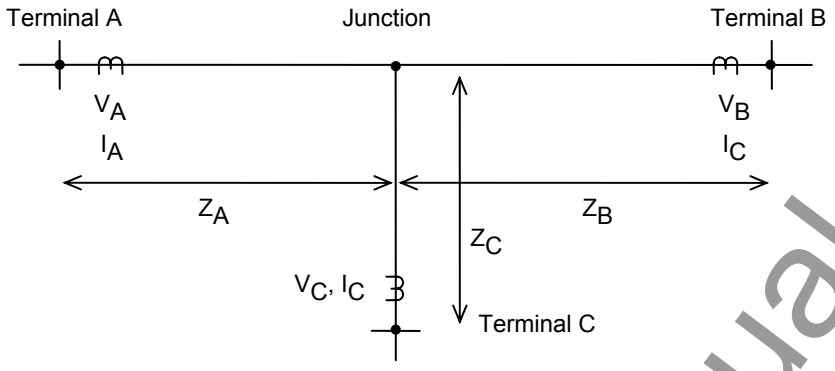



**Figure 2.17.4.2 Three-terminal Model**

$$\chi_A = (V_A - V_B + Z_A(I_B + I_C) + Z_B I_B) / Z_A I_d \quad (5)$$

$$\chi_{JB} = (V_A - V_B + Z_B I_B - Z_A I_A) / Z_B I_d \quad (6)$$

$$\chi_{JC} = (V_A - V_C + Z_C I_C - Z_A I_A) / Z_C I_d \quad (7)$$

where,

$I_d = I_A + I_B + I_C$

$V_C$ = voltage at terminal C

$I_C$ = current at terminal C

$\chi_A$ = distance from terminal A to fault point as a ratio to line length from terminal A to junction

$\chi_{JB}$ , $\chi_{JC}$ = distance from junction to fault point as a ratio to line length from junction to terminal B or C

$Z_A$ ,$Z_B$ ,$Z_C$ = impedance from each terminal to junction

Firstly, $\chi_A$ is calculated using Equation (5) assuming that the fault is between terminal A and the junction. If the result does not match the input line data, then $\chi_{JB}$ is calculated using Equation (6) assuming that the fault is between the junction and terminal B. If the result does not match the input line data, the calculation is repeated using Equation (7) assuming that the fault is between the junction and terminal C.

**Calculation Method**

In the calculation, the sequence quantities of voltages and currents are employed instead of the phase quantities. Thus, equation (4) is combined with Equation (8) to give:

$$\chi = \frac{V_{A1} - V_{B1} + (Z_{11} I_{B1} + Z_{12} I_{B2} + Z_{10} I_{B0})}{Z_{11} I_{d1} + Z_{12} I_{d2} + Z_{10} I_{d0}} \quad (8)$$

where,

$V_{A1}$ = positive sequence voltage at terminal A

$V_{B1}$ = positive sequence voltage at terminal B

www.ElectricalPartManuals.com

$I_{B1}$, $I_{B2}$ and $I_{B0}$ = positive, negative and zero sequence current at terminal B

$I_{d1}$,$I_{d2}$ and $I_{d0}$ = positive, negative and zero sequence differential current

$Z_{11}$, $Z_{12}$ and $Z_{10}$ are expressed by the following equations assuming that $Z_{ab} = Z_{ba}$, $Z_{bc} = Z_{cb}$ and $Z_{ca} = Z_{ac}$:

$$Z_{11} = (Z_{aa} + Z_{bb} + Z_{cc} - Z_{ab} - Z_{bc} - Z_{ca})/3$$
$$Z_{12} = (Z_{aa} + a^2 Z_{bb} + aZ_{cc} + 2(aZ_{ab} + Z_{bc} + a^2 Z_{ca}))/3 \quad (9)$$
$$Z_{10} = (Z_{aa} + aZ_{bb} + a^2 Z_{cc} - a^2 Z_{ab} - Z_{bc} - aZ_{ca})/3$$

where, $Z_{aa}$, $Z_{bb}$ and $Z_{cc}$ are self-impedances and $Z_{ab}$, $Z_{bc}$ and $Z_{ca}$ are mutual impedances.

If $Z_{aa} = Z_{bb} = Z_{cc}$ and $Z_{ab} = Z_{bc} = Z_{ca}$, then $Z_{11}$ is equal to the positive sequence impedance, and Z12 and Z10 are zero. For setting, the positive-sequence impedance is input using the expression of the resistive component R1 and reactive component X1.

#### 2.17.4.2 Fault location using the only local end data

The distance to fault $x_1$ is calculated from equation (1) and (2) using the local voltage and current of the fault phase and a current change before and after the fault occurrence. The current change before and after the fault occurrence represented by Iβ" and Iα" is used as the reference current. The impedance imbalance compensation factor is used to maintain high measuring accuracy even when the impedance of each phase has great variations.

**Distance calculation for phase fault (in the case of BC-phase fault)**

$$x_1 = \frac{I_m(V_{bc} \cdot I\beta'') \times L}{\{I_m(R_1 \cdot I_{bc} \times I\beta'') + R_e(X_1 \cdot I_{bc} \cdot I\beta'')\} \times K_{bc}} \quad (1)$$

where,

$V_{bc}$ = fault voltage between faulted phases = $V_b - V_c$

$I_{bc}$ = fault current between faulted phases = $I_b - I_c$

Iβ" = change of fault current before and after fault occurrence = $(I_b - I_c) - (I_{Lb} - I_{Lc})$

$I_{Lb}$, $I_{Lc}$ = load current

$R_1$ = resistance component of line positive sequence impedance

$X_1$ = reactance component of line positive sequence impedance

$K_{bc}$ = impedance imbalance compensation factor

$I_m( )$ = imaginary part in parentheses

$R_e( )$ = real part in parentheses

L = line length (km)

www . ElectricalPartManuals . com

**Distance calculation for earth fault (in the case of A-phase earth fault)**

$$x_1 = \frac{I_m(V_a \cdot I_\alpha'') \times L}{\{I_m(R_1 \cdot I_\alpha \cdot I_\alpha'' + R_0 \cdot I_{0S} \cdot I_\alpha'' + R_{0m} \cdot I_{0m} \cdot I_\alpha'') + R_e(X_1 \cdot I_\alpha \cdot I_\alpha'' + X_0 \cdot I_{0S} \cdot I_\alpha'' + X_{0m} \cdot I_{0m} \cdot I_\alpha'')\} \times K_a} \quad (2)$$

where,

$V_a$ = fault voltage

$I_\alpha$ = fault current = $(2I_a - I_b - I_c)/3$

$I_\alpha''$ = change of fault current before and after fault occurrence

$$= \frac{2I_a - I_b - I_c}{3} - \frac{2I_{La} - I_{Lb} - I_{Lc}}{3}$$

$I_a$, $I_b$, $I_c$ = fault current

$I_{La}$, $I_{Lb}$, $I_{Lc}$ = load current

$I_{0s}$ = zero sequence current

$I_{0m}$ = zero sequence current of parallel line

$R_1$ = resistance component of line positive sequence impedance

$X_1$ = reactance component of line positive sequence impedance

$R_0$ = resistance component of line zero sequence impedance

$X_0$ = reactance component of line zero sequence impedance

$R_{0m}$ = resistance component of line mutual zero sequence impedance

$X_{0m}$ = reactance component of line mutual zero sequence impedance

$K_a$ = impedance imbalance compensation factor

$I_m( )$ = imaginary part in parentheses

$R_e( )$ = real part in parentheses

L = line length (km)

Equations (1) and (2) are general expressions when lines are treated as having lumped constants and these expressions are sufficient for lines within 100 km. For lines exceeding 100 km, influences of the distributed capacitance must be considered. For this fault locator, the following equation is used irrespective of line length to find the compensated distance $x_2$ with respect to distance $x_1$ which was obtained in equation (1) or (2).

$$x_2 = x_1 - k^2 \cdot \frac{x_1^3}{3} \quad (3)$$

where,

k = propagation constant of the protected line = $0.001 km^{-1}$ (fixed)

www.ElectricalPartManuals.com

### 2.17.5 Setting

**Fault location using the local and remote end data**

The setting items necessary for the fault location and their setting ranges are shown in the table below.

When setting the line impedance, one of the following methods can be selected.

Inputting phase impedances:

The self-impedances $Z_{aa}$, $Z_{bb}$ and $Z_{cc}$ and mutual impedances $Z_{ab}$, $Z_{bc}$ and $Z_{ca}$ are input individually using the expression of the resistive components $R_{**}$ and reactive components $X_{**}$.

Inputting positive-sequence impedances:

This can be done provided that $Z_{aa} \fallingdotseq Z_{bb} \fallingdotseq Z_{cc}$ and $Z_{ab} \fallingdotseq Z_{bc} \fallingdotseq Z_{ca}$. The positive-sequence impedance is input using the expression of the resistive component $R_1$ and reactive component $X_1$.

The resistive and reactive components are input with the secondary values for the line.

When setting the line impedance, the three-terminal line is divided into three sections. The first section is from the local terminal to the junction, the second is from the junction to remote terminal 1 and the third is from the junction to remote terminal 2. The line constants are input for each section in the same way as the two-terminal application.

Note that remote terminals 1 and 2 are automatically set according to the communication system setup. Remote terminal 1 is a terminal to which local communication port 1 is linked and remote terminal 2 is a terminal to which local communication port 2 is linked.

| Item | Range | Step | Default | | Remarks |
|---|---|---|---|---|---|
| Fault locator | ON/OFF | | OFF | | |
| Line data | | | | | |
| Section 1 | | | | | |
| $1R_1$ | 0.00 - 199.99 Ω | 0.10 Ω | 0.20 Ω | | |
| | (0.0 - 999.9 Ω | 0.1 Ω | 1.0 Ω) | (*) | |
| $1X_1$ | 0.00 - 199.99 Ω | 0.10 Ω | 2.00 Ω | | |
| | (0.0 - 999.9 Ω | 0.1 Ω | 10.0 Ω) | (*) | |
| 1Line | 0.0 - 399.9 km | 0.1 km | 50.0 km | | Line length from local terminal to junction |
| or | | | | | |
| $1R_{aa}$ | 0.00 - 199.99 Ω | 0.10 Ω | 0.21 Ω | | |
| $1X_{aa}$ | (0.0 - 999.9 Ω | 0.1 Ω) | (1.1 Ω) | | |
| $1R_{bb}$ | | | | | |
| $1X_{bb}$ | | | 0.01 Ω | | |
| $1R_{cc}$ | | | (0.1 Ω) | | |
| $1X_{cc}$ | | | | | |
| $1R_{ab}$ | | | 2.10 Ω | | |
| $1X_{ab}$ | | | (10.5 Ω) | | |
| $1R_{bc}$ | | | | | |
| $1X_{bc}$ | | | 0.10 Ω | | |
| $1R_{ca}$ | | | (0.5 Ω) | | |
| $1X_{ca}$ | | | | | |
| 1Line | 0.0 - 399.9 km | 0.1 km | 50.0 km | | Line length from local terminal to junction |

www.ElectricalPartManuals.com

| Item | Range | Step | Default | Remarks |
|---|---|---|---|---|
| Section 2 | | | | |
| $2R_1$ | 0.00 - 199.99 Ω<br>(0.0 - 999.9 Ω | 0.10 Ω<br>0.1 Ω | 0.20 Ω<br>1.0 Ω) (*) | |
| $2X_1$ | 0.00 - 199.99 Ω<br>(0.0 - 999.9 Ω | 0.10 Ω<br>0.1 Ω | 2.00 Ω<br>10.0 Ω) (*) | |
| 2Line | 0.0 - 399.9 km | 0.1 km | 50.0 km | Line length from local terminal to junction |
| or | | | | |
| $2R_{aa}$<br>$2X_{aa}$ | 0.00 - 199.99 Ω<br>(0.0 - 999.9 Ω | 0.10 Ω<br>0.1 Ω) | 0.21 Ω<br>(1.1 Ω) | |
| $2R_{bb}$ | | | | |
| $2X_{bb}$<br>$2R_{cc}$<br>$2X_{cc}$ | | | 0.01 Ω<br>(0.1 Ω) | |
| $2R_{ab}$<br>$2X_{ab}$<br>$2R_{bc}$ | | | 2.10 Ω<br>(10.5 Ω) | |
| $2X_{bc}$<br>$2R_{ca}$<br>$2X_{ca}$ | | | 0.10 Ω<br>(0.5 Ω) | |
| 2Line | 0.0 - 399.9 km | 0.1 km | 50.0 km | Line length from junction to remote terminal 1 |
| Section 3 | | | | |
| $3R_1$ | 0.00 - 199.99 Ω<br>(0.0 - 999.9 Ω | 0.10 Ω<br>0.1 Ω | 0.20 Ω<br>1.0 Ω) (*) | |
| $3X_1$ | 0.00 - 199.99 Ω<br>(0.0 - 999.9 Ω | 0.10 Ω<br>0.1 Ω | 2.00 Ω<br>10.0 Ω) (*) | |
| 3Line | 0.0 - 399.9 km | 0.1 km | 50.0 km | Line length from junction to remote terminal 2 |
| or | | | | |
| $3R_{aa}$<br>$3X_{aa}$ | 0.00 - 199.99 Ω<br>(0.0 - 999.9 Ω | 0.10 Ω<br>0.1 Ω) | 0.21 Ω<br>(1.1 Ω) | |
| $3R_{bb}$ | | | | |
| $3X_{bb}$<br>$3R_{cc}$<br>$3X_{cc}$ | | | 0.01 Ω<br>(0.1 Ω) | |
| 3Rab<br>$3X_{ab}$<br>$3R_{bc}$ | | | 2.10 Ω<br>(10.5 Ω) | |
| $3X_{bc}$<br>$3R_{ca}$<br>$3X_{ca}$ | | | 0.10 Ω<br>(0.5 Ω) | |
| 3Line | 0.0 - 399.9 km | 0.1 km | 50.0 km | Line length from junction to remote terminal 2 |

(*) Ohmic values shown in parentheses are in the case of 1A rating.

www.ElectricalPartManuals.com

**Fault location using the only local end data**

The setting items necessary for the fault location and their setting ranges are shown in the table below. The settings of $R_{0m}$ and $X_{0m}$ are only required for the double circuit lines. The reactance and resistance values are input in expressions on the secondary side of CT and VT.

When there are great variations in the impedance of each phase, equation (10) is used to find the positive sequence impedance, zero sequence impedance and zero sequence mutual impedance, while equation (11) is used to find imbalance compensation factors $K_{ab}$ to $K_a$.

When variations in impedance of each phase can be ignored, the imbalance compensation factor is set to 100%.

$$\left.\begin{aligned} Z_1 &= \{(Z_{aa} + Z_{bb} + Z_{cc}) - (Z_{ab} + Z_{bc} + Z_{ca})\}/3 \\ Z_0 &= \{(Z_{aa} + Z_{bb} + Z_{cc}) + 2(Z_{ab} + Z_{bc} + Z_{ca})\}/3 \\ Z_{0m} &= (Z_{am} + Z_{bm} + Z_{cm})/3 \end{aligned}\right\} \quad (10)$$

$$\left.\begin{aligned} K_{ab} &= \{(Z_{aa} + Z_{bb})/2 - Z_{ab}\}/Z_1 \\ K_{bc} &= \{(Z_{bb} + Z_{cc})/2 - Z_{bc}\}/Z_1 \\ K_{ca} &= \{(Z_{cc} + Z_{aa})/2 - Z_{ca}\}/Z_1 \\ K_a &= \{Z_{aa} - (Z_{ab} + Z_{ca})/2\}/Z_1 \\ K_b &= \{Z_{bb} - (Z_{bc} + Z_{ab})/2\}/Z_1 \\ K_c &= \{Z_{cc} - (Z_{ca} + Z_{ab})/2\}/Z_1 \end{aligned}\right\} \quad (11)$$

The scheme switch [FL-Z0B] is used when zero sequence compensation of the parallel line is not performed in double circuit line.

The switch [FL-Z0B] is set to "OFF" when the current input to the earth fault measuring element is compensated by residual current of the parallel line. When not, the switch [FL-Z0B] is set to "ON" and Z0B-L, Z0B-R, $R_{0m}$ and $X_{0m}$ are set.

Z0B-L = zero sequence back source impedance at local terminal

Z0B-R = zero sequence back source impedance at remote terminal

In double circuit line, however, it is recommended that the current input compensated by residual current of the parallel line is used in order for the earth fault measuring element to correctly measure the impedance.

In the case of single circuit line, the switch [FL-Z0B] is set to "OFF".

www . ElectricalPartManuals . com

| Item | Range | Step | Default | Remarks |
|---|---|---|---|---|
| Section 1 | | | | |
| $R_1$ | 0.0 - 199.99 Ω | 0.01 Ω | 0.20Ω | |
| | (0.0 - 999.9 Ω | 0.1 Ω | 1.0Ω) (*) | |
| $X_1$ | 0.0 - 199.99 Ω | 0.01 Ω | 2.00Ω | |
| | (0.0 - 999.9 Ω | 0.1 Ω | 10.0Ω) | |
| $R_0$ | 0.0 - 999.99 Ω | 0.01 Ω | 0.70Ω | |
| | (0.0 - 999.9 Ω | 0.1 Ω | 3.5Ω) | |
| $X_0$ | 0.0 - 199.99 Ω | 0.01 Ω | 6.80Ω | |
| | (0.0 - 999.9 Ω | 0.1 Ω | 34.0Ω) | |
| $R_{0m}$ | 0.0 - 199.99 Ω | 0.01 Ω | 0.20Ω | |
| | (0.0 - 999.9 Ω | 0.1 Ω | 1.0Ω) | |
| $X_{0m}$ | 0.0 - 199.99 Ω | 0.01 Ω | 2.00Ω | |
| | (0.0 - 999.9 Ω | 0.1 Ω | 10.0Ω) | |
| $K_{ab}$ | 80 - 120% | 1% | 100% | |
| $K_{bc}$ | 80 - 120% | 1% | 100% | |
| $K_{ca}$ | 80 - 120% | 1% | 100% | |
| $K_a$ | 80 - 120% | 1% | 100% | |
| $K_b$ | 80 - 120% | 1% | 100% | |
| $K_c$ | 80 - 120% | 1% | 100% | |
| Line | 0.0 - 399.9 km | 0.1 km | 50.0km | Line length from local terminal to junction if three-terminal application |
| FL-Z0B | OFF/ON | | OFF | |
| ZOB-L | 0.0 - 199.99 Ω | 0.01 Ω | 2.00Ω | |
| | (0.0 - 999.9 Ω | 0.1 Ω | 10.0Ω) | |
| ZOB-R | 0.0 - 199.99 Ω | 0.01 Ω | 2.00Ω | |
| | (0.0 - 999.9 Ω | 0.1 Ω | 10.0Ω) | |
| UVLS | 50 – 100V | 1V | 77V | Phase fault detection |

(*) Ohmic values shown in the parentheses are in the case of 1 A rating. Other ohmic values are in the case of 5A rating.

www . ElectricalPartManuals . com

# 3. Technical Description

## 3.1 Hardware Description

### 3.1.1 Outline of Hardware Modules

The GRL100 models are classified into two types by their case size. Models 701 and 711 have type A cases, while models 702 and 712 have type B cases. Case outlines are shown in Appendix F.

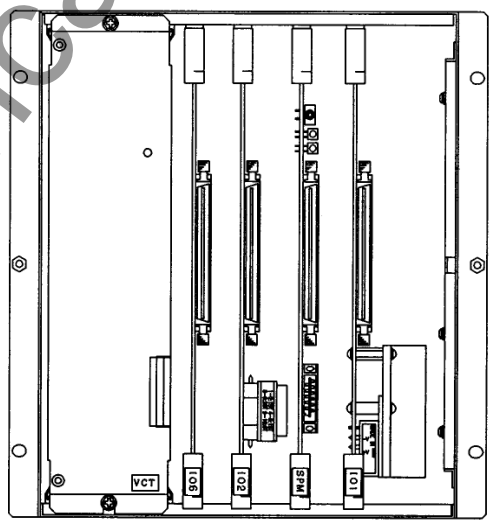
The hardware structures of the models are shown in Figure 3.1.1.1 and Figure 3.1.1.2. The front view shows the equipment without the human machine interface module.

The GRL100 consists of the following hardware modules. The human machine interface module is provided with the front panel.

- Transformer module (VCT)
- Signal processing and communication module (SPM)
- Binary input and output module 2 (IO2)
- Human machine interface module (HMI)

The following hardware modules are added depending on the model:

- Binary input and output module 1 (IO1)
- Binary output module 3 (IO3)
- Binary output module 4 (IO4)
- Binary input and output module 5 (IO5)
- Binary input and output module 6 (IO6)

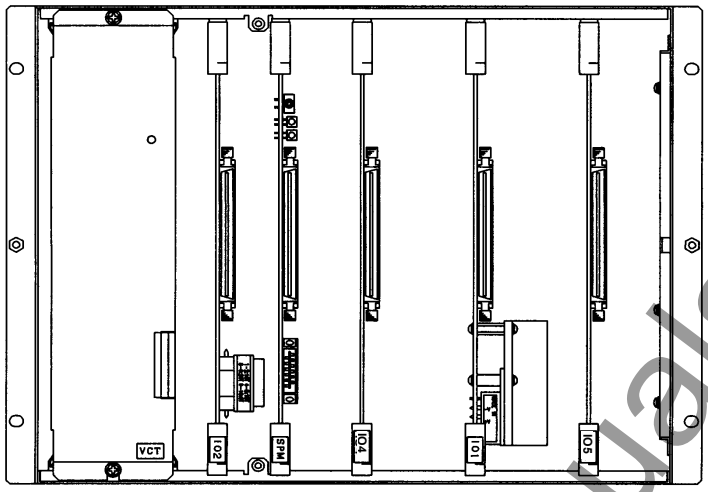



VCT IO#3 IO#2 SPM IO#1

Note: IO#1 is IO1 module.
IO#2 and IO#3 are IO2 module and IO6 module respectively.

**Figure 3.1.1.1 Hardware Structure (Model: 701, 711)**

www . ElectricalPartManuals . com




VCT IO#2 SPM IO#4 IO#1 IO#3

Note: IO#1 is IO1 module.
IO#2, IO#3 and IO#4 are IO2, IO5 and IO4 module respectively.

**Figure 3.1.1.2 Hardware Structure (Model: 702, 712)**

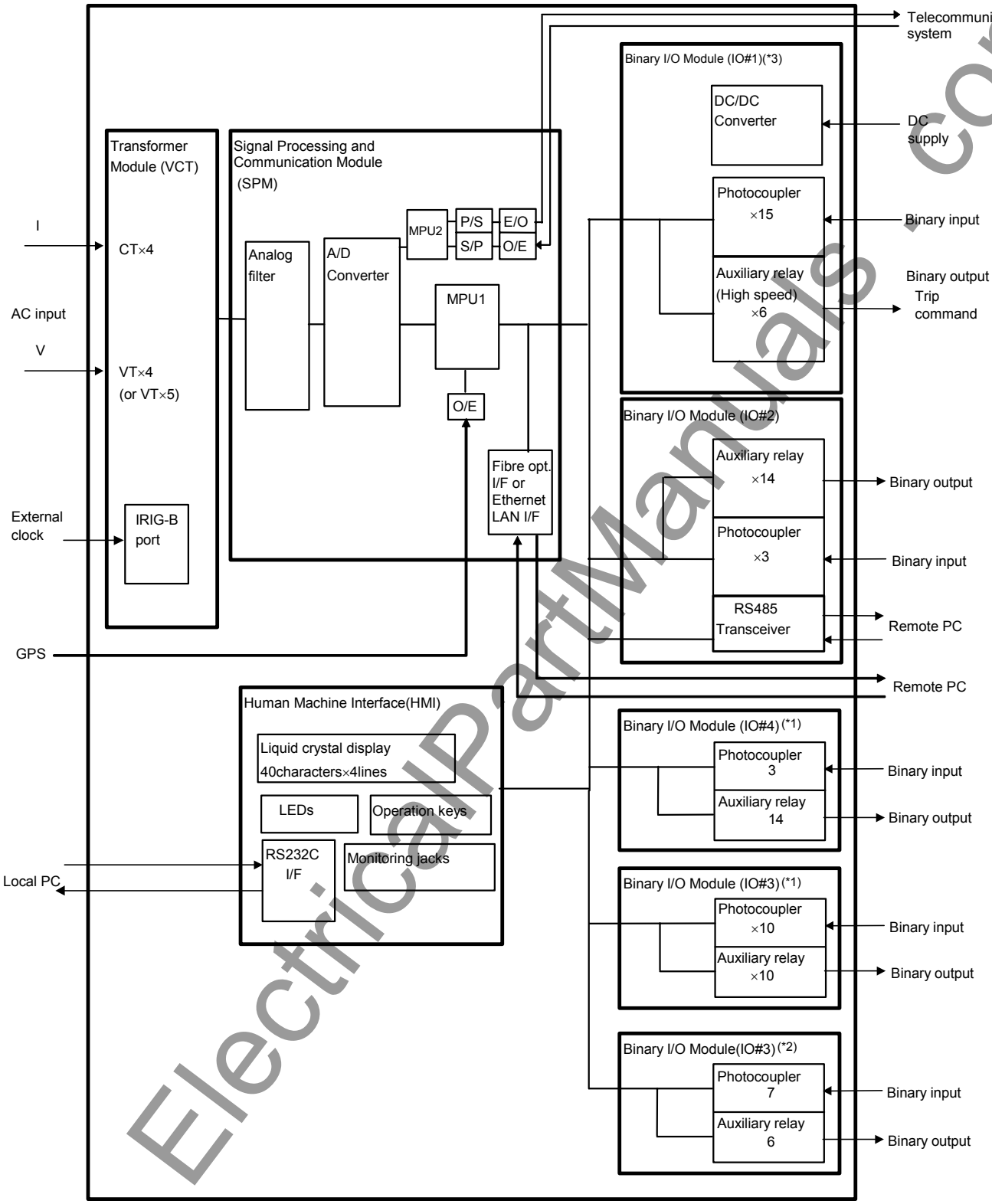
The correspondence between each model and module used is as follows:

| Module \ Model | 701, **711** | 702, **712** |
|---|---|---|
| VCT | × | × |
| SPM | × | × |
| IO1 | × | × |
| IO2 | × | × |
| IO3 | | |
| IO4 | | × |
| IO5 | | × |
| IO6 | × | |
| HMI | × | × |

**Note**: The VCT and SPM modules are not interchangeable among different models.

The hardware block diagrams of the GRL100 using these modules are shown in Figure 3.1.1.3.

www . ElectricalPartManuals . com




(*1): required for models 702, 712
(*2) : required for models 701, 711

**Figure 3.1.1.3 Hardware Block Diagram**

www.ElectricalPartManuals.com

### 3.1.2 Transformer Module

The transformer module (VCT module) provides isolation between the internal and external AC circuits through an auxiliary transformer and transforms the magnitude of AC input signals to suit the electronic circuits. The AC input signals are as follows:

- three-phase currents ($I_a$, $I_b$ and $I_c$)
- residual current ($3I_o$)
- residual current of parallel line ($3I_{om}$)
- three-phase voltages ($V_a$, $V_b$ and $V_c$)
- autoreclose reference voltage ($V_{ref1}$)
- autoreclose reference voltage ($V_{ref2}$)

Figure 3.1.2.1 shows a block diagram of the transformer module. There are 5 auxiliary CTs mounted in the transformer module, and an additional 5 auxiliary VTs. (The reference between terminal numbers and AC input signals is given in Table 3.2.1.1.)

$V_{ref1}$ and $V_{ref2}$ are the busbar or line voltages necessary for the voltage and synchronism check for the autoreclose.

The transformer module is also provided with an IRIG-B port. This port collects the serial IRIG-B format data from the external clock for synchronization of the relay calendar clock. The IRIG-B port is insulated from the external circuit by a photo-coupler. A BNC connector is used as the input connector.

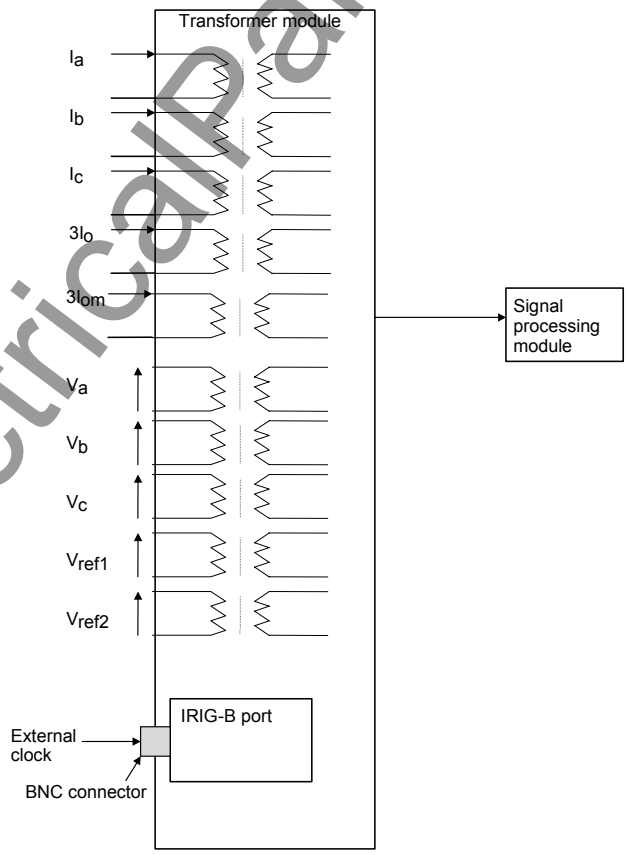



**Figure 3.1.2.1 Transformer Module**

www . ElectricalPartManuals . com

### 3.1.3 Signal Processing and Communication Module

The signal processing and communication module (SPM) incorporates a signal processing circuit and a communication control circuit. Figure 3.1.3.1 shows the block diagram. The telecommunication control circuit is incorporated in the sub-module GCOM.

The signal processing circuit consists of an analog filter, multiplexer, analog to digital (A/D) converter, main processing unit (MPU1) and memories (RAM and ROM), and executes all kinds of processing including protection, measurement, recording and display.

The analog filter performs low-pass filtering for the corresponding current and voltage signals.

The A/D converter has a resolution of 16 bits and samples input signals at sampling frequencies of 2400Hz (at 50Hz) and 2880Hz (at 60Hz).

The MPU1 carries out operations for the measuring elements and scheme logic operations for protection, recording, displaying and signal transmission control. It implements 60 MIPS and uses two RISC (Reduced Instruction Set Computer) type 32-bit microprocessors.

The telecommunication control circuit consists of MPU2 executing control processing of local and received data, memories (RAM and ROM), parallel-to-serial and serial-to-parallel data converter, and electrical-to-optical and optical-to-electrical converter.

The SPM can be provided with fibre optic interface, Ethernet LAN interface, RS232C etc. for serial communication system.

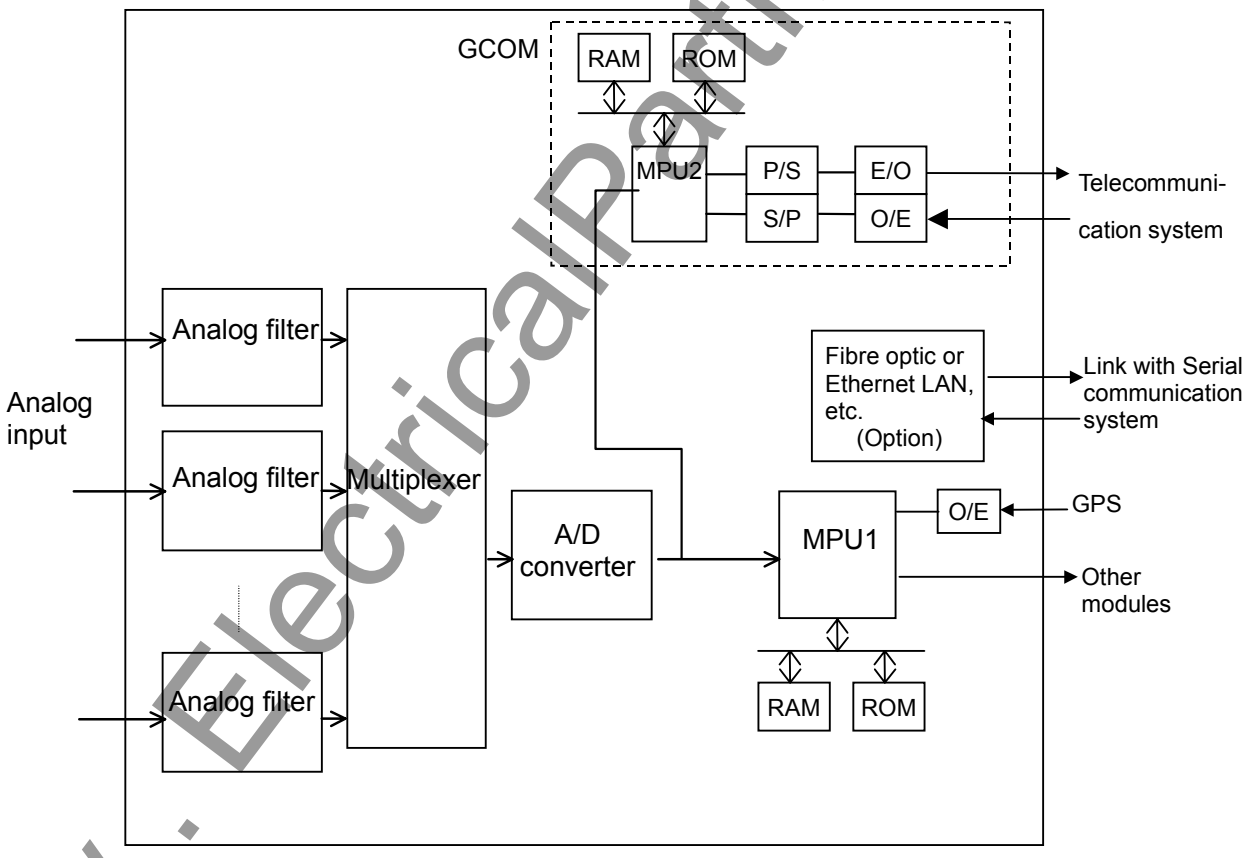



**Figure 3.1.3.1 Signal Processing and Communication Module**

www . ElectricalPartManuals . com

### 3.1.4 Binary Input and Output Module

There are four types of binary input and output module (IO module): These modules are used depending on the model (see Section 3.1.1).

#### 3.1.4.1 IO1 Module

IO1 provides a DC/DC converter, binary inputs and binary outputs for tripping.

As shown in Figure 3.1.4.1, the IO1 module incorporates a DC/DC converter, 15 photo-coupler circuits (BI) for binary input signals and 6 auxiliary relays (TP-A1 to TP-C2) dedicated to the circuit breaker tripping command.

The input voltage rating of the DC/DC converter is 24V, 48V, 110V/125V or 220V/250V. The normal range of input voltage is –20% to +20%.

The six or three tripping command auxiliary relays are the high-speed operation type and have one normally open output contact.

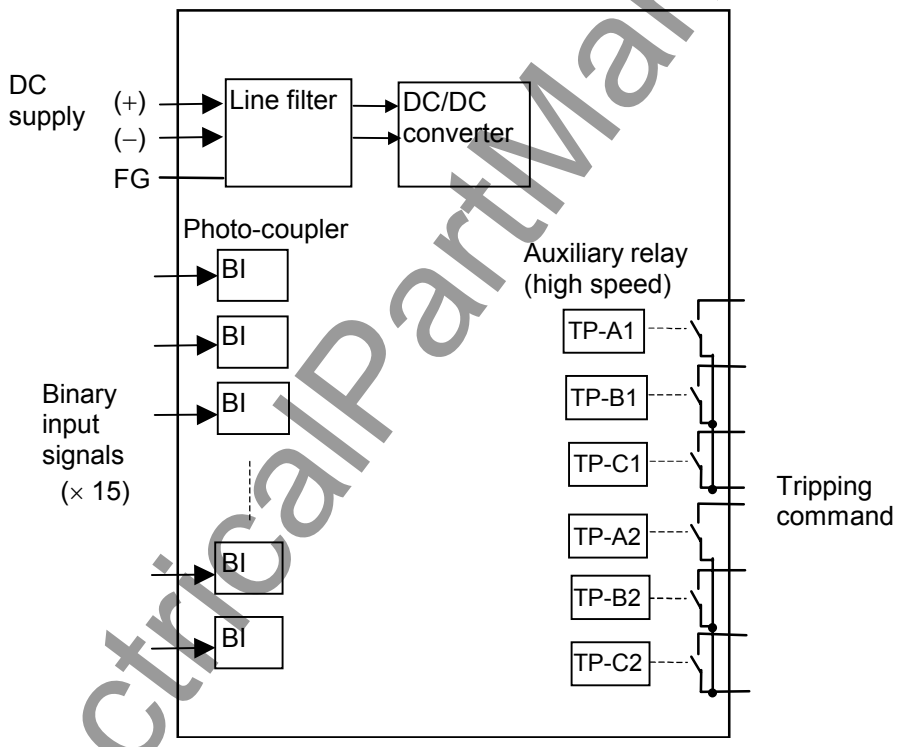



**Figure 3.1.4.1 IO1 Module**

www . ElectricalPartManuals . com

### 3.1.4.2 IO2 Module

As shown in Figure 3.1.4.2, the IO2 module incorporates 3 photo-coupler circuits (BI) for binary input signals, 14 auxiliary relays (13 BOs and FAIL) for binary output signals and an RS485 transceiver.

The auxiliary relay FAIL has one normally closed contact, and operates when a relay failure or abnormality in the DC circuit is detected. Each BO has one normally open contact. BO13 is a high-speed operation type.

The RS485 is used for the link with communication system such as RSM (Relay Setting and Monitoring) or IEC60870-5-103 etc. The external signal is isolated from the relay internal signal.

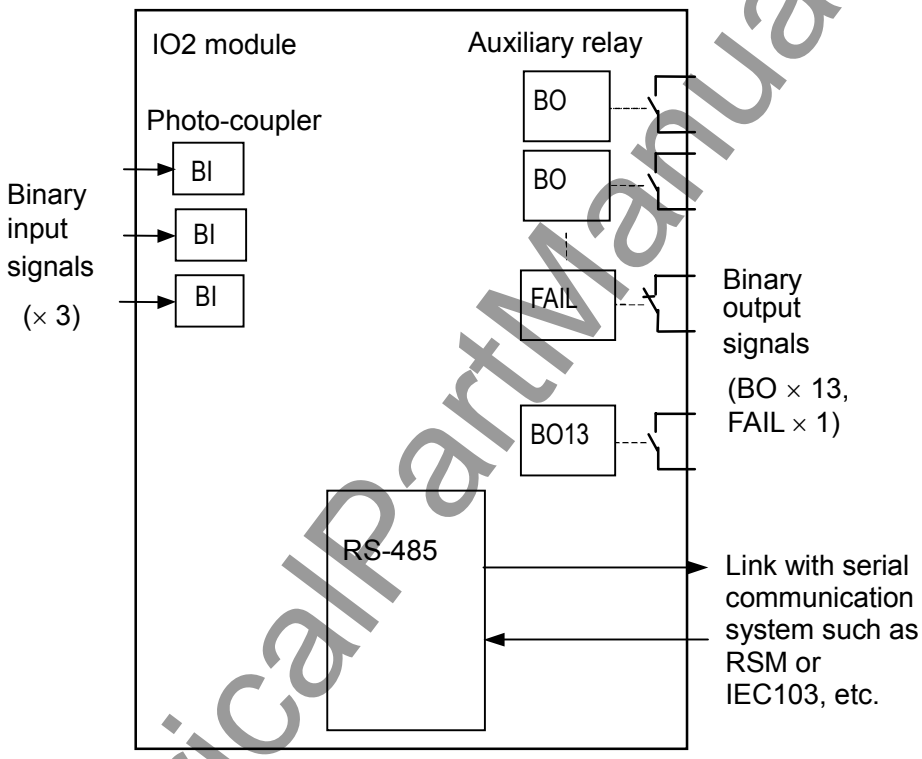



**Figure 3.1.4.2 IO2 Module**

www . ElectricalPartManuals . com

### 3.1.4.3 IO3 and IO4 Modules

The IO3 and IO4 modules are used to increase the number of binary outputs.

The IO3 module incorporates 10 auxiliary relays (BO) for binary outputs. The IO4 module incorporates 14 auxiliary relays (BO) for binary outputs and 3 photo-coupler circuits (BI). All auxiliary relays each have one normally open contact.

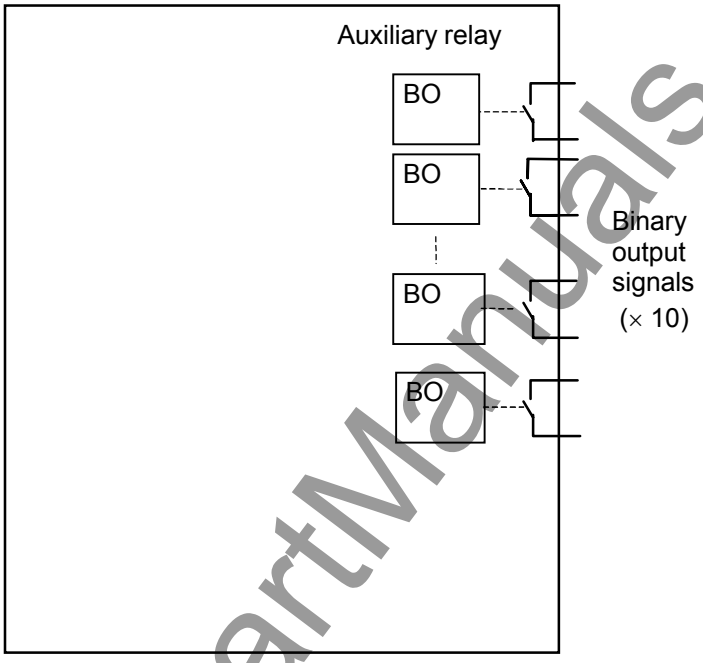



**Figure 3.1.4.3 IO3 Module**

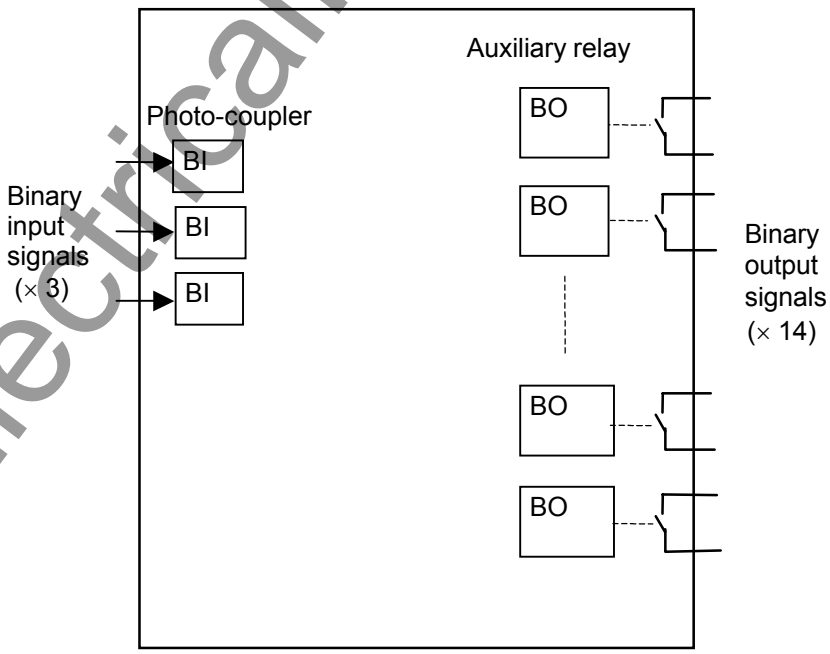



**Figure 3.1.4.4 IO4 Module**

www . ElectricalPartManuals . com

### 3.1.4.4 IO5 and IO6 Modules

The IO5 and IO6 modules are used to increase the number of binary inputs and outputs.

The IO5 module incorporates 10 photo-coupler circuits (BI) for binary inputs and 10 auxiliary relays (BO) for binary outputs. The IO6 module incorporates 7 photo-coupler circuits (BI) for binary inputs and 6 auxiliary relays (BO) for binary outputs. All auxiliary relays each have one normally open contact.

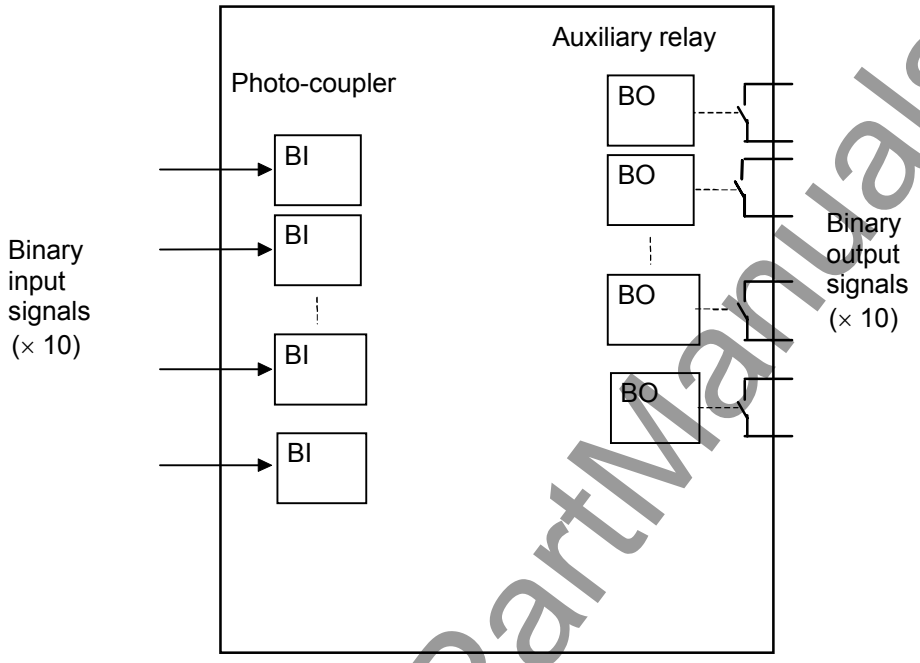



**Figure 3.1.4.5 IO5 Module**

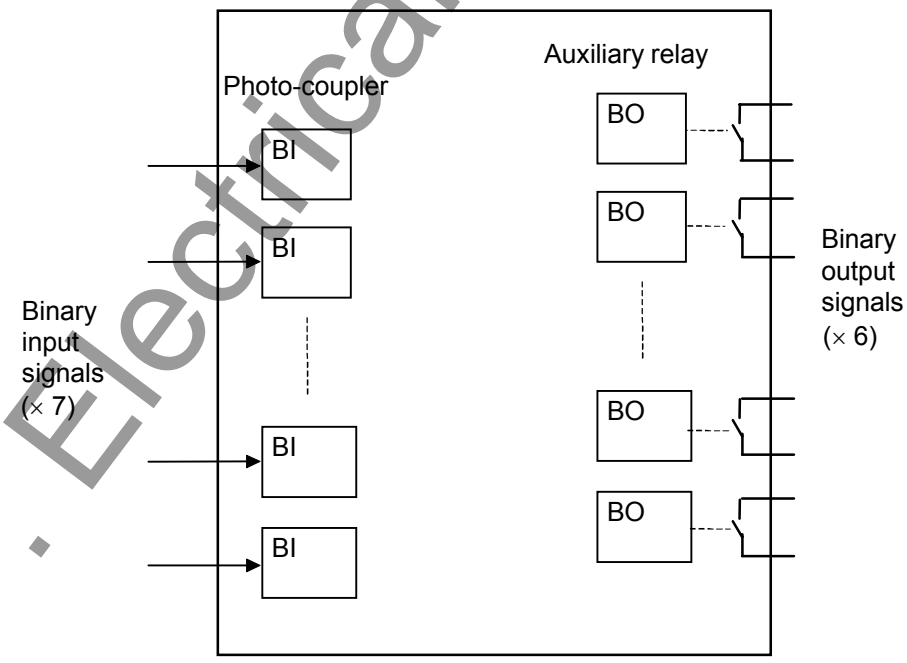



**Figure 3.1.4.6 IO6 Module**

www . ElectricalPartManuals . com

### 3.1.5 Human Machine Interface (HMI) Module

The operator can access the GRL100 via the human machine interface (HMI) module. As shown in Figure 3.1.5.1, the HMI module has a liquid crystal display (LCD), light emitting diodes (LED), view and reset keys, operation keys, monitoring jacks and an RS232C connector on the front panel.

The LCD consists of 40 columns by 4 rows with a backlight and displays record, status and setting data.

There are a total of 8 LED indicators and their signal labels and LED colors are defined as follows:

| Label | Color | Remarks |
|---|---|---|
| IN SERVICE | Green | Lit when the relay is in service. |
| TRIP | Red | Lit when a trip command is issued. |
| ALARM | Red | Lit when a failure is detected. |
| TESTING | Red | Lit when the testing switches are in test position. |
| (LED1) | Red | Configurable LED to assign signals with or without latch when relay operates. |
| (LED2) | Red | Configurable LED to assign signals with or without latch when relay operates. |
| (LED3) | Red | Configurable LED to assign signals with or without latch when relay operates. |
| (LED4) | Red | Configurable LED to assign signals with or without latch when relay operates. |

LED1 to LED4 are user-configurable. Each is driven via a logic gate which can be programmed for OR gate or AND gate operation. Further, each LED has a programmable reset characteristic, settable for instantaneous drop-off, or for latching operation. For the setting, see Section 4.2.6.10. For the operation, see Section 4.2.1.

The TRIP LED is controlled with the scheme switch [AOLED] whether it is lit or not by an output of alarm element such as THM ALARM, etc.

The [VIEW] key starts the LCD indication and switches between windows. The [RESET] key clears the LCD indication and turns off the LCD backlight.

The operation keys are used to display the record, status and setting data on the LCD, input the settings or change the settings.

The monitoring jacks and two pairs of LEDs, A and B, on top of the jacks can be used while the test mode is selected in the LCD window. Signals can be displayed on LED A or LED B by selecting the signal to be observed from the "Signal List" or "Variable Timer List" and setting it in the window and the signals can be output to an oscilloscope via the monitoring jacks. (For the "Signal List" or "Variable Timer List", see Appendix B or C.)

The RS232C connector is a 9-way D-type connector for serial RS232C connection. This connector is used for connection with a local personal computer.

www.ElectricalPartManuals.com

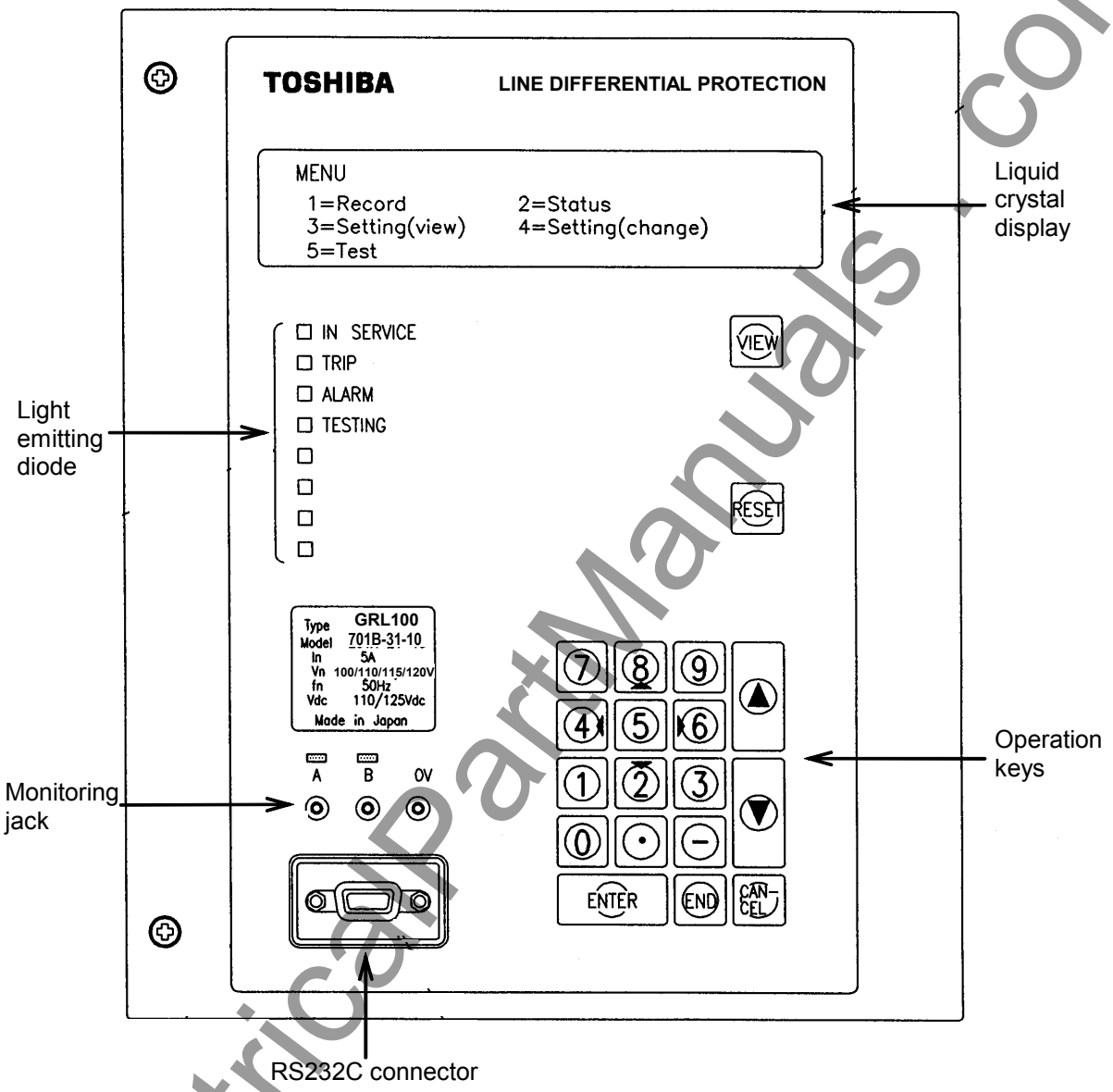



**Figure 3.1.5.1 Front Panel**

www . ElectricalPartManuals . com

## 3.2 Input and Output Signals

### 3.2.1 Input Signals

#### AC input signals

Table 3.2.1.1 shows the AC input signals necessary for the GRL100-700 series and their respective input terminal numbers. The AC input signals are input via terminal block TB1. See Appendix G for external connections.

The GRL100-700 series require 5 current inputs and 3 voltage inputs, and also required an additional voltage signal using voltage and synchronism checks for the autoreclose function. For single or double busbar applications, one voltage signal is required, while for one-and-a-half circuit breaker arrangements, two voltage signals are required. (For the busbar and line voltages, see Figure 2.15.2.7.)

**Table 3.2.1.1 AC Input Signals**

| Terminal No. | GRL100-701, 702, 711, 712 |
|---|---|
| 1-2 | A-phase Current |
| 3-4 | B-phase Current |
| 5-6 | C-phase Current |
| 7-8 | Residual Current |
| 9-10 | Residual Current of parallel line |
| 11-14 | A-phase Voltage |
| 12-14 | B-phase Voltage |
| 13-14 | C-phase Voltage |
| 15-16 | Voltage for Autoreclose |
| 17-18 | Voltage for Autoreclose |
| 20 | (earth) |

#### Binary input signals

Table 3.2.1.2 shows the binary input signals necessary for the GRL100, their driving contact conditions and functions enabled.

Input signals are configurable and depend on the GRL100 models. See Appendix G for the default settings and external connections.

**Note:** For the three-phase binary input signals of Interlink A, B and C, interlink signals of the parallel line are applied.
The interlink signals are assigned to the binary output relays as LINK-A1, -B1 and -C1 in two-terminal line application and as LINK-A1, -B1 and -C1 and LINK-A2, -B2 and -C2 in the three-terminal line application. For the default setting, see Appendix D.
Two-terminal line application: Apply the LINK-A1, -B1 and -C1 contacts of the parallel line to the binary input signals of Interlink A, B and C (Terminal 1).
Three-terminal line application: Apply the LINK-A1, -B1 and -C1 contacts of the parallel line to Interlink A, B and C (Terminal 1) and LINK-A2, -B2 and -C2 contacts to Interlink A, B and C (Terminal 2) respectively.

The binary input circuit of the GRL100 is provided with a logic level inversion function as shown in Figure 3.2.1.1. Each input circuit has a binary switch BISW which can be used to select either normal or inverted operation. This allows the inputs to be driven either by normally open or normally closed contact.

If a signal is not input, the function concerned is disabled.

www . ElectricalPartManuals . com

Further, all binary input functions are programmable by PLC (Programmable Logic Controller) function.

The default setting of the binary input is shown in Table 3.2.1.2.

**Table 3.2.1.2 Binary Input Signals**

| Module Name | BI No. | Contents | Setting | | |
|---|---|---|---|---|---|
| | | | Signal No. & Signal Name | | Norm or Inv |
| IO#1 | BI1 | CB1 AUXILIARY CONTACT - A Ph | 1536 | CB1_CONT-A | |
| | BI2 | CB1 AUXILIARY CONTACT - B Ph | 1537 | CB1_CONT-B | |
| | BI3 | CB1 AUXILIARY CONTACT - C Ph | 1538 | CB1_CONT-C | |
| | BI4 | CB2 AUXILIARY CONTACT - A Ph | 1539 | CB2_CONT-A | |
| | BI5 | CB2 AUXILIARY CONTACT - B Ph | 1540 | CB2_CONT-B | |
| | BI6 | CB2 AUXILIARY CONTACT - C Ph | 1541 | CB2_CONT-C | |
| | BI7 | DISCONNECTOR NORMALLY CLOSED | 1542 | DS_N/O_CONT | |
| | BI8 | DISCONNECTOR NORMALLY OPEN | 1543 | DS_N/C_CONT | |
| | BI9 | SIGNAL RECEIVE (R1) | 1856 | CAR.R1-1 | |
| | BI10 | SIGNAL RECEIVE (R2) | 1864 | CAR.R2-1 | |
| | BI11 (*) | DC POWER SUPPLY | 1546 | DC_SUPPLY | |
| | BI12 | TRANSFER TRIP COMMAND 1 | 1547 | 85S1 | |
| | BI13 | TRANSFER TRIP COMMAND 2 | 1548 | 85S2 | |
| | BI14 | DEF SIGNAL RECEIVE (R1) | 1857 | CAR.R1-2 | |
| | BI15 | DEF SIGNAL RECEIVE (R2) | 1865 | CAR.R2-2 | |
| IO#2 | BI16 | EXTERNAL TRIP - A Ph | 1551<br>1556 | EXT_TRIP-A<br>EXT_CBFIN-A | See the BISW setting in Relay setting sheet |
| | BI17 | EXTERNAL TRIP - B Ph | 1552<br>1557 | EXT_TRIP-B<br>EXT_CBFIN-B | |
| | BI18 | EXTERNAL TRIP - C Ph | 1553<br>1558 | EXT_TRIP-C<br>EXT_CBFIN-C | |
| IO#3 | BI19 | CARRIER PROTECTION BLOCK | 1544 | CRT_BLOCK | |
| | BI20 | EXTERNAL CB CLOSE COMMAND | 1545 | CB_CLOSE | |
| | BI21 | INDICATION RESET | 1549 | IND.RESET | |
| | BI22 | CB1 AUTORECLISNG READY | 1571 | CB1_READY | |
| | BI23 | CB2 AUTORECLISNG READY | 1572 | CB2_READY | |
| | BI24 | AUTORECLOSING BLOCK COMMAND | 1573 | ARC_RESET | |
| | BI25 | Spare | | | |
| | BI26 | Spare | | | |
| | BI27 | Spare | | | |
| | BI28 | Spare | | | |
| IO#4 | BI34 | Spare | | | |
| | BI35 | Spare | | | |
| | BI36 | Spare | | | |

Note (*): If the binary input of DC power supply is OFF, the ready signal of relay is OFF and the message 'Term* rdy off' is displayed. See Section 3.3.6.

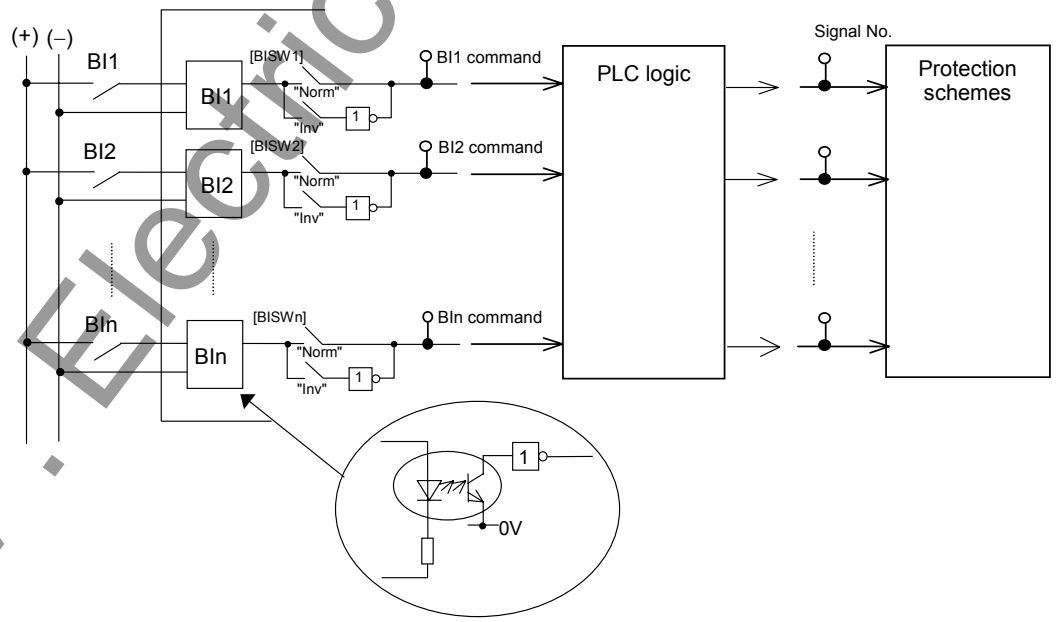



**Figure 3.2.1.1 Logic Level Inversion**

www.ElectricalPartManuals.com

The binary input signals of circuit breaker auxiliary contact are transformed as shown in Figure 3.2.1.2 to use in the scheme logic.

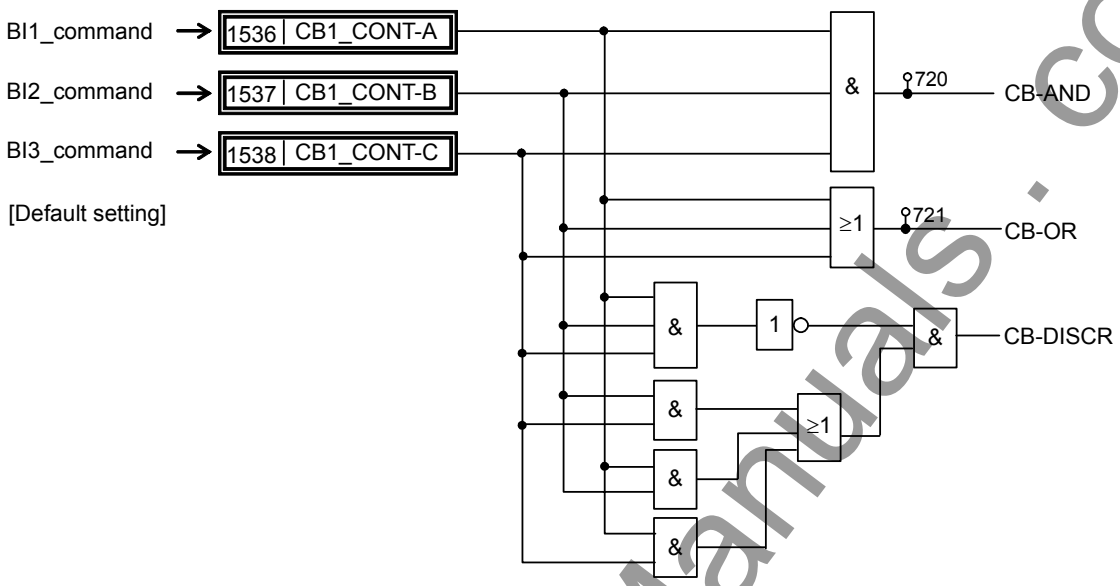



**Figure 3.2.1.2 Circuit Breaker Signals Transformation**

www . ElectricalPartManuals . com

### 3.2.2 Binary Output Signals

The number of binary output signals and their output terminals vary depending on the relay model. For all models, all outputs except the tripping command and relay failure signal can be configured.

The signals shown in the signal list in Appendix B can be assigned to the output relay individually or in arbitrary combinations. Signals can be combined using either an AND circuit or OR circuit with 6 gates each as shown in Figure 3.2.2.1. The output circuit can be configured according to the setting menu. Appendix D shows the factory default settings.

A 0.2s delayed drop-off timer can be attached to these assigned signals. The delayed drop-off time is disabled by the scheme switch [BOTD].

All the models are equipped with normally open trip contacts for each phase.

The relay failure contact closes the contact when a relay defect or abnormality in the DC power supply circuit is detected.

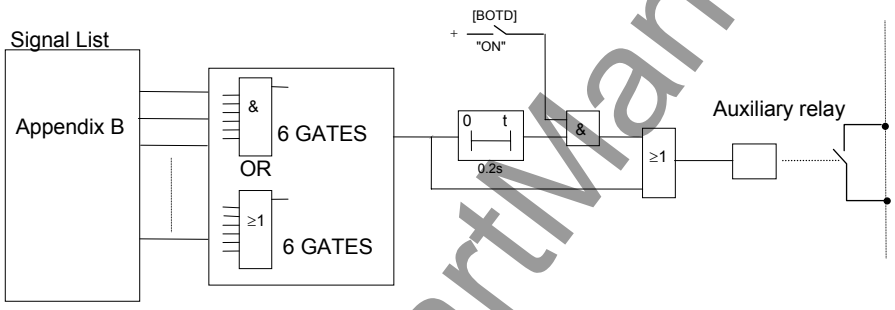



**Figure 3.2.2.1 Configurable Output**

### 3.2.3 PLC (Programmable Logic Controller) Function

GRL100 is provided with a PLC function allowing user-configurable sequence logics on binary signals. The sequence logics with timers, flip-flops, AND, OR, XOR, NOT logics, etc. can be produced by using the PC software "PLC tool" and linked to signals corresponding to relay elements or binary circuits.

Configurable binary inputs, binary outputs and LEDs, and the initiation trigger of disturbance record are programmed by the PLC function. Temporary signals are provided for complicated logics or for using a user-configured signal in many logic sequences.

PLC logic is assigned to protection signals by using the PLC tool. For PLC tool, refer to PLC tool instruction manual.

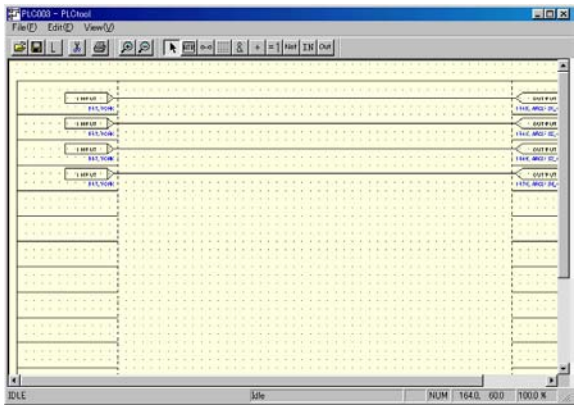


**Figure 3.2.3.1 Sample Screen of PLC Tool**

www . ElectricalPartManuals . com

## 3.3 Automatic Supervision

### 3.3.1 Basic Concept of Supervision

Though the protection system is in the non-operating state under normal conditions, it is waiting for a power system fault to occur at any time and must operate for faults without fail. Therefore, the automatic supervision function, which checks the health of the protection system during normal operation, plays an important role. A numerical relay based on microprocessor operations is suitable for implementing this automatic supervision function of the protection system. The GRL100 implements the automatic supervision function taking advantage of this feature based on the following concept:

- The supervising function should not affect protection performance.
- Perform supervision with no omissions whenever possible.
- When a failure occurs, it should be able to easily identify the location of the failure.

### 3.3.2 Relay Monitoring

The following items are supervised:

#### AC input imbalance monitoring

The AC voltage and current inputs are monitored to check that the following equations are satisfied and the health of the AC input circuits is checked.

- Zero sequence voltage monitoring

  $|V_a + V_b + V_c| / 3 \leq 6.35(V)$

- Negative sequence voltage monitoring

  $|V_a + a^2V_b + aV_c| / 3 \leq 6.35(V)$

  where,

  a = Phase shifter of 120°

- Zero sequence current monitoring

  $|I_a + I_b + I_c - 3I_o| / 3 \leq 0.1 \times Max(|I_a|, |I_b|, |I_c|) + k_0$

  where,

  $3I_o$ = Residual current

  $Max(|I_a|, |I_b|, |I_c|)$ = Maximum amplitude among $I_a$, $I_b$ and $I_c$

  $k_0$ = 5% of rated current

These zero sequence monitoring and negative sequence monitoring allow high-sensitivity detection of failures that have occurred in the AC input circuits.

The negative sequence voltage monitoring allows high sensitivity detection of failures in the voltage input circuit, and it is effective for detection particularly when cables have been connected with the incorrect phase sequence.

The zero sequence current monitoring allows high-sensitivity detection of failures irrespective of the presence of the zero sequence current on the power system by introduction of the residual circuit current.

Only zero sequence monitoring is carried out for the current input circuit, because zero sequence

www.ElectricalPartManuals.com

monitoring with the introduction of the residual circuit current can be performed with higher sensitivity than negative sequence monitoring.

#### A/D accuracy checking

An analog reference voltage is input to a prescribed channel in the analog-to-digital (A/D) converter, and the system checks that the data after A/D conversion is within the prescribed range and that the A/D conversion characteristics are correct.

#### Memory monitoring

The memories are monitored as follows depending on the type of memory, and the health of the memory circuits is checked:

- Random access memory monitoring: Writes/reads prescribed data and checks the storage function.
- Program memory monitoring: Checks the checksum value of the written data.
- Setting value monitoring: Checks for discrepancies between the setting values stored in duplicate.

#### Watchdog Timer

A hardware timer, which is cleared periodically by software, is provided and the system checks that the software is running normally.

#### DC Supply monitoring

The secondary voltage level of the built-in DC/DC converter is monitored and the system checks that the DC voltage is within the prescribed range. If a failure is detected, the relay trip is blocked and the alarm is issued.

Furthermore, DC supply is monitored by using the binary input signal in the current differential protection. If the binary input signal is "OFF" (= DC supply "OFF" or "Failure"), the ready condition of the differential protection is "OFF" and both local and remote relays are blocked. (Refer to Table 3.2.1.2.) This monitoring is provided to surely block the unwanted operation of remote terminal relays caused by sending the remote terminals an uncertain data even for short time at DC supply off or failure, though the former monitoring is enough at DC supply off or failure in general.

### 3.3.3 CT Circuit Current Monitoring

The CT circuit is monitored to check that the following equation is satisfied and the health of the CT circuit is checked.

$$\mathrm{Max}(|I_a|, |I_b|, |I_c|) - 4 \times \mathrm{Min}(|I_a|, |I_b|, |I_c|) \geq k_0$$

where,

$\mathrm{Max}(|I_a|, |I_b|, |I_c|)$ = Maximum amplitude among $I_a$, $I_b$ and $I_c$
$\mathrm{Min}(|I_a|, |I_b|, |I_c|)$ = Minimum amplitude among $I_a$, $I_b$ and $I_c$
$k_0$ = 20% of rated current

The CT circuit current monitoring allows high sensitivity detection of failures that have occurred in the AC input circuit. This monitoring can be disabled by the scheme switch [CTSV].

www.ElectricalPartManuals.com

### 3.3.4 CT Circuit Failure Detection

If a failure occurs in a CT circuit, the differential elements may operate incorrectly. GRL100 incorporates a CT failure detection function (CTF) against such incorrect operation. When the CTF detects a CT circuit failure, it can block the DIF trip.

The CTF is enabled or disabled by the scheme switch [CTFEN] as follows:

- "Off": Disabled.
- "On": Enabled. If once CTF is detected, the CTF function cannot be reset until ID is reset.
- "OPT-On": Enabled. After CTF is detected, the CTF function is reset if CTFUV, CTFDV or CTFOVG operates.

The DIF trip is blocked or not by the scheme switch [CTFCNT].

- "NA": No block the DIF trip
- "BLK": Block the DIF trip

#### Detection logic

Figure 3.3.4.1 shows the CTF detection logic.

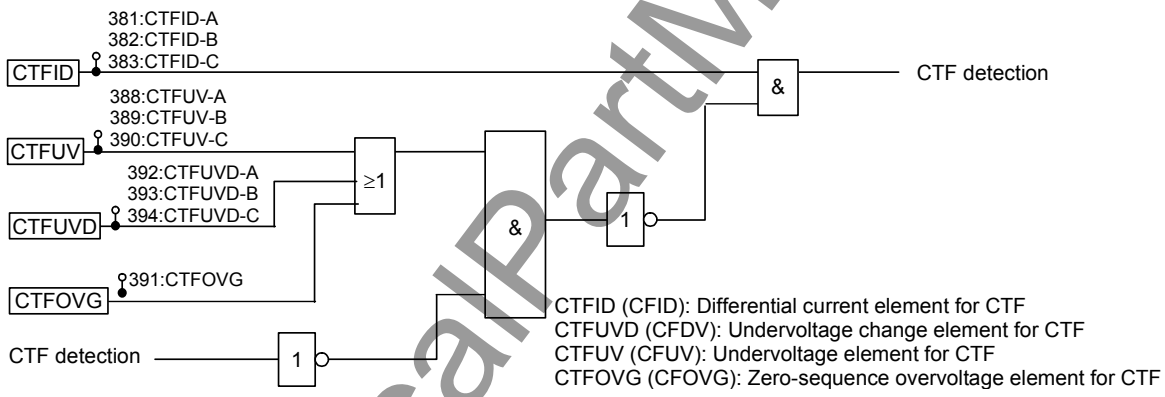



**Figure 3.3.4.1 CTF Detection Logic**

#### Setting

The setting elements necessary for the CTF and their setting ranges are as follows:

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| CFID | 0.25 - 5.00 A | 0.1 A | 0.25 A | Id current level |
| | ( 0.05 - 1.00 A | 0.01 A | 0.05 A) (*) | |
| CFUV | 20 - 60 V | 1 V | 20 V | |
| CFDV | 1 - 10 % | 1 % | 7 % | % of rated voltage |
| CFOVG | 0.1 - 10.0 V | 0.1 V | 1.0 V | Zero-sequence voltage |
| [CTFEN] | Off/On/OPT-On | | Off | CTF enabled or not |
| [CTFCNT] | NA / BLK | | NA | Control by CTF detection |

(*) Current values shown in the parentheses are in the case of 1 A rating. Other current values are in the case of 5 A rating.

### 3.3.5 Voltage Transformer Failure Supervision

When a fault occurs in the secondary circuit of the voltage transformer (VT), the voltage dependent measuring elements may operate incorrectly. GRL100 incorporates a VT failure

www.ElectricalPartManuals.com

supervision function (VTFS) as a measure against such incorrect operation. When the VTFS detects a VT failure, it blocks the following voltage dependent protections instantaneously. In 10 seconds, it displays the VT failure and outputs an alarm.

- Zone 1-3 and R distance protection
- Directional earth fault protection
- Command protection

Resetting of the blocks above and resetting of the display and alarm are automatically performed when it is confirmed that all three phases are healthy.

A binary input signal to indicate a miniature circuit breaker trip in the VT circuits is also available for the VTFS.

#### Scheme logic

Figure 3.3.5.1 shows the scheme logic for the VTFS. VT failures are detected under any one of the following conditions and then a trip block signal VTF is output.

VTF1: The phase-to-phase undervoltage element UVFS or phase-to-earth undervoltage element UVFG operates (UVFS = 1 or UVFG =1) when the three phases of the circuit breaker are closed (CB-AND = 1) and the phase current change detection element OCD1 does not operate (OCD1 = 0).

VTF2: The residual overcurrent element EFL does not operate (EFL = 0), the residual overvoltage element OVG operates (OVG = 1) and the phase current change detection element OCD1 does not operate (OCD1 = 0).

In order to prevent detection of false VT failures due to unequal pole closing of the circuit breaker, the VTFS is blocked for 200 ms after line energisation.

The trip block signal VTF is reset 100 milliseconds after the VT failure condition has reset. When the VTF continues for 10s or more, an alarm signal VTF-ALM is output.

Further, the VT failure is detected when the binary input signal (PLC signal) EXT_VTF is received. The binary input signal requires the time coordinated with Zone 1 operation and reset. If not, the time can be adjusted by the PLC function.

This function can be enabled or disabled by the scheme switch [VTF1EN] or [VTF2EN] and has a programmable reset characteristic. When set to “ON”, the latched operation for VTF1 is reset by reset of UVFS/UVFG element, and that for VTF2 is reset by reset of OVG element. Set to “OPT-ON” to reset the latched operation when OCD1 or EFL operates.

The VTFS can be disabled by the PLC signal VTF_BLOCK.

www . ElectricalPartManuals . com

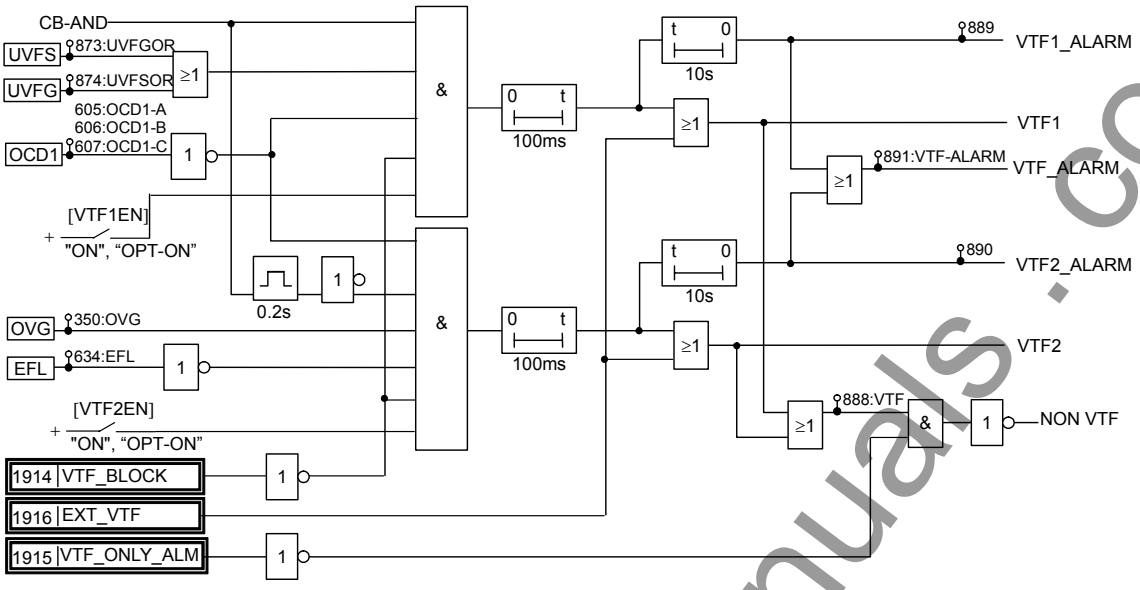



**Figure 3.3.5.1 VTFS Logic**

### Setting

The setting elements necessary for the VTFS and their setting ranges are as follows:

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| UVFS | 50 - 100 V | 1 V | 88 V | Phase - to - phase undervoltage |
| UVFG | 10 - 60 V | 1 V | 51 V | Phase - to - earth undervoltage |
| EFL | 0.5 - 5.0 A | 0.1 A | 1.0 A | Residual overcurrent |
| | ( 0.10 - 1.00 A | 0.01 A | 0.20 A) (*) | |
| [VTF1EN] | Off/On/OPT-On | | On | VTF1 supervision |
| [VTF2EN] | Off/On/OPT-On | | On | VTF2 supervision |
| [VTF-Z4] | Off / On | | On | Z4 blocked by VTF |

(*) Current values shown in the parentheses are in the case of 1 A rating. Other current values are in the case of 5 A rating.

The following elements have fixed setting values.

| Element | Setting | Remarks |
|---|---|---|
| OCD1 | Fixed to 0.5 A<br>(Fixed to 0.1 A) | Current change detection |
| OVG | Fixed to 20 V | Residual overvoltage |

(*) Current value shown in the parentheses is in the case of 1 A rating. Other current value is in the case of 5 A rating.

When setting the UVFS, UVFG and EFL, the maximum detection sensitivity of each element should be set with a margin of 15 to 20% taking account of variations in the system voltage, the asymmetry of the primary system and CT and VT error.

## 3.3.6 Differential Current (Id) Monitoring

The DIFSV element is provided to detect any erroneous differential current appearing as a result of CT circuit failure. The tripping output signal of the DIF elements can be blocked when the DIFSV element output is maintained for the setting time of TIDSV. To block the tripping output with DIFSV operation, set scheme switch [IDSV] to “ALM&BLK”. To alarm only, set to “ALM”.

www.ElectricalPartManuals.com

### 3.3.7 Telecommunication Channel Monitoring

#### Signal channel monitoring for current differential protection

The telecommunication channel is monitored at each terminal by employing a cyclic redundancy check and fixed bit check of the received data. The check is carried out for every sampling.

If a data failure occurs between the local terminal and remote terminal 1 and lasts for ten seconds, failure alarms "Com1 fail" and "Com1 fail-R" are issued at the local and remote terminals respectively. "Com1 fail" is a failure detected by the local terminal relay, and "Com1 fail-R" is a failure detected by the remote terminal relay. If the failure occurs between the local terminal and remote terminal 2, "Com2 fail" and "Com2 fail-R" are issued.

Note: The remote terminal 1 and 2 are those with which the local communication port 1 (CH1) and 2 (CH2) are linking with.

In the case that the GRL100 is linked directly to a dedicated optical fiber communication circuit, sending and receiving signal levels are monitored and error messages "TX1 level err" of CH1 or "TX2 level err" of CH2 for sending signal and "RX1 level err" of CH1 or "RX2 level err" of CH2 for receiving signal are output when the levels fall below the minimum allowed.

In the communication setup in which the GRL100 receives the clock signal from the multiplexer, an error message "CLK1 fail" of CH1 or "CLK2 fail" of CH2 is output when the signal is interrupted.

Note: Messages "Com2 fail", "RX2 level err", "TX2 level err" and "CLK2 fail" are valid in three-terminal applications.

If the ready signal of the remote terminal relay via CH1 or CH2 is OFF during ten seconds or more, the message ‘Term1 rdy off’ or ‘Term2 rdy off’ is displayed. (For the ready signal, see Appendix N.)

#### Signal channel monitoring for command protection

In the PUP, POP or UOP schemes, when a trip permission signal is received consecutively for 10 seconds, this is considered to be an error of the signal channel and an alarm of "Ch-R1. fail" and/or "Ch-R2. fail" is issued.

### 3.3.8 GPS Signal Reception Monitoring (For GPS-mode only)

If the GPS signal receiving from the GPS receiver unit is interrupted, an alarm is issued.

### 3.3.9 Relay Address Monitoring

In applications where the telecommunication channel can be switched, it is possible that the data could be communicated to the wrong terminal. To avoid this, the relay address can be assigned and monitored at each terminal to check that the data is communicated to the correct terminal.

The different address must be assigned to a relay at each terminal.

The monitoring is enabled by setting the scheme switch [RYIDSV] to "ON".

### 3.3.10 Disconnector Monitoring

The disconnector is monitored because the disconnector contact signal is used for the out-of-service terminal detection and for the stub fault protection in the one-and-a-half busbar system.

To monitor the disconnector, one pair of normally open contacts 89A and normally closed contacts 89B are introduced. Disconnector failure is detected when both 89A and 89B are

www.ElectricalPartManuals.com

simultaneously in the open or closed state for the prescribed period.

The monitoring is blocked by setting the scheme switch [LSSV] to OFF. The default setting of [LSSV] is OFF to prevent a false failure detection when the disconnector contacts are not introduced.

### 3.3.11 Failure Alarms

When a failure is detected by the automatic supervision, LCD display, LEDs indication, external alarm and event recording are performed.

Table 3.3.11.1 summarizes the supervision items and alarms. The LCD messages are shown on the "Auto-supervision" screen which is displayed automatically when a failure is detected or displayed by pressing the VIEW key. The event record messages are shown on the "Event record" screen by opening the "Record" sub-menu. The alarms are retained until the failure is recovered.

The alarms can be disabled collectively by setting the scheme switch [AMF] to OFF. This setting is used to block unnecessary alarms during commissioning tests or maintenance.

When the Watch Dog Timer detects that the software is not running normally, LCD display and event recording of the failure may not function normally.

A DC supply failure disables the LCD display and event recording of the failure as well.

For details of discrimination of the two failures mentioned above, see Section 6.7.2.

**Table 3.3.11.1 Supervision Items and Alarms**

| Supervision Item | LCD message | LED "IN SERVICE" | LED "ALARM" | External alarm | Event record message (default) |
|---|---|---|---|---|---|
| AC input imbalance monitoring Vo, V2, Io | (1) | on/off (2) | on | (4) | V0 err / V2 err / I0 err |
| CT circuit monitoring | (1) | on/off (7) | on | (4) | CT err |
| A/D accuracy checking<br>Memory monitoring | (1) | off | on | (4) | Relay fail |
| Watch Dog Timer | — | off | on | (4) | — |
| DC supply monitoring | — | off | (3) | (4) | DC supply |
| Communication monitoring for differential protection | Com.□ fail<br>Com.□ fail-R (*) | on<br>on | on<br>off | (5)<br>(5) | Com.□ fail<br>Com.□ fail-R (*) |
| Communication monitoring for differential protection | Ch-R□. fail (*) | on | on | (5) | Ch-R□. fail (*) |
| Sampling Synchronization monitoring | Sync.□ fail (*) | on | on | (4) | Sync.□ fail (*) |
| Send signal level monitoring | TX □ level err (*) | on | off | (5) | TX □ level err (*) |
| Receive signal level monitoring | RX □ level err (*) | on | off | (5) | RX □ level err (*) |
| Clock monitoring | CLK.□ fail (*) | on | off | (5) | CLK.□ fail (*) |
| Ready signal monitoring | Term.□ rdy off (*) | on | on | (5) | Term.□ rdy off (*) |
| GPS signal reception monitoring | GPS 1PPS off | on | on | (5) | GPS 1PPS off |
| Disconnector monitoring | DS fail | on | on | (4) | DS fail |
| Id monitoring | Id err | on/off (6) | on | (4) | Relay fail |
| Relay address monitoring | RYID□ err | on | on | (5) | RYID□ err |
| CTF monitoring | CT fail | On | On (8) | (5) | CTF |
| VTF monitoring | VT fail | On | On (8) | (5) | VTF |

(*) □ takes 1 or 2 according to the channel linking, either with remote terminal 1 or 2.



www.ElectricalPartManuals.com

(1) There are various messages such as "··· err" and "··· fail" as shown in the table in Section 6.7.2.
(2) The LED is on when the scheme switch [SVCNT] is set to "ALM", and off when "ALM & BLK" (refer to Section 3.3.11).
(3) Whether the LED is lit or not depends on the degree of voltage drop.
(4) The binary output relay "FAIL" will operate.
(5) User-configurable binary output relay will operate if the supervision function and signal applied.
(6) The LED is on when the scheme switch [IDSV] is set to "ALM", and off when "ALM & BLK".
(7) The LED is on when the scheme switch [CTSV] is set to "ALM", and off when "ALM & BLK".
(8) The LED is on if the signals is assigned and the scheme switch [CTFEN] / [VTFEN] is set to "On" or "OPT-On".

### 3.3.12 Trip Blocking

When a failure is detected by the following supervision items, the trip function is blocked as long as the failure exists and is restored when the failure is removed:

- A/D accuracy checking
- Memory monitoring
- Watch Dog Timer
- DC supply monitoring
- Telecommunication channel monitoring

When a failure is detected by AC input imbalance monitoring, CT circuit current monitoring or differential current monitoring, the scheme switch [SVCNT], [CTSV] or [IDSV] setting can be used to determine if both tripping is blocked and an alarm is output, or, if only an alarm is output. The CT circuit current monitoring and the differential current monitoring can be disabled by the [CTSV] and [IDSV] respectively.

### 3.3.13 Setting

The setting elements necessary for the automatic supervision and their setting ranges are shown in the table below.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| DIFSV | 0.25 – 10.00A<br>(0.05 – 2.00A | 0.01A<br>0.01A | 0.50A<br>0.10A) (*) | Differential current supervision |
| TIDSV | 0 – 60s | 1s | 10s | Detected time setting |
| RYID | 0-63 | | 0 | Local relay address |
| RYID1 | 0-63 | | 0 | Remote 1 relay address |
| RYID2 | 0-63 | | 0 | Remote 2 relay address |
| [IDSV] | OFF/ALM&BLK/ALM | | OFF | Differential current supervision |
| [RYIDSV] | OFF/ON | | ON | Relay address supervision |
| [LSSV] | ON/OFF | | OFF | Disconnector monitoring |
| [SVCNT] | ALM&BLK/ALM | | ALM&BLK | Alarming and/or blocking |
| [CTSV] | OFF/ALM&BLK/ALM | | OFF | CT circuit monitoring |

(*) Current values shown in parentheses are in the case of 1A rating. Other current values are in the case of 5A rating.

For setting method, see Section 2.2.12. For the setting range of CT circuit failure detection, see section 3.3.4.

www.ElectricalPartManuals.com

## 3.4 Recording Function

The GRL100 is provided with the following recording functions:

Fault recording

Event recording

Disturbance recording

These records are displayed on the LCD of the relay front panel or on the local or remote PC.

### 3.4.1 Fault Recording

Fault recording is started by a tripping command of the GRL100, a tripping command of the external main protection or PLC command by user-setting (max. 4) and the following items are recorded for one fault:

Date and time of fault occurrence
Faulted phase
Tripping phase
Tripping mode
Fault location
Relevant events
Power system quantities

Up to 8 most-recent faults are stored as fault records. If a new fault occurs when 8 faults have been stored, the record of the oldest fault is deleted and the record of the latest fault is then stored.

**Date and time of fault occurrence**

The time resolution is 1 ms using the relay internal clock. To be precise, this is the time at which a tripping command has been output.

**Fault phase**

The faulted phase is indicated by DIF, OC or OCI operating phase.

**Tripping phase**

This is the phase to which a tripping command is output.

**Tripping mode**

This shows the protection scheme that outputted the tripping command.

**Fault location**

The distance to the fault point calculated by the fault locator is recorded. The distance is expressed in km and as a percentage (%) of the line length in two-terminal application. In case of three-terminal application, the distance in km and the section on the fault point are displayed.

For the fault locator, see Section 2.17.

**Relevant events**

Such events as autoreclose, re-tripping following the reclose-on-to-a fault or autoreclose and tripping for evolving faults are recorded with time-tags.

**Power system quantities**

The following power system quantities in pre-faults and post-faults are recorded. The power system quantities are not recorded for evolving faults.

www.ElectricalPartManuals.com

- Magnitude and phase angle of phase voltage ($V_a$, $V_b$, $V_c$)
- Magnitude and phase angle of phase current at the local terminal ($I_a$, $I_b$, $I_c$)
- Magnitude and phase angle of phase voltage for autoreclose ($V_{s1}$, $V_{s2}$)
- Magnitude and phase angle of symmetrical component voltage ($V_1$, $V_2$, $V_0$)
- Magnitude and phase angle of symmetrical component current at the local terminal ($I_1$, $I_2$, $I_0$)
- Magnitude and phase angle of positive sequence voltage at the remote terminal 1 and 2 ($V_{11}$, $V_{12}$)
- Magnitude and phase angle of phase current and residual current at the remote terminal 1 ($I_{a1}$, $I_{b1}$, $I_{c1}$, $I_{01}$)
- Magnitude and phase angle of phase current and residual current at the remote terminal 2 ($I_{a2}$, $I_{b2}$, $I_{c2}$, $I_{02}$)
- Magnitude of phase differential current ($I_{da}$, $I_{db}$, $I_{dc}$)
- Magnitude of residual differential current ($I_{d0}$)
- Telecommunication delay time 1 at the remote terminal 1
- Telecommunication delay time 2 at the remote terminal 2
- Magnitude of parallel line zero sequence current ($I_{0m}$)
- Resistive and reactive component of phase impedance ($R_a$, $R_b$, $R_c$, $X_a$, $X_b$, $X_c$)
- Resistive and reactive component of phase-to-phase impedance (Rab, Rbc, Rca, Xab, Xbc, Xca)

Phase angles above are expressed taking that of positive sequence voltage or positive sequence current when the voltage is small or no voltage is input) as a reference phase angle.

### 3.4.2 Event Recording

The events shown are recorded with a 1 ms resolution time-tag when the status changes. The user can set the maximum 128 recording items and their status change mode. The event recording is initiated by a binary input signal. The event items can be assigned to a signal number in the signal list. The status change mode is set to "On" (only recording when On.) or "On/Off"(recording when both On and Off.) mode by setting. The items of "On/Off" mode are specified by "Bi-trigger events" setting. If the "Bi-trigger events" is set to "100", No.1 to 100 events are "On/Off" mode and No.101 to 128 events are "On" mode.

The name of event can be set by RSM100. Maximum 22 characters can be set, but LCD displays up to 11 characters of them. Therefore, it is recommended the maximum characters are set. The set name can be viewed on the Setting(view) screen.

The elements necessary for event recording and their setting ranges are shown in the table below. The default setting of event record is shown in Appendix H.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| BITRN | 0 - 128 | 1 | 100 | Number of bi-trigger(on/off) events |
| EV1 – EV128 | 0 - 3071 | | | Assign the signal number |

Up to 480 records can be stored. If an additional event occurs when 480 records have been stored, the oldest event record is deleted and the latest event record is then stored.

### 3.4.3 Disturbance Recording

Disturbance recording is started when overcurrent or undervoltage starter elements operate or a tripping command is output, or PLC command by user-setting (max. 4: Signal No. 2632 to 2635) is outputted. The records include 19 analog signals (local terminal: $V_a$, $V_b$, $V_c$, $I_a$, $I_b$, $I_c$, $3I_0$,

www.ElectricalPartManuals.com

$I_{da}$, $I_{db}$, $I_{dc}$, $I_{d0}$, remote terminal 1: $I_{a1}$, $I_{b1}$, $I_{c1}$, $3I_{01}$ remote terminal 2: $I_{a2}$, $I_{b2}$, $I_{c2}$, $3I_{02}$), 32 binary signals and the dates and times at which recording started. Any binary signal shown in Appendix B can be assigned by signal setting of disturbance record. The default setting of binary signal is shown in Appendix H.

The name of binary signal can be set by RSM100. Maximum 22 characters can be set, but LCD displays up to 11 characters of them. Therefore, it is recommended the maximum characters are set. The set name can be viewed on the Setting(view) screen.

The LCD display only shows the dates and times of disturbance records stored. Details can be displayed on the PC. For how to obtain disturbance records on the PC, see the PC software instruction manual.

The pre-fault recording time is fixed at 0.3s and the post-fault recording time can be set between 0.1 and 3.0s and the default setting is 1.0s.

The number of records stored depends on the post-fault recording time and the relay model. The typical number of records stored in 50Hz and 60Hz power system is shown in Table 3.4.3.1.

**Note:** If the recording time setting is changed, the records stored so far are deleted.

**Table 3.4.3.1 Post Fault Recording Time and Number of Disturbance Records Stored**

| Recording time | 0.1s | 0.5s | 1.0s | 1.5s | 2.0s | 2.5s | 3.0s |
|---|---|---|---|---|---|---|---|
| 50Hz | 36 | 18 | 11 | 8 | 6 | 5 | 4 |
| 60Hz | 30 | 15 | 9 | 6 | 5 | 4 | 3 |

### Setting

The elements necessary for starting disturbance recording and their setting ranges are shown in the table below.

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| Timer | 0.1-3.0 s | 0.1 s | 1.0 s | Post-fault recording time |
| OCP-S | 0.5-250.0 A<br>(0.1-50.0 A | 0.1 A<br>0.1 A | 10.0 A<br>2.0 A) (*) | Overcurrent detection (phase fault) |
| OCP-G | 0.5-250.0 A<br>(0.1-50.0 A | 0.1 A<br>0.1 A | 5.0 A<br>1.0 A) (*) | Overcurrent detection (earth fault) |
| UVP-S | 0-132 V | 1 V | 88 V | Undervoltage detection (phase fault) |
| UVP-G | 0-76 V | 1 V | 51 V | Undervoltage detection (earth fault) |

(*) Current values shown in the parentheses are in the case of 1A rating. Other current values are in the case of 5A rating.

Starting the disturbance recording by a tripping command or the starter elements listed above is enabled or disabled by setting the following scheme switches with identical names with the starter elements except the switch [TRIP].

| Element | Range | Step | Default | Remarks |
|---|---|---|---|---|
| [TRIP] | ON/OFF | | ON | Start by tripping command |
| [OCP-S] | ON/OFF | | ON | Start by OCP-S operation |
| [OCP-G] | ON/OFF | | ON | Start by OCP-G operation |
| [UVP-S] | ON/OFF | | ON | Start by UVP-S operation |
| [UVP-G] | ON/OFF | | ON | Start by UVP-G operation |

www.ElectricalPartManuals.com

## 3.5 Metering Function

The GRL100 performs continuous measurement of the analog input quantities. The measurement data shown below is updated every second and displayed on the LCD of the relay front panel or on the local or remote PC.

- Magnitude and phase angle of phase voltage ($V_a$, $V_b$, $V_c$)
- Magnitude and phase angle of phase current at the local terminal ($I_a$, $I_b$, $I_c$)
- Magnitude and phase angle of phase voltage for autoreclose ($V_{s1}$, $V_{s2}$)
- Magnitude and phase angle of symmetrical component voltage ($V_1$, $V_2$, $V_0$)
- Magnitude and phase angle of symmetrical component current at the local terminal ($I_1$, $I_2$, $I_0$)
- Magnitude and phase angle of positive sequence voltage at the remote terminal 1 and 2 ($V_{11}$, $V_{12}$)
- Magnitude and phase angle of phase current and residual current at the remote terminal 1 ($I_{a1}$, $I_{b1}$, $I_{c1}$, $I_{01}$)
- Magnitude and phase angle of phase current and residual current at the remote terminal 2 ($I_{a2}$, $I_{b2}$, $I_{c2}$, $I_{02}$)
- Magnitude of phase differential current ($I_{da}$, $I_{db}$, $I_{dc}$)
- Magnitude of residual differential current ($I_{d0}$)
- Percentage of thermal capacity (THM%)
- Pickup current of segregated-phase current differential element ($I_{pua}$, $I_{pub}$, $I_{puc}$)
- Restraining current of segregated-phase current differential element ($I_{ra}$, $I_{rb}$, $I_{rc}$)
- Telecommunication delay time 1 at the remote terminal 1
- Telecommunication delay time 2 at the remote terminal 2
- Magnitude of parallel line zero sequence current ($I_{0m}$)
- Resistive and reactive component of phase impedance ($R_a$, $R_b$, $R_c$, $X_a$, $X_b$, $X_c$)
- Resistive and reactive component of phase-to-phase impedance (Rab, Rbc, Rca, Xab, Xbc, Xca)
- Active power and reactive power
- Frequency

Phase angles above are expressed taking that of positive sequence voltage or positive sequence current at the local terminal when the voltage is small or no voltage is input) as a reference phase angle, where leading phase angles are expressed as positive, (+). When electrical quantities at the local terminal are "0", electrical quantities at the remote terminal are displayed as "–".

The above system quantities are displayed in values on the primary side or on the secondary side determined by the setting. To display accurate values, it is necessary to set the CT ratio and VT ratio as well. For the setting method, see "Setting the line parameters" in 4.2.6.7.

The signing of active and reactive power flow direction can be set positive for either power sending or power receiving. The signing of reactive power can be also set positive for either lagging phase or leading phase. For the setting method, see Section 4.2.6.6.

www.ElectricalPartManuals.com

# 4. User Interface

## 4.1 Outline of User Interface

The user can access the relay from the front panel.

Local communication with the relay is also possible using a personal computer (PC) via an RS232C port. Furthermore, remote communication is also possible using RSM (Relay Setting and Monitoring) or IEC60870-5-103 communication, etc., via an RS485.

This section describes the front panel configuration and the basic configuration of the menu tree of the local human machine communication ports and HMI (Human Machine Interface).

### 4.1.1 Front Panel

As shown in Figure 3.1.5.1, the front panel is provided with a liquid crystal display (LCD), light emitting diode (LED), operation keys, VIEW and RESET keys, monitoring jack and RS232C connector.

#### LCD

The LCD screen, provided with a 4-line, 40-character back-light, displays detailed information of the relay interior such as records, status and settings. The LCD screen is normally unlit, but pressing the VIEW key will display the digest screen and pressing any key other than VIEW and RESET will display the menu screen.

These screens are turned off by pressing the RESET key or END key. If any display is left for 5 minutes or longer without operation, the back-light will go off.

#### LED

There are 8 LED displays. The signal labels and LED colors are defined as follows:

| Label | Color | Remarks |
|---|---|---|
| IN SERVICE | Green | Lit when the relay is in service. |
| TRIP | Red | Lit when a trip command is issued. |
| ALARM | Red | Lit when a failure is detected. |
| TESTING | Red | Lit when the testing switches are in test position. |
| (LED1) | Red | Configurable LED to assign signals with or without latch when relay operates. |
| (LED2) | Red | Configurable LED to assign signals with or without latch when relay operates. |
| (LED3) | Red | Configurable LED to assign signals with or without latch when relay operates. |
| (LED4) | Red | Configurable LED to assign signals with or without latch when relay operates. |

The TRIP LED lights up once the relay is operating and remains lit even after the trip command goes off. For the operation, see Section 4.2.1.

www.ElectricalPartManuals.com

### Operation keys

The operation keys are used to display records, status, and set values on the LCD, as well as to input or change set values. The function of each key is as follows:

① 0-9, –: Used to enter a selected number, numerical values and text strings.

② ▼, ▲: Used to move between lines displayed on a screen.
Keys 2, 4, 6 and 8 marked with ▼, ◀, ▶ and ▲ are also used to enter text strings.

③ [CANCEL]: Used to cancel entries and return to the upper screen.

④ [END]: Used to end entry operation, return to the upper screen or turn off the display.

⑤ [ENTER]: Used to store or establish entries.

### [VIEW] and [RESET] keys

Pressing the [VIEW] key displays digest screens such as "Metering", "Latest fault" and "Auto-supervision".

Pressing the [RESET] key turns off the display.

### Monitoring jacks

The two monitoring jacks A and B and their respective LEDs can be used when the test mode is selected on the LCD screen. By selecting the signal to be observed from the "Signal List" and setting it on the screen, the signal can be displayed on LED A or LED B, or output to an oscilloscope via a monitoring jack.

### RS232C connector

The RS232C connector is a 9-way D-type connector for serial RS232C connection with a local personal computer.

www . ElectricalPartManuals . com

### 4.1.2 Communication Ports

The following interfaces are provided as communication ports:

- RS232C port
- RS485, Fibre optic or Ethernet LAN port for serial communication
- IRIG-B port
- Interface port for telecommunication link

#### RS232C port

This connector is a standard 9-way D-type connector for serial port RS232C transmission and is mounted on the front panel. By connecting a personal computer to this connector, setting and display functions can be performed from the personal computer.

#### RS485, Fibre optic or Ethernet LAN port

One or two serial communication ports can be provided. In the single-port type, it is connected to the RSM (Relay Setting and Monitoring system) via the protocol converter G1PR2 or IEC60870-5-103 communication via BCU/RTU (Bay Control Unit / Remote Terminal Unit) to connect between relays and to construct a network communication system. (See Figure 4.4.1 in Section 4.4.)

In the case of the two-port type, one port can be used for the relay setting and monitoring (RSM) system or IEC60870-5-103 communication, while the other port is used for IEC60870-5-103 communication only.

Screw terminal for RS485, ST connector for fibre optic or RJ45 connector for Ethernet LAN (10Base-T) is provided on the back of the relay as shown in Figure 4.1.2.1.

#### IRIG-B port

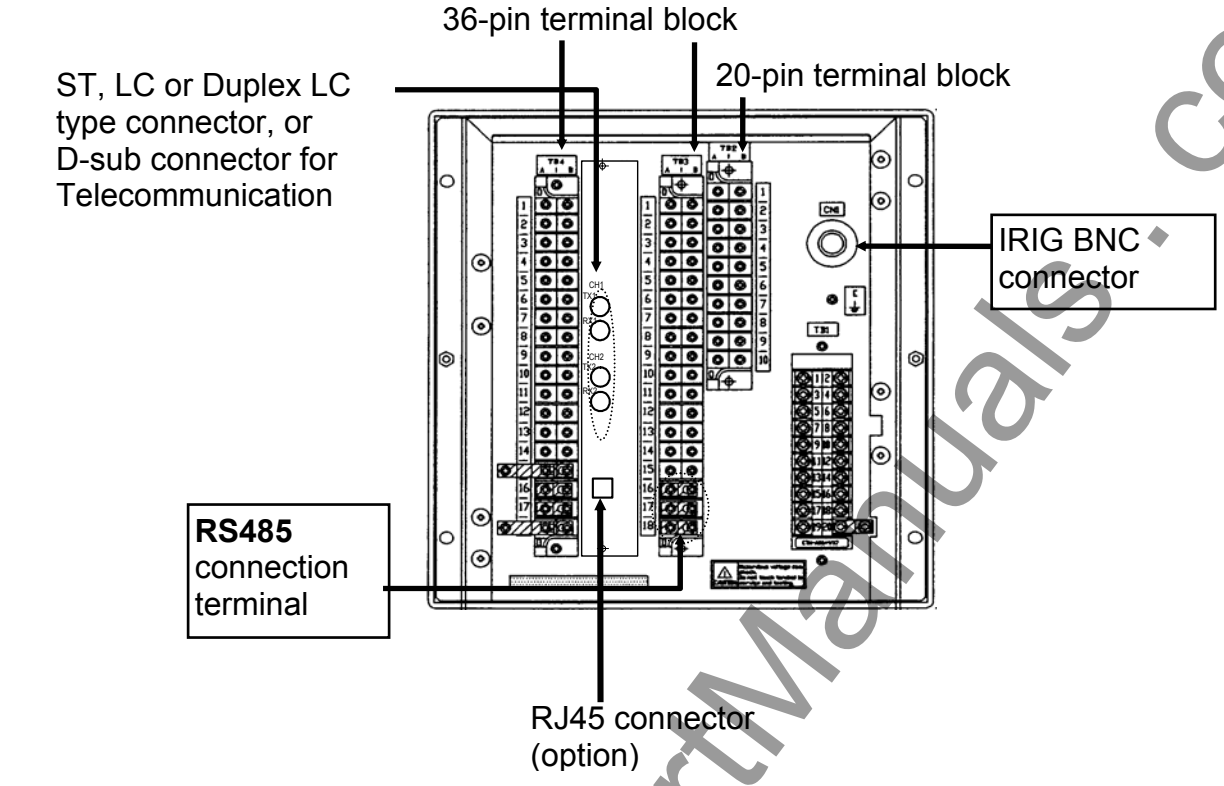
The IRIG-B port is mounted on the transformer module, and collects serial IRIG-B format data from the external clock to synchronize the relay calendar clock. The IRIG-B port is isolated from the external circuit by a photo-coupler. A BNC connector is used as the input connector.

This port is on the back of the relay, as shown in Figure 4.1.2.1.

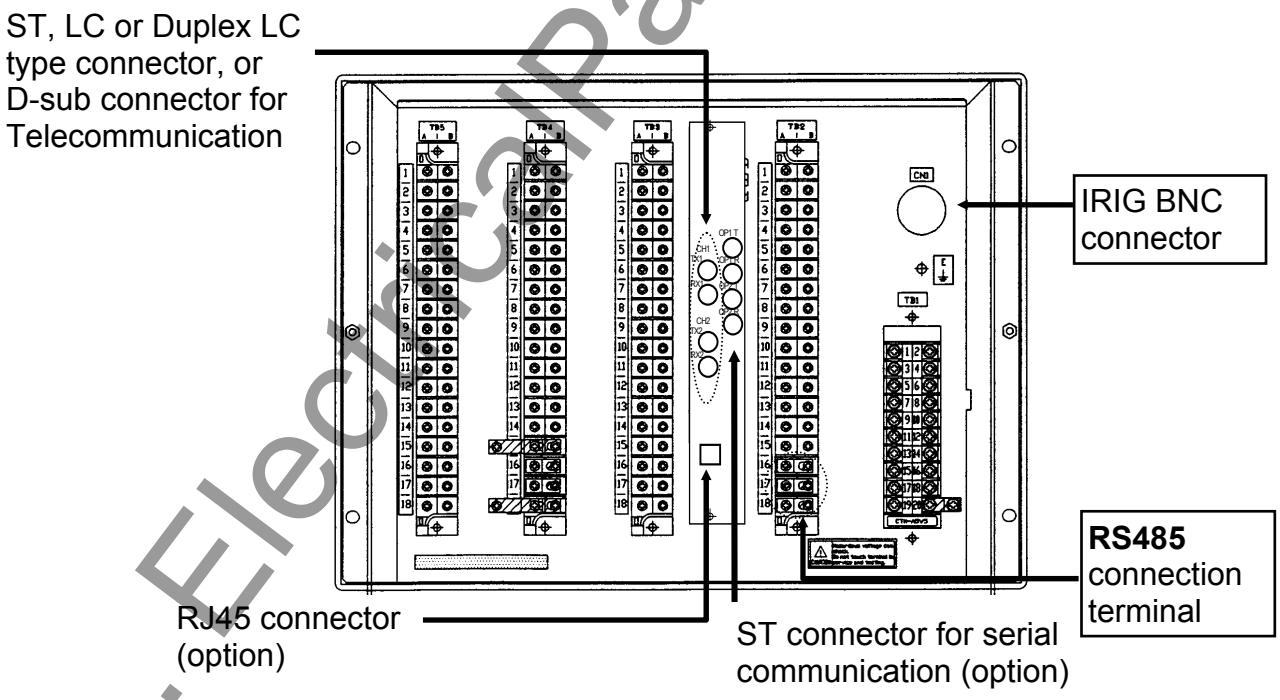
#### Interface port for telecommunication link

The optical or electrical interface port for telecommunication link is provided on the back of the relay as shown in Figure 4.1.2.1. The connector using for the optical interface port is the ST type (for 2km class), SC type (for 30km class) or Duplex LC type (for 80km class) connector and the connector for the electrical interface port is the D-sub connector.

www . ElectricalPartManuals . com




**Relay rear view (Case Type A)**




**Relay rear view (Case Type B)**

**Figure 4.1.2.1 Locations of Communication Port**

www.ElectricalPartManuals.com

## 4.2 Operation of the User Interface

The user can access such functions as recording, measurement, relay setting and testing with the LCD display and operation keys.

**Note:** LCD screens depend on the relay model and the scheme switch setting. Therefore, LCD screens described in this section are samples of typical model.

### 4.2.1 LCD and LED Displays

#### Displays during normal operation

When the GRL100 is operating normally, the green "IN SERVICE" LED is lit and the LCD is off.

Press the [VIEW] key when the LCD is off to display the digest screens "Metering1", "Metering2", "Metering3", "Metering4", "Latest fault" and "Auto-supervision" in turn. The last two screens are displayed only when there is some data. The following are the digest screens and can be displayed without entering the menu screens.

```
Metering1              16/Oct/1997  18:13
Va   127.0kV    Ia    2.10kA
Vb   127.0kV    Ib    2.10kA
Vc   127.0kV    Ic    2.10kA
```

```
Metering1              16/Oct/1997  18:13
Vab  ***.*kV    Iab   **.**kA
Vbc  ***.*kV    Ibc   **.**kA
Vca  ***.*kV    Ica   **.**kA
```

```
Metering3              16/Oct/1997  18:13
Ida   0.00kA   Ia1   1.05kA    Ia2   1.05kA
Idb   0.00kA   Ib1   1.05kA    Ib2   1.05kA
Idc   0.00kA   Ic1   1.05kA    Ic2   1.05kA
```

Note: I*1 and I*2 are phase currents of remote terminal 1 and remote terminal 2.

```
Metering4              16/Oct/1997  18:13
+  400.11MW
-   25.51Mvar
    60.1Hz
```

Press the [RESET] key to turn off the LCD.

For any display, the back-light is automatically turned off after five minutes.

#### Displays in tripping

```
Latest fault    16/Oct/1997  18:13:45.160
Phase   ABN            Trip   ABC
DIF
47.3km  (57.1%)
```

If a fault occurs and a tripping command is output when the LCD is off, the red "TRIP" LED and other configurable LED if signals assigned to trigger by tripping.

www.ElectricalPartManuals.com

Press the VIEW key to scroll the LCD screen to read the rest of messages.

Press the RESET key to turn off the LEDs and LCD display.

Notes:

1) When configurable LEDs (LED1 through LED4) are assigned to latch signals by trigger of tripping, press the RESET key more than 3s until the LCD screens relight. Confirm turning off the configurable LEDs. Refer to Table 4.2.1 Step 1.
2) Then, press the RESET key again on the "Latest fault" screen in short period, confirm turning off the "TRIP" LED. Refer to Table 4.2.1 Step 2.
3) When only the "TRIP" LED is go off by pressing the RESET key in short period, press the RESET key again to reset remained LEDs in the manner 1) on the "Latest fault" screen or other digest screens. LED1 through LED4 will remain lit in case the assigned signals are still active state.

**Table 4.2.1 Turning off latch LED operation**

| | Operation | LED lighting status | |
|---|---|---|---|
| | | "TRIP" LED | Configurable LED (LED1 - LED4) |
| Step 1 | Press the RESET key more than 3s on the "Latest fault" screen | continue to lit | turn off |
| Step 2 | Then, press the RESET key in short period on the "Latest fault" screen | turn off | |

When any of the menu screens is displayed, the VIEW and RESET keys do not function.

To return from menu screen to the digest "Latest fault" screen, do the following:

- Return to the top screen of the menu by repeatedly pressing the END key.
- Press the END key to turn off the LCD.
- Press the VIEW key to display the digest "Latest fault" screen.

**Displays in automatic supervision operation**

```
Auto-supervision    08/Dec/1997   22:56

 DIO  err,
```

If the automatic supervision function detects a failure while the LCD is off, the "Auto-supervision" screen is displayed automatically, showing the location of the failure and the "ALARM" LED lights.

Press the VIEW key to display other digest screens in turn including the "Metering" and

www.ElectricalPartManuals.com

"Latest fault" screens.

Press the RESET key to turn off the LEDs and LCD display. However, if the failure continues, the "ALARM" LED remains lit.

After recovery from a failure, the "ALARM" LED and "Auto-supervision" display turn off automatically.

If a failure is detected while any of the screens is displayed, the current screen remains displayed and the "ALARM" LED lights.

Notes:

1) When configurable LEDs (LED1 through LED4) are assigned to latch signals by issuing an alarm, press the RESET key more than 3s until all LEDs reset except "IN SERVICE" LED.
2) When configurable LED is still lit by pressing RESET key in short period, press RESET key again to reset remained LED in the above manner.
3) LED1 through LED4 will remain lit in case the assigned signals are still active state.

While any of the menu screen is displayed, the VIEW and RESET keys do not function. To return to the digest "Auto-supervision" screen, do the following:

- Return to the top screen of the menu by repeatedly pressing the END key.
- Press the END key to turn off the LCD.
- Press the VIEW key to display the digest "Auto-supervision" screen.
- Press the RESET key to turn off the LCD.

www . ElectricalPartManuals . com

### 4.2.2 Relay Menu

Figure 4.2.2.1 shows the menu hierarchy in the GRL100. The menu has five sub-menus, "Record", "Status", "Setting (view)", "Setting (change)", and "Test". For details of the menu hierarchy, see Appendix E.

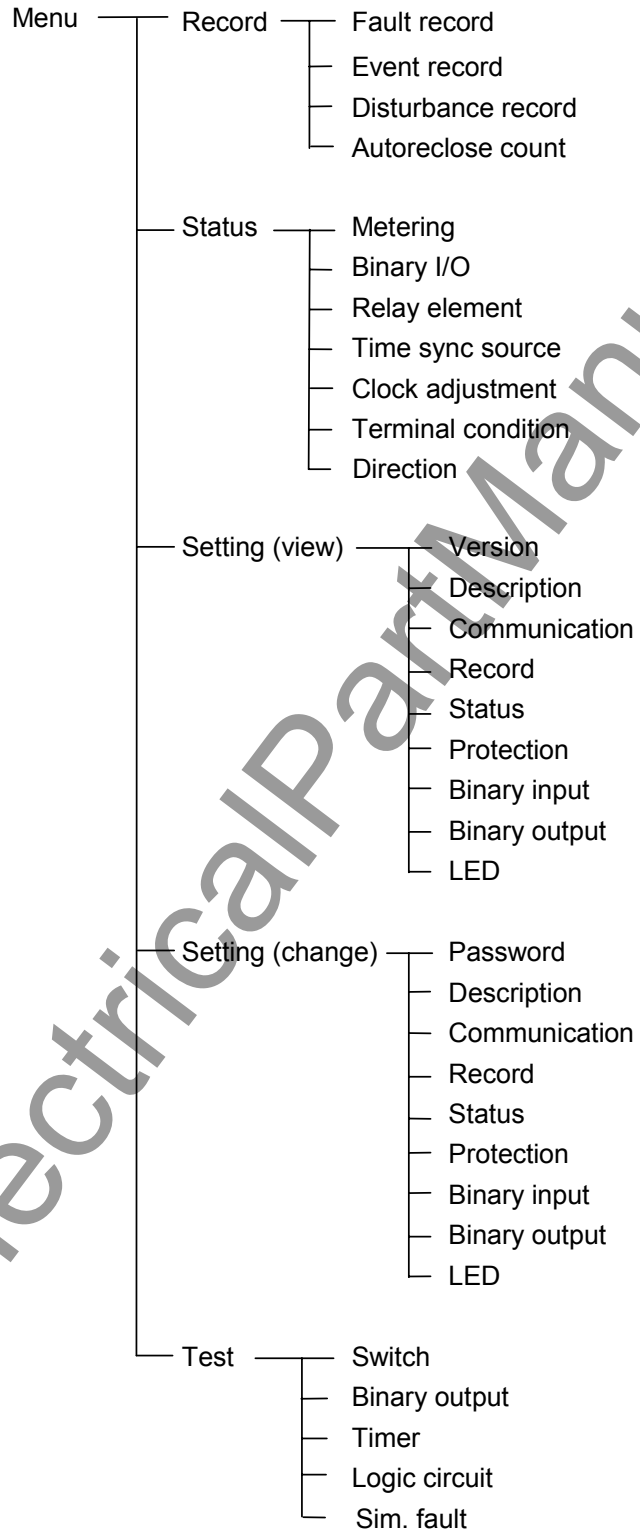



**Figure 4.2.2.1 Relay Menu**

www . ElectricalPartManuals . com

**Record**

In the "Record" menu, the fault records, event records and disturbance records can be displayed or erased. Furthermore, autoreclose function can be displayed in counter form or reset.

**Status**

The "Status" menu displays the power system quantities, binary input and output status, relay measuring element status, signal source for time synchronization (IRIG-B, RSM, IEC or GPS), terminal condition (In- or out-of-service) and adjusts the clock.

**Setting (view)**

The "Setting (view)" menu displays the relay version, plant name and the current settings of relay address, IP address and RS232C baud rate in communication, record, status, protection, configurable binary inputs, configurable binary outputs and configurable LEDs.

**Setting (change)**

The "Setting (change)" menu is used to set or change the settings of password, plant name, relay address, IP address and RS232C baud rate in communication, record, status, protection, configurable binary inputs, configurable binary outputs and configurable LEDs.

Since this is an important menu and is used to set or change settings related to relay tripping, it has password security protection.

**Test**

The "Test" menu is used to set testing switches, to test the trip circuit, to forcibly operate binary output relays, to measure variable timer time, to observe the binary signals in the logic circuit, and to set the synchronized trigger signal for end-to-end dynamic test.

When the LCD is off, press any key other than the VIEW and RESET keys to display the top "MENU" screen and then proceed to the relay menus.

```
    MENU
1=Record              2=Status
3=Setting(view)       4=Setting(change)
5=Test
```

To display the "MENU" screen when the digest screen is displayed, press the RESET key to turn off the LCD, then press any key other than the VIEW and RESET keys.

Press the END key when the top screen is displayed to turn off the LCD.

An example of the sub-menu screen is shown below. The top line shows the hierarchical layer of the screen, screen title and total number of lines of the screen. The last item is not displayed for all the screens. "/6" displayed on the far left means that the screen is in the sixth hierarchical layer, while "1/8" displayed on the far right means that the screen has eight lines excluding the top line and that the cursor is on the first line.

To move the cursor downward or upward for setting or viewing other lines not displayed on the window, use the ▼ and ▲ keys.

www.ElectricalPartManuals.com

```
/6 Scheme switch                                    1/ 8
ARC-EXT  0=Off   1=On                               1  _
ARC-BU   0=Off   1=On                               1
ARCDIFG  0=Off   1=On                               1
VCHK     0=Off   1=LB   2=DB   3=SY                 1
ARC-SM   0=Off   1=S2   2=S3   3=S4                 1
VTPHSEL  1=A     2=B     3=C                        1
VT-RATE  1=PH/G    2=PH/PH                          1
3PH-VT   1=BUS     2=Line                           1
```

To move to the lower screen or move from the left-side screen to the right-side screen in Appendix E, select the appropriate number on the screen. To return to the higher screen or move from the right-side screen to the left-side screen, press the [END] key.

The [CANCEL] key can also be used to return to the higher screen but it must be used carefully because it may cancel entries made so far.

To move between screens of the same hierarchical depth, first return to the higher screen and then move to the lower screen.

### 4.2.3 Displaying Records

The sub-menu of "Record" is used to display fault records, event records, disturbance records and autoreclose counts.

#### 4.2.3.1 Displaying Fault Records

To display fault records, do the following:

- Open the top "MENU" screen by pressing any keys other than the [VIEW] and [RESET] keys.
- Select 1 (=Record) to display the "Record" sub-menu.

```
/1 Record
1=Fault record          2=Event record
3=Disturbance record 4=Autoreclose count
```

- Select 1 (=Fault record) to display the "Fault record" screen.

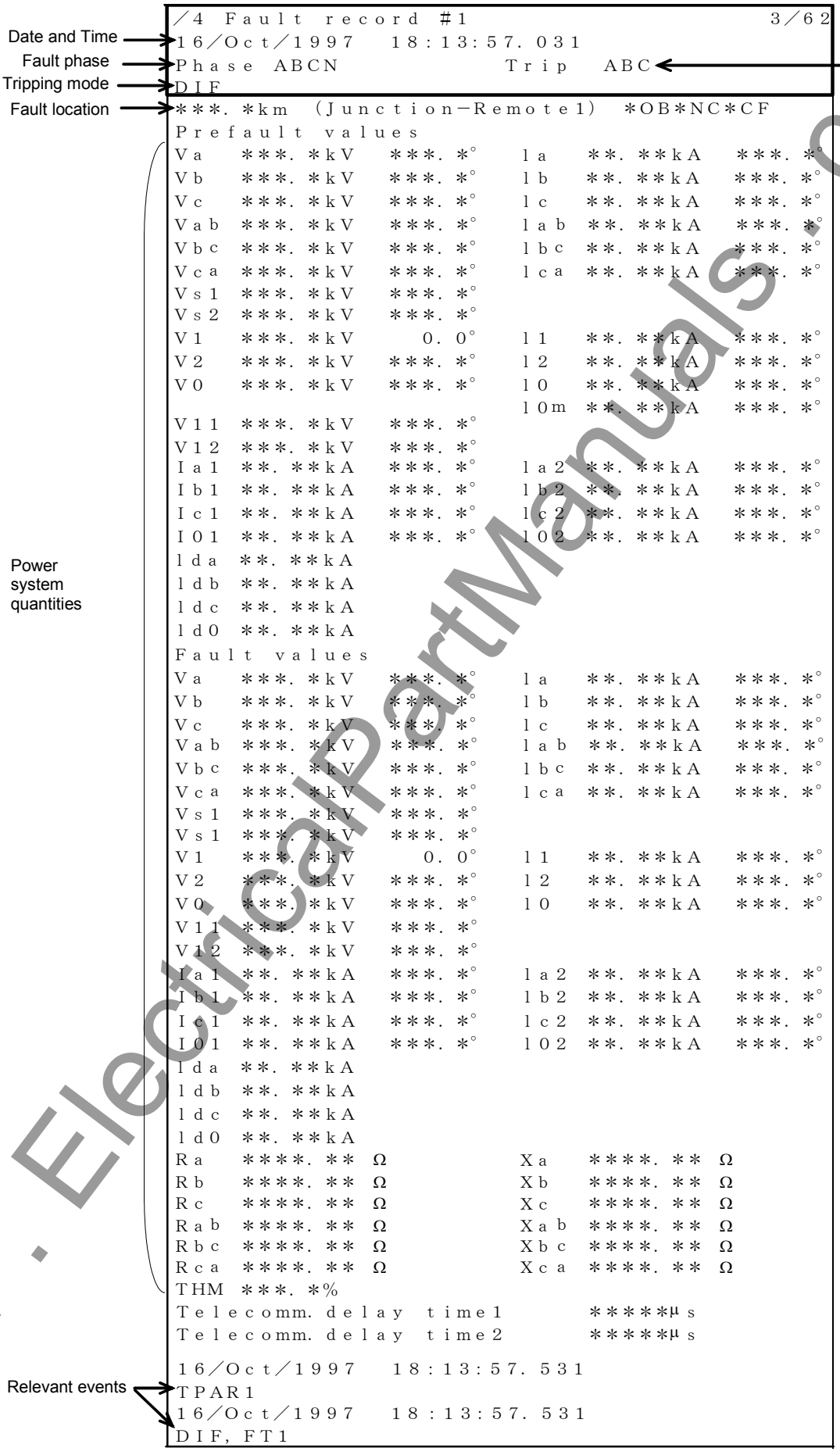
```
/2 Fault record
1=Display     2=Clear
```

- Select 1 (=Display) to display the dates and times of fault records stored in the relay from the top in new-to-old sequence.

```
/3 Fault record                                     1/ 8
#1   16/Oct/1997  18:13:57.031
#2   20/Sep/1997  15:29:22.463
#3   04/Jul/1997  11:54:53.977
```

- Move the cursor to the fault record line to be displayed using the ▲ and ▼ keys and press the [ENTER] key to display the details of the fault record.

www.ElectricalPartManuals.com




www . ElectricalPartManuals . com

Note: I∗1 and I∗2 are phase currents of remote terminal 1 and remote terminal 2. V11 and V12 are symmetrical component voltages of remote terminal 1 and remote terminal 2.

The lines which are not displayed in the window can be displayed by pressing the ▲ and ▼ keys.

To clear all the fault records, do the following:

- Open the "Record" sub-menu.
- Select 1 (=Fault record) to display the "Fault record" screen.
- Select 2 (=Clear) to display the following confirmation screen.

```
/2 Fault record
Clear all fault records?
          ENTER=Yes     CANCEL=No
```

- Press the [ENTER] (=Yes) key to clear all the fault records stored in non-volatile memory.

If all fault records have been cleared, the "Latest fault" screen of the digest screens is not displayed.

#### 4.2.3.2 Displaying Event Records

To display event records, do the following:

- Open the top "MENU" screen by pressing any keys other than the [VIEW] and [RESET] keys.
- Select 1 (=Record) to display the "Record" sub-menu.
- Select 2 (=Event record) to display the "Event record" screen.

```
/2 Event record
1=Disply      2=Clear
```

- Select 1 (=Display) to display the events with date and time from the top in new-to-old sequence.

```
/3 Event record                                  3/21
23/Oct/1997 18:18:58.255  DS On
23/Oct/1997 18:13:58.028  DS Off
16/Aug/1997  6:13:57.773  Com.1 fail Off
```

The lines which are not displayed in the window can be displayed by pressing the ▲and ▼ keys.

To clear all the event records, do the following:

- Open the "Record" sub-menu.
- Select 2 (=Event record) to display the "Event record" screen.
- Select 2 (=Clear) to display the following confirmation screen.

www.ElectricalPartManuals.com

```
/2 Event record
Clear all event records?
        ENTER=Yes     CANCEL=No
```

- Press the [ENTER] (=Yes) key to clear all the event records stored in non-volatile memory.

#### 4.2.3.3 Displaying Disturbance Records

Details of disturbance records can be displayed on the PC screen only (*); the LCD displays only the recorded date and time for all disturbances stored in the relay. To display them, do the following:

(*) For the display on the PC screen, refer to RSM100 manual.

- Open the top "MENU" screen by pressing any keys other than the [VIEW] and [RESET] keys.
- Select 1 (=Record) to display the "Record" sub-menu.
- Select 3 (=Disturbance record) to display the "Disturbance record" screen.

```
/2 Disturbance record
1=Disply        2=Clear
```

- Select 1 (=Display) to display the date and time of the disturbance records from the top in new-to-old sequence.

```
/3 Disturbance record                    3/12
#1   16/Oct/1997 18:13:57.031
#2   20/Sep/1997 15:29:22.463
#3   04/Jul/1997 11:54:53.977
```

The lines which are not displayed in the window can be displayed by pressing the ▲ and ▼ keys.

To clear all the disturbance records, do the following:

- Open the "Record" sub-menu.
- Select 3 (=Disturbance record) to display the "Disturbance record" screen.
- Select 2 (=Clear) to display the following confirmation screen.

```
/2 Disturbance record
Clear all disturbance records?
        ENTER=Yes     CANCEL=No
```

- Press the [ENTER] (=Yes) key to clear all the disturbance records stored in non-volatile memory.

#### 4.2.3.4 Displaying Autoreclose Counts

The autoreclose output counts can be displayed or can be reset to zero as follows.

To display the autoreclose output counts on the LCD, do the following:

www.ElectricalPartManuals.com

- Select 1 (=Record) on the top "MENU" screen to display the "Record" sub-menu.
- Select 4 (=Autoreclose count) to display the "Autoreclose count" screen.

```
/2 Autoreclose count
1=Disply        2=Reset
```

- Select 1 (=Display) to display the autoreclose counts.

```
/3 Autoreclose count
             SPAR        TPAR        MPAR
   CB1      [  46]      [  22]      [  12]
   CB2      [  46]      [  22]      [  12]
```

In the case of two breaker autoreclose, CB1 and CB2 mean busbar breaker and center breaker, respectively. SPAR, TPAR and MPAR mean single-phase, three-phase and multi-phase autoreclose, respectively.

To reset the autoreclose output count, do the following:

- Select 2 (=Reset) on the "Autoreclose count" screen to display the "Reset autoreclose count" screen.

```
/3 Reset autoreclose count
1=CB1
2=CB2
```

- Select 1 (=CB1) or 2 (=CB2) to display the confirmation screen.

```
/3 Reset autoreclose count
Reset counts?
        ENTER=Yes     CANCEL=No
```

- Press the [ENTER] key to reset the count to zero and return to the previous screen.

### 4.2.4 Displaying the Status

From the sub-menu of "Status", the following statuses can be displayed on the LCD:

Metering data of the protected line

Status of binary inputs and outputs

Status of measuring elements output

Status of time synchronization source

Status of remote terminal

The data are updated every second.

This sub-menu is also used to adjust the time of the internal clock.

#### 4.2.4.1 Displaying Metering Data

To display metering data on the LCD, do the following:

- Select 2 (=Status) on the top "MENU" screen to display the "Status" screen.

www.ElectricalPartManuals.com

```
/1 Status
1=Metering              2=Binary I/O
3=Relay element         4=Time sync source
5=Clock    6=Term. cond    7=Direction
```

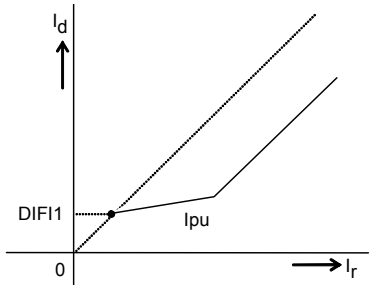
- Select 1 (=Metering) to display the "Metering" screen.

```
/2 Metering     16/Oct/1997   18:13     3/ 31
Va     ***.*kV  ***.*°    Ia     **.***kA  ***.*°
Vb     ***.*kV  ***.*°    Ib     **.***kA  ***.*°
Vc     ***.*kV  ***.*°    Ic     **.***kA  ***.*°
Vab    ***.*kV  ***.*°    Iab    **.***kA  ***.*°
Vbc    ***.*kV  ***.*°    Ibc    **.***kA  ***.*°
Vca    ***.*kV  ***.*°    Ica    **.***kA  ***.*°
Vs1    ***.*kV  ***.*°
Vs2    ***.*kV  ***.*°
V1     ***.*kV    0.0°    I1     **.***kA  ***.*°
V2     ***.*kV  ***.*°    I2     **.***kA  ***.*°
V0     ***.*kV  ***.*°    I0     **.***kA  ***.*°
                          I0m    **.***kA  ***.*°
V11    ***.*kV  ***.*°
V12    ***.*kV  ***.*°
Ia1    **.***kA ***.*°    Ia2    **.***kA  ***.*°
Ib1    **.***kA ***.*°    Ib2    **.***kA  ***.*°
Ic1    **.***kA ***.*°    Ic2    **.***kA  ***.*°
I01    **.***kA ***.*°    I02    **.***kA  ***.*°
Ida    **.***kA Ipua **.***kA Ira **.***kA
Idb    **.***kA Ipub **.***kA Irb **.***kA
Idc    **.***kA Ipuc **.***kA Irc **.***kA
Id0    **.***kA
THM    ***.*%
I2/I1  **.**
Synch.:MODE2A      GPS:OK(L)  NG(R)
Dif.RY:blocked     θdiff:+***.*° (under θ)
Telecomm delay time1        *****us
Telecomm delay time2        *****us
Active power     +****.**MW
Reactive power   -****.**Mvar
Frequency           **.*Hz
```

Note: I∗1 and I∗2 are phase currents of remote terminal 1 and remote terminal 2. V11 and V12 are symmetrical component voltages of remote terminal 1 and remote terminal 2.
In the case of two terminal line application, I∗2 and V12 are not displayed.

Id∗, Ir∗ and Ipu∗ are differential current, restraining current and pickup current respectively.
Ipu∗ = DIFI1 when Id∗ = Ir∗.
When input electrical quantities at the local terminal are "0", electrical quantities at the remote terminal are displayed as "–".

Lines 6 and 7 from bottom are displayed in COMMODE=GPS setting only.




Metering data is expressed as primary values or secondary values depending on the setting. For details of the setting, see Section 4.2.6.6.

www.ElectricalPartManuals.com

#### 4.2.4.2 Displaying the Status of Binary Inputs and Outputs

To display the binary input and output status, do the following:

- Select 2 (=Status) on the top "MENU" screen to display the "Status" screen.
- Select 2 (=Binary I/O) to display the binary input and output status.

```
/2 Binary input & output                    3/ 8
Input (IO#1)          [000 000 000 000 000]
Input (IO#2)          [000                ]
Input (IO#3)          [000 000 000 0      ]
Input (IO#4)          [000                ]
Output(IO#1-trip)     [000 000            ]
Output(IO#2)          [000 000 000 000 00 ]
Output(IO#3)          [000 000 000 0      ]
Output(IO#4)          [000 000 000 000 00 ]
```

The display format of IO and FD modules is shown below.

| | [■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Input (IO#1) | BI1 | BI2 | BI3 | BI4 | BI5 | BI6 | BI7 | BI8 | BI9 | BI10 | BI11 | BI12 | BI13 | BI14 | BI15 |
| Input (IO#2) | BI16 | BI17 | BI18 | — | — | — | — | — | — | — | — | — | — | — | — |
| Input (IO#3:IO5) | BI19 | BI20 | BI21 | BI22 | BI23 | BI24 | BI25 | BI26 | BI27 | BI28 | — | — | — | — | — |
| Input (IO#3:IO6) | BI19 | BI20 | BI21 | BI22 | BI23 | BI24 | BI25 | — | — | — | — | — | — | — | — |
| Input (IO#4:IO4) | BI34 | BI35 | BI36 | — | — | — | — | — | — | — | — | — | — | — | — |
| Output (IO#1-trip) | TPA1 | TPB1 | TPC1 | TPA2 | TPB2 | TPC2 | — | — | — | — | — | — | — | — | — |
| Output (IO#2) | BO1 | BO2 | BO3 | BO4 | BO5 | BO6 | BO7 | BO8 | BO9 | BO10 | BO11 | BO12 | FAIL | BO13 | — |
| Output (IO#3:IO3) | BO1 | BO2 | BO3 | BO4 | BO5 | BO6 | BO7 | BO8 | BO9 | BO10 | — | — | — | — | — |
| Output (IO#3:IO5) | BO1 | BO2 | BO3 | BO4 | BO5 | BO6 | BO7 | BO8 | BO9 | BO10 | — | — | — | — | — |
| Output (IO#3:IO6) | BO1 | BO2 | BO3 | BO4 | BO5 | BO6 | — | — | — | — | — | — | — | — | — |
| Output (IO#4:IO4) | BO1 | BO2 | BO3 | BO4 | BO5 | BO6 | BO7 | BO8 | BO9 | BO10 | BO11 | BO12 | BO13 | BO14 | — |

Lines 1 and 2 show the binary input status. BI1 to BI18 correspond to each binary input signal. For details of the binary input signals, see Appendix G. The status is expressed with logical level "1" or "0" at the photo-coupler output circuit. The module names of IO#1 to IO#4 in the table depend on the model. (Refer to Appendix G.)

Lines 5 to 12 show the binary output status. TPA1 to TPC2 of line 5 correspond to the tripping command outputs. Other outputs expressed with BO1 to BO14 are configurable. The status of these outputs is expressed with logical level "1" or "0" at the input circuit of the output relay driver. That is, the output relay is energized when the status is "1".

To display all the lines, press the ▲ and ▼ keys.

#### 4.2.4.3 Displaying the Status of Measuring Elements

To display the status of measuring elements on the LCD, do the following:

- Select 2 (=Status) on the top "MENU" screen to display the "Status" screen.
- Select 3 (=Relay element) to display the status of the relay elements.

www.ElectricalPartManuals.com

```
/2 Relay element                                    3/19
DIF, DIFG                [000 0                          ]
OST                      [000 000                        ]
CBF                      [000                            ]
OC, EF                   [000 000 000 00                 ]
THM                      [00                             ]
BCD                      [0                              ]
ZG                       [000 000 000 000 000            ]
ZS                       [000 000 000 000 000            ]
BL                       [000 000 000 000                ]
PSB                      [000 000 000 000                ]
OC, DEF                  [000 00                         ]
OV1                      [000 000                        ]
OV2                      [000 000                        ]
UV1                      [000 000 000 000                ]
UV2                      [000 000 000                    ]
UV3                      [000 000 000                    ]
CTF                      [000 000 0                      ]
VTF                      [000 000 0                      ]
Autoreclose              [000 000 000                    ]
```

The display format is as shown below.

| | [■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DIF, DIFG | A | B | C | DIFG | — | — | — | — | — | — | — | — | — | — | — |
| | DIF | | | | | | | | | | | | | | |
| OST | α | β | OST | α | β | OST | — | — | — | — | — | — | — | — | — |
| | OST1 | | | OST2 | | | | | | | | | | | |
| CBF | A | B | C | — | — | — | — | — | — | — | — | — | — | — | — |
| OC, EF | A | B | C | A | B | C | EF | EFI | A | B | C | — | — | — | — |
| | OC | | | OCI | | | | | OC1 | | | | | | |
| THM | THM-A | THM-T | — | — | — | — | — | — | — | — | — | — | — | — | — |
| BCD | BCD | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| ZG | A | B | C | A | B | C | A | B | C | A | B | C | A | B | C |
| | Z1G | | | Z2G | | | Z3G | | | Z4G | | | ZRG | | |
| ZS | AB | BC | CA | AB | BC | CA | AB | BC | CA | AB | BC | CA | AB | BC | CA |
| | Z1S | | | Z2S | | | Z3S | | | Z4S | | | ZRS | | |
| BL | AB | BC | CA | AB | BC | CA | A | B | C | A | B | C | — | — | — |
| | BFS | | | BRS | | | BFG | | | BRG | | | | | |
| PSB | AB | BC | CA | AB | BC | CA | A | B | C | A | B | C | — | — | — |
| | PSBSOUT | | | PSBSIN | | | PSBGOUT | | | PSBGIN | | | | | |
| OC, DEF | A | B | C | DEFF | DEFR | — | — | — | — | — | — | — | — | — | — |
| | OCH | | | | | | | | | | | | | | |
| OV1 | AB | BC | CA | AB | BC | CA | — | — | — | — | — | — | — | — | — |
| | OVS1 | | | OVS2 | | | | | | | | | | | |
| OV2 | A | B | C | A | B | C | — | — | — | — | — | — | — | — | — |
| | OVG1 | | | OVG2 | | | | | | | | | | | |
| UV1 | A | B | C | AB | BC | CA | A | B | C | A | B | C | — | — | — |
| | UVC | | | UVLS | | | UVLG | | | UVPWI | | | | | |

www.ElectricalPartManuals.com

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UV2 | AB | BC | CA | AB | BC | CA | AB | BC | CA | — | — | — | — | — | — |
| | UVS1 | | | UVS2 | | | UVSBLK | | | | | | | | |
| UV3 | A | B | C | A | B | C | A | B | C | — | — | — | — | — | — |
| | UVG1 | | | UVG2 | | | UVGBLK | | | | | | | | |
| CTF | A | B | C | A | B | C | CTF OVG | — | — | — | — | — | — | — | — |
| | CTFID | | | CTFUV | | | | | | | | | | | |
| VTF | AB | BC | CA | A | B | C | OVG | — | — | — | — | — | — | — | — |
| | UVFS | | | UVFG | | | | | | | | | | | |
| Autoreclose | OVB | UVB | SYN1 | OVL1 | UVL1 | SYN2 | OVL2 | UVL2 | OVL1 (3PH) | — | — | — | — | — | — |

Line 1 shows the operation status of current differential elements for phase faults and earth faults, respectively.

Line 2 shows the status of the out-of-step protection. α and β is "1" when the remote terminal voltage is at α-zone and β-zone respectively. OST shows the operation status of out-of-step element. OST1 and OST2 correspond to the out-of-step detection with remote terminal 1 and 2 respectively.

Line 3 shows the status of the overcurrent element for breaker failure protection.

Line 4 shows the status of the overcurrent elements and fail-safe elements.

Line 5 shows the status of the thermal overload element.

Line 6 shows the status of the broken conductor detection element.

Lines 7 and 8 show the status of the distance measuring element for phase and earth faults.

Lines 9 and 10 show the status of the blinder element and power swing blocking element.

Line 11 shows the status of the overcurrent element and directional earth fault element.

Lines 12 to 16 show the status of the overvoltage elements and undervoltage elements.

Lines 17 and 18 show the status of elements used for CTF and VTF detection.

Line 19 shows the status of elements used for autoreclose.

The status of each element is expressed with logical level "1" or "0". Status "1" means the element is in operation.

To display all the lines on the LCD, press the ▲ and ▼ keys.

#### 4.2.4.4 Displaying the Status of the Time Synchronization Source

The internal clock of the GRL100 can be synchronized with external clocks such as the IRIG-B time standard signal clock or RSM (relay setting and monitoring system) clock or by an IEC60870-5-103 control system or GPS. To display on the LCD whether these clocks are active or inactive and which clock the relay is synchronized with, do the following:

- Select 2 (=Status) on the top "MENU" screen to display the "Status" screen.
- Select 4 (=Time sync source) to display the status of time synchronization sources.

```
/2 Time synchronization source          3/ 4
*IRIG:   Active
 RSM:    Inactive
 IEC:    Inactive
 GPS:    Inactive
```

www.ElectricalPartManuals.com

The asterisk on the far left shows that the inner clock is synchronized with the marked source clock. If the marked source clock is inactive, the inner clock runs locally.

For the setting time synchronization, see Section 4.2.6.6.

#### 4.2.4.5 Adjusting the Time

To adjust the clock when the internal clock is running locally, do the following:

- Select 2 (=Status) on the top "MENU" screen to display the "Status" screen.
- Select 5 (=Clock) to display the setting screen.

```
/2    12/Feb/1998 22:56:19 「Local」  1/ 5
Minute(     0-    59):      41 _
Hour  (     0-    23):      22
Day   (     1-    31):      12
Month (     1-    12):       2
Year  ( 1990- 2089):    1998
```

Line 1 shows the current date, time and time synchronization source with which the internal clock is synchronized. The time can be adjusted only when [Local] is indicated on the top line, showing that the clock is running locally. When [IRIG] or [RSM] or [IEC] or [GPS] is indicated, the following adjustment is invalid.

- Enter a numerical value within the specified range for each item and press the (ENTER) key.
- Press the (END) key to adjust the internal clock to the set hours without fractions and return to the previous screen.

If a date which does not exist in the calendar is set and (END) key is pressed, "Error: Incorrect date" is displayed on the top line and the adjustment is discarded. Adjust again.

#### 4.2.4.6 Displaying the Terminal Condition

Terminal condition is displayed when the scheme switch [OTD] is "ON" and the out-of-service logic is used.

To display the terminal condition on the LCD, do the following:

- Select 2 (= Status) on the top "MENU" screen to display the "Status" screen.
- Select 6 (= Terminal condition) to display the status of the terminal conditions.

```
/2 Terminal condition                    2/ 2
Terminal1: In service
Terminal2: Out of service
```

Note: “Out of service” is displayed when the switch [OTD] ="ON" setting.

Bottom line (Terminal 2:) is displayed only for three-terminal line application ("3TERM" setting).

#### 4.2.4.7 Displaying the Direction of Load Current

To display the direction of load current on the LCD, do the following:

- Select 2 (=Status) on the top "MENU" screen to display the "Status" screen.
- Select 6 (=Direction) to display the status of the relay elements.

www.ElectricalPartManuals.com

```
/2 Direction
Phase A: Forward
Phase B: Forward
Phase C: __________
```

Note: If the load current is less than 0.04xIn, the direction is expressed as "----".
The BFL element is used to detect the direction of load current and shared with blinder. (See Figure 2.3.1.12.)

### 4.2.5 Viewing the Settings

The sub-menu "Setting (view)" is used to view the relay version or the settings made using the sub-menu "Setting (change)".

The following items are displayed:

Relay version
Description
Communication (Relay address and baud rate in the RSM or IEC60870-5-103)
Recording setting
Status setting
Protection setting
Binary input setting
Binary output setting
LED setting

Enter a number on the LCD to display each item as described in the previous sections.

#### 4.2.5.1 Relay version

To view the relay version, do the following.

- Press 3 (=Setting (view)) on the main "MENU" screen to display the "Setting (view)" screen.

```
/1 Setting(view)
1=Version    2=Description    3=Comm.
4=Record     5=Status         6=Protection
7=Binary input   8=Binary output   9=LED
```

- Press 1 (=Version) on the "Setting (view)" screen to display the "Relay version" screen.

```
/2 Relay version                    3/ 6
Relay type:
Serial No.:
Main software:
COM software:
PLC data:
IEC103 data :
```

#### 4.2.5.2 Settings

The "Description", " Comm.", "Record", "Status", "Protection", "Binary input", "Binary output" and "LED" screens display the current settings input using the "Setting (change)" sub-menu.

www.ElectricalPartManuals.com

### 4.2.6 Changing the Settings

The "Setting (change)" sub-menu is used to make or change settings for the following items:

Password
Description
Communication
Recording
Status
Protection
Binary input
Binary output
LED

All of the above settings except the password can be seen using the "Setting (view)" sub-menu.

#### 4.2.6.1 Setting Method

There are three setting methods as follows:

- To enter a selected number
- To enter numerical values
- To enter a text string

**To enter a selected number**

If a screen as shown below is displayed, perform the setting as follows.

The number to the left of the cursor shows the current setting or default setting set at shipment. The cursor can be moved to upper or lower lines within the screen by pressing the ▲ and ▼ keys. If setting (change) is not required, skip the line with the ▲ and ▼ keys.

```
/6 Scheme switch                                    1/14
ARC-CB   1=ONE 2=01  3=02  4=L1  5=L2               1  _
ARC-EXT  0=Off   1=On                               1
ARC-BU   0=Off   1=On                               1
ARCDLFG  0=Off   1=On                               0
ARCDEFC  0=Off   1=On                               1
VCHK     0=Off  1=LB1  2=LB2  3=DB  4=SY            1
ARC-SM   0=Off   1=S2   2=S3   3=S4                 1
ARC-CCB  0=Off   1=TPAR   2=MPAR                    1
MA-NOLK  0=FT   1=T   2=S+T                         0
ARC-SUC  0=Off   1=On                               0
VTPHSEL  1=A      2=B      3=C                      1
VT-RATE  1=PH/G    2=PH/PH                          1
3PH-VT   1=BUS      2=Line                          1
UARCSW   1=P1   2=P2   3=PB                         1
```

- Move the cursor to a setting line.
- Enter the selected number. (Numbers other than those displayed cannot be entered.)
- Press the [ENTER] key to confirm the entry and the cursor will move to the next line below. (On the lowest line, the entered number blinks.)
- After completing the setting on the screen, press the [END] key to return to the upper menu.

www.ElectricalPartManuals.com

To correct the entered number, do the followings.

- If it is before pressing the [ENTER] key, press the [CANCEL] key and enter the new number.
- If it is after pressing the [ENTER] key, move the cursor to the correcting line by pressing the ▲ and ▼ keys and enter the new number.

**Note:** If the [CANCEL] key is pressed after any of the entry is confirmed by pressing the [ENTER] key, all the entries performed so far on the screen concerned are canceled and screen returns to the upper one.

When the screen shown below is displayed, perform the setting as follows.

The number to the right of "Current No. = " shows the current setting.

```
/6 Autoreclose mode
1=Disable  2=SPAR   3=TPAR   4=SPAR&TPAR
5=MPAR2  6=MPAR3  7=EXT1P  8=EXT3P  9=EXTMP
  Current No.= 4          Select No. = _
```

- Enter a number to the right of "Select No. = ". (Numbers other than those displayed cannot be entered.)
- Press the [ENTER] key to confirm the entry and the entered number blinks.
- After completing the setting on the screen, press the [END] key to return to the upper screen.

To correct the entered number, do the following.

- If it is before pressing the [ENTER] key, press the [CANCEL] key and enter the new number.
- If it is after pressing the [ENTER] key, enter the new number.

**To enter numerical values**

When the screen shown below is displayed, perform the setting as follows:

The number to the left of the cursor shows the current setting or default setting set at shipment. The cursor can be moved to upper or lower lines within the screen by pressing the ▲ and ▼ keys. If setting (change) is not required, skip the line with the ▲ and ▼ keys.

www . ElectricalPartManuals . com

```
/6 Protection element                          1/ **
DIFI1(   0.50-  10.00):     1.00 _              A
DIFI2(    3.0-  120.0):      2.0                A
DIFGI(   0.25-   5.00):     0.50               A
DIFIC(   0.00-   5.00):     1.00               A
Vn   (    100-    120):      110               V
TDIFG(   0.00-  10.00):     0.10               s
DIFSV(   0.05-   1.00):     0.10               A
TIDSV(      0-     60):       10               s
OCBF (    0.5-   10.0):      0.5               A
TBF1 (     50-    500):       50              ms
TBF2 (     50-    500):       50              ms
OC   (    0.5-  100.0):      0.5               A
TOC  (   0.00-  10.00):     1.00               s
OC1  (    0.5-  100.0):      1.0               A
OCI  (    0.5-   25.0):      0.5               A
TOCI (   0.05-   1.00):     1.00
TOCIR(    0.0-   10.0):      0.0               s
EF   (    0.5-    5.0):      0.5               A
TEF  (   0.00-  10.00):     1.00               s
EFI  (    0.5-    5.0):      0.5               A
TEFI (   0.05-   1.00):     1.00
TEFIR(    0.0-   10.0):      0.0               s
THM  (    2.0-   10.0):      5.0               A
THMIP(    0.0-    5.0):      0.0               A
TTHM (    0.5-  300.0):     10.0              min
THMA (     50-     99):       80               %
OCCHK(    0.5-    5.0):      0.5               A
HYSθ (      1-      5):        1              deg
   :          :          :
   :          :          :
TECCB(   0.00-200.00):     0.10               s
TSBCT(   0.00-   1.00):     0.10               s
```

- Move the cursor to a setting line.
- Enter the numerical value.
- Press the [ENTER] key to confirm the entry and the cursor will move to the next line below. (If a numerical value outside the displayed range is entered, "Error: Out of range" appears on the top line and the cursor remains on the line. Press the [CANCEL] key to clear the entry.)
- After completing the setting on the screen, press the [END] key to return to the upper screen.

To correct the entered numerical value, do the followings.

- If it is before pressing the [ENTER] key, press the [CANCEL] key and enter the new numerical value.
- If it is after pressing the [ENTER] key, move the cursor to the correct line by pressing the ▲ and ▼ keys and enter the new numerical value.

**Note:** If the [CANCEL] key is pressed after any of the entry is confirmed by pressing the [ENTER] key, all the entries made so far on the screen concerned are canceled and the screen returns to the upper one.

### To enter a text string

Text strings are entered in the bracket under "Plant name" or "Description" screen.

To select a character, use keys 2, 4, 6 and 8 to move the blinking cursor down, left, up and right. "→" and "←" on each of lines 2 to 4 indicate a space and backspace, respectively. A maximum of 22 characters can be entered within the brackets.

www.ElectricalPartManuals.com

- Set the cursor position in the bracket by selecting "→" or "←" and pressing the ENTER key.
- Move the blinking cursor to select a character.
- Press the ENTER to enter the blinking character at the cursor position in the brackets.
- Press the END key to confirm the entry and return to the upper screen.

To correct the entered character, do either of the following.

- Discard the character by selecting "←" and pressing the ENTER key and enter the new character.
- Discard the whole entry by pressing the CANCEL key and restart the entry from the first.

**To complete the setting**

Enter after making entries on each setting screen by pressing the ENTER key, the new settings are not yet used for operation, though stored in the memory. To validate the new settings, take the following steps.

- Press the END key to return to the upper screen. Repeat this until the confirmation screen shown below is displayed. The confirmation screen is displayed just before returning to the "Setting (change)" sub-menu.

- When the screen is displayed, press the ENTER key to start operation using the new settings, or press the CANCEL key to correct or cancel entries. In the latter case, the screen turns back to the setting screen to enable reentries. Press the CANCEL key to cancel entries made so far and to turn to the "Setting (change)" sub-menu.

#### 4.2.6.2 Password

For the sake of security of changing the settings, password protection can be set as follows:

- Press 4 (=Setting (change)) on the main "MENU" screen to display the "Setting (change)" screen.
- Press 1 (=Password) to display the "Password" screen.

- Enter a 4-digit number within the brackets after "Input new password" and press the ENTER key.

www.ElectricalPartManuals.com

- For confirmation, enter the same 4-digit number in the brackets after "Retype new password" and press the [ENTER] key.
- Press the [END] key to display the confirmation screen. If the retyped number is different from that first entered, the following message is displayed on the bottom of the "Password" screen before returning to the upper screen.

  "Mismatch-password unchanged"

Reentry is then requested.

#### Password trap

After the password has been set, the password must be entered in order to enter the setting change screens.

If 4 (=Setting (change)) is entered on the top "MENU" screen, the password trap screen "Password" is displayed. If the password is not entered correctly, it is not possible to move to the "Setting (change)" sub-menu screens.

```
Password
          Input password [_    ]
```

#### Canceling or changing the password

To cancel the password protection, enter "0000" in the two brackets on the "Password" screen. The "Setting (change)" screen is then displayed without having to enter a password.

The password can be changed by entering a new 4-digit number on the "Password" screen in the same way as the first password setting.

#### If you forget the password

Press [CANCEL] and [RESET] together for one second on the top "MENU" screen. The screen disappears, and the password protection of the GRL100 is canceled. Set the password again.

### 4.2.6.3 Description

To enter the plant name and other data, do the following. These data are attached to records.

- Press 4 (=Setting (change)) on the main "MENU" screen to display the "Setting (change)" screen.
- Press 2 (=Description) to display the "Description" screen.

```
/2 Description
1=Plant name      2=Description
```

- To enter the plant name, select 1 (=Plant name) on the "Description" screen.

```
/3 Plant name  [  _                              ]
ABCDEFGHIJKLMNOPQRSTUVWXYZ ()[]@_      ←→
abcdefghijklmnopqrstuvwxyz {}*/+-<=>   ←→
0123456789 !"#$%&':;,.^`              ←→
```

To enter special items, select 2 (=Description) on the "Description" screen.



www.ElectricalPartManuals.com

```
/3 Description [  _                                    ]
ABCDEFGHIJKLMNOPQRSTUVWXYZ ()「」@          ←→
abcdefghijklmnopqrstuvwxyz {}*/+-<=>       ←→
0123456789 !"#$%&' :;.. ^`                 ←→
```

- Enter the text string.

The plant name and special items entered are viewed with the "Setting (view)" sub-menu and attached to disturbance records when they are displayed on a local or a remote PC.

#### 4.2.6.4 Communication

If the relay is linked with RSM (relay setting and monitoring system), IEC60870-5-103 or Ethernet LAN, the relay address must be set. Do this as follows:

- Press 4 (=Setting (change)) on the main "MENU" screen to display the "Setting (change)" screen.
- Press 3 (=Comm.) to display the "Communication" screen.

```
/2 Communication
1=Address/Parameter
2=Switch
```

- Press 1 (=Address/Parameter) to enter the relay address number.

```
/3 Address/Parameter                          1/ 15
HDLC  (      1-     32):        1 _
IEC   (      0-    254):        2
SYADJ ( -9999-   9999):        0        ms
IP1-1 (      0-    254):        0
IP1-2 (      0-    254):        0
IP1-3 (      0-    254):        0
IP1-4 (      0-    254):        0
SM1-1 (      0-    254):        0
SM1-2 (      0-    254):        0
SM1-3 (      0-    254):        0
SM1-4 (      0-    254):        0
GW1-1 (      0-    254):        0
GW1-2 (      0-    254):        0
GW1-3 (      0-    254):        0
GW1-4 (      0-    254):        0
```

- Enter the address number on "HDLC" column for RSM and/or "IEC" column for IEC60870-5-103 and the compensation value on "SYADJ" column for adjustment of time synchronization of protocol used. (–: lags the time, +: leads the time) And enter IP address for IP1-1 to IP1-4, Subnet mask for SM1-1 to SM4, and Default gateway for GW1-1 to GW1-4.

  IP address: $\underbrace{***}_{\text{IP1-1}}, \underbrace{***}_{\text{IP1-2}}, \underbrace{***}_{\text{IP1-3}}, \underbrace{***}_{\text{IP1-4}}$

  Subnet mask SM1-1 to SM4 and Default gateway GW1-1 to GW1-4: same as above.

- Press the [ENTER] key.

**CAUTION:** Do not overlap the number in a network.

www.ElectricalPartManuals.com

- Press 2 (=Switch) on the "Communication" screen to select the protocol and the RS232C transmission speed (baud rate), etc., of the RSM or IEC60870-5-103.

```
/3 Switch                                          1/4
PRTCL1    1=HDLC   2=IEC103                        2 _
232C      1=9.6  2=19.2  3=38.4  4=57.6             4
IECBR     1=9.6  2=19.2                            2
IECBLK    1=Normal  2=Blocked                      1
```

- Select the number corresponding to the system and press the [ENTER] key.

**<PRTCL1>**

PRTCL1 is used to select the protocol for channel 1 (COM1 or OP1) of the serial communication port RS485 or FO (fibre optic).

- When the remote RSM system applied, select 1 (=HDLC). When the IEC60870-5-103 applied, select 2 (=IEC103).

**<232C>**

This line is to select the RS232C baud rate when the RSM system applied.

**Note:** The default setting of the 232C is 9.6kbps. The 57.6kbps setting, if possible, is recommended to serve user for comfortable operation. The setting of RSM100 is also set to the same baud rate.

**<IECBR>**

This line is to select the baud rate when the IEC60870-5-103 system applied.

**<IECBLK>**

Select 2 (=Blocked) to block the monitor direction in the IEC60870-5-103 communication.

#### 4.2.6.5 Setting the Recording

To set the recording function as described in Section 4.2.3, do the following:

- Press 4 (=Setting (change)) on the main "MENU" screen to display the "Setting (change)" screen.
- Press 4 (=Record) to display the "Record" screen.

```
/2 Record
1=Fault record          2=Event record
3=Disturbance record
```

**Setting the fault recording**

- Press 1 (=Fault record) to display the "Fault record" screen.

```
/3 Fault record                                    1/ 1
Fault locator       0=Off      1=On                1 _
```

- Enter 1 (=On) to record the fault location.

  Enter 0 (=Off) not to record the fault location.

- Press the [ENTER] key.

www.ElectricalPartManuals.com

**Setting the event recording**

- Press 2 (=Event record) to display the "Event record" screen.

```
/3 Event record                                  1/129
BITRN (      0-    128):       128 _
EV1   (      0-   3071):         0
EV2   (      0-   3071):         1
EV3   (      0-   3071):         1
EV4   (      0-   3071):         1
                  :
EV128 (      0-   3071):      3071
```

**<BITRN>**

- Enter the number of event to record the status change both to "On" and "Off". If enter 20, both status change is recorded for EV1 to EV20 events and only the status change to "On" is recorded for EV21 to EV128 events.

**<EV*>**

- Enter the signal number to record as the event in Appendix B. It is recommended that this setting can be performed by RSM100 because the signal name cannot be entered by LCD screen. (Refer to Section 3.4.2.)

**Setting the disturbance recording**

- Press 3 (=Disturbance record) to display the "Disturbance record" screen.

```
/3 Disturbance record
1=Recor time & starter
2=Scheme switch
3=Binary signal
```

- Press 1 (=Record time & starter) to display the "Record time & starter" screen.

```
/4 Record time & starter                         1/5
Time (    0.1-    3.0):    2.0 _                 A
OCP-S(    0.5-  250.0):   10.0                   A
OCP-G(    0.5-  250.0):   10.0                   A
UVP-S(      0-    132):    100                   V
UVP-G(      0-     76):     57                   V
```

- Enter the recording time and starter element settings.

To set each starter to use or not to use, do the following:

- Press 2 (=Scheme switch) on the "Disturbance record" screen to display the "Scheme switch" screen.

```
/4 Scheme switch                                 1/ 5
TRIP     0=Off   1=On                           1 -
OCP-S    0=Off   1=On                           1
OCP-G    0=Off   1=On                           1
UVP-S    0=Off   1=On                           1
UVP-G    0=Off   1=On                           1
```

- Enter 1 to use as a starter.

www.ElectricalPartManuals.com

- Press 3 (=Binary signal) on the "Disturbance record" screen to display the "Binary signal" screen.

```
/4 Binary signal                                    1/32
SIG1 (       0-   3071):       1 _
SIG2 (       0-   3071):       2
SIG3 (       0-   3071):       3
SIG4 (       0-   3071):       4
  :            :                :
SIG32(       0-   3071):       0
```

- Enter the signal number to record binary signals in Appendix B. It is recommended that this setting can be performed by RSM100 because the signal name cannot be entered by LCD screen. (Refer to Section 3.4.3.)

#### 4.2.6.6 Status

To set the status display described in Section 4.2.4, do the following:

- Press 5 (=Status) on the "Setting (change)" sub-menu to display the "Status" screen.

```
/2 Status
1=Metering
2=Time synchronization
3=Time zone
```

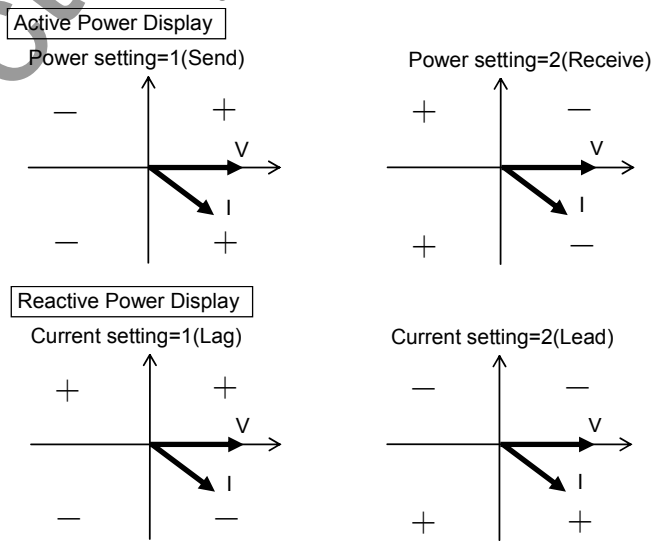
**Setting the metering**

- Press 1 (=Metering) to display the "Metering" screen.

```
/3 Metering                                          3/3
Display value  1=Primary   2=Secondary   1
Power (P/Q)    1=Send      2=Receive     1
Current        1=Lag       2=Lead        1 _
```

- Enter the selected number and press the [ENTER] key. Repeat this for all items.

**Note:** Power and Current setting




www.ElectricalPartManuals.com

**Setting the time synchronization**

The calendar clock can run locally or be synchronized with external IRIG-B time standard signal, RSM clock, IEC60870-5-103 or GPS. This is selected by setting as follows:

- Press 2 (=Time synchronization) to display the "Time synchronization" screen.

```
/3 Time synchronization                    1/1
Sync 0=Off 1=IRIG 2=RSM 3=IEC 4=GPS   1
```

- Enter the selected number and press the [ENTER] key.

**Note:** When to select IRIG-B, RSM, IEC or GPS, check that they are active on the "Time synchronization source" screen in "Status" sub-menu. If it is set to an inactive IRIG-B, RSM, IEC or GPS, the calendar clock runs locally.

**Setting the time zone**

When the calendar clock is synchronized with the IRIG-B time standard signal or GPS signal, it is possible to transfer GMT to the local time.

- Press 3 (=Time zone) to display the "Time zone" screen.

```
/3 Time zone                                1/1
GMT   (   -12-   +12):    +9 _      hrs
```

- Enter the difference between GMT and local time and press the [ENTER] key.

#### 4.2.6.7 Protection

The GRL100 can have 8 setting groups for protection according to the change of power system operation, one of which is assigned to be active. To set protection, do the following:

- Press 6 (=Protection) on the "Setting (change)" screen to display the "Protection" screen.

```
/2 Protection
1=Change active group
2=Change setting
3=Copy group
```

**Changing the active group**

- Press 1 (=Change active group) to display the "Change active group" screen.

```
/3 Change active group(Active group= *)
1=Group1  2=Group2  3=Group3  4=Group4
5=Group5  6=Group6  7=Group7  8=Group8
  Current No.= *          Select No. = _
```

- Enter the selected number and press the [ENTER] key.

**Changing the settings**

Almost all the setting items have default values that are set when the GRL100 was shipped. For the default values, see Appendix D and H. To change the settings, do the following:

www.ElectricalPartManuals.com

- Press 2 (=Change setting) to display the "Change setting" screen.

```
/3 Change setting          (Active group= *)
1=Group1   2=Group2   3=Group3   4=Group4
5=Group5   6=Group6   7=Group7   8=Group8
```

- Press the group number to change the settings and display the "Protection" screen.

```
/4 Protection                          (Group *)
1=Line parameter
2=Telecommunication    3=Trip
4=Autoreclose
```

**Setting the line parameters**

Enter the line name, VT&CT ratio and settings for the fault locator as follows:

- Press 1 (=Line parameter) on the "Protection" screen to display the "Line parameter" screen.

```
/5 Line parameter                      (Group *)
1=Line name
2=VT & CT ratio
3=Fault locator
```

- Press 1 (=Line name) to display the "Line name" screen.
- Enter the line name as a text string.
- Press the [END] key to return the display to the "Line parameter" screen.
- Press 2 (=VT&CT ratio) to display the "VT&CT ratio" screen.

```
/6 VT & CT ratio                                    1/4
VT     (    1-  20000):    2200   _
VTs1   (    1-  20000):    2200
VTs2   (    1-  20000):    2200
CT     (    1-  20000):     400
```

- Enter the VT ratio for protection function and press the [ENTER] key.
- Enter the VTs1 ratio and/or VTs2 ratio for autoreclose function and press the [ENTER] key. VTs1 is used for the VT ratio setting for voltage and synchronism check of autoreclose function. VTs2 is used for the VT ratio setting for the other voltage and synchronism check at the time of two-breaker autoreclose.
- Enter the CT ratio and press the [ENTER] key.
- Press the [END] key to return the display to the "Line parameter" screen.
- Press 3 (= Fault locator) to display the "Fault locator" screen.

```
/6 Fault locator                       (Group *)
1=Setting impedance mode
2=Line data
```

- Press 1 (=Setting impedance mode) to display the "Setting impedance mode" screen.

www.ElectricalPartManuals.com

```
/7 Setting impedance mode          (Group *)
1=Symmetrical impedance
2=Phase impedance
  Current No.= 1              Select No. = _
```

One of the setting modes can be selected.

- Select 1 (=Symmetrical impedance), then the following "Line data" screen is displayed.

```
/7 Line data                                          1/**
1X1   (  0.00 - 199.99) :    9.50 _     Ω
1X0   (  0.00 - 199.99) :   34.00       Ω
1X0m  (  0.00 - 199.99) :    2.00       Ω
1R1   (  0.00 - 199.99) :    3.04       Ω
1R0   (  0.00 - 199.99) :    0.70       Ω
1R0m  (  0.00 - 199.99) :   10.00       Ω
Z0B-L (  0.00 - 199.99) :   10.00       Ω
Z0B-R (  0.00 - 199.99) :   10.00       Ω
Kab   (    80 -   120) :     100       %
Kbc   (    80 -   120) :     100       %
Kca   (    80 -   120) :     100       %
Ka    (    80 -   120) :     100       %
Kb    (    80 -   120) :     100       %
Kc    (    80 -   120) :     100       %
1Line (   0.0 -  399.9) :    80.0       km
2X1   (  0.00 - 199.99) :    9.50       Ω
2R1   (  0.00 - 199.99) :    3.04       Ω
2Line (   0.0 -  399.9) :    40.0       km
3X1   (  0.00 - 199.99) :    9.50       Ω
3R1   (  0.00 - 199.99) :    3.04       Ω
3Line (   0.0 -  399.9) :    20.0       km
```

In case of two-terminal lines, enter the reactive and resistive component of the symmetrical line impedance to the items 1X1 and 1R1 and line length to 1 Line. Press the enter key for each entry.

**Note:** The line impedance is input with the secondary value.

In case of three-terminal lines, enter the data on the first section from the local terminal to the junction to the items expressed as 1**, the data on the second section from the junction to the remote terminal 1 to 2** and the data on the third section from the junction to the remote terminal 2 to 3**.

- Select 2 (=Phase impedance), then the following "Line data" screen is displayed.

In case of two-terminal lines, enter the reactive and resistive component of the self-impedances and mutual-impedances of the line to the items expressed as 1X** and 1R** and line length to 1 Line. Press the [ENTER] key for each entry.

In case of three-terminal lines, enter the data on the first section from the local terminal to the junction to 1***, the data on the second section from the junction to the remote terminal 1 to 2*** and the data on the third section from the junction to the remote terminal 2 to 3***.

- Press the [END] key after completing the settings to return the display to the "Line parameter" screen

www.ElectricalPartManuals.com

```
/7 Line data                                    1/**
1Xaa  ( 0.00 - 199.99) :  10.00_                Ω
1Xbb  ( 0.00 - 199.99) :  10.00                 Ω
1Xcc  ( 0.00 - 199.99) :  10.00                 Ω
1Xab  ( 0.00 - 199.99) :   0.50                 Ω
1Xbc  ( 0.00 - 199.99) :   0.50                 Ω
1Xca  ( 0.00 - 199.99) :   0.50                 Ω
1Raa  ( 0.00 - 199.99) :   3.20                 Ω
1Rbb  ( 0.00 - 199.99) :   3.20                 Ω
1Rcc  ( 0.00 - 199.99) :   3.20                 Ω
1Rab  ( 0.00 - 199.99) :   0.16                 Ω
1Rbc  ( 0.00 - 199.99) :   0.16                 Ω
1Rca  ( 0.00 - 199.99) :   0.16                 Ω
1X0m  ( 0.00 - 199.99) :   2.00                 Ω
1R0m  ( 0.00 - 199.99) :  10.00                 Ω
Z0B-L ( 0.00 - 199.99) :  10.00                 Ω
Z0B-R ( 0.00 - 199.99) :  10.00                 Ω
1Line (  0.0 -  399.9) :  80.0                  km
2Xaa  ( 0.00 - 199.99) :  10.00                 Ω
2Xbb  ( 0.00 - 199.99) :  10.00                 Ω
2Xcc  ( 0.00 - 199.99) :  10.00                 Ω
2Xab  ( 0.00 - 199.99) :   0.50                 Ω
2Xbc  ( 0.00 - 199.99) :   0.50                 Ω
2Xca  ( 0.00 - 199.99) :   0.50                 Ω
2Raa  ( 0.00 - 199.99) :   3.20                 Ω
2Rbb  ( 0.00 - 199.99) :   3.20                 Ω
2Rcc  ( 0.00 - 199.99) :   3.20                 Ω
2Rab  ( 0.00 - 199.99) :   0.16                 Ω
2Rbc  ( 0.00 - 199.99) :   0.16                 Ω
2Rca  ( 0.00 - 199.99) :   0.16                 Ω
2Line (  0.0 -  399.9) :  40.0                  km
3Xaa  ( 0.00 - 199.99) :  10.00                 Ω
3Xbb  ( 0.00 - 199.99) :  10.00                 Ω
3Xcc  ( 0.00 - 199.99) :  10.00                 Ω
3Xab  ( 0.00 - 199.99) :   0.50                 Ω
3Xbc  ( 0.00 - 199.99) :   0.50                 Ω
3Xca  ( 0.00 - 199.99) :   0.50                 Ω
3Raa  ( 0.00 - 199.99) :   3.20                 Ω
3Rbb  ( 0.00 - 199.99) :   3.20                 Ω
3Rcc  ( 0.00 - 199.99) :   3.20                 Ω
3Rab  ( 0.00 - 199.99) :   0.16                 Ω
3Rbc  ( 0.00 - 199.99) :   0.16                 Ω
3Rca  ( 0.00 - 199.99) :   0.16                 Ω
3Line (  0.0 -  399.9) :   20.0                 km
```

**Setting the telecommunication**

- Press 2 (=Telecommunication) on the "Protection" screen to display the "Telecommunication" screen.

```
/5 Telecommunication                    (Group *)
1=Scheme switch
2=Telecommunication element
```

- Press 1 (=Scheme switch) to display the "Scheme switch" screen. Set the communication

www.ElectricalPartManuals.com

mode "A", "B" or "GPS", and the "Master" or "Slave", and "2 terminal line (=2TERM)" or "3 terminal line (=3TERM)" or "Dual communication for 2 terminal line (=Dual)". Refer to Section 2 and 2.2.2.

However "TERM", "CH.CON", "T.SFT2" and "B.SYN2" items are not displayed in the case of 2 terminal models.

For the "CH.CON" setting, refer to Section 2.2.14.

In "B.SYN∗", set to "On" when synchronizing the sending signal of GRL100 with the external clock signal or the receiving signal from multiplexer.

For "GPSBAK", "AUTO2B" and "SRCθ", refer to Section 2.2.7.

| /6 Scheme switch | | | 1/12 |
|---|---|---|---|
| COMMODE | 1=A 2=B | 3=GPS | 2 |
| SP.SYN. | 1=Master | 2=Slave | 1 |
| TERM | 1=2TERM | 2=3TERM 3=Dual | 1 |
| CH.CON | 1=Normal | 2=Exchange | 1 |
| RYIDSV | 0=Off | 1=On | 1 |
| T.SFT1 | 0=Off | 1=On | 1 |
| T.SFT2 | 0=Off | 1=On | 1 |
| B.SYN1 | 0=Off | 1=On | 1 |
| B.SYN2 | 0=Off | 1=On | 1 |
| GPSBAK | 0=Off | 1=On | 1 |
| AUTO2B | 0=Off | 1=On | 0 |
| SRCθ | 0=Disable | 1=I | 1 |

Note: The setting of [COMMODE], [TERM], [GPSBAK], [AUTO2B], [SRC θ] and [RYIDSV] must be identical at all terminals.

- Press 2 (=Telecommunication element) to display the "Telecommunication element" screen.

| /6 Telecommunication element | | | 1/ 7 |
|---|---|---|---|
| PDTD | ( 200 - 2000) : | 1000 | μs |
| RYID | ( 0 - 63) : | 0 | |
| RYID1 | ( 0 - 63) : | 0 | |
| RYID2 | ( 0 - 63) : | 0 | |
| TDSV | ( 100 - 16000) : | 6000 | μs |
| TCDT1 | (-10000- 10000) : | 0 | us |
| TCDT2 | (-10000- 10000) : | 0 | us |

- Enter the time delay setting values and the relay identity numbers (address numbers) and press the [ENTER] key for each setting.

  PDTD: Setting for permissible difference of telecommunication delay time.

  RYID, RYID1, RYID2: Setting for address numbers of the local (RYID) and remote (RYID1 and RYID2) relays. These items are only enabled when the switch [RYIDSV] is set to "ON". See Section 2.2.14.

  TDSV: Setting for transmission delay time to be supervised.

  TCDT1, TCDT2: Adjusting the transmission delay time for CH1 and CH2

- After settings, press the [END] key to return to the "Telecommunication" screen.

### Setting the trip function

To set the scheme switches and protection elements, do the following. Protection elements are measuring elements and timers.

www.ElectricalPartManuals.com

- Press 3 (=Trip) on the "Protection" screen to display the "TRIP" screen.

```
/5 Trip                                    (Group *)
1=Scheme switch
2=Protection element
```

**Note:** Depending on the scheme switch setting, some of the scheme switches and protection elements are not used and so do not need to be set. The trip function setting menu of the GRL100 does not display unnecessary setting items. Therefore, start by setting the scheme switch, and set the protection elements.
As a result of the above, note that some of the setting items described below may not appear in the actual setting.

### Setting the scheme switches

- Press 1 (=Scheme switch) to display the "Scheme switch" screen.

```
/6 Scheme switch                                    1/**
DIF        0=Off   1=On                             1  -
STUB       0=Off   1=On                             1
DIFG       0=Off   1=On                             1
OST        0=Off   1=Trip   2=BO                    1
OCBT       0=Off   1=On                             1
OCBIT      0=Off   1=On                             1
MOCI       1=Long  2=Std  3=Very  4=Ext             1
EFBT       0=Off   1=On                             1
EFBTAL     0=Off   1=On                             1
EFIBT      0=Off   1=NOD   2=F   3=R                1
MEFI       1=Long  2=Std  3=Very  4=Ext             1
BF1        0=Off   1=T     2=TOC                    1
BF2        0=Off   1=On                             1
BFEXT      0=Off   1=On                             1
THMT       0=Off   1=On                             0
THMAL      0=Off   1=On                             0
TTSW1      0=Off   1=Trip   2=BO                    0
TTSW2      0=Off   1=Trip   2=BO                    0
RDIF       0=Off   1=On                             1
OTD        0=Off   1=On                             0
DIF-FS     0=Off   1=On   2=OCD   3=Both            0
DIFG-FS    0=Off   1=On                             0
  :                  :
LSSV       0=Off   1=On                             1
SVCNT      0=ALM&BLK  1=ALM                         0
CTSV       0=Off  1=ALM&BLK  3=ALM                  0
IDSV       0=Off  1=ALM&BLK  3=ALM                  0
  :                  :
AOLED      0=Off   1=On                             1
```

Note: The setting elements depend on the relay model.

- Enter the number corresponding to the switch status to be set and press the [ENTER] key for each switch.
- After setting all switches, press the [END] key to return to the "Trip" screen.

www.ElectricalPartManuals.com

### Setting the protection elements

- Press 2 (=Protection element) to display the "Protection element" screen.

```
/6 Protection element                          1/ **
DIFI1(  0.50- 10.00):    1.00 _                  A
DIFI2(  3.0- 120.0):     2.0                     A
DIFGI(  0.25-  5.00):    0.50                    A
DIFIC(  0.00-  5.00):    1.00                    A
Vn    (   100-   120):     110                   V
TDIFG(  0.00- 10.00):    0.10                    s
DIFSV(  0.05-  1.00):    0.10                    A
TIDSV(     0-    60):       10                   s
OCBF  (   0.5-  10.0):     0.5                   A
TBF1  (    50-   500):      50                  ms
TBF2  (    50-   500):      50                  ms
OC    (   0.5- 100.0):     0.5                   A
TOC   (  0.00- 10.00):    1.00                   s
OC1   (   0.5- 100.0):     1.0                   A
OCI   (   0.5-  25.0):     0.5                   A
TOCI  (  0.05-  1.00):    1.00
TOCIR(   0.0-  10.0):      0.0                   s
EF    (   0.5-   5.0):     0.5                   A
TEF   (  0.00- 10.00):    1.00                   s
EFI   (   0.5-   5.0):     0.5                   A
TEFI  (  0.05-  1.00):    1.00
TEFIR(   0.0-  10.0):      0.0                   s
THM   (   2.0-  10.0):     5.0                   A
THMIP(   0.0-   5.0):      0.0                   A
TTHM  (   0.5- 300.0):    10.0                 min
THMA  (    50-    99):      80                   %
OCCHK(   0.5-   5.0):      0.5                   A
HYSθ  (     1-     5):        1                 deg
   :          :          :
   :          :          :
TECCB(  0.00-200.00):     0.10                   s
TSBCT(  0.00-  1.00):     0.10                   s
```

Note: The setting elements depend on the relay model.

- Enter the numerical value and press the [ENTER] key for each element.
- After setting all elements, press the [END] key to return to the "Trip" screen.

### Setting the autoreclose function

To set the autoreclose mode, scheme switches and autoreclose elements, do the following:

**Note:** Depending on the autoreclose mode and scheme switch setting, some of the scheme switches and autoreclose elements are not used and so do not need to be set. The autoreclose function setting menu of the GRL100 does not display unnecessary setting items. Therefore, start by setting the autoreclose mode, and proceed to set the scheme switch, then the autoreclose elements.
As a result of the above, note that some of the setting items described below may not appear in the actual setting.

- Press 4 (=Autoreclose) on the "Protection" screen to display the "Autoreclose" screen.

```
/5 Autoreclose                          (Group *)
1=Autoreclose mode
2=Scheme switch
3=Autoreclose element
```

### Setting the autoreclose mode

- Press 1 (=Autoreclose mode) to display the "Autoreclose mode" screen.

www.ElectricalPartManuals.com

```
/6 Autoreclose mode
1=Disable  2=SPAR   3=TPAR   4=SPAR&TPAR
5=MPAR2 6=MPAR3 7=EXT1P 8=EXT3P 9=EXTMP
  Current No.= 4          Select No. = _
```

Note: The setting elements on the screen depend on the relay model.

- Select the autoreclose mode to be used by entering the number corresponding to the autoreclose mode and press the [ENTER] key.
- Press the [END] key to return to the "Autoreclose" screen.

### Setting the scheme switches

- Press 2 (=Scheme switch) to display the "Scheme switch" screen.

```
/6 Scheme switch                                  1/14
ARC-CB   1=ONE 2=01 3=02 4=L1 5=L2          1  _
ARC-EXT  0=Off  1=On                        1
ARC-BU   0=Off  1=On                        1
ARCDIFG  0=Off  1=On                        0
ARCDEFC  0=Off  1=On                        1
VCHK     0=Off 1=LB1 2=LB2 3=DB 4=SY        1
ARC-SM   0=Off  1=S2  2=S3  3=S4            1
ARC-CCB  0=Off  1=TPAR  2=MPAR              1
MA-NOLK  0=FT  1=T  2=S+T                   0
ARC-SUC  0=Off  1=On                        0
VTPHSEL  1=A    2=B    3=C                  1
VT-RATE  1=PH/G 2=PH/PH                     1
3PH-VT   1=BUS  2=Line                      1
UARCSW   1=P1  2=P2  3=PB                   1
```

- Enter the number corresponding to the switch status to be set and press the [ENTER] key for each switch.
- After setting all switches, press the [END] key to return to the "Autoreclose" screen.

### Setting the autoreclose elements

- Press 3 (=Autoreclose element) to display the "Autoreclose element" screen.

```
/6 Autoreclose element          (Group *)
1=Autoreclose timer
2=Synchrocheck
```

Press 1 to display the "Autoreclose timer" screen or 2 to display the "Synchrocheck" screen for voltage check and synchronism check elements.

Set these elements in the same way as protection elements.

### Setting group copy

To copy the settings of one group and overwrite them to another group, do the following:

- Press 3 (=Copy group) on the "Protection" screen to display the "Copy group A to B" screen.

www.ElectricalPartManuals.com

```
/3 Copy group A to B   (Active group= *)
A      (       1-       8) :          _
B      (       1-       8) :
```

- Enter the group number to be copied in line A and press the ENTER key.
- Enter the group number to be overwritten by the copy in line B and press the ENTER key.

#### 4.2.6.8 Binary Input

The logic level of binary input signals can be inverted by setting before entering the scheme logic. Inversion is used when the input contact cannot meet the requirement described in Table 3.2.2.

- Press 7 (=Binary input) on the "Setting (change)" sub-menu to display the "Binary input" screen.

```
/2 Binary input                                  1/ 31
BISW 1  1=Norm  2=Inv                             1 _
BISW 2  1=Norm  2=Inv                             1
BISW 3  1=Norm  2=Inv                             1
BISW 4  1=Norm  2=Inv                             1
BISW 5  1=Norm  2=Inv                             1
BISW 6  1=Norm  2=Inv                             1
BISW 7  1=Norm  2=Inv                             1
BISW 8  1=Norm  2=Inv                             1
BISW 9  1=Norm  2=Inv                             1
BISW10  1=Norm  2=Inv                             1
BISW11  1=Norm  2=Inv                             1
BISW12  1=Norm  2=Inv                             1
BISW13  1=Norm  2=Inv                             1
BISW14  1=Norm  2=Inv                             1
BISW15  1=Norm  2=Inv                             1
BISW16  1=Norm  2=Inv                             1
BISW17  1=Norm  2=Inv                             1
BISW18  1=Norm  2=Inv                             1
BISW19  1=Norm  2=Inv                             1
BISW20  1=Norm  2=Inv                             1
BISW21  1=Norm  2=Inv                             1
BISW22  1=Norm  2=Inv                             1
BISW23  1=Norm  2=Inv                             1
BISW24  1=Norm  2=Inv                             1
BISW26  1=Norm  2=Inv                             1
BISW27  1=Norm  2=Inv                             1
BISW28  1=Norm  2=Inv                             1
BISW34  1=Norm  2=Inv                             1
BISW35  1=Norm  2=Inv                             1
BISW36  1=Norm  2=Inv                             1
```

Note: The setting elements depend on the relay model.

- Enter 1 (=Normal) or 2 (=Inverted) and press the ENTER key for each binary input.

#### 4.2.6.9 Binary Output

All the binary outputs of the GRL100 except the tripping command, and relay failure signal are

www . ElectricalPartManuals . com

user-configurable. It is possible to assign one signal or up to six ANDing or ORing signals to one output relay. Available signals are listed in Appendix B.

It is also possible to attach a drop-off delay time of 0.2 second to these signals. The drop-off delay time is disabled by the scheme switch [BOTD].

Appendix D shows the factory default settings.

To configure the binary output signals, do the following:

#### Selection of output module

- Press 8 (=Binary output) on the "Setting (change)" screen to display the "Binary output" screen. The available output module(s) will be shown. (This differs depending on the relay model.)

```
/2 Binary output
1=IO#2      2=IO#3      3=IO#4
```

- Press the number corresponding to the selected output module to display the "Binary output" screen.

```
/3 Binary output                          (*****)
Select BO                  ( 1- **)

                                Select No.= _
```

**Note:** The setting is required for all the binary outputs. If any of the binary outputs are not to be used, enter 0 for logic gates #1 to #6 when assigning signals.

#### Selecting the output relay

- Enter the output relay number and press the [ENTER] key to display the "Setting" screen.

```
/4 Setting                    (BO** of *****)
1=Logic gate type & delay timer
2=Input to logic gate
```

#### Setting the logic gate type and timer

- Press 1 to display the "Logic gate type & delay timer" screen.

```
/5 Logic gate type & delay timer      1/ 2
Logic    1=OR    2=AND                1 _
BOTD     0=Off   1=On                 1
```

- Enter 1 or 2 to use an OR gate or AND gate and press the [ENTER] key.
- Enter 0 or 1 to add 0.2s off-delay time to the output relay or not and press the [ENTER] key.
- Press the [END] key to return to the "Setting" screen.

#### Assigning signals

- Press 2 on the "Setting" screen to display the "Input to logic gate" screen.

www.ElectricalPartManuals.com

```
/5 Input to logic gate                    1/ 6
In #1(      0-  3071) :      21 _
In #2(      0-  3071) :       4
In #3(      0-  3071) :      67
In #4(      0-  3071) :       0
In #5(      0-  3071) :       0
In #6(      0-  3071) :       0
```

- Assign signals to gates (In #1 to #6) by entering the number corresponding to each signal referring to Appendix B.

  **Note:** If signals are not assigned to all the gates #1 to #6, enter 0 for the unassigned gate(s).

Repeat this process for the outputs to be configured.

#### 4.2.6.10 LEDs

Four LEDs of the GRL100 are user-configurable. Each is driven via a logic gate which can be programmed for OR gate or AND gate operation. Further, each LED has a programmable reset characteristic, settable for instantaneous drop-off, or for latching operation. The signals listed in Appendix B can be assigned to each LED as follows.

**Selection of LED**

- Press 9 (=LED) on the "Setting (change)" screen to display the "LED" screen.

```
/2 LED
Select LED          (1-  4)

                    Select No.= _
```

- Enter the LED number and press the ENTER key to display the "Setting" screen.

```
/3 Setting                (LED1)
1=Logic gate type & reset
2=Input to logic gate
```

**Setting the logic gate type and reset**

- Press 1 to display the "Logic gate type and reset" screen.

```
/4 Logic gate type & reset                1/ 2
Logic    1=OR    2=AND                    1 _
Reset    0=Inst  1=Latch                  1
```

- Enter 1 or 2 to use an OR gate or AND gate and press the ENTER key.
- Enter 0 or 1 to select “Instantaneous reset” or “Latch reset” and press the ENTER key.
- Press the END key to return to the "Setting" screen.

  **Note:** To release the latch state, refer to Section 4.2.1.

**Assigning signals**

- Press 2 on the "Setting" screen to display the "Input to logic gate" screen.

www.ElectricalPartManuals.com

```
/4 Input to logic gate                    1/ 4
In #1(      0-  3071) :      21 _
In #2(      0-  3071) :       4
In #3(      0-  3071) :      67
In #4(      0-  3071) :       0
```

- Assign signals to gates (In #1- #4) by entering the number corresponding to each signal referring to Appendix B.

  **Note:** If signals are not assigned to all the gates #1-#4, enter 0 to the unassigned gate(s).

Repeat this process for other LEDs to be configured.

### 4.2.7 Testing

The sub-menu "Test" provides such functions as setting of testing switches, forced operation of binary outputs, time measurement of the variable setting timer, logic signal observation and synchronized end-to-end tests.

#### 4.2.7.1 Testing switches

- Press 5 (=Test) on the top "MENU" screen to display the "Test" screen.

```
/1 Test
1=Switch                    2=Binary output
3=Timer                     4=Logic circuit
5=Sim. fault                6=Init. 2B
```

- Press 1 (=Switch) to display the switch screen.
- Enter the number corresponding to the switch status to be set and press the [ENTER] key for each switch.
- Press the [END] key to return to the "Test" screen.

```
/2 Switch                                    1/**
A.M.F.    0=Off    1=On                      1 _
L.test    0=Off    1=On                      0
Open1     0=Off    1=On                      0
Open2     0=Off    1=On                      0
T.test    0=Off    1=On                      0
D.test    0=Off    1=On                      0
IECTST    0=Off    1=On                      0
THMRST    0=Off    1=On                      0
Z1S-1PH   0=Off    1=On                      0
ZB-CTRL   0=Norm   1=OFST   2=Non-FST        0
XANGLE    0=Off    1=On                      0
UVTEST    0=Off    1=On                      0
COM4      0=Off    1=On                      0
COM5      0=Off    1=On                      0
SCOM1     0=Off    1=On                      0
SCOM2     0=Off    1=On                      0
S2COM1    0=Off    1=On                      0
S2COM2    0=Off    1=On                      0
    :
S3COM12   0=Off    1=On                      0
```

www.ElectricalPartManuals.com

The fourth line (Open2) is displayed only for three-terminal line application ("3TERM" setting).

The automatic monitor function (A.M.F.) can be disabled by setting the switch [A.M.F] to "OFF".

**A.M.F.**

Disabling the A.M.F. prevents tripping from being blocked even in the event of a failure in the items being monitored by this function. It also prevents failures from being displayed on the "ALARM" LED and LCD described in Section 4.2.1. No events related to A.M.F. are recorded, either.

Disabling A.M.F. is useful for blocking the output of unnecessary alarms during testing.

**Note**: If the simulated fault inputs are applied under a failure condition and the A.M.F. is switched "OFF", the relay will issue a trip command but the operation of the relay cannot be displayed correctly.

**L.TEST**

The switch [L. test] is used for local testing.

When the switch [L. test] is set to "1" (=On), the voltage and current data received from the remote terminal are set to zero. This switching is transmitted to the remote terminal and the remote terminal sets the voltage and current data received from the switching terminal to zero.

Thus in the three-terminal application, the out-of-service terminal can carry out a local relay testing without disturbing the in-service terminals.

**Note**: When [L. test] is set to "1" (=On) in the two-terminal application, the current differential element can operate at both terminals if the load current is larger than the setting of DIFI1.

**Open1, Open2**

The switch [Open 1] and [Open 2] are used to maintain two terminal operation in three-terminal line application, when one terminal is out-of-service (i.e., breaker and/or disconnector are opened) due to relay failures or communication failures and fault investigations.

When the remote terminal 1 or 2 is out-of-service, set the switch [Open 1] or [Open 2] to "1" (=On) at the in-service terminals to remove the out-of-service remote terminal from protection. The remote terminal 1 is a terminal to which the local communication port 1 is linked and the remote terminal 2 is a terminal to that the local communication port 2 is linked.

**T.TEST**

The switch [T. test] is used for local testing of the current differential elements. When the [T. test] is set to "1" (=On), the local current data is looped into the receiving circuit interrupting the current data from the remote terminal as well as transmitted to the remote terminal.

**Note**: The switch [T. test] must be used only when all the terminals are out-of-service. If not, the local test current may cause a disturbance at the in-service remote terminal because this switching is not recognized at the remote terminal.
In case of electrical interface, the electrical cable must be removed to prevent signal interfering between sending and the receiving data. The remote terminal will detect the communication failure.

**D.TEST**

The switch [D. test] is used to test the relay models with an optical interface (Short wavelength light, GI, 2km class) and with an electrical interface in accordance with CCITT-G703-1.2.1, 1.2.2 and 1.2.3. Setting the [D. test] to "1" (=On) enables loop-back tests as well as end-to-end tests of the relays under the direct connection of the communication circuit. For the loop-back test or end-to-end test setup, see Section 6.5.1.1.

www.ElectricalPartManuals.com

**Note**: Be sure to restore these switches after the tests are completed or three-terminal normal operation resumes. In normal operation, the switch [A.M.F] is set to "1" (=On) and other switches to "0" (=Off). In other situation, the red "TESTING" LED is lit for alarming.

**IECTST**

- Enter 1(=On) for [IECTST] to transmit 'test mode' to the control system by IEC60870-5-103 communication when testing the local relay, and press the ENTER key.
- Press the END key to return to the "Test" screen.

**THMRST**

The switch [THMRST] is used to perform the thermal overload element test because the resetting time is in the order of minutes. The thermal overload element is instantaneously reset when the [THMRST] is ON.

- Enter 1(=On) for testing the thermal overload element, and press the ENTER key.
- Press the END key to return to the "Test" screen.

**Z1S-1PH**

When a three-phase voltage source is not available, the distance measuring element operation can be tested using a single-phase voltage source by setting the switch [Z1S-1PH] to "On". This is not fit for the high-accuracy test, though. Then, press the ENTER key.

- Press the END key to return to the "Test" screen.

**ZB-CTRL**

The switch [ZB-CTRL] is used to test the Z1 characteristic with offset or not. When the switch [ZB-CTRL] is set to "1", the Z1 is an offset characteristic. When the switch [ZB-CTRL] is set to "2", the Z1 is a characteristic without offset. Then, press the ENTER key.

- Press the END key to return to the "Test" screen.

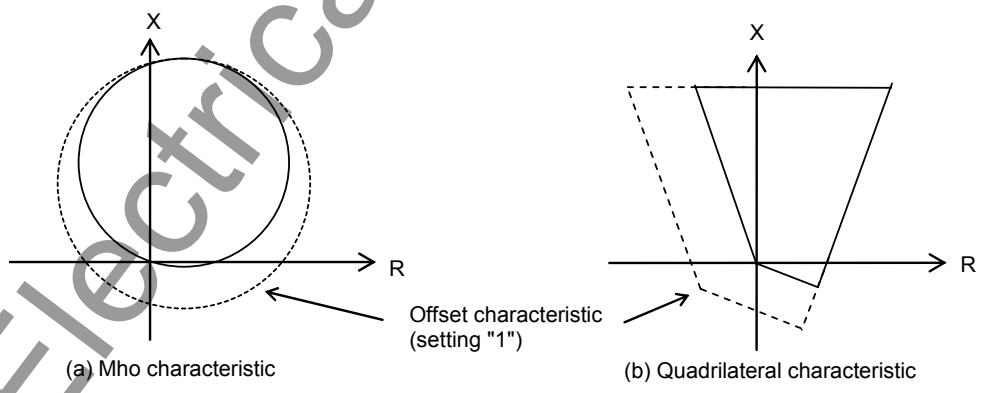



**Figure 4.2.7.1 Z1 Characteristics by [ZB-CTRL] Setting**

**XANGLE**

The gradient characteristic of Zone 1 reactance elements is obtained only when the load current is transmitted from local to remote terminal. So, the switch [XANGLE] is used to fix the gradient characteristic for testing. When testing, the switch [XANGLE] is set to "1" and press the ENTER key.

- Press the END key to return to the "Test" screen.

www.ElectricalPartManuals.com

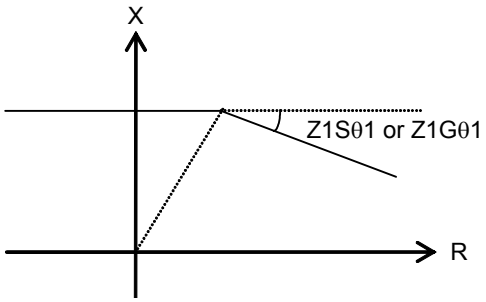



**Figure 4.2.7.2 Gradient Characteristic of Zone 1**

**UVTEST**

- Enter 0 (=Off) or 1 (=On) to set disable/enable the UV blocking (UVBLK) and press the [ENTER] key.
- Press the [END] key to return to the "Test" screen.

**COM∗ and S∗COM∗**

It is possible to forcibly send communication data [COM4], [COM5], [SCOM1], [SCOM2], [S2COM1] to [S2COM12] and [S3COM1] to [S3COM12] for testing. If testing, a desired communication data is set to “ON” and press the [ENTER] key.

- Press the [END] key to return to the "Test" screen.

### 4.2.7.2 Binary Output Relay

It is possible to forcibly operate all binary output relays for checking connections with the external devices. Forced operation can be performed on one or more binary outputs at a time for each module.

- Press 2 (=Binary output) on the "Test" screen to display the "Binary output" screen.

```
/2 Binary output
1=IO#1        2=IO#2        3=IO#3
```

The LCD displays the output modules installed depending on the model.

- Enter the selected number corresponding to each module to be operated. Then the LCD displays the name of the module, the name of the output relay, the name of the terminal block and the terminal number to which the relay contact is connected.

```
/3 BO              (0=Disable 1=Enable)   1/ 6
IO#1   TP-A1                              1 _
IO#1   TP-B1                              1
IO#1   TP-C1                              1
IO#1   TP-A2                              0
IO#1   TP-B2                              0
IO#1   TP-C2                              0
```

www . ElectricalPartManuals . com

```
/3 BO              (0=Disable 1=Enable)   1/14
IO#2   BO1                                1 _
IO#2   BO2                                1
IO#2   BO3                                1
IO#2   BO4                                0
IO#2   BO5                                0
IO#2   BO6                                0
IO#2   BO7                                0
IO#2   BO8                                0
IO#2   BO9                                0
IO#2   BO10                               0
IO#2   BO11                               0
IO#2   BO12                               0
IO#2   FAIL                               0
IO#2   BO13                               0
```

- Enter 1 and press the [ENTER] key to operate the output relays forcibly.
- After completing the entries, press the [END] key. Then the LCD displays the screen shown below.

```
/3 BO
Keep pressing 1 to operate.

Press CANCEL to cancel.
```

- Keep pressing the [1] key to operate the assigned output relays.
- Release pressing the [1] key to reset the operation.

  **Caution**: In case of relay models with fault detector, FD module BO also operates when IO#1 module BO is forcibly operated.

- Press the [CANCEL] key to return to the upper screen.

#### 4.2.7.3 Timer

The pick-up or drop-off delay time of the variable timer used in the scheme logic can be measured with monitoring jacks A and B. Monitoring jacks A and B are used to observe the input signal and output signal to the timer, respectively.

- Press 3(=Timer) on the "Test menu" screen to display the "Timer" screen.

```
/2 Timer                                  1/ 1
Timer(      1-    100):       1 _
```

- Enter the number corresponding to the timer to be observed and press the [ENTER] key. The timers and related numbers are listed in Appendix C.
- Press the [END] key to display the following screen.

www.ElectricalPartManuals.com

```
/2 Timer                                    1/ 1
Press ENTER to operate.

Press CANCEL to cancel.
```

- Press the [ENTER] key to operate the timer. The "TESTING" LED turns on, and timer is initiated and the following display appears. The input and output signals of the timer can be observed at monitoring jacks A and B respectively. The LEDs above monitoring jacks A or B are also lit if the input or output signal exists.

```
/2 Timer                                    1/ 1
Operating...
Press END to reset.
Press CANCEL to cancel.
```

- Press the [CANCEL] key to test other timers. Repeat the above testing.
- Press the [END] key to reset the input signal to the timer. The "TESTING" LED turns off.

To measure the drop-off delay time, press the [END] key after the LED above jack B lights.

#### 4.2.7.4 Logic Circuit

It is possible to observe the binary signal level on the signals listed in Appendix B with monitoring jacks A and B.

- Press 4 (=Logic circuit) on the "Test" screen to display the "Logic circuit" screen.

```
/2 Logic circuit                            1/ 2
TermA(      0- 3071) :       1 _
TermB(      0- 3071) :      48
```

- Enter a signal number to be observed at monitoring jack A and press the [ENTER] key.
- Enter the other signal number to be observed at monitoring jack B and press the [ENTER] key.

After completing the setting, the signals can be observed by the binary logic level at monitoring jacks A and B or by the LEDs above the jacks.

On screens other than the above screen, observation with the monitoring jacks is disabled.

#### 4.2.7.5 Synchronized Test Trigger

The "Sim. fault" on the "Test" menu is used to generate a synchronized trigger signal for end-to-end dynamic tests. The signal can be monitored when the signal FG (No.196) in the signal list is assigned to a user configurable high-speed type auxiliary relay (BO12 or BO13 of IO2) at the local and remote terminals.

Note: Even if a logic including the signal FG (No.196) is programmed and assigned into the BO13 of IO2, the BO13 outputs the signal FG itself instead of the result of the logic programmed.

The auxiliary relays trigger a simultaneous test current application to the local and remote terminal differential elements when the [1] key is pressed on the "Sim. fault" screen at either terminal. The signal transmission delay time is automatically compensated in the relay and the operation time difference of the auxiliary relays is within 1ms. For the signal list, see Appendix B.

Note: FG signal cannot be observed at monitoring jacks A and B.

www.ElectricalPartManuals.com

- Press 5 (=Test) on the top "MENU" screen to display the "Test" screen.

```
/1 Test
1=Switch                    2=Binary output
3=Timer                     4=Logic circuit
5=Sim. fault
```

- Press 5 (=Sim. fault) on the "Test" screen to display the "Simultaneous fault" screen

```
/2 Simultaneous fault
Keep pressing 1 to operate.

Press CANCEL to cancel.
```

- Keep pressing the [1] key to generate the synchronized trigger signal.
- Release pressing the [1] key to reset the operation.
- Press the [CANCEL] key to return to the "Test" screen.

#### 4.2.7.6 Init. 2B

To change the synchronization mode to MODE 2B manually in GPS mode, do the followings.

- Press 6 (=Init.2B) on the "Test" screen to display the "Init.2B" screen.

```
/2 Initiate MODE2B
Keep pressing 1 to Initiate MODE2B.
```

- Keep pressing the [1] key for 1 second to initiate MODE2B.

When the initiation succeeded, the message "Initiated." is displayed.

```
/2 Initiate MODE2B
Keep pressing 1 to Initiate MODE2B.
Initiated.
```

If not, the message "Failed." is displayed.

```
/2 Initiate MODE2B
Keep pressing 1 to Initiate MODE2B.
Failed.
```

www.ElectricalPartManuals.com

## 4.3 Personal Computer Interface

The relay can be operated from a personal computer using an RS232C port on the front panel. On the personal computer, the following analysis and display of the fault voltage and current are available in addition to the items available on the LCD screen.

- 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

## 4.4 Relay Setting and Monitoring System

The Relay Setting and Monitoring (RSM) system is a system that retrieves and analyses the data on power system quantities, fault and event records and views or changes settings in individual relays via a telecommunication network using a remote PC.

For the details, see the separate instruction manual "PC INTERFACE RSM100".

Figure 4.4.1 shows the typical configuration of the RSM system via a protocol converter G1PR2. The relays are connected through twisted pair cables, and the maximum 256 relays can be connected since the G1PR2 can provide up to 8 ports. The total length of twisted pair wires should not exceed 1200 m. Relays are mutually connected using an RS485 port on the relay rear panel and connected to a PC RS232C port via G1PR2. Terminal resistor (150 ohms) is connected the last relay. The transmission rate used is 64 kbits/s.

Figure 4.4.2 shows the configuration of the RSM system with Ethernet LAN (option). The relays are connected to HUB through UTP cable using RJ-45 connector at the rear of the relay. The relay recognizes the transmission speed automatically.

In case of the optional fiber optic interface (option), the relays are connected through graded-index multi-mode 50/125μm or 62.5/125μm type optical fiber using ST connector at the rear of the relay.

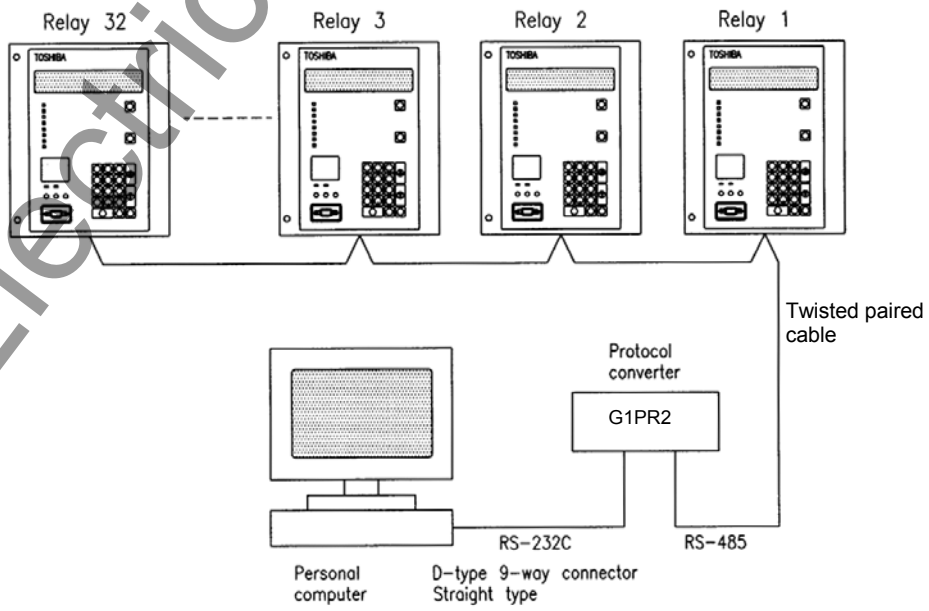



**Figure 4.4.1 Relay Setting and Monitoring System (1)**

www . ElectricalPartManuals . com

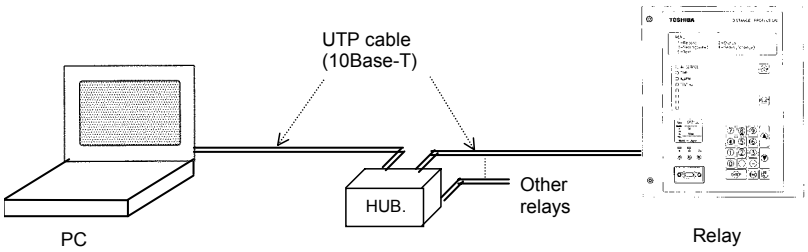



**Figure 4.4.2 Relay Setting and Monitoring System (2)**

## 4.5 IEC 60870-5-103 Interface

The GRL100 can support the IEC60870-5-103 communication protocol. This protocol is mainly used when the relay communicates with a control system and is used to transfer the following measurand, status data and general command from the relay to the control system.

- Measurand data: current, voltage, active power, reactive power, frequency
- Status data: events, fault indications, etc.

The IEC60870-5-103 function in the relay can be customized with the original software "IEC103 configurator". It runs on a personal computer (PC) connected to the relay, and can help setting of Time-tagged messages, General command, Metering, etc. For details of the setting method, refer to "IEC103 configurator" manual. For the default setting of IEC60870-5-103, see Appendix Q.

The protocol can be used through the RS485 port on the relay rear panel and can be also used through the optional fibre optical interface.

The relay supports two baud-rates 9.6kbps and 19.2kbps.

The data transfer from the relay can be blocked by the setting.

For the settings, see the Section 4.2.6.4.

## 4.6 Clock Function

The clock function (Calendar clock) is used for time-tagging for the following purposes:

- Event records
- Disturbance records
- Fault records
- Metering
- Automatic supervision
- Display of the system quantities on the digest screen
- Display of the fault records on the digest screen
- Display of the automatic monitoring results on the digest screen

The calendar clock can run locally or be synchronized with the external IRIG-B time standard signal, RSM, IEC or GPS clock. This can be selected by setting.

If it is necessary to synchronize with the IRIG-B time standard signal or GPS signal, it is possible to transform GMT to the local time by setting.

When the relays are connected to the RSM system as shown in Figure 4.4.1, the calendar clock of each relay is synchronized with the RSM clock. If the RSM clock is synchronized with the external time standard (GPS clock etc.), then all the relay clocks are synchronized with the external time standard.

www.ElectricalPartManuals.com

# 5. Installation

## 5.1 Receipt of Relays

When relays are received, carry out the acceptance inspection immediately. In particular, check for damage during transportation, and if any is found, contact the vendor.

Check that the following accessories are attached.

- 3 pins for the monitoring jack, packed in a plastic bag.
- An attachment kit required in rack-mounting, if ordered. (See Appendix F.)

  1 large bracket with 5 round head screws, spring washers and washers (M4×10)
  1 small bracket with 3 countersunk head screws (M4×6)
  2 bars with 4 countersunk head screws (M3×8)

Always store the relays in a clean, dry environment.

## 5.2 Relay Mounting

Either a rack or flush mounting relay is delivered as designated by the customer. The GRL100 models are classified into two types by their case size, type A and type B. Appendix F shows the case outlines.

If the customer requires a rack-mounting relay, support metal fittings necessary to mount it in the 19-inch rack are also supplied with the relay.

When to mount the relay in the rack, detach the original brackets fixed on both sides of the relay and seals on the top and bottom of the relay. Attach the larger bracket and smaller bracket on the left and right side of the relay respectively and the two bars on the top and bottom of the relay.

How to mount the attachment kit, see Appendix F.

Dimensions of the attachment kits EP-101 and EP-102 is also shown in Appendix F.

## 5.3 Electrostatic Discharge

**⚠CAUTION**

Do not take out any modules outside the relay case since electronic components on the modules are very sensitive to electrostatic discharge. If it is absolutely essential to take the modules out of the case, do not touch the electronic components and terminals with your bare hands. Additionally, always put the module in a conductive anti-static bag when storing it.

## 5.4 Handling Precautions

A person's normal movements can easily generate electrostatic potential of several thousand volts. Discharge of these voltages into semiconductor devices when handling electronic circuits can cause serious damage, which often may not be immediately apparent but the reliability of the circuit will have been reduced.

The electronic circuits are completely safe from electrostatic discharge when housed in the case. Do not expose them to risk of damage by withdrawing modules unnecessarily.

Each module incorporates the highest practicable protection for its semiconductor devices. However, if it becomes necessary to withdraw a module, precautions should be taken to preserve

www.ElectricalPartManuals.com

the high reliability and long life for which the equipment has been designed and manufactured.

**⚠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.
- Do not pass the module to another person without first ensuring you are both at the same electrostatic potential. Shaking hands achieves equipotential.
- Place the module on an anti-static surface, or on a conducting surface which is at the same potential as yourself.
- Do not place modules in polystyrene trays.

It is strongly recommended that detailed investigations on electronic circuitry should be carried out in a Special Handling Area such as described in the IEC 60747.

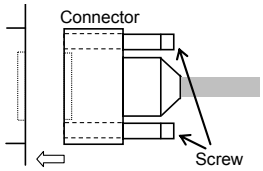
## 5.5 External Connections

External connections are shown in Appendix G.

**Electrical interface for telecommunication**

The connector should be handled as follows:

- Insert the connector horizontally and tighten both upper and lower screws alternately.
- Do not touch the connector pin with your bare hand.




In electrical interface to multiplexed communication circuit for GRL100-****-*9-**, the earthing wire of electrical cable is connected to the earth terminal (E) of the relay as shown in Figure 5.5.1, if required.

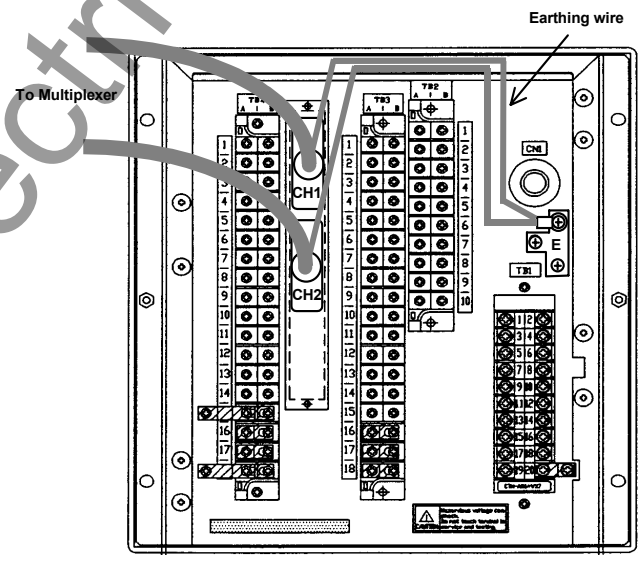


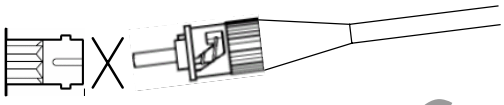
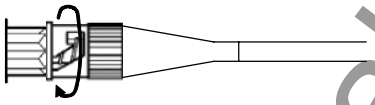
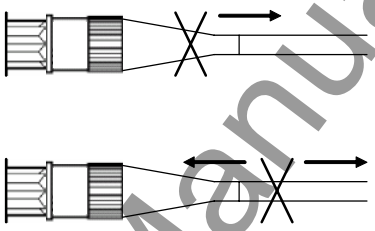
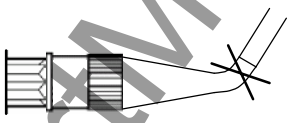
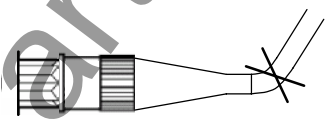
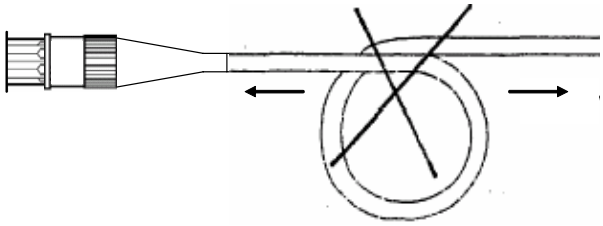
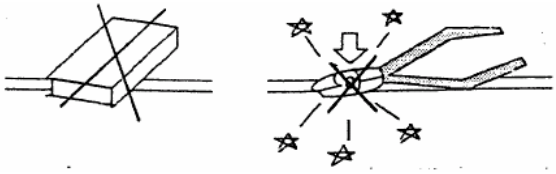
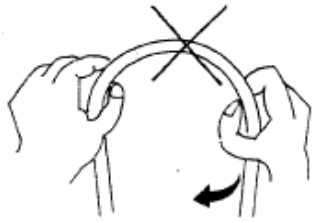

**Figure 5.5.1 Connection of communication cable**

www . ElectricalPartManuals . com

**Optical interface for telecommunication**

The optical cables tend to come down, therefore, bending requires special attention.

Handling instructions of optical cable are as follows:

| № | Instructions | |
|---|---|---|
| 1 | Do not insert the connector obliquely. |  |
| 2 | Tighten the connector when connecting. |  |
| 3 | Do not pull the cable. |  |
| 4 | Do not bend the cable. |  |
| 5 | Do not bend the neck of the connector. |  |
| 6 | Do not twist the cable. | |
| 7 | Do not kink in the cable. |  |
| 8 | Do not put and drop on the cable. |  |
| 9 | Do not bend the cable to (*)mm or less in radius.<br><br>(*)Length differs from characteristics of optical cable. |  |

www.ElectricalPartManuals.com

# 6. Commissioning and Maintenance

## 6.1 Outline of Commissioning Tests

The GRL100 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 relay or local PC can be fully applied.

Test personnel must be familiar with general relay 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

www . ElectricalPartManuals . com

## 6.2 Cautions

### 6.2.1 Safety Precautions

**⚠CAUTION**

- The relay rack is provided with a grounding terminal.
  Before starting the work, always make sure the relay rack is grounded.
- When connecting the cable to the back of the relay, firmly fix it to the terminal block and attach the cover provided on top of it.
- Before checking the interior of the relay, be sure to turn off the power.
- Class 1M laser radiation when remove cap for models with <30km class optical interface. Do not view directly with optical instruments.

Failure to observe any of the precautions above may cause electric shock or malfunction.

### 6.2.2 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 turning on the power, 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.
- Be careful that the transformer module is not damaged due to an overcurrent or overvoltage.
- If settings are changed for testing, remember to reset them to the original settings.

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.

www . ElectricalPartManuals . com

## 6.3 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.

For the default settings, see the following appendixes:

Appendix D Binary Output Default Setting List
Appendix H Relay Setting Sheet

### Visual inspection

After unpacking the product, check for any damage to the relay 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 relay 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

When using a local PC, connect it with the relay via the RS232C port on the front of the relay. RSM100 software is required to run the PC.

For the details, see the separate instruction manual "PC INTERFACE RSM100".

www . ElectricalPartManuals . com

## 6.4 Hardware Tests

The tests can be performed without external wiring, but DC power supply and AC voltage and current source are required.

### 6.4.1 User Interfaces

This test ensures that the LCD, LEDs and keys function correctly.

#### LCD display

- Apply the rated DC voltage and check that the LCD is off.

  **Note:** If there is a failure, the LCD displays the "Auto-supervision" screen when the DC voltage is applied.

- Press the [RESET] key for 1 second when the LCD is off, and check that black dots appear on the whole screen.

#### LED display

- Apply the rated DC voltage and check that the "IN SERVICE" LED is lit in green.
- Press the [RESET] key for 1 second when the LCD is off, and check that seven LEDs under the "IN SERVICE" LED and two LEDs for monitoring jacks A and B are lit in red.

#### VIEW and RESET keys

- Press the [VIEW] key when the LCD is off and check that the "Metering" screen is displayed on the LCD.
- Press the [RESET] key and check that the LCD turns off.

#### Keypad

- Press any key on the keypad when the LCD is off and check that the LCD displays the "MENU" screen. Press the [END] key to turn off the LCD.
- Repeat this for all keys.

www . ElectricalPartManuals . com

### 6.4.2 Binary Input Circuit

The testing circuit is shown in Figure 6.4.2.1.

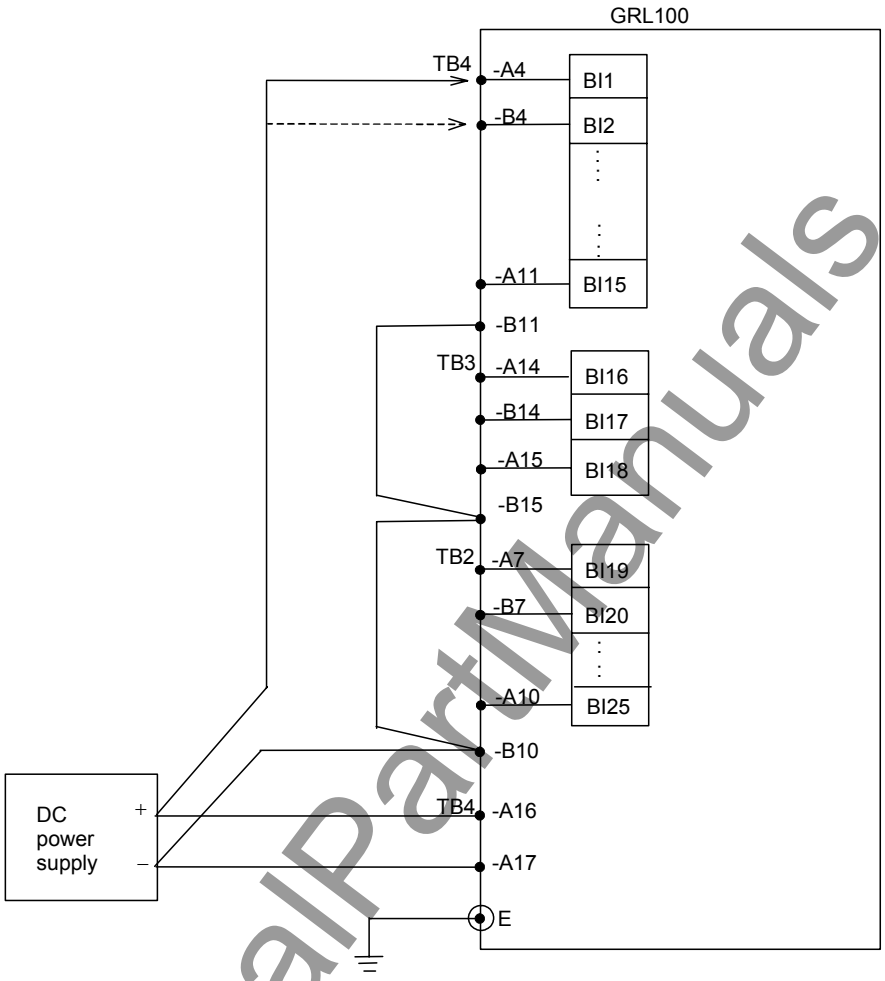



**Figure 6.4.2.1 Testing Binary Input Circuit**

- Display the "Binary input & output" screen from the "Status" sub-menu.

```
/2 Binary input & output                    3/ 6
Input (IO#1)          [000 000 000 000 000]
Input (IO#2)          [000                 ]
Input (IO#3)          [000 000 0           ]
Output(IO#1-trip)     [000 000             ]
Output(IO#2)          [000 000 000 000 00  ]
Output(IO#3)          [000 000             ]
```

- Apply the rated DC voltage to terminal A4, B4, ..., A11 of terminal block TB4, A14, B14 and A15 of terminal block TB3 and A7, B7, ..., A10 of terminal block TB2, in case of the model 7∗1.
  Check that the status display corresponding to the input signal changes from 0 to 1. (For details of the binary input status display, see Section 4.2.4.2.)

  **Note:** Different models have different terminal block and terminal number, so refer to Appendix G.

The user will be able to perform this test for one terminal to another or for all the terminals at once.

www.ElectricalPartManuals.com

### 6.4.3 Binary Output Circuit

This test can be performed by using the "Test" sub-menu and forcibly operating the relay drivers and output relays. Operation of the output contacts is monitored at the output terminal. The output contact and corresponding terminal number are shown in Appendix G.

- Press 2 (= Binary output) on the "Test" screen to display the "Binary output" screen. The LCD displays the output modules mounted depending on the model.
- Enter the selected number corresponding to each module to be operated. Then the LCD displays the name of the module, the name of the output relay, the name of the terminal block and the terminal number to which the relay contact is connected.
- Enter 1 and press the [ENTER] key.
- After completing the entries, press the [END] key. Then the LCD displays the screen shown below. If 1 is entered for all the output relays, the following forcible operation can be performed collectively.

```
/3 BO
Keep pressing 1 to operate.

Press CANCEL to cancel.
```

- Keep pressing the [1] key to operate the output relays forcibly.
- Check that the output contacts operate at the terminal.
- Release pressing the [1] key to reset the operation.

www . ElectricalPartManuals . com

### 6.4.4 AC Input Circuits

This test can be performed by applying known values of voltages and currents to the AC input circuits and verifying that the values applied coincide with the values displayed on the LCD screen.

The testing circuit is shown in Figure 6.4.4.1. A three-phase voltage source and a single-phase current source are required.

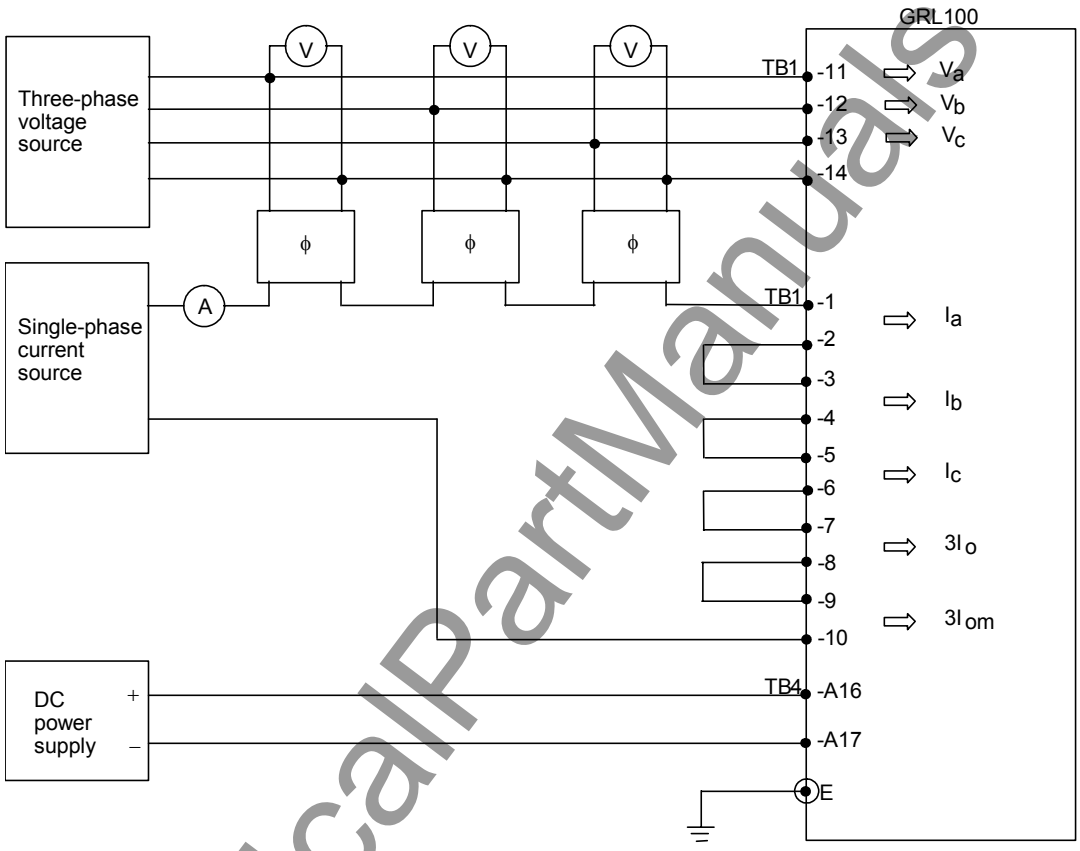



**Figure 6.4.4.1 Testing AC Input Circuit**

- Check that the metering data is set to be expressed as secondary values (Display value = 2) on the "Metering" screen.

  "Setting (view)" sub-menu → "Status" screen → "Metering" screen

  If the setting is Primary (Display value = 1), change the setting in the "Setting (change)" sub-menu. Remember to reset it to the initial setting after the test is finished.

- Open the "Metering" screen in the "Status" sub-menu.

  "Status" sub-menu → "Metering" screen

- Apply AC rated voltages and currents and check that the displayed values are within ± 5% of the input values.

www.ElectricalPartManuals.com

## 6.5 Function Test

### CAUTION

The function test may cause the output relays to operate including the tripping output relays. Therefore, the test must be performed with tripping circuits disconnected.

### 6.5.1 Measuring Element

Measuring element characteristics are realized by software, so it is possible to verify the overall characteristics by checking representative points.

Operation of the element under test is observed by the binary output signal at monitoring jacks A or B or by the LED indications above the jacks. In any case, the signal number corresponding to each element output must be set on the "Logic circuit" screen of the "Test" sub-menu.

```
/2 Logic circuit                                1/ 2
TermA(      0-   3071) :       1
TermB(      0-   3071) :      48
```

When a signal number is entered for the TermA line, the signal is observed at monitoring jack A and when entered for the TermB line, observed at monitoring jack B.

**Note:** The voltage level at the monitoring jacks is +15V ±3V for logic level "1" when measured by an instrument with 10kΩ input impedance, and less than 0.1V for logic level "0".

### CAUTION

- Use test equipment with more than 1kΩ of internal impedance when observing the output signal at the monitoring jacks.
- Do not apply an external voltage to the monitoring jacks.

In case of a three-phase element, it is enough to test a representative phase. A-phase is selected hereafter.

www . ElectricalPartManuals . com

#### 6.5.1.1 Phase current differential element DIF

The phase current differential element is checked for the following items.

Operating current value

Charging current compensation

Percentage restraining characteristic

The top two items are tested locally or under an end-to-end setup of each terminal relay.

The last item is tested only under an end-to-end setup of each terminal relay.

**Operating current value**

Figure 6.5.1.1 shows the circuit to test the A-phase element locally.

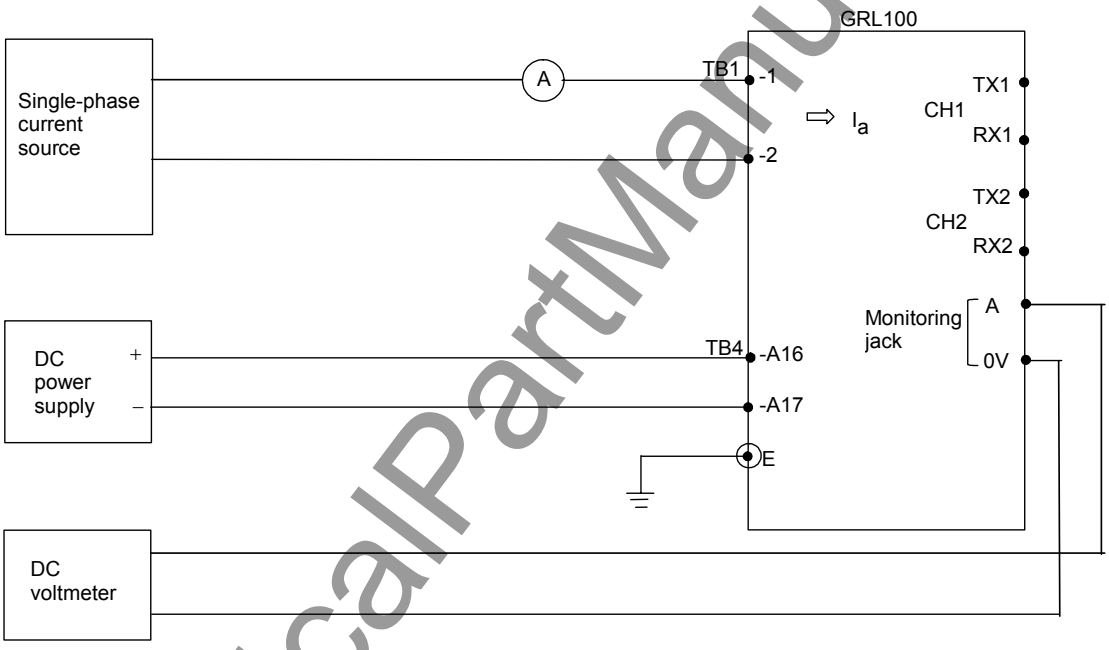



**Figure 6.5.1.1 Testing Phase Current Differential Element**

The output signal numbers of the DIF element are as follows.

| Element | Signal number |
|---|---|
| DIF-A | 41 |
| DIF-B | 42 |
| DIF-C | 43 |

- Set the [L.test] to “1” (=On) on the “Switch” screen of the “Test” sub-menu.
- Check that the charging current compensation DIFIC is set to zero on the "Protection element" screen in the "Setting (view)" sub-menu. If not, set it to zero in the "Setting (change)" sub-menu.
- Press 4 (=Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number 41 for Term A line to observe the DIF-A operation at monitoring jack A and press the ENTER key.

www.ElectricalPartManuals.com

- Apply a test current and change the magnitude of the current applied and measure the value at which the element operates.
- Check that the measured value is within 7% of the setting DIFI1.

#### Charging current compensation

The charging current compensation function is checked by displaying the differential current on the LCD.

Figure 6.5.1.2 shows the test circuit.

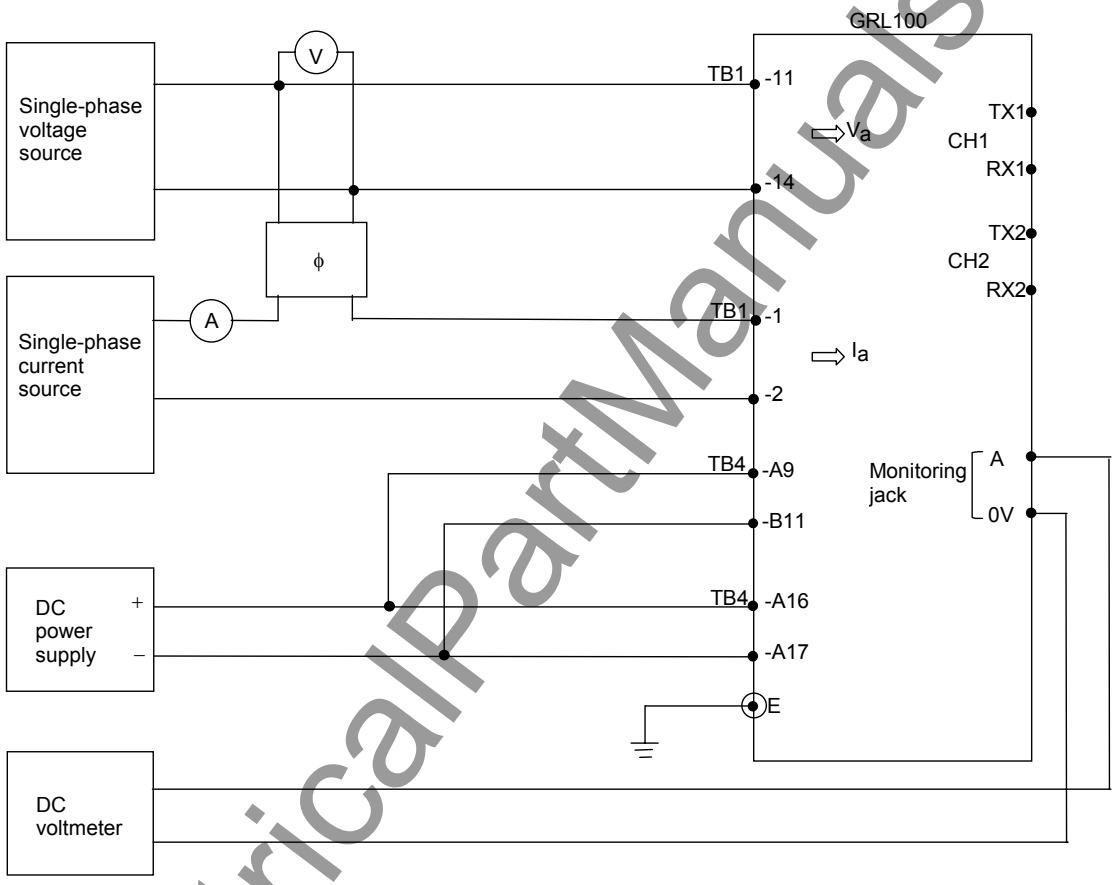



**Figure 6.5.1.2 Testing Charging Current Compensation**

- Set the [L.test] to "1" (=On) on the "Switch" screen of the "Test" sub-menu.

When the charging current compensation is in operation, the differential current $I_d$ is expressed with the following equation:

$$I_d = I - (1/n)\ DIFIC$$

where,

I = applied test current

n = 2 in case of two-terminal line application

= 3 in case of three-terminal line application

DIFIC = setting of charging current compensation

- Open the "Metering" screen in the "Status" sub-menu.
- Apply a rated phase voltage and a test current to A-phase, and adjust the voltage lagging by

www.ElectricalPartManuals.com

90°.

- Check that the A-phase differential current $I_{da}$ on the "Metering" screen coincides with the $I_d$ mentioned above with an error within ±7%.

#### End-to-end test setup

When the percentage restraint characteristic is checked, an end-to-end setup using two relays is required.

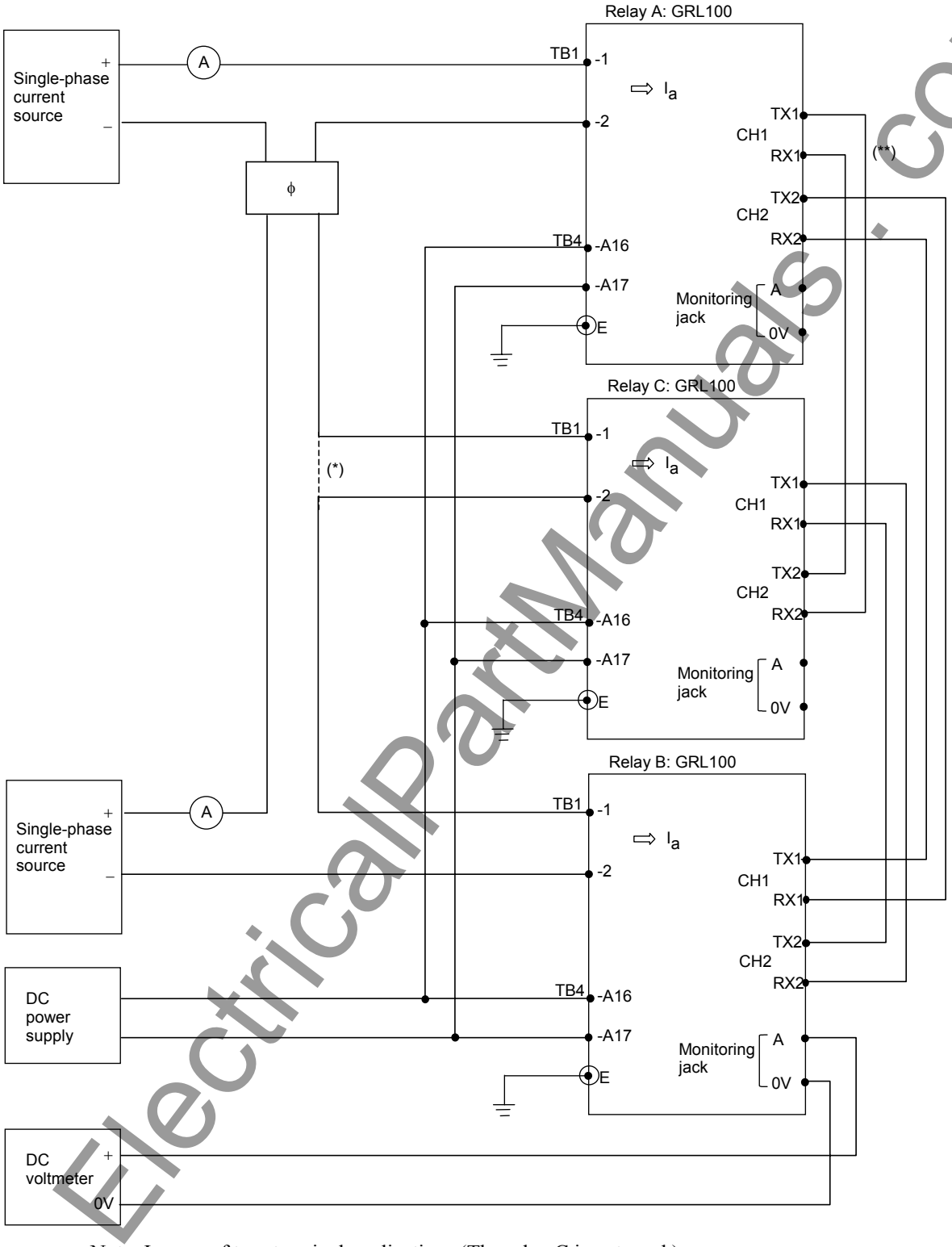
**<Testing at laboratory>**

If the relays can be collected and tested at a laboratory, the end-to-end test is possible by directly connecting their communication ports. Figure 6.5.1.3 (a) shows the testing circuit of the laboratory end-to-end test.

In case of two-terminal applications, the signal terminals CH1-TX1 and -RX1 of one relay are directly connected to CH1-RX1 and -TX1 of another relay.

**Note:** When the relays have an electrical telecommunications interface in accordance with CCITT-G703-1.2.1 or an optical interface (Short wavelength light, GI, 2km class), the scheme switch [D. test] must be set to "1" (= On) to test them under the direct connection of the communication circuits.

www . ElectricalPartManuals . com




Note: In case of two-terminal applications (The relay C is not used.),
(*) Connect the dotted line.
(**) Connect CH1-TX1 and CH1-RX1 of the relay A to CH1-RX1 and CH1-TX1 of the relay B.

**Figure 6.5.1.3 (a) End-to-end Test Setup at Laboratory**

www.ElectricalPartManuals.com

**<Testing on site>**

If the relays are tested at each installation site, the end-to-end test is performed after the telecommunication circuit between terminals is setup. Figure 6.5.1.3 (b) shows the testing circuit of the on-site end-to-end test.

In the on-site test, it is necessary to set the phase relationship between the test currents of each terminal. The pulse signal PULSE generated from the synchronized sampling clock is used as a reference phase signal at each terminal because it is in-phase between the terminals.

www . ElectricalPartManuals . com

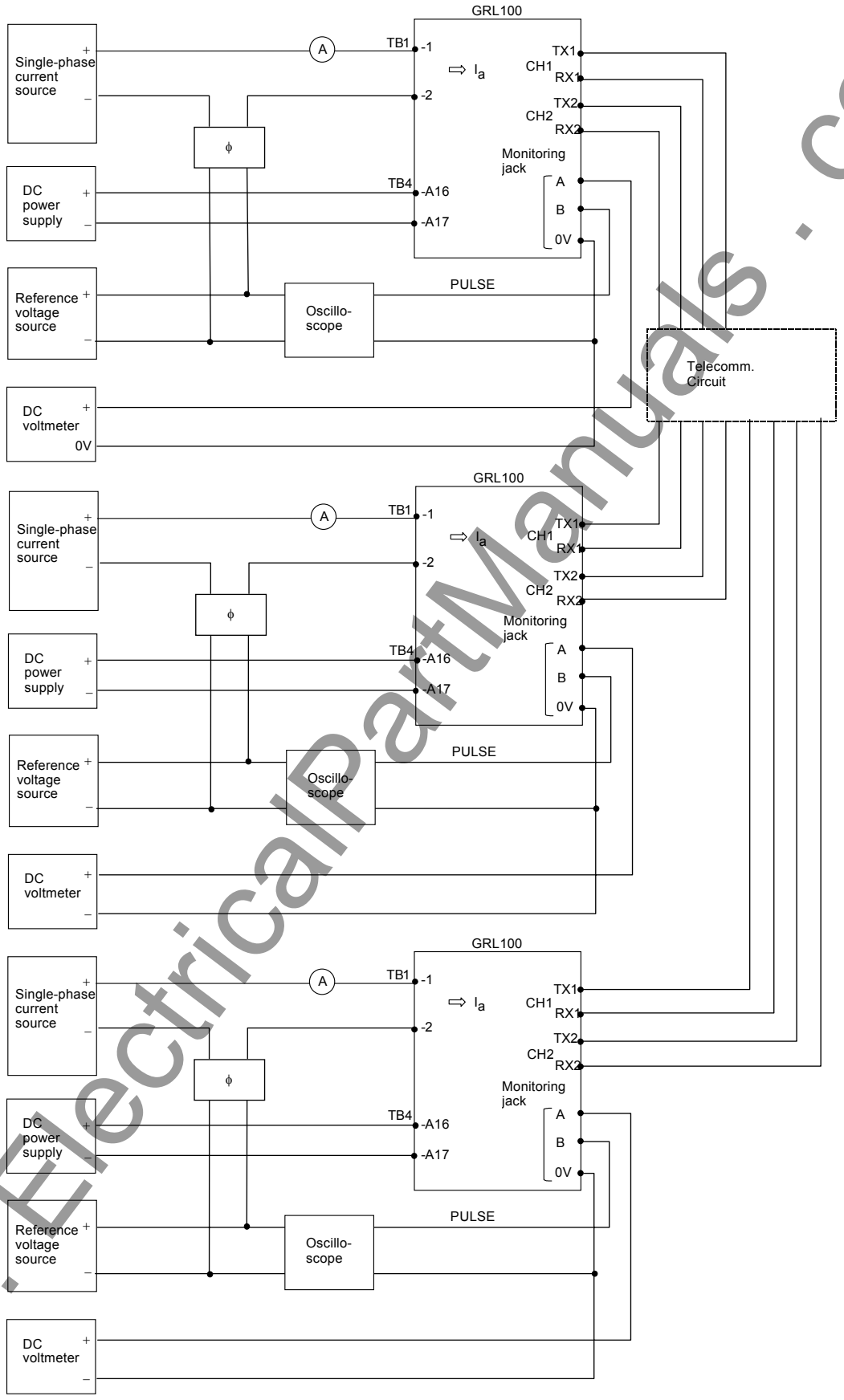



**Figure 6.5.1.3 (b) On-site Setup for Testing Differential Element**

- Press 4 (=Logic circuit) on the "TEST" sub-menu screen to display the "Logic circuit" screen.

www.ElectricalPartManuals.com

- Enter a signal number 270 for Term B to observe a signal PULSE at monitoring jack B, and then press the [ENTER] key.

The phase of the test current is adjusted as follows.

- Adjust the reference voltage to be in-phase with the pulse signal PULSE monitoring a CRT oscilloscope.
- Adjust the test current to be in-phase with the reference voltage to simulate an infeed current and counter-phase to simulate an outflow current.

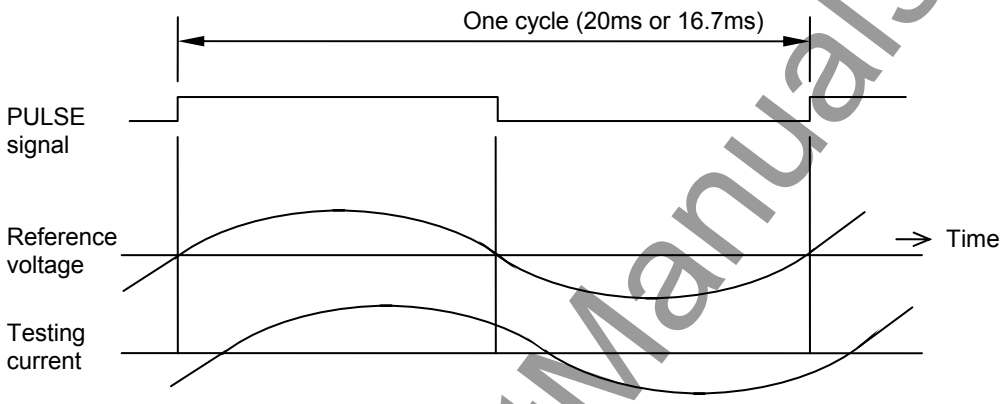



**Figure 6.5.1.4 Phase Adjustment**

**Percentage restraint characteristics**

The percentage restraint characteristic is tested on the outflow current ($I_{out}$) and infeed current ($I_{in}$) plane as shown in Figure 6.5.1.5 by applying an infeed current to one relay and an outflow current to another relay.

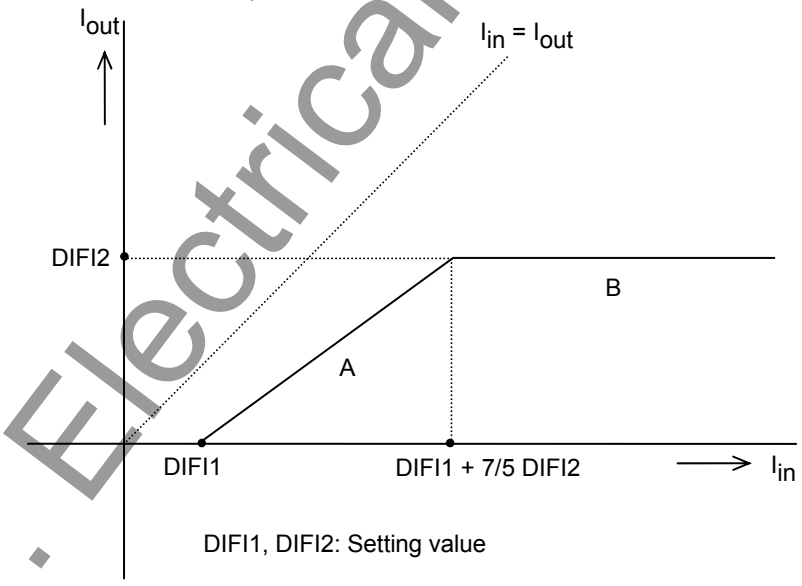



**Figure 6.5.1.5 Percentage Restraining Characteristic on $I_{in}$-$I_{out}$ Plane**

Characteristic A is expressed by the following equation,

$$I_{out} \leq (5/7)\ (I_{in} - DIFI1)$$

Characteristic B is expressed by the following equation,

www . ElectricalPartManuals . com

$I_{out} \leq$ DIFI2

where, DIFI1 and DIFI2 are setting values.

- Set the charging current compensation DIFIC to zero.
- Press 4 (=Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number 41 to observe the DIF-A output at monitoring jack A and press the [ENTER] key.
- Apply a fixed infeed current to one relay. Apply an outflow current to another relay, change the magnitude of the current applied and measure the value at which the element operates.
- Repeat the above by changing the magnitude of the infeed current.
- Check that the measured value of the outflow current is within ±7% of the theoretical values obtained using the equations mentioned above. (The infeed current is more than 0.5×In).

#### 6.5.1.2 Residual current differential element DIFG

The residual current differential element is checked on the operating current and percentage restraining characteristic in the same way as described in Section 6.5.1.1.

| Element | Signal number |
|---|---|
| DIFG | 44 |

The differences from the procedure described in Section 6.5.1.1 are as follows.

- Apply a test current to terminal 7 and 8 instead of 1 and 2.
- Enter a signal number 44 instead of 41 to observe the DIFG element operation at monitoring jack A.
- Use the settings DIFGI instead of DIFI1.

www . ElectricalPartManuals . com

### 6.5.1.3 Distance Measuring Element Z1, Z2, Z3, Z4, ZR and PSB

**Phase fault element reach test**

The test voltage and current input test circuit is shown in Figure 6.5.1.6.

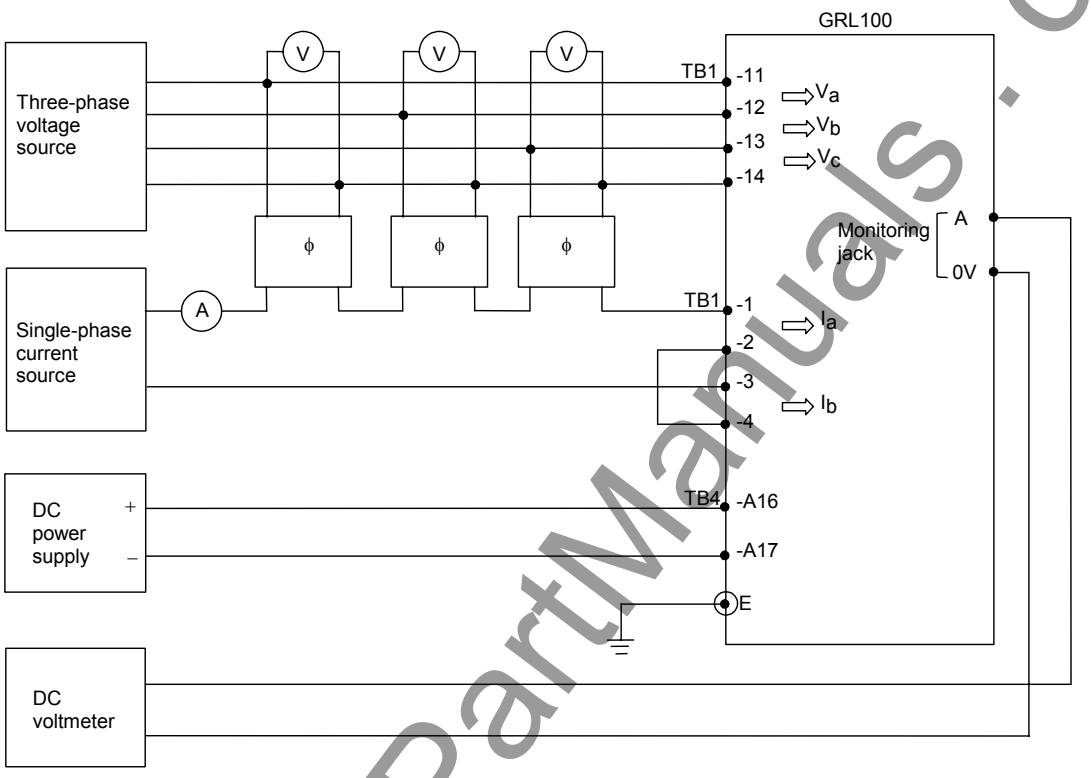



**Figure 6.5.1.6 Testing Phase-Fault Element**

Phase fault elements and their output signal numbers are listed below.

| Measuring element | Signal number |
|---|---|
| Z1S-AB | 575 |
| Z2S-AB | 578 |
| Z3S-AB | 581 |
| Z4S-AB | 584 |
| ZRS-AB | 364 |
| PSBSIN-AB | 596 |
| PSBSOUT-AB | 593 |

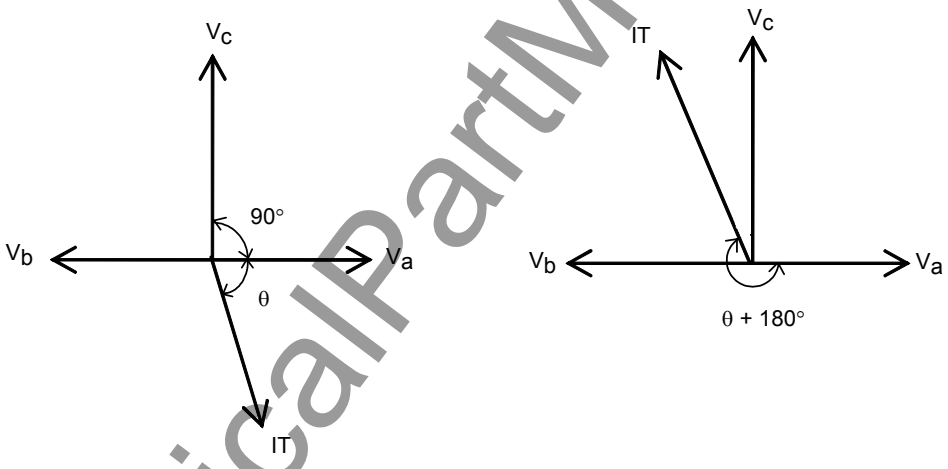
- Press 5 (=Logic circuit) on the "Test" screen to display the "Logic circuit" screen.
- Enter a signal number to be observed at monitoring jack A and press the [ENTER] key.
- Apply three-phase rated voltage.
- Choose a test current IT by referring to the table below, the table shows the relationship between the reach setting, test current and measuring error.

www.ElectricalPartManuals.com

| Reach setting | IT | Error |
|---|---|---|
| 0.01 - 0.05Ω<br>(0.1 - 0.2Ω | 25A<br>5A)(*) | ±10% |
| 0.06 - 0.09Ω<br>(0.3 - 0.4Ω | 20A<br>4A) | ±7% |
| 0.10 - 1.00Ω<br>(0.5 - 5.0Ω | 10A<br>2A) | ±5% |
| 1.01 - 10.00Ω<br>(5.1 - 50.0Ω | 5A<br>1A) | ±5% |
| 10.01 - 20.00Ω<br>(50.1 – 100.0Ω | 2.5A<br>0.5A) | ±5% |
| 20.01 - 50.00Ω<br>(100.1 – 250.0Ω | 1A<br>0.2A) | ±7% |

(*) Values shown in parentheses are in the case of 1A rating.
Other values are in the case of 5A rating.

- Set the voltage and current phase relationship as shown below. That is, $V_a$ lags Vc by 90°, Vb = - $V_a$ and IT lags $V_a$ by θ or θ + 180°. θ is 90° when testing.




Z1S, Z2S, Z3S and PSB Z4S

- Adjust the magnitude of $V_a$ and $V_b$ while retaining the conditions above and measure the voltage $V_a$ at which the element operates.
- The theoretical operating voltage is obtained by 2IT × ZS when the setting reach is ZS. Check that the measured voltage is within the above-mentioned error of the theoretical voltage value when it is expressed with $2V_a$ (= $V_a$ – $V_b$).

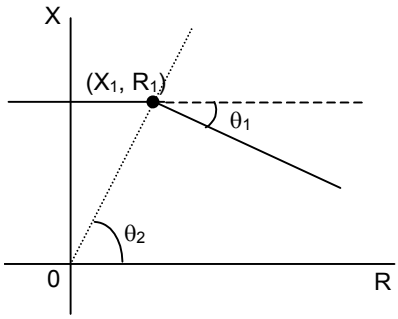
| Element reach setting (ZS) | IT | 2IT × ZS | Measured voltage ($2V_a$) |
|---|---|---|---|
| Z1S | | | |
| Z2S | | | |
| Z3S | | | |
| Z4S | | | |
| ZRS | | | |
| PSBSIN | | | |
| PSBSOUT | | | |

www . ElectricalPartManuals . com

**[Testing of Zone 1 bending characteristic]**

The test circuit and test method is same as above.

The operating voltage of Zone 1 bending characteristic can be calculated as follows:




$\theta_1$: Z1S$\theta$1 setting angle

$\theta_2$: Z1S$\theta$2 setting angle

$$V = X_p I \cdot \frac{1}{\sin\theta} = \frac{X_1\left(1+\frac{\tan\theta_1}{\tan\theta_2}\right)}{\left(1+\frac{\tan\theta_1}{\tan\theta}\right)} \cdot I \cdot \frac{1}{\sin\theta}$$

where,

$X_1$ is the Z1S setting reach.

$\theta$ is the angle difference between voltage and current.

Note: Toshiba recommend that a minimum of three values for $\theta$ be tested to check that the correct relay settings have been applied.
Care must be taken in choosing values of $\theta$ to ensure that the testing points come within the operating boundary defined by the Z1S $\theta$2 setting and either the load blinder or mho settings, as appropriate.

www . ElectricalPartManuals . com

### Earth fault element reach test

The test circuit is shown in Figure 6.5.1.7.

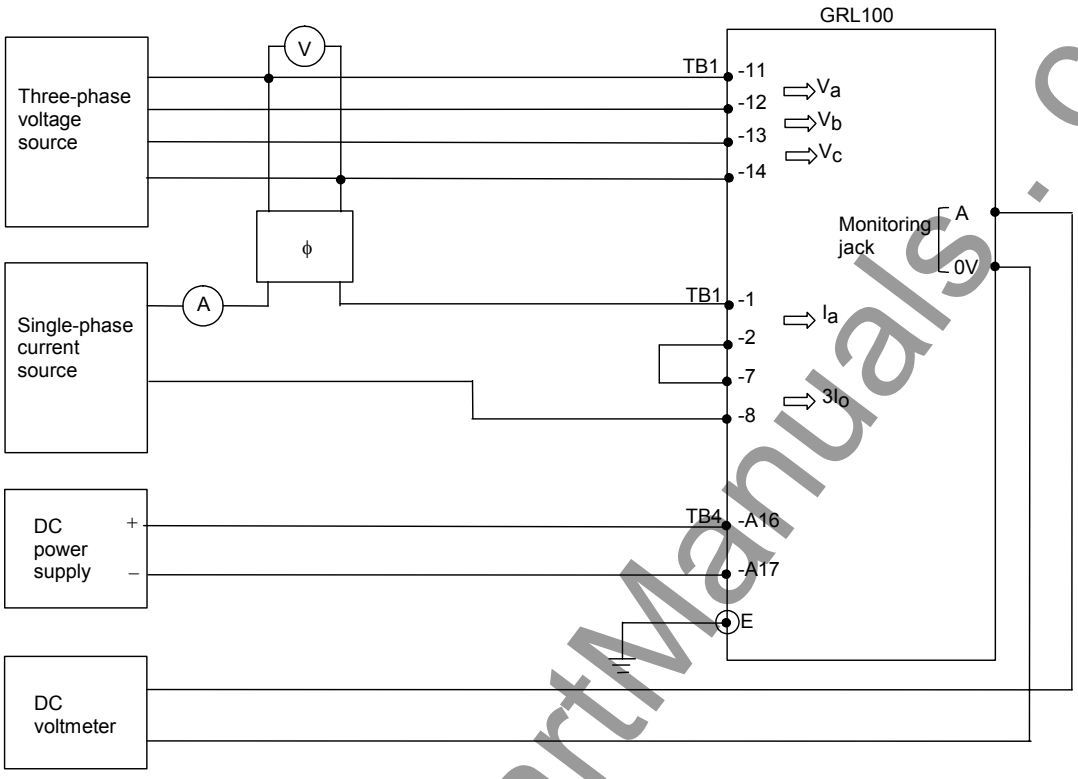



**Figure 6.5.1.7 Testing Earth-Fault Element**

Earth fault elements and their output signal number are listed below.

| Measuring element | Signal number |
|---|---|
| Z1G-A | 560 |
| Z2G-A | 563 |
| Z3G-A | 566 |
| Z4G-A | 569 |
| ZRG-A | 572 |
| PSBGIN-A | 590 |
| PSBGOUT-A | 587 |

- Press 5 (=Logic circuit) on the Test screen to display the Logic circuit screen.
- Enter a signal number to be observed at monitoring jack A and press the [ENTER] key.
- Apply three-phase rated voltage.
- Choose a test current IT by referring to the table below, the table shows the relationship between the reach setting, test current and measuring error.

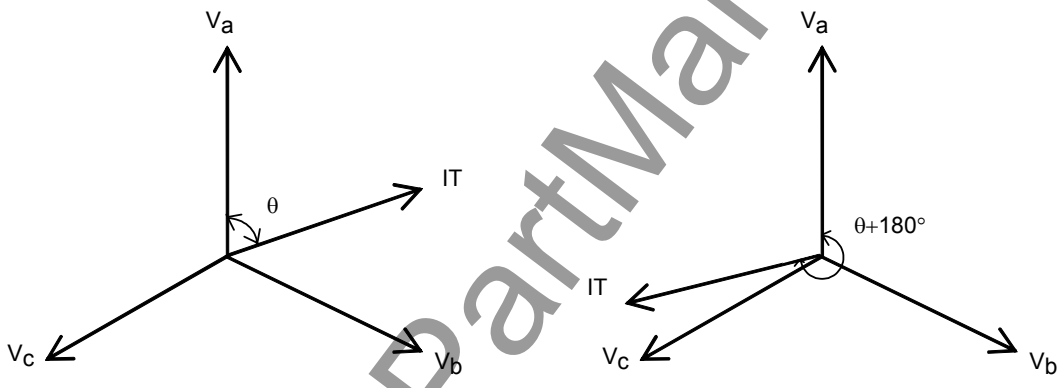
| Reach setting | IT | Error |
|---|---|---|
| 0.01 - 0.05Ω<br>(0.1 - 0.2Ω | 25A<br>5A)(*) | ±10% |
| 0.06 - 0.09Ω | 20A | ±7% |

www.ElectricalPartManuals.com

| | | |
|---|---|---|
| (0.3 - 0.4Ω | 4A) | |
| 0.1 - 1.0Ω<br>(0.5 - 5.0Ω | 10A<br>2A) | ±5% |
| 1.01 - 10.0Ω<br>(5.1 - 50.0Ω | 5A<br>1A) | ±5% |
| 10.01 - 20.0Ω<br>(50.1 - 100Ω | 2.5A<br>0.5A) | ±5% |
| 20.01 - 50.0Ω<br>(100.1 - 250Ω | 1A<br>0.2A) | ±7% |
| 50.01 - 100Ω<br>(250.1 - 500Ω | 0.6A<br>0.12A) | ±10% |

(*) Values shown in parentheses are in the case of 1A rating. Other values are in the case of 5A rating.

- Set the test voltage and test current phase relation as shown below. That is, $V_a$, $V_b$, and $V_c$ are balanced, and IT lags $V_a$ by θ or θ + 180°. θ is 90° when testing.




Z1G, Z2G, and Z3G　　Z4G

- Adjust the magnitude of Va while retaining the conditions above and measure the voltage at which the element operates.
- The theoretical operating voltage Vop is obtained by the following equations when the setting reach is ZG. Check that the measured voltage is within the above-mentioned error of the theoretical voltage.

$$\text{Z1G, Z2G: } Vop = ZG \times \left( IT + \frac{\frac{K_{xs}}{100} - 1}{3} \times IT \right)$$

$$\text{Z3G, Z4G, ZRG: } Vop = IT \times ZG$$

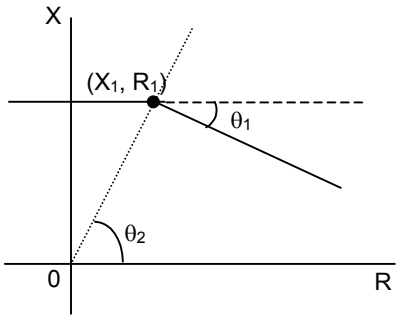
| Element | ZG | IT | Vop | Measured voltage |
|---|---|---|---|---|
| Z1G | | | | |
| Z2G | | | | |
| Z3G | | | | |
| Z4G | | | | |
| ZRG | | | | |
| PSBGIN | | | | |
| PSBGOUT | | | | |

www.ElectricalPartManuals.com

**[Testing of Zone 1 bending characteristic]**

The test circuit and test method is same as above.

The operating voltage of Zone 1 bending characteristic can be calculated as follows:




θ1: Z1Gθ1 setting angle

θ2: Z1Gθ2 setting angle

$$V = X_p I'_x \cdot \frac{1}{\sin\theta} = \frac{X_1\left(1+\frac{\tan\theta_1}{\tan\theta_2}\right)}{\left(1+\frac{\tan\theta_1}{\tan\theta}\cdot\frac{I'_x}{I'_r}\right)} \cdot I'_x \cdot \frac{1}{\sin\theta}$$

where,

$$I'_x = I + \frac{k_{xs}-100}{100} I_0 + \frac{k_{xm}}{100} I_{0m},\ I'_r = I + \frac{k_{rs}-100}{100} I_0 + \frac{k_{rm}}{100} I_{0m}$$

$X_1$ is the Z1G setting reach.

$\theta$ is the angle difference between voltage and current.

Note: Toshiba recommend that a minimum of three values for $\theta$ be tested to check that the correct relay settings have been applied.
Care must be taken in choosing values of $\theta$ to ensure that the testing points come within the operating boundary defined by the Z1G $\theta$2 setting and either the load blinder or mho settings, as appropriate

#### 6.5.1.4 Phase Selection Element UVC

The testing circuit is shown in Figure 6.5.1.7.

UVC elements and their output signal numbers are listed below.

| Measuring element | Signal number |
|---|---|
| UVC-A | 608 |
| UVC-B | 609 |
| UVC-C | 610 |

The following shows the case when testing UVC-A.

- Press 5 (=Logic circuit) on the Test screen to display the Logic circuit screen.
- Enter 608 as a signal number to be observed at monitoring jack A and press the [ENTER] key.
- Apply a three-phase rated voltage.
- Set the test current IT to zero ampere and adjust the voltage. Measure the voltage at which the element operates. Check that the voltage is within ±5% of the setting UVCV. (The

www.ElectricalPartManuals.com

default setting of the UVCV is 48 V.)

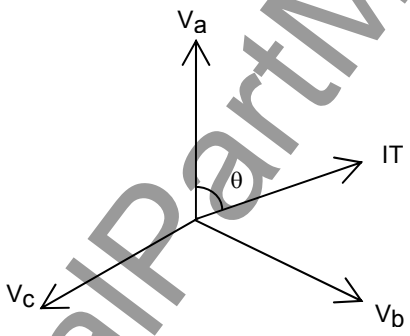
- Choose a test current IT by referring to the table below, which shows the relation of setting reach UVCZ, test current IT and measuring error.

| UVCZ | IT | Error |
|---|---|---|
| 0.0- 2.0Ω<br>(0 - 10Ω | 10A<br>5A) (*) | ±5% |
| 2.1 – 10.0Ω<br>(11 - 50Ω | 5A<br>1A) | ±5% |
| 10.1 – 20.0Ω<br>(51 - 100Ω | 2.5A<br>0.5A) | ±5% |
| 20.1 – 50.0Ω<br>(101 - 250Ω | 1A<br>0.2A) | ±7% |

(*) Values shown in parentheses are in the case of 1A rating. Other values are in the case of 5A rating.

- Set the test voltage and test current phase relation as shown below. That is, $V_a$, $V_b$, and $V_c$ are balanced, and IT lags $V_a$ by UVC characteristic angle UVC θ.

(The default setting of UVC θ is 85°.)




- Adjust the magnitude of $V_a$ while retaining the conditions above and measure the voltage $V_a$ at which the element operates.
- The theoretical operating voltage is obtained by (IT × UVCZ + UVCV) when the setting reach is UVCZ. Check that the measured voltage is within the above-mentioned error of the theoretical voltage value. (The default setting of the UVCZ is 2.0 ohm for 5A rating and 10 ohm for 1A rating.)

| Element | UVCV | UVCZ | IT | IT×UVCZ + UVCV | Measured voltage |
|---|---|---|---|---|---|
| UVCZ | | | | | |

#### 6.5.1.5 Directional Earth Fault Element DEF

The testing circuit is shown in Figure 6.5.1.7.

DEF elements and their output signal number are listed below.

| Measuring element | Signal number |
|---|---|
| DEFF | 611 |
| DEFR | 612 |

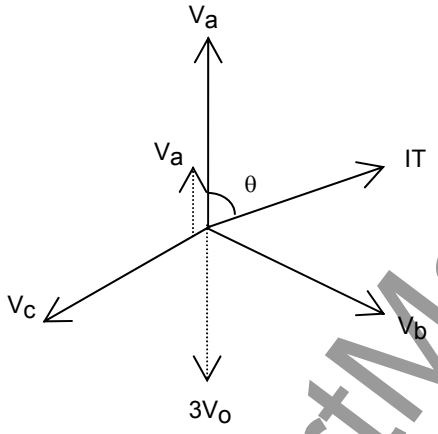
The following shows the case when testing DEFF.

www.ElectricalPartManuals.com

- Press 5 (=Logic circuit) on the Test screen to display the Logic circuit screen.
- Enter 59 as a signal number to be observed at monitoring jack A and press the [ENTER] key.

Residual current level detection is verified as follows:

- Apply three-phase rated voltage and single-phase test current IT (= $3I_O$).
  Set IT to lag $V_a$ by DEFF characteristic angle DEF θ. (The default setting of DEF θ is 85°.)
- Lower $V_a$ to 10 V to generate a residual voltage. Changing the magnitude of IT while retaining the phase angle with the voltages, and measure the current at which the element operates. Check that the measured current magnitude is within ± 5% of the current setting.




Residual voltage level detection is verified as follows:

- Set IT to rated current and the three-phase voltage to rated voltage. Lower the magnitude of $V_a$ while retaining the phase angle with the current and measure the voltage $V_a$ at which the element operates. Operating residual voltage is expressed by (VR-$V_a$), where VR is the rated voltage. Check that the (VR-$V_a$) is within 5% of the residual voltage setting.

#### 6.5.1.6 Inverse Definite Minimum Time Overcurrent Element (IDMT) OCI, EFI

The testing circuit is shown in Figure 6.5.1.8.

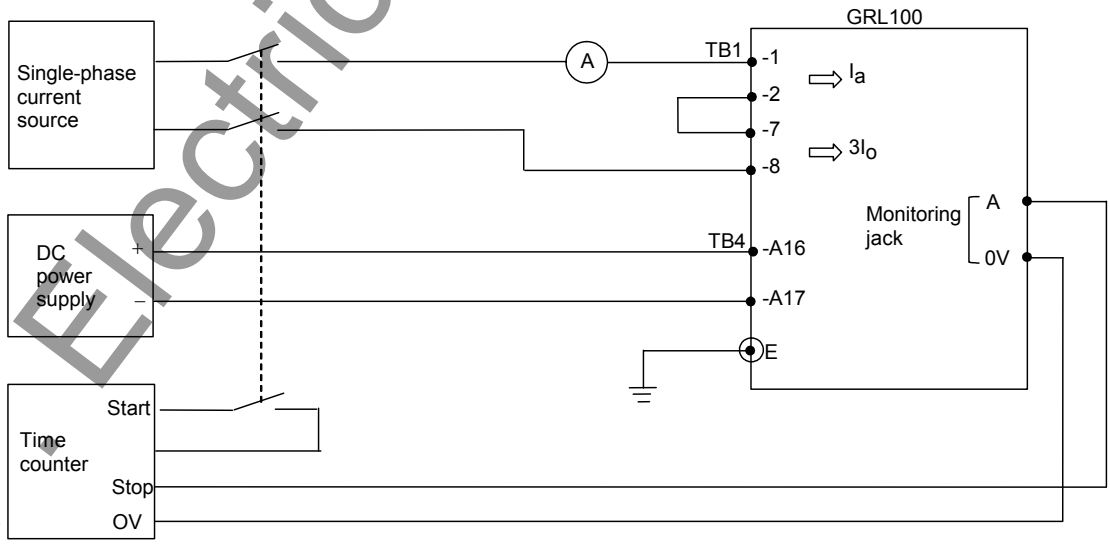



**Figure 6.5.1.8 Testing IDMT**

One of the four inverse time characteristics can be set, and the output signal numbers of the IDMT are as follows:

www.ElectricalPartManuals.com

| Element | Signal number |
|---|---|
| OCI-A | 68 |
| OCI-B | 69 |
| OCI-C | 70 |
| EFI | 72 |

Fix the time characteristic to test by setting the scheme switch MEFI or MOCI on the "Scheme switch" screen.

"Setting (change)" sub-menu → "Protection" screen → "Trip" screen → "Scheme switch" screen

The test procedure is as follows:

- Press 5 (=Logic circuit) on the "Test" screen to display the "Logic circuit" screen.
- Enter a signal number to observe the OCI or EFI output at monitoring jack A and press the [ENTER] key.
- Apply a test current and measure the operating time. The magnitude of the test current should be between $1.2 \times I_S$ to $20 \times I_S$, where $I_S$ is the current setting.
- Calculate the theoretical operating time using the characteristic equations shown in Section 2.16.6. Check that the measured operating time is within IEC 60255-3 class 5 for standard, very and long-time inverse or IEC 60255-3 class 7.5 for extremely inverse.

#### 6.5.1.7 Thermal overload element THM-A and THM-T

The testing circuit is same as the circuit shown in Figure 6.5.1.8.

The output signal of testing element is assigned to the monitoring jack A.

The output signal numbers of the elements are as follows:

| Element | Signal No. |
|---|---|
| THM-A | 367 |
| THM-T | 363 |

To test easily the thermal overload element, the scheme switch [THMRST] in the "Switch" screen on the "Test" menu is used.

- Set the scheme switch [THMRST] to "ON".
- Enter the signal number to observe the operation at the monitoring jack A as shown in Section 6.5.1.
- Apply a test current and measure the operating time. The magnitude of the test current should be between $1.2 \times I_S$ to $10 \times I_S$, where $I_S$ is the current setting.

**CAUTION**

After the setting of a test current, apply the test current after checking that the THM% has become 0 on the "Metering" screen.

- Calculate the theoretical operating time using the characteristic equations shown in Section 2.8. Check that the measured operating time is within 5%.

#### 6.5.1.8 Broken conductor detection element BCD

The testing circuit is shown in Figure 6.5.1.9.

www.ElectricalPartManuals.com

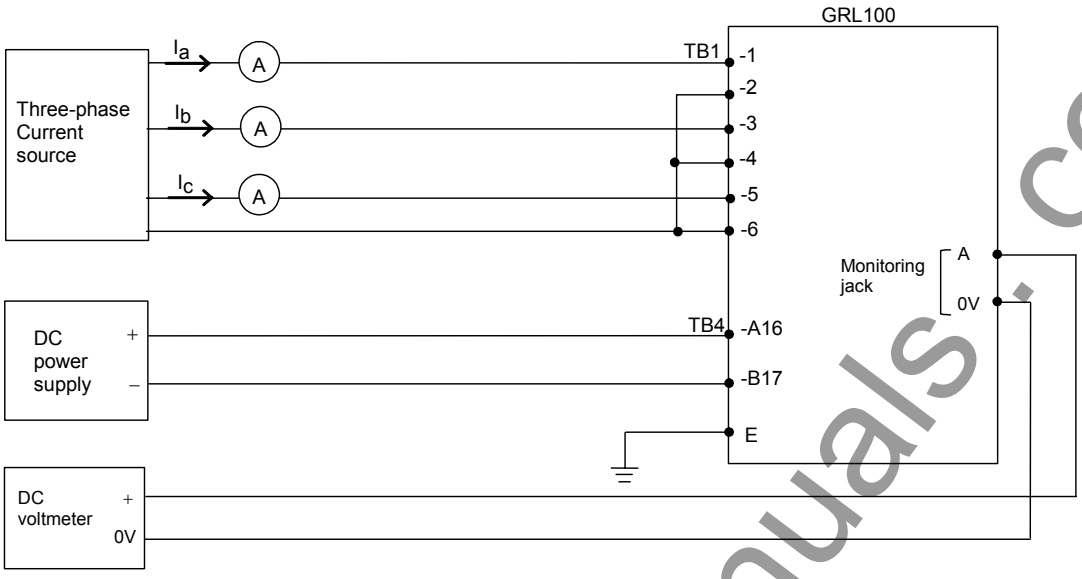



**Figure 6.5.1.9 Testing BCD element**

The output signal of testing element is assigned to the monitoring jack A.

The output signal numbers of the elements are as follows:

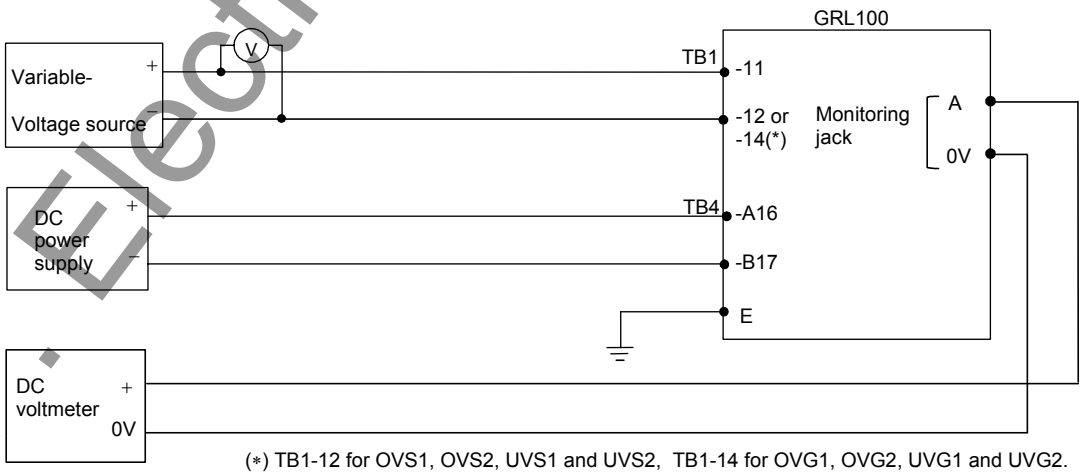
| Element | Signal No. |
|---|---|
| BCD | 635 |

- Enter the signal number to observe the operation at the monitoring jack A as shown in Section 6.5.1.
- Apply the three-phase balance current at 10% of the rated current and interrupt a phase current.

Then, check the BCD element operates.

### 6.5.1.9 Overvoltage / undervoltage elements OVS1, OVS2, OVG1, OVG2, UVS1, UVS2, UVG1, UVG2

The testing circuit is shown in Figure 6.5.1.10.




(*) TB1-12 for OVS1, OVS2, UVS1 and UVS2, TB1-14 for OVG1, OVG2, UVG1 and UVG2.

**Figure 6.5.1.10 Operating Value Test Circuit**

The output signal of testing element is assigned to the monitoring jack A.

www.ElectricalPartManuals.com

Overvoltage and undervoltage elements and their output signal number are listed below.

| Element | Signal No. |
|---|---|
| OVS1-AB | 639 |
| OVS2-AB | 642 |
| OVG1-A | 645 |
| OVG2-A | 648 |
| UVS1-AB | 663 |
| UVS2-AB | 666 |
| UVG1-A | 669 |
| UVG2-A | 672 |

- Enter the signal number to observe the operation at the monitoring jack A as shown in Section 6.5.1.

**Operating value test of OVS1, OVS2, OVG1, OVG2**

- Apply a rated voltage as shown in Figure 6.5.1.10.
- Increase the voltage and measure the value at which the element operates. Check that the measured value is within ± 5% of the setting.

**Operating value test of UVS1, UVS2, UVG1, UVG2**

- Apply a rated voltage and frequency as shown Figure 6.5.1.10.
- Decrease the voltage and measure the value at which the element operates. Check that the measured value is within ± 5% of the setting.

**Operating time check of OVS1, OVG1, UVS1, UVG1 IDMT curves**

- Apply a rated voltage at the IDMT time multiplier setting 10.0 of the relay.
- Change the voltage from the rated voltage to the test voltage quickly and measure the operating time. Test voltage: 1.5 × (setting voltage) or 0.5 × (setting voltage)
- Calculate the theoretical operating time using the characteristic equations shown in Section 2.9.1 and 2.9.2. Check the measured operating time within ±5%.

### 6.5.1.10 Out-of-step element OST

The out-of-step element can be tested with an end-to-end setup using two relays.

Figure 6.5.1.11 (a) and (b) shows the testing circuits of the laboratory test and on-site test. For the test setup, refer to Section 6.5.1.1.

www . ElectricalPartManuals . com

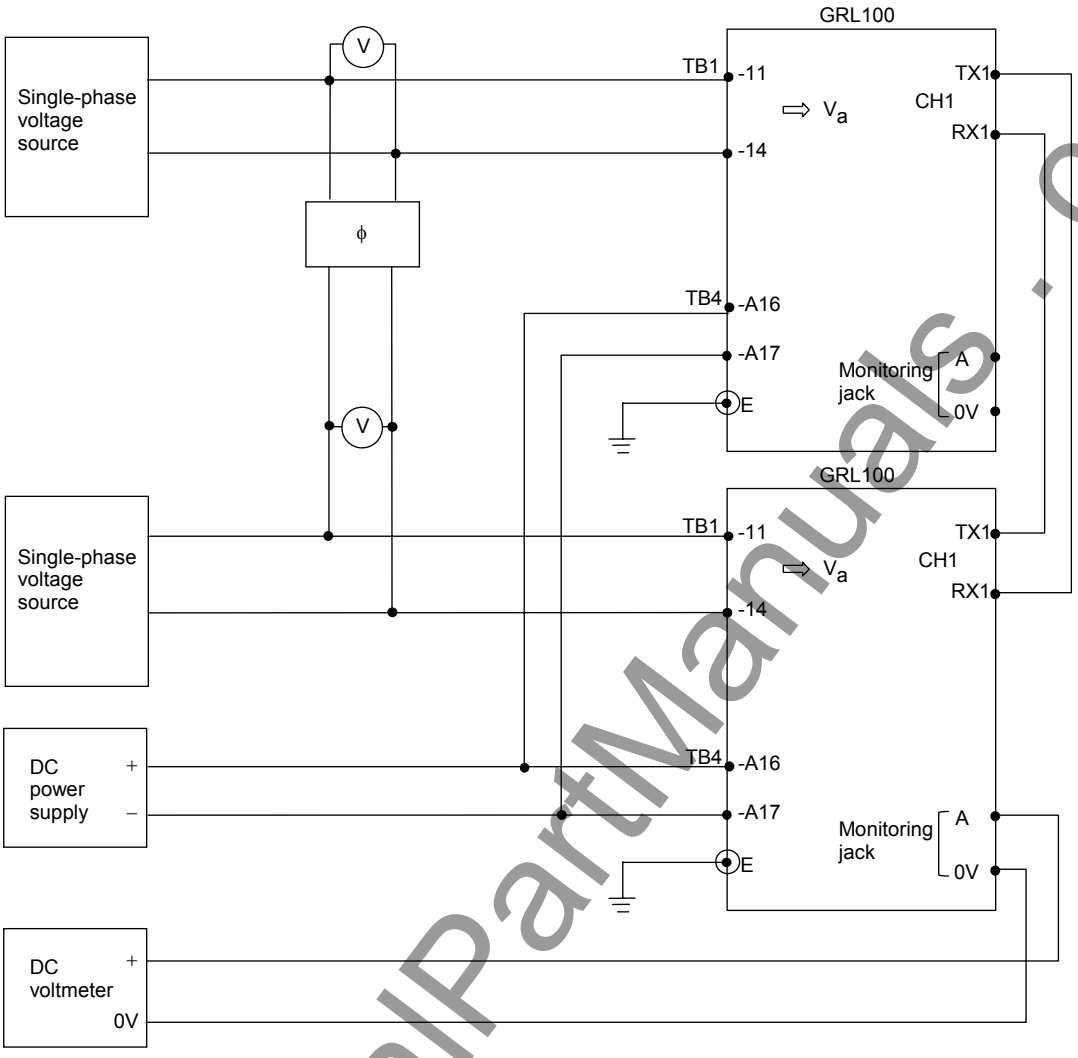



**Figure 6.5.1.11 (a) Laboratory Setup for Testing Out-of-step Element**

www . ElectricalPartManuals . com

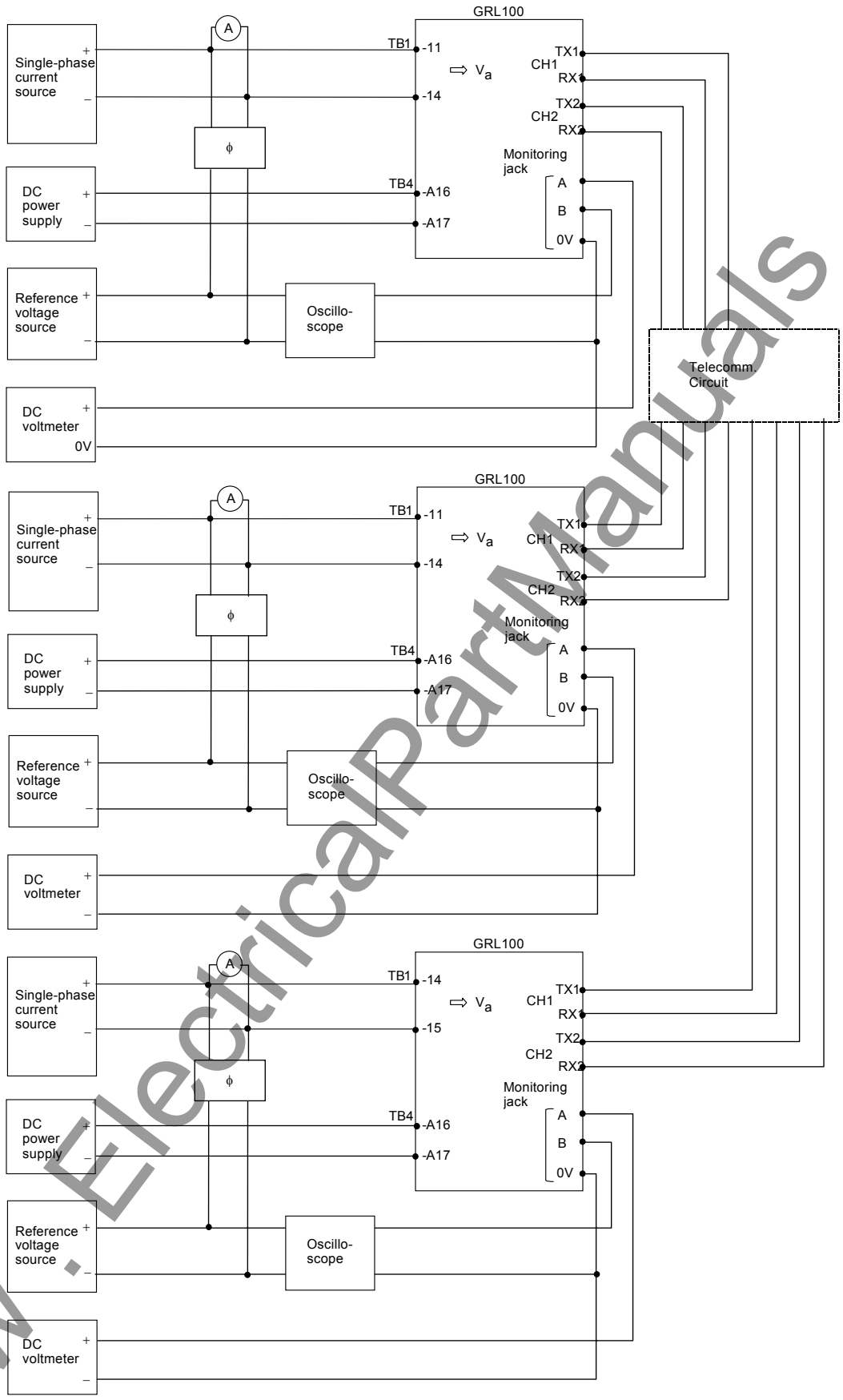



**Figure 6.5.1.11 (b) On-site Setup for Testing Out-of-step Element**

www.ElectricalPartManuals.com

The output signal numbers of the OST element are as follows.

| Element | Signal number | Remarks |
|---|---|---|
| OST1 | 47 | Two-terminal and three-terminal application |
| OST2 | 51 | Three-terminal application |

- Press 4 (=Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number 47 (OST1) or 51 (OST2) to be observed at monitoring jack A and press the [ENTER] key.
- Apply the rated voltage in phase with the reference voltage signal to both relays.
- Shift the applied voltage phase angle from the reference signal at one terminal, and measure the angle just at which the element operates.
- Check that the measured angle is within 180° ±5°.

#### 6.5.1.11 Voltage and synchronism check elements

The test circuit is shown in Figure 6.5.1.12. If scheme switch "3PH-VT" is set to "Bus", the three-phase voltage simulates the busbar voltage, and the single-phase voltage simulates the line voltage. If the switch is set to "Line", the opposite is true.

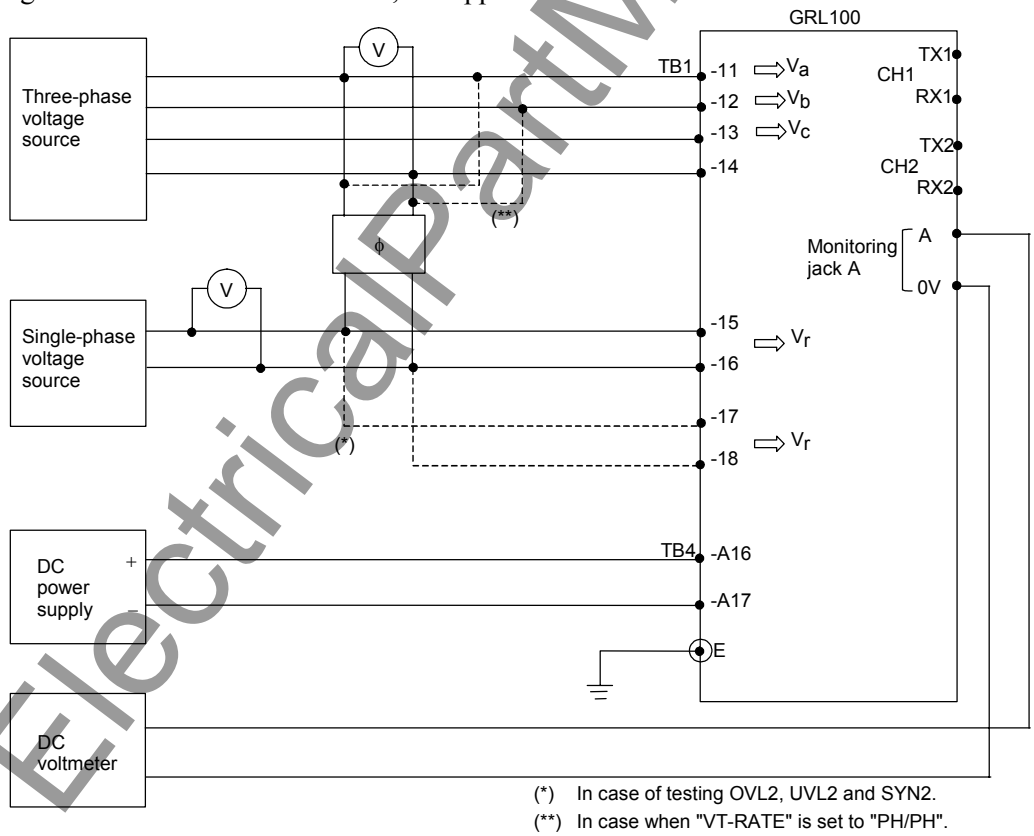



**Figure 6.5.1.12 Testing Synchronism Check Elements**

When testing OVL2, UVL2 and SYN2, a single-phase voltage must be applied to terminals 17 and 18, instead of terminals 15 and 16 and "3PH-VT" is set to "Line".

Voltage and synchronism check elements and their output signal number are listed below. OVL2, UVL2 and SYN2 are used for two-breaker autoreclose.

www.ElectricalPartManuals.com

| Element | Signal number |
|---|---|
| OVB | 57 |
| UVB | 58 |
| OVL1 | 60 |
| UVL1 | 61 |
| OVL2 | 62 |
| UVL2 | 63 |
| SYN1 | 59 |
| SYN2 | 64 |
| OVL1(3PH) | 78 |

Connect the phase angle meter to the three-phase voltages taking the scheme switch "VT-RATE" and VTPH-SEL settings into consideration. The phase angle meter connection shown in Figure 6.5.1.12 is the case for the default settings, ie., "VT-RATE" and "VTPH-SEL" are set to PH/G and A, respectively.

| VT-RATE setting | VTPH-SEL setting | Meter connection phase |
|---|---|---|
| PH/G | A | A-N |
| | B | B-N |
| | C | C-N |
| PH/PH | A | A-B |
| | B | B-C |
| | C | C-A |

**Voltage check element OVB, UVB, OVL1, UVL1, OVL2, and UVL2**

- Press 4 (=Logic circuit) on the "Test" screen to display the "Logic circuit" screen.
- Enter a signal number for the TermA line to be observed at monitoring jack A and press the [ENTER] key.
- Apply a three-phase rated voltage and a single-phase rated voltage as shown in Figure 6.5.1.12.

OVB and UVB:

- Change the magnitude of the three-phase voltage if the scheme switch "3PH-VT" is set to "Bus" or change the magnitude of the single-phase voltage if it is set to "Line". Measure the value at which the element operates and check that it is within ± 5% of the setting.

OVL1 and UVL1:

- Change the magnitude of the single-phase voltage if the scheme switch "3PH-VT" is set to "Bus" or change the magnitude of the three-phase voltage if it is set to "Line". Measure the value at which the element operates and check that it is within ± 5% of the setting.

OVL2 and UVL2:

- Change the magnitude of the single-phase voltage applied to terminal 17 and 18 and measure the value at which the element operates. Check that the measured value is within ± 5% of the setting.

www.ElectricalPartManuals.com

**Synchronism check element SYN1**

- Press 4 (=Logic circuit) on the "Test" screen to display the "Logic circuit" screen.
- Enter a signal number for the TermA line to be observed at monitoring jack A and press the [ENTER] key.
- Apply a three-phase rated voltage and a single-phase rated voltage as shown in Figure 6.5.1.12.

Voltage check:

- Set the three-phase voltage to any value over the SY1OV setting. (The default setting of SY1OV is 51V.)

  Whilst keeping $V_r$ in-phase with $V_a$, lower the single-phase voltage $V_r$ from the rated value. Measure the voltage at which the element operates. Check that the measured voltage is within ± 5% of the SY1UV setting.
- Further lower Vr and measure the voltage at which the element resets. Check that the measured voltage is within ±5% of the SY1OV setting.

Phase angle check:

- Set $V_a$ and $V_r$ to any value between the SY1OV and SY1UV settings keeping $V_a$ in-phase with $V_r$. Then the SYN1 element operates.
- Shift the angle of $V_r$ away from that of $V_a$, and measure the angle at which the element resets.
- Check that the measured angle is within ±5° of the SY1 θ setting. (The default setting of SY1 θ is 30°.)
- Change $V_a$ and $V_r$, and repeat the above.

**Synchronism check element SYN2**

- Apply single-phase rated voltage to terminals 17 and 18 as shown with broken lines in Figure 6.5.1.12 and set the scheme switch "3PH-VT" to "Line". The test can be performed taking the same steps as testing SYN1.

### 6.5.1.12 Current Change Detection Elements OCD, OCD1 and EFD

The test circuit is shown in Figure 6.5.1.13.

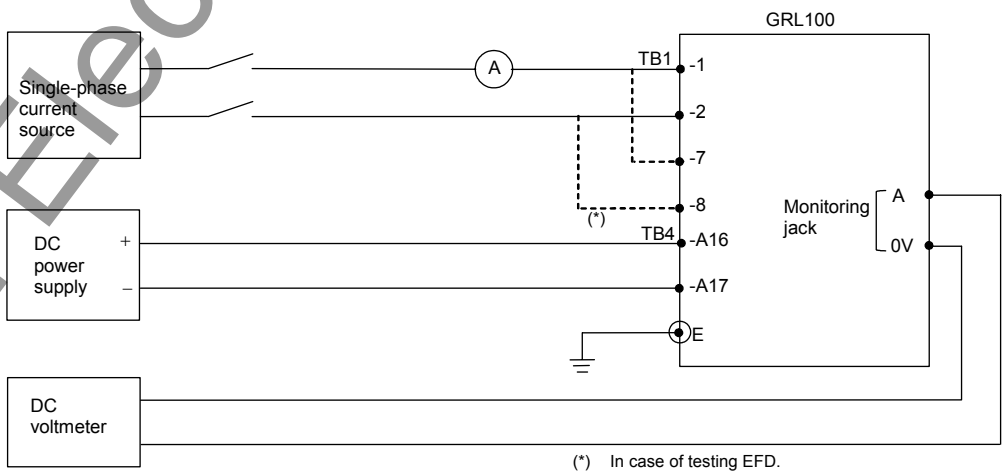



**Figure 6.5.1.13 Testing Current Change Detection Element**

www.ElectricalPartManuals.com

The output signal number of the OCD and OCDP is as follows:

| Measuring element | Signal number |
|---|---|
| OCD-A | 372 |
| OCD-B | 373 |
| OCD-C | 374 |
| OCD1-A | 605 |
| OCD1-B | 606 |
| OCD1-C | 607 |
| EFD | 375 |

Operation must be verified by abruptly changing the test current from 0 A to 1.2 × Setting value or vice versa.

OCD, OCD1 and EFD have a fixed setting.

#### 6.5.1.14 Level Detectors OCH, OC, EF, EFL, OVG, UVLS, UVLG, UVFS, UVFG, OCBF and OC1

Voltage or current level detectors are tested by applying voltage or current individually. A single-phase test source is adequate for these tests.

Change the magnitude of the voltage or current applied and measure the value at which the element operates. Check that the measured value is within 5% of the setting in operation. OCBF resets within 5% of the setting × 0.8.

Level detectors and their output signal numbers are listed below.

| Measuring element | Signal number | Remarks |
|---|---|---|
| OCH-A | 599 | A-phase current |
| OC-A | 65 | A-phase current |
| EF | 71 | Residual current |
| EFL | 634 | Residual current |
| OVG | 350 | Residual voltage |
| UVFS-AB | 619 | A-to-B-phase voltage |
| UVFG-A | 625 | A-phase voltage |
| UVLS-AB | 622 | A-to-B-phase voltage |
| UVLG-A | 628 | A-phase voltage |
| OC1-A | 368 | A-phase current |
| OCBF-A | 54 | A-phase current |

### 6.5.2 Timer

The pick-up delay time of the variable timer can be measured by connecting the monitoring jacks A and B to a time counter as shown in Figure 6.5.2.1. Jacks A and B are used to observe the input signal and output signal of the timer, respectively.

www.ElectricalPartManuals.com

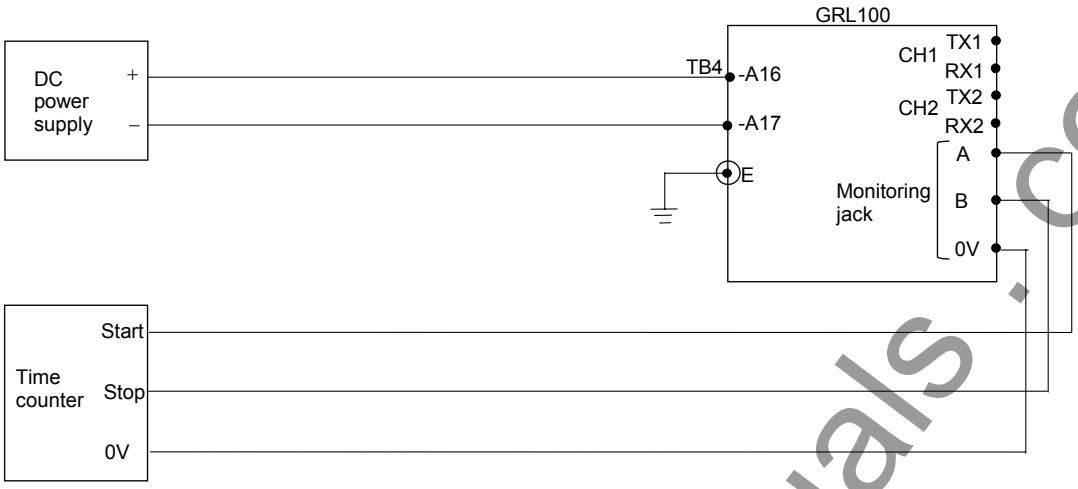



**Figure 6.5.2.1 Testing Variable Timer**

- Press 3 (=Timer) on the "Test" screen to display the "Timer" screen.
- Enter the number corresponding to the timer to be observed. The timers and assigned numbers are listed in Appendix C.
- Press the END key to display the following screen.

```
/2 Timer
Press ENTER to operate.

Press CANCEL to cancel.
```

  - Press the ENTER key to operate the timer. The "TESTING" LED turns on, and the timer is initiated and the following display appears. The input and output signals of the timer can be observed at monitoring jacks A and B respectively. The LEDs above monitoring jacks A or B are also lit if the input or output signal exists.

    Check that the measured time is within 10 ms of the setting time.

```
/2 Timer
Operating.....
Press END to reset.
Press CANCEL to cancel.
```

- Press the END key to reset the input signal to the timer. The "TESTING" LED turns off.

Press CANCEL key to test other timers. Repeat the above testing.

To measure the drop-off delay time, press the END key after the LED above jack B lights. The off-delay time is the time from a signal at the monitoring jack A resets till a signal at the monitoring jack B resets.

www.ElectricalPartManuals.com

### 6.5.3 Protection Scheme

Protection schemes implemented in GRL100 are basically for unit protection. It is recommended that the protection schemes are tested under end-to-end mode. The setup of the end-to-end synchronized test is described in Section 6.5.1.

In the protection scheme tests, a dynamic test set with the three-phase voltage source and current source is required to simulate power system pre-fault, fault and post-fault conditions.

The "Sim.fault" on the LCD "Test" menu is available to test local and remote terminals synchronously. For use, see Section 4.2.7.5

The autoreclose function can be tested together with these tests. A permanent fault should be applied to test a reclose-onto-fault.

Tripping is observed with the tripping command output relays TP-A1 to -C1 and TP-A2 to -C2.

Reclosing is observed with the user configurable reclosing command output relays assigned to signals ARC1 and ARC2. For the default setting, see Appendix D.

#### Differential tripping

When a phase current is applied, instantaneous per phase based tripping or three-phase tripping is performed depending on the fault types, setting of the scheme switches [ARC-M], and [STUB].

The tripping should be checked for the current which is two times or larger than the minimum operating current DIFI1 or DIFGI. Operating time is measured by the operating time of the tripping command output relay. It will typically be 1 cycle.

Check that the indications and recordings are correct.

When a residual current is applied, time-delayed three-phase tripping is performed. Operating time will be 1 cycle plus setting of timer TDIFG. The tripping or reclosing is blocked when the scheme switch [DIFG] or [ARC-DIFG] is set to "OFF".

Check that the indications and recordings are correct.

#### Zone 1 tripping

This performs instantaneous or time-delayed, and single-phase or three-phase tripping depending on the fault types, setting of trip mode control switch [Z1CNT] and autoreclose mode switch [ARC-M].

Zone 1 tripping should be checked for the fault at 50% of the zone 1 reach setting.
Operating time is measured on operation of the trip output relay. It will typically be 1 cycle in case of instantaneous tripping.

Check that the indications and recordings are correct.

#### Zone 2 tripping

Check that three-phase time-delayed final tripping is performed for all kinds of faults. Faults should be set midway between zone 1 and zone 2.

Check that the operating time is 1-1.5 cycle plus zone 2 timer setting.

Check that the indications and recordings are correct.

#### Zone 3 tripping

Check that three-phase time-delayed final tripping is performed for all kinds of faults. Faults should be set midway between zone 2 and zone 3.

www.ElectricalPartManuals.com

Check that the operating time is 1-1.5 cycle plus zone 3 timer setting.

Check that the indications and recordings are correct.

#### Zone R tripping

Set the scheme switches [ZRTP] to "On". (The [ZRTP] default setting is "Off".)

Check that three-phase time-delayed final tripping is performed for all kinds of faults. Faults should be set in the center of zone R.

Check that the operating time is 1-1.5 cycle plus zone R timer setting.

Check that the indications and recordings are correct.

#### Command Protection

The scheme switch [DISCR] is set "On". The carrier send and receive signals are assigned to the binary output and input by PLC function.

#### PUP tripping

Set the scheme switch [CRSCM] to "PUP".

Energize the binary input BIn (assigned to the receive Signal No. 1856 CAR.R1-1) to simulate a trip permission signal reception and apply a zone 2 fault.

Check that instantaneous single-phase or three-phase tripping is performed depending on the fault types and setting of autoreclose mode selection switch [ARC-M].

De-energize the binary input BIn and apply a zone 2 fault. Check that PUP tripping does not occur.

Apply a zone 1 fault, and check that binary output relay BO13 (assigned to the send signal No. 886 CAR-S as default) operates.

Check that the indications and recordings are correct.

#### POP tripping

Set the scheme switch [CRSCM] to "POP", [WKIT] and [ECHO] to "off".

Energize the binary input BIn to simulate a trip permission signal reception and apply a zone 2 fault.

Check that instantaneous single-phase or three-phase tripping is performed depending on the fault types and setting of autoreclose mode selection switch [ARC-M].

Set [WKIT] and [ECHO] to "On" and apply a weak-infeed fault. Check that instantaneous tripping is performed.

De-energize the binary input BIn and apply a zone 2 fault. Check that POP tripping does not occur.

Apply a zone 2 fault, and check that binary output relay BO13 operates.

Set the scheme switch [ECHO] to "On".
De-energize the binary inputs BI1, BI2 and BI3 to simulate the breaker being open.
Check that binary output relay BO13 operates when the binary input BIn is energized.

Apply a zone 4 fault (reverse fault) while the binary inputs BI1, BI2 and BI3 are energized, and check that the binary output relay BO13 does not operate when the binary input BIn is energized.

Check that the indications and recordings are correct.

www.ElectricalPartManuals.com

#### UOP tripping

Set the scheme switch [CRSCM] to "UOP", [WKIT] and [ECHO] to "Off".

De-energize the binary input BIn to simulate interruption of a trip block signal reception and apply a zone 2 fault.

Check that instantaneous single-phase or three-phase tripping is performed depending on the fault types and setting of autoreclose mode selection switch [ARC-M].

Set [WKIT] and [ECHO] to "On" and apply a weak-infeed fault. Check that instantaneous tripping is performed.

Energize the binary input BIn to simulate trip block signal reception and apply a zone 2 fault. Check that UOP tripping does not occur.

Check that binary output relay BO13 operates in the normal condition.
Apply a zone 2 fault, and check that the BO13 resets.

Set the scheme switch [ECHO] to "On".
De-energize the binary inputs BI1, BI2 and BI3 to simulate the breaker being open.
Check that binary output relay BO13 resets when the binary input BIn is de-energized.

Apply a zone 4 fault (reverse fault) while the binary inputs BI1, BI2 and BI3 are energized, and check that the binary output relay BO13 remains operated when the binary input BIn is de-energized.

Check that the indications and recordings are correct.

#### BOP tripping

Set the scheme switch [CRSCM] to "BOP".

Check that the binary input BIn is de-energized and apply a zone 2 fault.

Check that instantaneous single-phase or three-phase tripping is performed depending on the fault types and setting of autoreclose mode selection switch [ARC-M].

Energize the binary input BIn to simulate trip block signal reception and apply a zone 2 fault. Check that BOP tripping does not occur.

Apply a zone 2 fault, and check that binary output relay BO13 does not operate. Apply a zone 4 fault (reverse fault), and check that BO13 operates.

Check that the indications and recordings are correct.

#### SOTF-OC and SOTF-Z tripping

SOTF tripping is carried out by distance measuring element Z1 to ZR operation or overcurrent element OCH operation. Z1 to ZR can perform the SOTF tripping by setting.

The SOTF function is activated when the breaker has been open for timer TSOTF (0 – 300s) setting and active for an additional 500ms after the breaker is closed.

The SOTF function is checked as follows:

- Set the scheme switch [SOTF-OC] to "On" and [SOTF-Z∗] to "Off".

  De-energize the binary input signals BI1 to BI3 (terminal number A4, B4 and A5 of terminal block TB4) for more than TSOTF (0 – 300s) setting.

- Energize the binary input signals and apply a zone 1 fault at the same time.

  Check that the operating time is within 1-1.5 cycle.

- Set the scheme switch [SOTF-OC] to "Off" and [SOTF-Z∗] to "On" and repeat the above.

www.ElectricalPartManuals.com

#### Voltage transformer failure supervision

A voltage transformer (VT) failure is detected when an undervoltage element or residual overvoltage element operates but a current change detection element or residual overcurrent element does not operate accordingly.

VT failure detection is checked as follows:

- Set the circuit breaker closed condition by applying a "1" signal to binary inputs BI1, BI2 and BI3.
- Press 5 (=Logic circuit) on the "Test" screen to display the "Logic circuit" screen.
- Enter signal number 891 for the TermA line to observe the VT failure alarm signal, and 888 for the TermB line to observe the VT failure detection signal at monitoring jack A and B. Press the [ENTER] key.
- Apply a three-phase rated voltage. Then, remove single-, two- or three-phase voltage. Check that the signals are instantly observed at jack B and observed at jack A after a 10s delay.

Blocking of the voltage-dependent protection is checked as follows:

- Apply a three-phase rated voltage. Then, remove single-, two- or three-phase voltage and at the same time apply a zone 1 fault. During this process, do not change the current.

  Check that neither zone 1 tripping nor command tripping takes place.
- In the similar manner, apply a zone 1 extension, zone 2 or zone 3 fault and check that tripping does not take place.

Check that VT failure is recorded on the event record.

#### Power swing blocking

A power swing is detected when the condition that the PSBSOUT element operates and PSBSIN element and residual overcurrent element EFL do not operate, for a period of TPSB setting or more.

Power swing detection is checked as follows:

- Press 5 (=Logic circuit) on the "Test" screen to display the "Logic circuit" screen.
- Enter signal number 765 for the TermA line to observe the power swing blocking signal at monitoring jack A and press the [ENTER] key.
- Apply a phase fault which is set to midway between PSBSIN and PSBSOUT. Check that the signal is generated with a delay of TPSB setting after the PSBSOUT operates. The PSBSOUT operating time will be 1-2 cycles.
- Reset the fault and check that the monitoring signal resets with a 500ms delay after PSBSOUT resets.
- Apply an earth fault which is set to midway between PSBSIN and PSBSOUT. Check that the signal is not generated.

Power swing blocking is checked as follows:

- Apply a zone 1 phase fault after generating the power swing blocking signal. The blocking signal is generated in the way as mentioned above. Check that zone 1 tripping takes place if scheme switch [PSB-Z1] is set to "Off" and does not take place if set to "On".
- In the similar manner, apply zone 2, zone 3 and zone R faults, and check that tripping takes place or does not take place depending on the "On" or "Off" setting of scheme switch

www.ElectricalPartManuals.com

[PSB-Z2], [-Z3] and [-ZR].

Check that power swing blocking is recorded on the event record.

#### Out-of-step tripping

Set the scheme switch [OST] to "Trip".

Shift the phase angle from the second quadrant to the third quadrant or vice versa taking the remote terminal voltage as a reference voltage.

Check that the tripping output relay operates in all phases and autoreclose does not start.

Check that the indications and recordings are correct.

Shift the phase angle from the first quadrant to the fourth quadrant or vice versa taking the remote terminal voltage as a reference voltage.

Check that any of the tripping output relays do not operate.

#### Circuit breaker failure tripping

Set the scheme switch [BF1] to "T" or "TOC" and [BF2] to "ON".

Apply a fault and retain it. Check that the adjacent breaker tripping output relay operates after the time setting of the TBF2.

The adjacent breaker tripping output relay is user configurable and assigned to signal CBF-TRIP. For the setting, see Sections 4.2.6.9 and 4.2.7.2.

### 6.5.4 Metering and Recording

The metering function can be checked whilst testing the AC input circuit. See Section 6.4.4.

Fault recording can be checked whilst testing the protection schemes. Open the "Fault records" screen and check that the descriptions are correct for the applied fault.

The default setting of events is shown in Appendix H. Event recording on the external events such as CB1 ready, Ind.reset, etc., can be checked by changing the status of binary input signals. Change the status in the same way as the binary input circuit test (see Section 6.4.2) and check that the description displayed on the "Event Records" screen is correct.

**Note:** The choice of whether to record or not can be set for each event. Change the status of the binary input signal after confirming that the related event is set to record. (The default setting enables all the events to be recorded.)

Some of the internal events such as Trip, Com1.fail, etc., can be checked in the protection scheme tests.

Disturbance recording can be checked while testing the protection schemes. The LCD display only shows the date and time when a disturbance is recorded. Open the "Disturbance records" screen and check that the descriptions are correct.

Details can be displayed on the PC. Check that the descriptions on the PC are correct. For details on how to obtain disturbance records on the PC, see the RSM100 Manual.

### 6.5.5 Fault Locator

As the fault locator requires local and remote terminal currents, the fault locator can be tested under the end-to-end synchronized test setup.

In the tests, a dynamic test set with the three-phase voltage and current source is required for each terminal to simulate power system pre-fault, fault and post-fault conditions.

www.ElectricalPartManuals.com

The fault locator starts measurement when the current differential protection operates. Therefore, it is preferable to test it whilst testing the protection schemes by applying a fault.

The line parameter settings must be changed to meet those of the test set.

The measurement result is expressed as a percentage of the line length and the distance, and is displayed on the "Fault Record" screen of the LCD.

www . ElectricalPartManuals . com

## 6.6 Conjunctive Tests

### 6.6.1 On Load Test

With the relay connected to the line which is carrying load current, it is possible to check the polarity of the voltage and current transformers and the phase rotation with the metering displays on the LCD screen.

- Open the following "Metering" screen from the "Status" sub-menu.

```
/2 Metering     12/Feb/1998     22:56     3/13
Va    63.5V      0.0°     Ia    2.10A     4.9°
Vb    63.4V   -120.0°     Ib    2.10A  -115.0°
Vc    63.5V    120.1°     Ic    2.15A   125.1°
...
...
Active power     +    400.11MW
Reactive power   -     25.51Mvar
Frequency             60.1 Hz
```

**Note:** The magnitude of voltage, current and power can be set in values on the primary side or on the secondary side by the setting. (The default setting is the primary side.)
Phase angles are expressed taking that of the positive sequence voltage as the reference angle. The sign of the phase angle can be set positive for either lagging phase or leading phase. (In the default setting, it is set positive when the phase is leading to the reference angle.)
The sign of the power flow direction can be set positive for either power sending or power receiving. (The default setting is power sending.)

- Check that the phase rotation is correct.
- Verify the phase relationship between the voltage and current with a known load current direction.

### 6.6.2 Signaling Circuit Test

This test is performed when a command protection using a signaling channel is applied.

The test is to check whether the communication circuit is correctly connected between a

and a remote terminal.

Signal channel for current differential protection:

Input the voltage or current at a remote terminal relay. Check the voltage and current by the "Metering" screen from the "Status" sub-menu at a local relay.

Signal channel for command protection:

This test is performed when a command protection using a signaling channel is applied. The test is carried out after the signal receive and send contacts are connected to the telecommunication circuit.

The signal send circuit from the relay to the telecommunication equipment is checked by forcibly operating the signal send relay and monitoring the signal at the telecommunication equipment.

Signal sending is performed on the LCD using the "Test" sub-menu as follows.

www.ElectricalPartManuals.com

- Press 3 (= Binary output) on the "Test" screen to display the "Binary output" screen. The LCD displays the output modules installed depending on the model.
- Enter 2 to select the IO#2 module, the LCD will display the screen shown below, indicating the name of the module, the name of the output relay, the name of the terminal block and the terminal number to which the relay contact is connected.

```
/3 BO              (0=Disable 1=Enable)   1/14
IO#2   BO1                                0 _
IO#2   BO2                                0
IO#2   BO3                                0
 .
 .
IO#2   BO13                               1
```

- Move the cursor to the bottom line to select the BO13 output relay by pressing the ▼ key, then enter 1 and press the [ENTER] key.
- After completing the entries, press the [END] key. The LCD will display the screen shown below.

```
/3 BO
Keep pressing 1 to operate.

Press CANCEL to cancel.
```

- Keep pressing the [1] key to operate the BO13 output relay forcibly. Then the BO13 output contact will close. Monitor this at the telecommunication equipment.

The signal receive circuit from the telecommunication equipment to the relay is checked with the "Binary input & output" screen on the LCD as follows:

**Note:** The receive signal is assigned to any of the binary inputs by the user setting. The following description is the case of BIn and BIm assigned.

- Display the "Binary I/O" screen from the "Status" sub-menu. Position BIm indicates a receive signal status. Position BIn indicates the status of the guard signal in case of frequency shift signaling.

```
/2 Binary input & output                  3/ 8
Input (IO#1)          [000 000 000 000 000]
Input (IO#2)          [000                ]
Input (IO#3)          [000 000 000 0      ]
Input (IO#4)          [000                ]
Output(IO#1-trip)     [000 000            ]
Output(IO#2)          [000 000 000 000 00 ]
Output(IO#3)          [000 000 000 0      ]
Output(IO#4)          [000 000 000 000 00 ]
```

- Send a signal or interrupt sending a signal at the telecommunication equipment and monitor on the screen that the status of BIn or BIm changes accordingly.

If the signaling circuit connection is completed from the local relay to the remote relay, the test above can be extended to an end-to-end test.

- Send the signal by operating the BO13 output relay at one end with the "Test" sub-menu as described above and monitor the signal reception at the other end on the "Binary input &

www.ElectricalPartManuals.com

output" screen.

In the BOP scheme, the end-to-end test can be carried out more simply on the "Manual test" screen of the "Test" sub-menu. For the details, see Section 4.2.7.2.

**Note:** In these tests it is recommended to block the tripping circuit to prevent false tripping.

### 6.6.3 Tripping and Reclosing Circuit Test

The tripping and reclosing circuit including the circuit breaker is checked by forcibly operating the output relay and monitoring the circuit breaker that is tripped or reclosed. Forcible operation of the output relay is performed on the "Binary output" screen of the "Test" sub-menu as described in Section 6.4.3.

#### Tripping circuit

- Ensure that the circuit breaker is closed.
- Press 2 (=Binary output) on the "Test" sub-menu screen to display the "Binary output" screen. The LCD displays the output modules mounted.
- Enter 1 to select the IO#1 module, then the LCD displays the screen shown below.

```
/3 BO              (0=Disable 1=Enable)   1/ 6
IO#1   TP-A1                              1
IO#1   TP-B1                              1
IO#1   TP-C1                              1
IO#1   TP-A2                              0
IO#1   TP-B2                              0
IO#1   TP-C2                              0
```

TP-A1, B1 and C1 are output relays with one normally open contact, and trip the A-phase, B-phase and C-phase breakers. TP-A2 to C2 are used if two-breaker tripping is required in a one-and-a-half-breaker busbar arrangement.

- Enter 1 for TP-A1 and press the [ENTER] key.
- Press the [END] key. Then the LCD displays the screen shown below.

```
/3 BO
Keep pressing 1 to operate.

Press CANCEL to cancel.
```

- Keep the [1] key pressed to operate the output relay TP-A1 and check that the A-phase breaker is tripped.
- Release pressing the [1] key to reset the operation.
- Repeat the above for all the phases.

#### Reclosing circuit

- Ensure that the circuit breaker is open.
- Press 2 (=Binary output) on the "Test" sub-menu screen to display the "Binary output" screen. The LCD displays the output modules mounted.
- Enter the selected number corresponding to each module to be operated. Then the LCD

www.ElectricalPartManuals.com

displays the name of the module, the name of the output relay, the name of the terminal block and the terminal number to which the relay contact is connected.

**Note:** The autoreclose command is assigned to any of the output relays by the user setting. The following description is the case for the default setting.
In the default setting, the autoreclose command is set to BO9 and BO10 of the IO2 module. (BO9 is used in the two-breaker autoreclose.)

- Enter 2 to select the IO#2 module, then the LCD displays the screen shown below.

```
/3 BO              (0=Disable 1=Enable)   1/14
IO#2   BO1                                 0
IO#2   BO2                                 0
IO#2   BO3                                 0
 ...
IO#2   BO10                                1
IO#2   BO11                                0
IO#2   BO12                                0
IO#2   FAIL                                0
IO#2   BO13                                0
```

Move the cursor by pressing the ▼ key and select BO10. BO10 is an autoreclose command output relay with one normally open contact.

- Enter 1 and press the [ENTER] key.
- Press the [END] key. Then the LCD displays the screen shown below.

```
/3 BO
Keep pressing 1 to operate.

Press CANCEL to cancel.
```

- Keep pressing the [1] key to forcibly operate the output relay BO10 and check that the breaker is closed.
- Release pressing the [1] key to reset the operation.
- In case of two-breaker autoreclose, repeat the forcible operation for BO9.

www.ElectricalPartManuals.com

## 6.7 Maintenance

### 6.7.1 Regular Testing

The relay is almost completely self-supervised. The circuits which cannot be supervised are binary input and output circuits and human interfaces.

Therefore regular testing can be minimized to checking the unsupervised circuits. The test procedures are the same as described in Sections 6.4.1, 6.4.2 and 6.4.3.

### 6.7.2 Failure Tracing and Repair

Failures will be detected by automatic supervision or regular testing.

When a failure is detected by supervision, a remote alarm is issued with the binary output signal of FAIL (*) and the failure is indicated on the front panel with LED indicators or LCD display. It is also recorded in the event record.

(*) Failure signals on the external circuits, namely the signaling channel and isolator circuit, can be allotted to any of the binary output relays by the user. Failure signals of the signaling channel are set to BO11 of the IO2 module as the default setting.

Failures detected by supervision are traced by checking the "Auto-supervision" screen on the LCD.

If any messages are shown on the LCD, the failed module or failed external circuits can be located by referring to Table 6.7.2.1.

This table shows the relationship between messages displayed on the LCD and estimated failure location. Locations marked with (1) have a higher probability than locations marked with (2).

As shown in the table, some of the messages cannot identify the fault location definitely but suggest plural possible failure locations. In these cases, the failure location is identified by replacing the suggested failed modules with spare modules one by one or investigating and restoring the monitored external circuits (the signaling channel and isolator circuit) until the "ALARM" LED is turned off.

The replacement or investigation should be performed first for the module or circuit with higher probability in the table.

If there is a failure and the LCD is not working such as a screen is frozen or not displayed, the failure location is either SPM or HMI module.

www . ElectricalPartManuals . com

**Table 6.7.2.1 LCD Message and Failure Location**

| Message | Failure location | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | VCT | SPM (GCOM) | IO1 | IO2 | IO3, IO5, IO6 | IO4 | HMI | Channel | Discon-nector | AC cable |
| Checksum err | | × | | | | | | | | |
| ROM-RAM err | | × | | | | | | | | |
| SRAM err | | × | | | | | | | | |
| BU-RAM err | | × | | | | | | | | |
| DPRAM err | | × | | | | | | | | |
| EEPROM err | | × | | | | | | | | |
| ROM data err | | × | | | | | | | | |
| A/D err | | × | | | | | | | | |
| V0 err | × (2) | × (1) | | | | | | | | × (2) |
| V2 err | × (2) | × (1) | | | | | | | | × (2) |
| I0 err | × (2) | × (1) | | | | | | | | × (2) |
| Id err | × (2) | × (1) | | | | | | | | × (2) |
| CT err | × (2) | × (2) | | | | | | | | × (1) |
| Sampling err | | × | | | | | | | | |
| DIO err | | × (2) | × (1) | × (1) | × (1) | × (1) | | | | |
| RSM err | | × (2) | × (1) | | | | | | | |
| COM_ ….err | | × | | | | | | | | |
| FD: … err | | × (2) | × (1) | | | | | | | |
| O/P circuit fail | | × (2) | × (1) | | | | | | | |
| DS fail | | × (2) | × (2) | | | | | | × (1) | |
| Com.1 fail, Com.2 fail | | × (2)* | × (2)* | × (2)* | | | | × (1)* | | |
| Sync.1 fail, Sync.2 fail | | × (2)* | × (2)* | × (2)* | | | | × (1)* | | |
| TX1 level err, TX2 level err | | × (1)* | × (2)* | × (2)* | | | | × (1)* | | |
| RX1 level err, RX2 level err | | × (2)* | × (2)* | × (2)* | | | | × (1)* | | |
| CLK 1 fail, CLK 2 fail | | × (2)* | × (2)* | × (2)* | | | | × (1)* | | |
| Term1 rdy off, Term2 rdy off | | × (2)* | | | | | | × (1)* | | |
| RYID1 err, RYID2 err | | × (2)* | | | | | | × (1)* | | |
| CT fail | × (2) | × (2) | | | | | | | | × (1) |
| No-working of LCD | | × (2) | | | | | × (1) | | | |

Note: The location marked with (1) has a higher probability than the location marked with (2).
The item of location marked with (*): also check the remote terminal relays and equipment.

www.ElectricalPartManuals.com

If no message is shown on the LCD, it means that the failure location is either in the DC power supply circuit or in the microprocessors mounted on the SPM module. In this case, check the "ALARM" LED. If it is off, the failure is in the DC power supply circuit. If it is lit, open the relay front panel and check the LEDs mounted on the SPM module. If the LED is off, the failure is in the DC power supply circuit. If the LED is lit, the failure is in the microprocessors.

In the former case, check if the correct DC voltage is applied to the relay. If it is, replace the IO1 module mounting the DC/DC converter and confirm that the "ALARM" LED is turned off. In the latter case, replace the SPM module mounting the processors and confirm that the "ALARM" LED is turned off.

When a failure is detected during regular testing, it will not be difficult to identify the failed module to be replaced.

Note: When a failure or an abnormality is detected during the regular test, confirm the following first:
- Test circuit connections are correct.
- Modules are securely inserted in position.
- Correct DC power voltage with correct polarity is applied and connected to the correct terminals.
- Correct AC inputs are applied and connected to the correct terminals.
- Test procedures comply with those stated in the manual.

### 6.7.3 Replacing Failed Modules

If the failure is identified to be in the relay module and the user has spare modules, the user can recover the protection by replacing the failed modules.

Repair at the site should be limited to module replacement. Maintenance at the component level is not recommended.

Check that the replacement module has an identical module name (VCT, SPM, IO1, IO2, etc.) and hardware type-form as the removed module. Furthermore, the SPM and FD modules should have the same software name.

The module name is indicated on the bottom front of the relay case. The hardware type-form is indicated on the module in the following format:

| Module name | Hardware type-form |
|---|---|
| VCT | G1PC1 - **** |
| SPM | G1SP* - **** |
| IO1 | G1IO1 - **** |
| IO2 | G1IO2 - **** |
| IO3 | G1IO3 - **** |
| IO4 | G1IO2 - **** |
| IO5 | G1IO3 - **** |
| IO6 | G1IO3 - **** |

www . ElectricalPartManuals . com

The software name is indicated on the memory device on the module with six letters such as GS1LM1-**, GS1LC1-**, etc.

**⚠ CAUTION** When handling a module, take anti-static measures such as wearing an earthed wrist band and placing modules on an earthed conductive mat. Otherwise, many of the electronic components could suffer damage.

**CAUTION** After replacing the SPM module, check the settings including the PLC and IEC103 setting data are restored the original settings.

The initial replacement procedure is as follows:

- Switch off the DC power supply.

  **⚠ WARNING** Hazardous voltage may remain in the DC circuit just after switching off the DC power supply. It takes approximately 30 seconds for the voltage to discharge.

- Disconnect the trip outputs.
- Short circuit all AC current inputs and disconnect all AC voltage inputs.
- Unscrew the relay front cover.

**Replacing the Human Machine Interface Module (front panel)**

- Open the front panel of the relay by unscrewing the binding screw located on the left side of the front panel.
- Unplug the ribbon cable on the front panel by pushing the catch outside.
- Remove the two retaining screws and one earthing screw on the relay case side, then detach the front panel from the relay case.
- Attach the replacement module in the reverse procedure.

**Replacing the Transformer Module**

- Open the right-side front panel (HMI module) by unscrewing the two binding screws located on the left side of the panel.
- Open the left-side front panel (blind panel) (*) by unscrewing the two binding screws located on the right side of the panel.

  (*) This blind panel is attached only to models assembled in the type B case.

- Detach the module holding bar by unscrewing the binding screw located on the left side of the bar.
- Unplug the ribbon cable on the SPM by nipping the catch.
- Remove the metal cover by unscrewing the binding screw located at the top and bottom of the cover.
- Pull out the module by grasping the handles.
- Insert the replacement module in the reverse procedure.

**Replacing other modules**

- Open the right-side front panel (HMI module) by unscrewing the two binding screws located on the left side of the panel.
- Open the left-side front panel (blind panel) (*) by unscrewing the two binding screws located on the right side of the panel.

www.ElectricalPartManuals.com

(*) This panel is attached only to models assembled in the type B case.

- Detach the module holding bar by unscrewing the binding screw located on the left side of the bar.
- Unplug the ribbon cable running among the modules by nipping the catch (in case of black connector) and by pushing the catch outside (in case of gray connector) on the connector.
- Unplug the cable connector behind the case when replacing the SPM module.
- Pull out the module by pulling up or down on the top and bottom levers.
- Insert the replacement module in the reverse procedure.

### 6.7.4 Resumption of Service

After replacing the failed module or repairing failed external circuits, take the following procedures to restore the relay to service.

- Switch on the DC power supply and confirm that the "IN SERVICE" green LED is lit and the "ALARM" red LED is not lit.

  **Note:** Supply DC power after checking that all the modules are in their original positions and the ribbon cables are plugged in.

- If the telecommunication circuit or trip circuit was repaired, check that the circuit is normal.
- Supply the AC inputs and reconnect the trip outputs.

### 6.7.5 Storage

The spare relay or module should be stored in a dry and clean room. Based on IEC Standard 60255-0 the storage temperature should be –25°C to +70°C, but the temperature of 0°C to +40°C is recommended for long-term storage.

www . ElectricalPartManuals . com

# 7. Putting Relay into Service

The following procedure must be adhered to when putting the relay into service after finishing commissioning or maintenance tests.

- Check that all external connections are correct.
- Check the settings of all measuring elements, timers, scheme switches, recordings and clock are correct.

  In particular, when settings are changed temporarily for testing, be sure to restore them.
- Clear any unnecessary records on faults, events and disturbances which are recorded during the tests.
- Reset the counter figures of autoreclose, if necessary. For resetting the count, see Section 4.2.3.4.
- Press the VIEW key and check that no failure message is displayed on the "Auto-supervision" screen.
- Check that the green "IN SERVICE" LED is lit and no other LEDs are lit on the front panel.

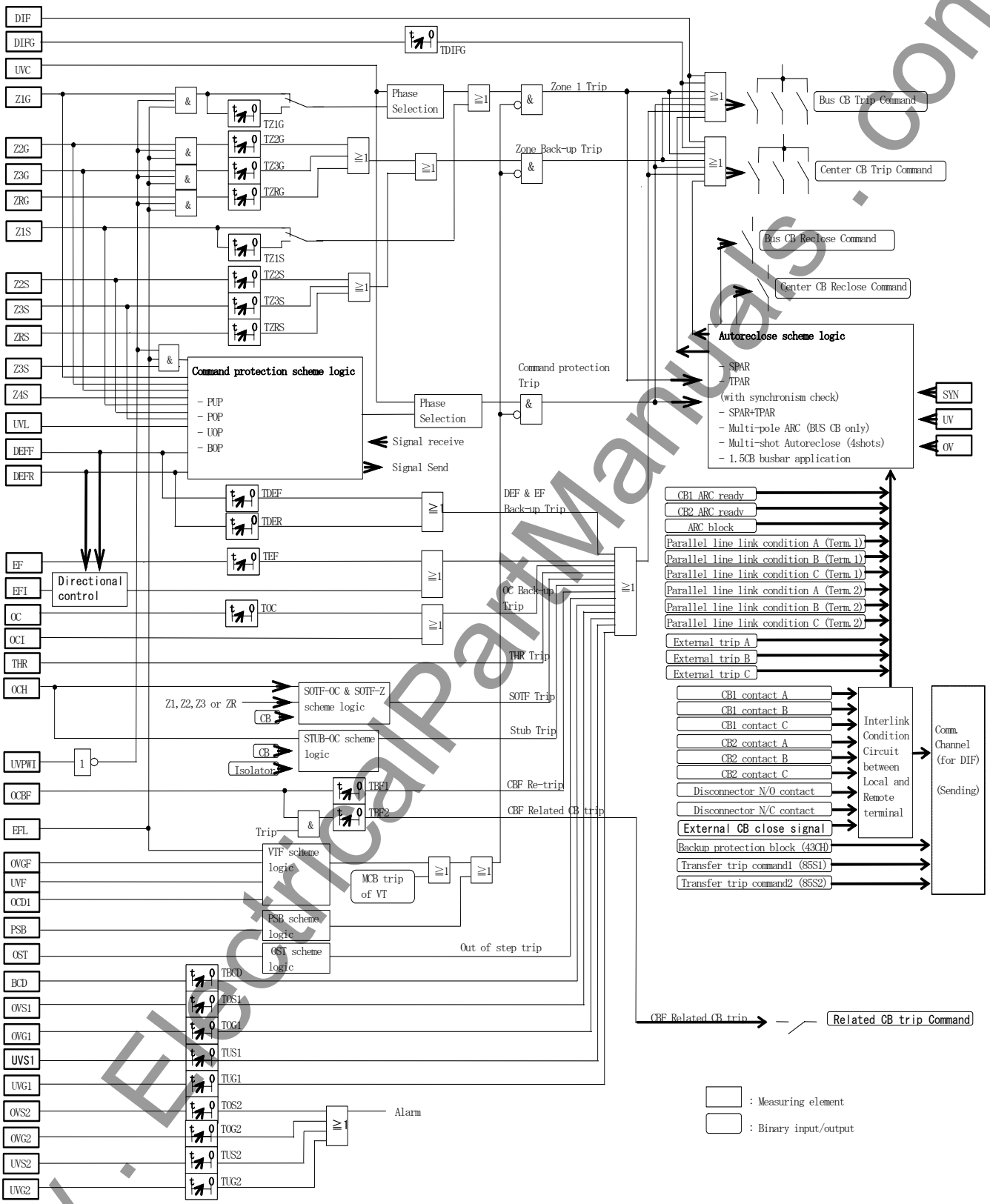
Whilst the relay is put into service at one terminal by supplying DC power and not yet at the other terminal, a communication failure will be detected by the automatic monitoring at the in-service terminal and a red "ALARM" LED is lit. But it will be reset when the relays are put into service at all terminals.

www . ElectricalPartManuals . com

# Appendix A

# Block Diagram

www . ElectricalPartManuals . com




**Block Diagram of Line Differential Relay GRL100-7****

www.ElectricalPartManuals.com

# Appendix B

# Signal List

www.ElectricalPartManuals.com

Signal list

Protection relay output

| No. | Signal Name | Contents |
|---|---|---|
| 0 | CONSTANT_0 | constant 0 |
| 1 | CONSTANT_1 | constant 1 |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | 43CX | Diff.protection enable condition |
| 10 | | |
| 11 | | |
| 12 | | |
| 13 | | |
| 14 | | |
| 15 | 43BUX | Backup protection enable condition |
| 16 | | |
| 17 | | |
| 18 | | |
| 19 | | |
| 20 | | |
| 21 | | |
| 22 | | |
| 23 | | |
| 24 | | |
| 25 | | |
| 26 | | |
| 27 | | |
| 28 | | |
| 29 | | |
| 30 | | |
| 31 | | |
| 32 | | |
| 33 | | |
| 34 | | |
| 35 | | |
| 36 | | |
| 37 | | |
| 38 | ARC_COM.ON | Autorecloser active (for IEC103) |
| 39 | TELE.COM.ON | Teleprotection active (for IEC103) |
| 40 | PROT.COM.ON | Protection active (for IEC103) |
| 41 | DIF-A | DIF-A element output |
| 42 | DIF-B | DIF-B element output |
| 43 | DIF-C | DIF-C element output |
| 44 | DIFG | DIFG element output |
| 45 | OST1A | OST1 A zone |
| 46 | OST1B | OST1 B zone |
| 47 | OST1AB | OST1 A+B zone |
| 48 | OST1 | OST1 element output (OST with terminal 1) |
| 49 | OST2A | OST2 A zone |
| 50 | OST2B | OST2 B zone |
| 51 | OST2AB | OST2 A+B zone |
| 52 | OST2 | OST2 element output (OST with terminal 2) |
| 53 | RELAY_BLOCK | DIF element block signal |
| 54 | OCBF-A | OCBF-A element output |
| 55 | OCBF-B | OCBF-B element output |
| 56 | OCBF-C | OCBF-C element output |
| 57 | OVB | OVB element output |
| 58 | UVB | UVB element output |
| 59 | SYN1 | SYN1 element output |
| 60 | OVL1 | OVL1 element output |
| 61 | UVL1 | UVL1 element output |
| 62 | OVL2 | OVL2 element output |
| 63 | UVL2 | UVL2 element output |
| 64 | SYN2 | SYN2 element output |
| 65 | OC-A | OC-A element output |
| 66 | OC-B | OC-B element output |
| 67 | OC-C | OC-C element output |
| 68 | OCI-A | OCI-A element output |
| 69 | OCI-B | OCI-B element output |
| 70 | OCI-C | OCI-C element output |
| 71 | EF | EF element output |
| 72 | EFI | EFI element output |
| 73 | | |
| 74 | | |
| 75 | | |
| 76 | | |
| 77 | | |
| 78 | OVL-ABC | OVL element output (for 3phase line voltage) |
| 79 | | |
| 80 | 52AND2 | CB2 contact AND logic |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 81 | 52AND1 | CB1 contact AND logic |
| 82 | DIF-A_TRIP | DIF trip signal A |
| 83 | DIF-B_TRIP | DIF trip signal B |
| 84 | DIF-C_TRIP | DIF trip signal C |
| 85 | TDIFG | TDIFG timer output |
| 86 | DIFG_TRIP | DIFG trip signal |
| 87 | OST_TRIP | OST trip signal |
| 88 | RETRIP-A | BFP retrip signal A |
| 89 | RETRIP-B | BFP retrip signal B |
| 90 | RETRIP-C | BFP retrip signal C |
| 91 | CBFDET | BFP operation (88+89+90+92) |
| 92 | CBF_TRIP | BFP adjacent breaker trip command |
| 93 | TRIP-A | Trip signal A |
| 94 | TRIP-B | Trip signal B |
| 95 | TRIP-C | Trip signal C |
| 96 | TRIP-DETOR | Trip signal (93+94+95) |
| 97 | TRIP | Trip signal single shot |
| 98 | STUB | Stub trip signal |
| 99 | TRIP-A1 | CB1 trip command A |
| 100 | TRIP-B1 | CB1 trip command B |
| 101 | TRIP-C1 | CB1 trip command C |
| 102 | TRIP-A2 | CB2 trip command A |
| 103 | TRIP-B2 | CB2 trip command B |
| 104 | TRIP-C2 | CB2 trip command C |
| 105 | FDX1 | Fault detector output relay 1 driving signal |
| 106 | FDX2 | Fault detector output relay 2 driving signal |
| 107 | M-OR | Main trip OR logic |
| 108 | M-AND | Main trip AND logic |
| 109 | FD | Fault detector output OR logic |
| 110 | FD-AND | Fault detector output AND logic |
| 111 | TOC | TOC timer output |
| 112 | TEF | TEF timer output |
| 113 | OC_TRIP | OC trip signal |
| 114 | OCI_TRIP | OCI trip signal |
| 115 | EF_TRIP | EF trip signal |
| 116 | EFBT | EF alarm signal |
| 117 | EFI_TRIP | EFI trip signal |
| 118 | BU_TRIP | Backup trip signal |
| 119 | OST-BO | OST trip signal for BO output |
| 120 | | |
| 121 | REC_BLK12 | Autoreclose block command from remote terminal |
| 122 | TRDY1 | Reclaim time count up signal of leader CB |
| 123 | TSPR1 | Dead time count up signal in leader CB SPAR |
| 124 | TTPR1 | Dead time count up signal in leader CB TPAR |
| 125 | ARC-L | Leader CB autoreclose signal |
| 126 | TPARL-SET | TPAR output set signal in leader CB autoreclose |
| 127 | TRR1 | Leader CB autoreclose reset signal |
| 128 | TRDY2 | Reclaim time count up signal of follower CB |
| 129 | TSPR2 | Dead time count up signal in follower CB SPAR |
| 130 | TTPR2 | Dead time count up signal in follower CB TPAR |
| 131 | ARC-F | Follower CB autoreclose signal |
| 132 | TPAR-F | TPAR output set signal in follower CB autoreclose |
| 133 | TRR2 | Follower CB autoreclose reset signal |
| 134 | TS2 | Second shot autoreclose signal |
| 135 | TS3 | Third shot autoreclose signal |
| 136 | TS4 | Fourth shot autoreclose signal |
| 137 | TS2R | Second shot autoreclose reset signal |
| 138 | TS3R | Third shot autoreclose reset signal |
| 139 | TS4R | Fourth shot autoreclose reset signal |
| 140 | MULTI-ARC | Multi-shot autoreclose signal (134+135+136) |
| 141 | MAROK0 | First shot autoreclose success signal |
| 142 | MAROK1 | Second shot autoreclose success signal |
| 143 | MAROK2 | Third shot autoreclose success signal |
| 144 | MAROK3 | Fourth shot autoreclose success signal |
| 145 | MAR-FT | Multi-shot autoreclose failure signal |
| 146 | 89CB-1AB | Interlink A with terminal 1 |
| 147 | 89CB-2AB | Interlink B with terminal 1 |
| 148 | 89CC-3AB | Interlink C with terminal 1 |
| 149 | 89CB-1AC | Interlink A with terminal 2 |
| 150 | 89CB-2AC | Interlink B with terminal 2 |
| 151 | 89CC-3AC | Interlink C with terminal 2 |
| 152 | LINK | Interlink signal |
| 153 | LB.DL-1 | Live bus and dead line status on CB1 |
| 154 | DB.LL-1 | Dead bus and live line status on CB1 |
| 155 | LB.LL.SYN-1 | Synchronism check output for CB1 |
| 156 | LB.DL-2 | Live bus and dead line status on CB2 |
| 157 | DB.LL-2 | Dead bus and live line status on CB2 |
| 158 | LB.LL.SYN-2 | Synchronism check output for CB2 |
| 159 | SYN-OP | Voltage and synchronism check output (153 +--+ 158) |
| 160 | SYN-SEL | SYN element selection signal |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 161 | TDBL1 | TDBL1 timer output |
| 162 | TLBD1 | TLBD1 timer output |
| 163 | TSYN1 | TSYN1 timer output |
| 164 | TDBL2 | TDBL2 timer output |
| 165 | TLBD2 | TLBD2 timer output |
| 166 | TSYN2 | TSYN2 timer output |
| 167 | REC-READY1 | ARC ready signal in leader CB autoreclose |
| 168 | REC-READY2 | ARC ready signal in follower CB autoreclose |
| 169 | BRIDGE1 | Bridge condition in leader CB autoreclose |
| 170 | BRIDGE2 | Bridge condition in follower CB autoreclose |
| 171 | IN-PROG1 | ARC in-progress in leader CB autoreclose |
| 172 | IN-PROG2 | ARC in-progress in follower CB autoreclose |
| 173 | SPAR1 | Single-phase autoreclose signal for leader CB |
| 174 | SPAR2 | Single-phase autoreclose signal for follower CB |
| 175 | TPAR1 | Three-phase autoreclose signal for leader CB |
| 176 | TPAR2 | Three-phase autoreclose signal for follower CB |
| 177 | ARC1 | Autoreclose command for CB1 |
| 178 | ARC2 | Autoreclose command for CB2 |
| 179 | 94TT1 | Discrepancy trip signal in leader CB autoreclose |
| 180 | 94TT2 | Discrepancy trip signal in follower CB ARC |
| 181 | FT1 | Final trip of leader CB |
| 182 | FT2 | Final trip of center CB |
| 183 | MPAR1 | Multi-phase auoteclosing signal in leader CB ARC |
| 184 | TEVLV | TEVLV timer output |
| 185 | MPAR2 | Multi-phase auoteclosing signal in follower CB ARC |
| 186 | TP-MPH | Multi-phase trip |
| 187 | TP-1PH | single phase trip |
| 188 | TP-2PH | two or more phase trip |
| 189 | TSPR3 | Dead time count up signal in follower CB MPAR |
| 190 | TTPR3 | Dead time count up signal in follower CB MPAR |
| 191 | READY | Local terminal ready |
| 192 | REM1_READY | Terminal 1 ready |
| 193 | REM2_READY | Terminal 2 ready |
| 194 | MASTER | Being set to master terminal |
| 195 | SLAVE | Being set to slave terminal |
| 196 | FG | Trigger signal for end-to-end synchronized test |
| 197 | 85R1.REM1 | Transfer trip command 1 receiving from terminal 1 |
| 198 | 85R2.REM1 | Transfer trip command 2 receiving from terminal 1 |
| 199 | REC-BLK1 | Autoreclose blocked at terminal 1 |
| 200 | TFC_ON1 | TFC scheme ON setting between remote terminal 1 |
| 201 | LOCAL_TEST1 | Terminal 1 "under local test" |
| 202 | 85R1.REM2 | Transfer trip command 1 receiving from terminal 2 |
| 203 | 85R2.REM2 | Transfer trip command 2 receiving from terminal 2 |
| 204 | REC-BLK2 | Autoreclose blocked at terminal 2 |
| 205 | TFC_ON2 | TFC scheme ON setting between remote terminal 2 |
| 206 | LOCAL_TEST2 | Terminal 2 "under local test" |
| 207 | REM1_IN_SRV | Terminal 1 "in-service" |
| 208 | REM1_OFF_SRV | Terminal 1 "out-of-service" |
| 209 | REM1_NON_USE | Terminal 1 "not used" |
| 210 | REM2_IN_SRV | Terminal 2 "in-service" |
| 211 | REM2_OFF_SRV | Terminal 2 "out-of-service" |
| 212 | REM2_NON_USE | Terminal 2 "not used" |
| 213 | UNREADY1 | Terminal 1 communication not ready |
| 214 | CFSV1 | Terminal 1 CFSV |
| 215 | SPSV1 | Sampling synchronization with terminal 1 failure signal |
| 216 | TX_LEVEL1 | Terminal 1 drop of transmission signal level |
| 217 | RX_LEVEL1 | Terminal 1 drop of receiving signal level |
| 218 | CLK1 | Terminal 1 interrupt of clock signal |
| 219 | UNREADY2 | Terminal 2 communication not ready |
| 220 | CFSV2 | Terminal 2 CFSV |
| 221 | SPSV2 | Sampling synchronization with terminal 2 failure signal |
| 222 | TX_LEVEL2 | Terminal 2 drop of transmission signal level |
| 223 | RX_LEVEL2 | Terminal 2 drop of receiving signal level |
| 224 | CLK2 | Terminal 2 interrupt of clock signal |
| 225 | COMM1_FAIL | Communication with terminal 1 failure signal |
| 226 | COMM2_FAIL | Communication with terminal 2 failure signal |
| 227 | TRANSFER | Transfer trip receive |
| 228 | RDIF-R1_OR | RDIF1 (Remote differential trip received from remote-1) |
| 229 | RDIF-R2_OR | RDIF2 (Remote differential trip received from remote-2) |
| 230 | CFSV1/2-L | CFSV1/2-L (Communication fail (236+238)) |
| 231 | RLY_FAIL | Relay failure |
| 232 | RLY_OP_BLK | Relay output block |
| 233 | AMF_OFF | A.M.F disabling signal |
| 234 | O/P_CIR._SV | False operation of tripping output circuit |
| 235 | LSSV | DS failure signal |
| 236 | CFSV1-L | CFSV1-L (Communication with term.1 fail detected by local relay) |
| 237 | CFSV1-R | CFSV1-R (Communication with term.1 fail detected by remote relay) |
| 238 | CFSV2-L | CFSV2-L (Communication with term.2 fail detected by local relay) |
| 239 | CFSV2-R | CFSV2-R (Communication with term.2 fail detected by remote relay) |
| 240 | | |

www.ElectricalPartManuals.com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 241 | | |
| 242 | | |
| 243 | | |
| 244 | | |
| 245 | | |
| 246 | | |
| 247 | | |
| 248 | | |
| 249 | | |
| 250 | | |
| 251 | CHECKING | During automatic checking |
| 252 | CHK_FAIL-Q | Fail-to-operate of tripping output circuit |
| 253 | CHK_STEP1 | Checking step1 |
| 254 | CHK_STEP2 | Checking step2 |
| 255 | CHK_STEP3 | Checking step3 |
| 256 | OC/OCI_TRIP | OC/OCI trip |
| 257 | EF/EFI_TRIP | EF/EFI trip |
| 258 | RYIDSV1 | RYIDSV1 (Remote 1 relay address monitoring) |
| 259 | RYIDSV2 | RYIDSV2 (Remote 2 relay address monitoring) |
| 260 | | |
| 261 | TRIP-H | Trip signal hold |
| 262 | | |
| 263 | DEG_ALARM | DEG ALARM output |
| 264 | AMP_ALARM | AMP ALARM output |
| 265 | DEG_OK | DEG OK output |
| 266 | CF1 | Telecommunication failure detect signal for ch#1 |
| 267 | CF2 | Telecommunication failure detect signal for ch#2 |
| 268 | TDSV1 | Telecommunication delay time over of ch#1 |
| 269 | TDSV2 | Telecommunication delay time over of ch#2 |
| 270 | 50/60Hz | Pulse signal for end-to-end test |
| 271 | 1PPS_OFF | 1PPS signal check (instant) |
| 272 | 1PPS_SV-L | 1PPS signal check for a certain time at local term. |
| 273 | 1PPS_SV-R | 1PPS signal check for a certain time at remote term. |
| 274 | 1PPS_ERROR | 1PPS signal interval error |
| 275 | | |
| 276 | | |
| 277 | | |
| 278 | | ch2 used for sampling synchoronization |
| 279 | DIF#1_ | DIF#1 element block signal |
| 280 | DIF#2 | DIF#2 element block signal |
| 281 | DIF-A#1 | DIF-A#1 element output |
| 282 | DIF-B#1 | DIF-B#1 element output |
| 283 | DIF-C#1 | DIF-C#1 element output |
| 284 | DIFG#1 | DIFG#1 element output |
| 285 | DIF-A#2 | DIF-A#2 element output |
| 286 | DIF-B#2 | DIF-B#2 element output |
| 287 | DIF-C#2 | DIF-C#2 element output |
| 288 | DIFG#2 | DIFG#2 element output |
| 289 | OVER_PH | Phase difference (over) |
| 290 | INVALID_PH | Phase difference (invalid) |
| 291 | UNDER_PH | Phase difference (under) |
| 292 | | |
| 293 | | |
| 294 | | |
| 295 | MODE2A | Synchronization in MODE2A |
| 296 | | |
| 297 | | |
| 298 | | |
| 299 | | |
| 300 | | |
| 301 | OCMF-L1 | OCMF-L1 element output |
| 302 | OCMF-L2 | OCMF-L2 element output |
| 303 | OCMF-L3 | OCMF-L3 element output |
| 304 | OCMF-L4 | OCMF-L4 element output |
| 305 | OCMF-L5 | OCMF-L5 element output |
| 306 | OCMF-L6 | OCMF-L6 element output |
| 307 | OCMF-L7 | OCMF-L7 element output |
| 308 | OCMF | OCMF element output “OR” |
| 309 | OCDF-A | OCDF-A element output |
| 310 | OCDF-B | OCDF-B element output |
| 311 | OCDF-C | OCDF-C element output |
| 312 | OVL-A | OVL-A element output (for 3phase line voltage) |
| 313 | OVL-B | OVL-B element output (for 3phase line voltage) |
| 314 | OVL-C | OVL-C element output (for 3phase line voltage) |
| 315 | | |
| 316 | EFF | EFF element output |
| 317 | UVSF-AB | UVSF-A element output |
| 318 | UVSF-BC | UVSF-B element output |
| 319 | UVSF-CA | UVSF-C element output |
| 320 | | |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 321 | UVGF-A | UVGF-A element output |
| 322 | UVGF-B | UVGF-B element output |
| 323 | UVGF-C | UVGF-C element output |
| 324 | | |
| 325 | UVDF-A | UVDF-A element output |
| 326 | UVDF-B | UVDF-B element output |
| 327 | UVDF-C | UVDF-C element output |
| 328 | | |
| 329 | | |
| 330 | | |
| 331 | | |
| 332 | | |
| 333 | TMPR1 | Dead time count up signal in leader CB MPAR |
| 334 | TMPR2 | Dead time count up signal in follower CB MPAR |
| 335 | TMPR3 | Dead time count up signal in follower CB MPAR |
| 336 | CF1 | Telecommunication failure detect signal for ch#1 |
| 337 | RXSA1_ERR | RXSA synchronization error for ch#1 |
| 338 | CF2 | Telecommunication failure detect signal for ch#2 |
| 339 | RXSA2_ERR | RXSA synchronization error for ch#2 |
| 340 | 1PPS_SV-R2 | 1PPS signal check for a certain time at remote#2 term. |
| 341 | | |
| 342 | | |
| 343 | | |
| 344 | | |
| 345 | | |
| 346 | | |
| 347 | | |
| 348 | | |
| 349 | | |
| 350 | OVG | EARTH OV RELAY |
| 351 | | |
| 352 | | |
| 353 | | |
| 354 | | |
| 355 | | |
| 356 | | |
| 357 | | |
| 358 | | |
| 359 | | |
| 360 | | |
| 361 | | |
| 362 | | |
| 363 | THMT | Thermal trip element output |
| 364 | ZRS-AB | PHASE FAULT RELAY ZRS |
| 365 | ZRS-BC | ditto |
| 366 | ZRS-CA | ditto |
| 367 | THMA | Thermal alarm element output |
| 368 | OC1-A | OC1-A element output |
| 369 | OC1-B | OC1-B element output |
| 370 | OC1-C | OC1-C element output |
| 371 | | |
| 372 | OCD-A | OCD-A element output |
| 373 | OCD-B | OCD-B element output |
| 374 | OCD-C | OCD-C element output |
| 375 | EFD | EFD element output |
| 376 | | |
| 377 | | |
| 378 | | |
| 379 | | |
| 380 | | |
| 381 | CTFID-A | Id element output |
| 382 | CTFID-B | ditto |
| 383 | CTFID-C | ditto |
| 384 | DIFSV-A | DIFSV-A element output |
| 385 | DIFSV-B | DIFSV-B element output |
| 386 | DIFSV-C | DIFSV-C element output |
| 387 | CTFID | Id element output |
| 388 | CTFUV-A | UV element for CTF function |
| 389 | CTFUV-B | ditto |
| 390 | CTFUV-C | ditto |
| 391 | CTFOVG | OVG element for CTF function |
| 392 | CTFUVD-A | UVD element for CTF function |
| 393 | CTFUVD-B | ditto |
| 394 | CTFUVD-C | ditto |
| 395 | CTFUV | UV element for CTF function |
| 396 | CTFUVD | UVD element for CTF function |
| 397 | | |
| 398 | | |
| 399 | | |
| 400 | DIF.FS_TRIP | DIF trip with FS |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 401 | DIF.FS-A_TRIP | DIF-A trip with FS |
| 402 | DIF.FS-B_TRIP | DIF-B trip with FS |
| 403 | DIF.FS-C_TRIP | DIF-C trip with FS |
| 404 | DIFG.FS_TRIP | DIFG trip with FS |
| 405 | DIF_TRIP | DIF trip signal |
| 406 | | |
| 407 | | |
| 408 | DIFFS_OP | Fail safe for DIF trip |
| 409 | DIFFS-A_OP | ditto |
| 410 | DIFFS-B_OP | ditto |
| 411 | DIFFS-C_OP | ditto |
| 412 | DIFGFS_OP | Fail safe for DIFG trip |
| 413 | | |
| 414 | | |
| 415 | | |
| 416 | THM_ALARM | Thermal alarm signal |
| 417 | THM_TRIP | Thermal trip signal |
| 418 | TR1_TRIP | TRANSFER TRIP-1 |
| 419 | TR1-A_TRIP | TRANSFER TRIP-1 (A ph.) |
| 420 | TR1-B_TRIP | TRANSFER TRIP-1 (B ph.) |
| 421 | TR1-C_TRIP | TRANSFER TRIP-1 (C ph.) |
| 422 | INTER_TRIP1 | INTER TRIP-1 |
| 423 | INTER_TRIP1-A | INTER TRIP-1 (A ph.) |
| 424 | INTER_TRIP1-B | INTER TRIP-1 (B ph.) |
| 425 | INTER_TRIP1-C | INTER TRIP-1 (C ph.) |
| 426 | TR2_TRIP | TRANSFER TRIP-2 |
| 427 | TR2-A_TRIP | TRANSFER TRIP-2 (A ph.) |
| 428 | TR2-B_TRIP | TRANSFER TRIP-2 (B ph.) |
| 429 | TR2-C_TRIP | TRANSFER TRIP-2 (C ph.) |
| 430 | INTER_TRIP2 | INTER TRIP-2 |
| 431 | INTER_TRIP2-A | INTER TRIP-2 (A ph.) |
| 432 | INTER_TRIP2-B | INTER TRIP-2 (B ph.) |
| 433 | INTER_TRIP2-C | INTER TRIP-2 (C ph.) |
| 434 | LOCAL_TEST | LOCAL TESTING SW ON |
| 435 | TP-A | Trip A-phase command without off-delay timer |
| 436 | TP-B | Trip B-phase command without off-delay timer |
| 437 | TP-C | Trip C-phase command without off-delay timer |
| 438 | SHOT_NUM1 | Trip/Auto-Reclosing shot number1 condition |
| 439 | SHOT_NUM2 | Trip/Auto-Reclosing shot number2 condition |
| 440 | SHOT_NUM3 | Trip/Auto-Reclosing shot number3 condition |
| 441 | SHOT_NUM4 | Trip/Auto-Reclosing shot number4 condition |
| 442 | SHOT_NUM5 | Trip/Auto-Reclosing shot number5 condition |
| 443 | I.LINK-A | InterIink signal |
| 444 | I.LINK-B | ditto |
| 445 | I.LINK-C | ditto |
| 446 | TRIP_ALARM | Trip alarm |
| 447 | READY1_ALARM | Terminal 1 ready |
| 448 | READY2_ALARM | Terminal 2 ready |
| 449 | ARCMD_ALARM | PLC Autoreclosing mode discrepancy alarm |
| 450 | TFC_ON | TFC scheme ON setting |
| 451 | RDIF-A-S | Remote DIF trip sending signal |
| 452 | RDIF-B-S | ditto |
| 453 | RDIF-C-S | ditto |
| 454 | RDIF-S | ditto |
| 455 | RD.FS_TRIP | RDIF trip with FS |
| 456 | RD.FS-A_TRIP | RDIF-A trip with FS |
| 457 | RD.FS-B_TRIP | RDIF-B trip with FS |
| 458 | RD.FS-C_TRIP | RDIF-C trip with FS |
| 459 | OC-A_TRIP | OC-A trip signal |
| 460 | OC-B_TRIP | OC-B trip signal |
| 461 | OC-C_TRIP | OC-C trip signal |
| 462 | OCI-A_TRIP | OCI-A trip signal |
| 463 | OCI-B_TRIP | OCI-B trip signal |
| 464 | OCI-C_TRIP | OCI-C trip signal |
| 465 | IDSV-A | Id-A failure signal |
| 466 | IDSV-B | Id-A failure signal |
| 467 | IDSV-C | Id-A failure signal |
| 468 | | |
| 469 | | |
| 470 | | |
| 471 | | |
| 472 | | |
| 473 | | |
| 474 | | |
| 475 | | |
| 476 | | |
| 477 | ARC-SET | output set signal in leader CB autoreclose |
| 478 | CCB-SET | CCB output set signal in leader CB autoreclose |
| 479 | CB_UNDRY.L_ST | Starting signal for Final Trip with CB unready |
| 480 | ARCMD_OFF | Autoreclosing mode (Disable) |

www.ElectricalFanuals.com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 481 | ARCMD_SPAR | ditto (SPAR) |
| 482 | ARCMD_TPAR | ditto (MPAR) |
| 483 | ARCMD_S&T | ditto (SPAR & TPAR) |
| 484 | ARCMD_MAPR2 | ditto (MPAR2) |
| 485 | ARCMD_MPAR3 | ditto (MPAR3) |
| 486 | ARCMD_EXT1P | ditto (EXT1P) |
| 487 | ARCMD_EXT3P | ditto (EXT3P) |
| 488 | ARCMD_EXTMP | ditto (EXTMP) |
| 489 | ARC_SUCCESS1 | Leader CB autoreclose success signal |
| 490 | ARC_SUCCESS2 | Follower CB autoreclose success signal |
| 491 | TSUC1 | ARC.L success reset signal |
| 492 | TSUC2 | ARC.F success reset signal |
| 493 | ARC_FAIL1 | Leader CB autoreclose fail signal |
| 494 | ARC_FAIL2 | Follower CB autoreclose fail signal |
| 495 | | |
| 496 | CTF | CTF detection |
| 497 | CTF_ALARM | CTF alarm |
| 498 | 3PLL | Three phase live line element output |
| 499 | LB | Selected live bus mode |
| 500 | DB | Selected dead bus mode |
| 501 | SYN | Selected Synchronism check mode |
| 502 | | |
| 503 | | |
| 504 | UARCSW_P1 | User ARC switch Position1 |
| 505 | UARCSW_P2 | User ARC switch Position2 |
| 506 | UARCSW_P3 | User ARC switch Position3 |
| 507 | | |
| 508 | | |
| 509 | | |
| 510 | | |
| 511 | | |
| 512 | | |
| 513 | BI1_COMMAND | Binary input signal BI1 |
| 514 | BI2_COMMAND | Binary input signal BI2 |
| 515 | BI3_COMMAND | Binary input signal BI3 |
| 516 | BI4_COMMAND | Binary input signal BI4 |
| 517 | BI5_COMMAND | Binary input signal BI5 |
| 518 | BI6_COMMAND | Binary input signal BI6 |
| 519 | BI7_COMMAND | Binary input signal BI7 |
| 520 | BI8_COMMAND | Binary input signal BI8 |
| 521 | BI9_COMMAND | Binary input signal BI9 |
| 522 | BI10_COMMAND | Binary input signal BI10 |
| 523 | BI11_COMMAND | Binary input signal BI11 |
| 524 | BI12_COMMAND | Binary input signal BI12 |
| 525 | BI13_COMMAND | Binary input signal BI13 |
| 526 | BI14_COMMAND | Binary input signal BI14 |
| 527 | BI15_COMMAND | Binary input signal BI15 |
| 528 | BI16_COMMAND | Binary input signal BI16 |
| 529 | BI17_COMMAND | Binary input signal BI17 |
| 530 | BI18_COMMAND | Binary input signal BI18 |
| 531 | BI19_COMMAND | Binary input signal BI19 |
| 532 | BI20_COMMAND | Binary input signal BI20 |
| 533 | BI21_COMMAND | Binary input signal BI21 |
| 534 | BI22_COMMAND | Binary input signal BI22 |
| 535 | BI23_COMMAND | Binary input signal BI23 |
| 536 | BI24_COMMAND | Binary input signal BI24 |
| 537 | BI25_COMMAND | Binary input signal BI25 |
| 538 | BI26_COMMAND | Binary input signal BI26 |
| 539 | BI27_COMMAND | Binary input signal BI27 |
| 540 | BI28_COMMAND | Binary input signal BI28 |
| 541 | BI34_COMMAND | Binary input signal BI34 |
| 542 | BI35_COMMAND | Binary input signal BI35 |
| 543 | BI36_COMMAND | Binary input signal BI36 |
| 544 | | |
| 545 | | |
| 546 | | |
| 547 | | |
| 548 | | |
| 549 | | |
| 550 | | |
| 551 | | |
| 552 | | |
| 553 | | |
| 554 | | |
| 555 | | |
| 556 | | |
| 557 | | |
| 558 | | |
| 559 | | |
| 560 | Z1G-A | EARTH FAULT RELAY Z1G |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 561 | Z1G-B | ditto |
| 562 | Z1G-C | ditto |
| 563 | Z2G-A | EARTH FAULT RELAY Z2G |
| 564 | Z2G-B | ditto |
| 565 | Z2G-C | ditto |
| 566 | Z3G-A | EARTH FAULT RELAY Z3G |
| 567 | Z3G-B | ditto |
| 568 | Z3G-C | ditto |
| 569 | Z4G-A | EARTH FAULT RELAY Z4G |
| 570 | Z4G-B | ditto |
| 571 | Z4G-C | ditto |
| 572 | ZRG-A | EARTH FAULT RELAY ZRG |
| 573 | ZRG-B | ditto |
| 574 | ZRG-C | ditto |
| 575 | Z1S-AB | PHASE FAULT RELAY Z1S |
| 576 | Z1S-BC | ditto |
| 577 | Z1S-CA | ditto |
| 578 | Z2S-AB | PHASE FAULT RELAY Z2S |
| 579 | Z2S-BC | ditto |
| 580 | Z2S-CA | ditto |
| 581 | Z3S-AB | PHASE FAULT RELAY Z3S |
| 582 | Z3S-BC | ditto |
| 583 | Z3S-CA | ditto |
| 584 | Z4S-AB | PHASE FAULT RELAY Z4S |
| 585 | Z4S-BC | ditto |
| 586 | Z4S-CA | ditto |
| 587 | PSBGOUT-A | POWER SWING BLOCK for ZG OUTER ELEMENT |
| 588 | PSBGOUT-B | ditto |
| 589 | PSBGOUT-C | ditto |
| 590 | PSBGIN-A | POWER SWING BLOCK FOR ZG INNER ELEMENT |
| 591 | PSBGIN-B | ditto |
| 592 | PSBGIN-C | ditto |
| 593 | PSBSOUT-AB | POWER SWING BLOCK for ZS OUTER ELEMENT |
| 594 | PSBSOUT-BC | ditto |
| 595 | PSBSOUT-CA | ditto |
| 596 | PSBSIN-AB | POWER SWING BLOCK FOR ZS INNER ELEMENT |
| 597 | PSBSIN-BC | ditto |
| 598 | PSBSIN-CA | ditto |
| 599 | OCH-A | HIGH SET OC RELAY |
| 600 | OCH-B | ditto |
| 601 | OCH-C | ditto |
| 602 | OCCR-A | OC RELAY FOR LINE VT |
| 603 | OCCR-B | ditto |
| 604 | OCCR-C | ditto |
| 605 | OCD1-A | CURRENT CHANGE DETEC. RELAY |
| 606 | OCD1-B | ditto |
| 607 | OCD1-C | ditto |
| 608 | UVC-A | UV RELAY (PHASE SELECTOR) |
| 609 | UVC-B | ditto |
| 610 | UVC-C | ditto |
| 611 | DEFF | DIRECT. EF RLY (INTERNAL) |
| 612 | DEFR | DIRECT. EF RLY (EXTERNAL) |
| 613 | DEFF_INST | DEFF relay element start |
| 614 | DEFF_RST | DEFF relay element delayed reset |
| 615 | DEFF_BU | DEFF backup |
| 616 | DEFR_INST | DEFR relay element start |
| 617 | DEFR_RST | DEFR relay element delayed reset |
| 618 | DEFR_BU | DEFR backup |
| 619 | UVFS-AB | UV RELAY (High set) |
| 620 | UVFS-BC | ditto |
| 621 | UVFS-CA | ditto |
| 622 | UVLS-AB | UV RELAY (Low set) |
| 623 | UVLS-BC | ditto |
| 624 | UVLS-CA | ditto |
| 625 | UVFG-A | UV RELAY (High set) |
| 626 | UVFG-B | ditto |
| 627 | UVFG-C | ditto |
| 628 | UVLG-A | UV RELAY (Low set) |
| 629 | UVLG-B | ditto |
| 630 | UVLG-C | ditto |
| 631 | UVPWI-A | UV RELAY |
| 632 | UVPWI-B | ditto |
| 633 | UVPWI-C | ditto |
| 634 | EFL | EARTH FAULT RELAY |
| 635 | BCD | BCD relay element output |
| 636 | UVD-A | UVD relay element |
| 637 | UVD-B | ditto |
| 638 | UVD-C | ditto |
| 639 | OVS1-AB | OVS1-AB relay element output |
| 640 | OVS1-BC | OVS1-BC relay element output |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 641 | OVS1-CA | OVS1-CA relay element output |
| 642 | OVS2-AB | OVS2-AB relay element output |
| 643 | OVS2-BC | OVS2-BC relay element output |
| 644 | OVS2-CA | OVS2-CA relay element output |
| 645 | OVG1-A | OVG1-A relay element output |
| 646 | OVG1-B | OVG1-B relay element output |
| 647 | OVG1-C | OVG1-C relay element output |
| 648 | OVG2-A | OVG2-A relay element output |
| 649 | OVG2-B | OVG2-B relay element output |
| 650 | OVG2-C | OVG2-C relay element output |
| 651 | OVS1-AB_INST | OVS1-AB relay element start |
| 652 | OVS1-BC_INST | OVS1-BC relay element start |
| 653 | OVS1-CA_INST | OVS1-CA relay element start |
| 654 | OVS1-AB_RST | OVS1-AB relay element delayed reset |
| 655 | OVS1-BC_RST | OVS1-BC relay element delayed reset |
| 656 | OVS1-CA_RST | OVS1-CA relay element delayed reset |
| 657 | OVG1-A_INST | OVG1-A relay element start |
| 658 | OVG1-B_INST | OVG1-B relay element start |
| 659 | OVG1-C_INST | OVG1-C relay element start |
| 660 | OVG1-A_RST | OVG1-A relay element delayed reset |
| 661 | OVG1-B_RST | OVG1-B relay element delayed reset |
| 662 | OVG1-C_RST | OVG1-C relay element delayed reset |
| 663 | UVS1-AB | UVS1-AB relay element output |
| 664 | UVS1-BC | UVS1-BC relay element output |
| 665 | UVS1-CA | UVS1-CA relay element output |
| 666 | UVS2-AB | UVS2-AB relay element output |
| 667 | UVS2-BC | UVS2-BC relay element output |
| 668 | UVS2-CA | UVS2-CA relay element output |
| 669 | UVG1-A | UVG1-A relay element output |
| 670 | UVG1-B | UVG1-B relay element output |
| 671 | UVG1-C | UVG1-C relay element output |
| 672 | UVG2-A | UVG2-A relay element output |
| 673 | UVG2-B | UVG2-B relay element output |
| 674 | UVG2-C | UVG2-C relay element output |
| 675 | UVS1-AB_INST | UVS1-AB relay element start |
| 676 | UVS1-BC_INST | UVS1-BC relay element start |
| 677 | UVS1-CA_INST | UVS1-CA relay element start |
| 678 | UVS1-AB_RST | UVS1-AB relay element delayed reset |
| 679 | UVS1-BC_RST | UVS1-BC relay element delayed reset |
| 680 | UVS1-CA_RST | UVS1-CA relay element delayed reset |
| 681 | UVG1-A_INST | UVG1-A relay element start |
| 682 | UVG1-B_INST | UVG1-B relay element start |
| 683 | UVG1-C_INST | UVG1-C relay element start |
| 684 | UVG1-A_RST | UVG1-A relay element delayed reset |
| 685 | UVG1-B_RST | UVG1-B relay element delayed reset |
| 686 | UVG1-C_RST | UVG1-C relay element delayed reset |
| 687 | UVSBLK-AB | UVSBLK-AB relay element output |
| 688 | UVSBLK-BC | UVSBLK-BC relay element output |
| 689 | UVSBLK-CA | UVSBLK-CA relay element output |
| 690 | UVGBLK-A | UVGBLK-A relay element output |
| 691 | UVGBLK-B | UVGBLK-B relay element output |
| 692 | UVGBLK-C | UVGBLK-C relay element output |
| 693 | BFS-AB | BLINDER FOR ZS (FORWARD) |
| 694 | BFS-BC | ditto |
| 695 | BFS-CA | ditto |
| 696 | BRS-AB | BLINDER FOR ZS (REVERSE) |
| 697 | BRS-BC | ditto |
| 698 | BRS-CA | ditto |
| 699 | BFG-A | BLINDER FOR ZG (FORWARD) |
| 700 | BFG-B | ditto |
| 701 | BFG-C | ditto |
| 702 | BRG-A | BLINDER FOR ZG (REVERSE) |
| 703 | BRG-B | ditto |
| 704 | BRG-C | ditto |
| 705 | UVD-OR | UVD relay element |
| 706 | | |
| 707 | | |
| 708 | | |
| 709 | | |
| 710 | | |
| 711 | | |
| 712 | | |
| 713 | | |
| 714 | | |
| 715 | | |
| 716 | | |
| 717 | | |
| 718 | | |
| 719 | | |
| 720 | CB-AND | CB CONTACT (3PHASE AND) |

www.ElectricalPartManuals.com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 721 | CB-OR | CB CONTACT (3PHASE OR) |
| 722 | Z1G-AX | Z1G-AX |
| 723 | Z1G-BX | Z1G-BX |
| 724 | Z1G-CX | Z1G-CX |
| 725 | Z2G-AX | Z2G-AX |
| 726 | Z2G-BX | Z2G-BX |
| 727 | Z2G-CX | Z2G-CX |
| 728 | Z3G-AX | Z3G-AX |
| 729 | Z3G-BX | Z3G-BX |
| 730 | Z3G-CX | Z3G-CX |
| 731 | Z4G-AX | Z4G-AX |
| 732 | Z4G-BX | Z4G-BX |
| 733 | Z4G-CX | Z4G-CX |
| 734 | ZRG-AX | ZRG-AX |
| 735 | ZRG-BX | ZRG-BX |
| 736 | ZRG-CX | ZRG-CX |
| 737 | Z1S-ABX | Z1S-ABX |
| 738 | Z1S-BCX | Z1S-BCX |
| 739 | Z1S-CAX | Z1S-CAX |
| 740 | Z2S-ABX | Z2S-ABX |
| 741 | Z2S-BCX | Z2S-BCX |
| 742 | Z2S-CAX | Z2S-CAX |
| 743 | Z3S-ABX | Z3S-ABX |
| 744 | Z3S-BCX | Z3S-BCX |
| 745 | Z3S-CAX | Z3S-CAX |
| 746 | Z4S-ABX | Z4S-ABX |
| 747 | Z4S-BCX | Z4S-BCX |
| 748 | Z4S-CAX | Z4S-CAX |
| 749 | ZRS-ABX | ZRS-ABX |
| 750 | ZRS-BCX | ZRS-BCX |
| 751 | ZRS-CAX | ZRS-CAX |
| 752 | PSBGOUT-AX | PSBGOUT-AX |
| 753 | PSBGOUT-BX | PSBGOUT-BX |
| 754 | PSBGOUT-CX | PSBGOUT-CX |
| 755 | PSBGIN-AX | PSBGIN-AX |
| 756 | PSBGIN-BX | PSBGIN-BX |
| 757 | PSBGIN-CX | PSBGIN-CX |
| 758 | PSBSOUT-ABX | PSBSOUT-ABX |
| 759 | PSBSOUT-BCX | PSBSOUT-BCX |
| 760 | PSBSOUT-CAX | PSBSOUT-CAX |
| 761 | PSBSIN-ABX | PSBSIN-ABX |
| 762 | PSBSIN-BCX | PSBSIN-BCX |
| 763 | PSBSIN-CAX | PSBSIN-CAX |
| 764 | PSBG_DET | PSB for ZG DETECTION |
| 765 | PSBS_DET | PSB for ZS DETECTION |
| 766 | PSB_DET | PSB DETECTION |
| 767 | OC1_OP | OC1 fail safe signal for DIF trip |
| 768 | OCD_OP | OCD fail safe signal for DIF trip |
| 769 | UVD_OP | UVD fail safe signal for DIF trip |
| 770 | EFD_OP | EFD fail safe signal for DIFG trip |
| 771 | UVDG_OP | UVD fail safe signal for DIFG trip |
| 772 | DIFFS | Fail safe signal for DIF trip |
| 773 | DIFGFS | Fail safe signal for DIFG trip |
| 774 | 2PH | 2PH |
| 775 | DEFFCR | DG CARRIER TRIP DELAY TIMER |
| 776 | DEFRCR | CARR. COORDINATION DGO TIMER |
| 777 | Z1GOR | Z1G RELAY OR LOGIC |
| 778 | Z2GOR | Z2G RELAY OR LOGIC |
| 779 | Z3GOR | Z3G RELAY OR LOGIC |
| 780 | ZRGOR | ZRG RELAY OR LOGIC |
| 781 | Z1SOR | Z1S RELAY OR LOGIC |
| 782 | Z2SOR | Z2S RELAY OR LOGIC |
| 783 | Z3SOR | Z3S RELAY OR LOGIC |
| 784 | ZRSOR | ZRS RELAY OR LOGIC |
| 785 | Z1CNT_INST | Z1 CONTROL COMMAND (Instantly trip) |
| 786 | Z1CNT_3PTP | Z1 CONTROL COMMAND (3-phase trip) |
| 787 | Z1CNT_ARCBLK | Z1 CONTROL COMMAND (Autoreclosing block) |
| 788 | Z1CNT_TPBLK | Z1 CONTROL COMMAND (Trip block) |
| 789 | DIF_OUT_SERV | DIF out-of-service |
| 790 | Z1G_TRIP | Z1G TRIP |
| 791 | Z1G-A_TRIP | Z1G TRIP A ph. |
| 792 | Z1G-B_TRIP | Z1G TRIP B ph. |
| 793 | Z1G-C_TRIP | Z1G TRIP C ph. |
| 794 | Z1S_TRIP | Z1S TRIP |
| 795 | Z2G_TRIP | Z2G TRIP |
| 796 | Z2G-A_TRIP | Z2G TRIP A ph. |
| 797 | Z2G-B_TRIP | Z2G TRIP B ph. |
| 798 | Z2G-C_TRIP | Z2G TRIP C ph. |
| 799 | Z2S_TRIP | Z2S TRIP |
| 800 | Z3G_TRIP | Z3G TRIP |

www.ElectricalPartManuals.com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 801 | Z3G-A_TRIP | Z3G TRIP A ph. |
| 802 | Z3G-B_TRIP | Z3G TRIP B ph. |
| 803 | Z3G-C_TRIP | Z3G TRIP C ph. |
| 804 | Z3S_TRIP | Z3S TRIP |
| 805 | ZRG_TRIP | ZRG TRIP |
| 806 | ZRG-A_TRIP | ZRG TRIP A ph. |
| 807 | ZRG-B_TRIP | ZRG TRIP B ph. |
| 808 | ZRG-C_TRIP | ZRG TRIP C ph. |
| 809 | ZRS_TRIP | ZRS TRIP |
| 810 | DEFF_TRIP | DEFF BACK-UP TRIP |
| 811 | DEFR_TRIP | DEFR BACK-UP TRIP |
| 812 | STUBOC_TRIP | STUB-OC TRIP |
| 813 | STUBOC-A_TP | STUB-OC TRIP A ph. |
| 814 | STUBOC-B_TP | STUB-OC TRIP B ph. |
| 815 | STUBOC-C_TP | STUB-OC TRIP C ph. |
| 816 | SOTF_TRIP | SOTF TRIP |
| 817 | SOTF-A_TRIP | SOTF-OCH TRIP A ph. |
| 818 | SOTF-B_TRIP | SOTF-OCH TRIP B ph. |
| 819 | SOTF-C_TRIP | SOTF-OCH TRIP C ph. |
| 820 | SOTF-Z_TRIP | SOTF-Zistance TRIP |
| 821 | OCH_TRIP | OCH TRIP |
| 822 | OCH-A_TRIP | OCH TRIP A ph. |
| 823 | OCH-B_TRIP | OCH TRIP B ph. |
| 824 | OCH-C_TRIP | OCH TRIP C ph. |
| 825 | OVS1_TRIP | OVS1 TRIP |
| 826 | OVS1-AB_TRIP | OVS1-AB TRIP |
| 827 | OVS1-BC_TRIP | OVS1-BC TRIP |
| 828 | OVS1-CA_TRIP | OVS1-CA TRIP |
| 829 | OVS2_ALARM | OVS2 ALARM |
| 830 | OVS2-AB_ALM | OVS2-AB ALARM |
| 831 | OVS2-BC_ALM | OVS2-BC ALARM |
| 832 | OVS2-CA_ALM | OVS2-CA ALARM |
| 833 | OVG1_TRIP | OVS1 TRIP |
| 834 | OVG1-A_TRIP | OVS1-A TRIP |
| 835 | OVG1-B_TRIP | OVS1-B TRIP |
| 836 | OVG1-C_TRIP | OVS1-C TRIP |
| 837 | OVG2_ALARM | OVS2 ALARM |
| 838 | OVG2-A_ALM | OVS2-A ALARM |
| 839 | OVG2-B_ALM | OVS2-B ALARM |
| 840 | OVG2-C_ALM | OVS2-C ALARM |
| 841 | UVS1_TRIP | UVS1 TRIP |
| 842 | UVS1-AB_TRIP | UVS1-AB TRIP |
| 843 | UVS1-BC_TRIP | UVS1-BC TRIP |
| 844 | UVS1-CA_TRIP | UVS1-CA TRIP |
| 845 | UVS2_ALARM | UVS2 ALARM |
| 846 | UVS2-AB_ALM | UVS2-AB ALARM |
| 847 | UVS2-BC_ALM | UVS2-BC ALARM |
| 848 | UVS2-CA_ALM | UVS2-CA ALARM |
| 849 | UVG1_TRIP | UVS1 TRIP |
| 850 | UVG1-A_TRIP | UVS1-A TRIP |
| 851 | UVG1-B_TRIP | UVS1-B TRIP |
| 852 | UVG1-C_TRIP | UVS1-C TRIP |
| 853 | UVG2_ALARM | UVS2 ALARM |
| 854 | UVG2-A_ALM | UVS2-A ALARM |
| 855 | UVG2-B_ALM | UVS2-B ALARM |
| 856 | UVG2-C_ALM | UVS2-C ALARM |
| 857 | UVSBLK | UVS BLOCK |
| 858 | UVGBLK | UVG BLOCK |
| 859 | BCD_TRIP | BCD TRIP |
| 860 | ZGCX | CARRIER CONTROL RELAY(Z2G/Z3G) |
| 861 | ZGC-AX | CARRIER CONTROL RELAY(Z2G/Z3G-A ph.) |
| 862 | ZGC-BX | CARRIER CONTROL RELAY(Z2G/Z3G-B ph.) |
| 863 | ZGC-CX | CARRIER CONTROL RELAY(Z2G/Z3G-C ph.) |
| 864 | ZSCX | CARRIER CONTROL RELAY(Z2S/Z3S) |
| 865 | REV_BLK | CARRIER SEND FOR BLOCK |
| 866 | REV_BLK-A | CARRIER SEND FOR BLOCK (ZG-A ph.) |
| 867 | REV_BLK-B | CARRIER SEND FOR BLOCK (ZG-B ph.) |
| 868 | REV_BLK-C | CARRIER SEND FOR BLOCK (ZG-C ph.) |
| 869 | REV_BLK-S | CARRIER SEND FOR BLOCK (ZS) |
| 870 | REV_BLK-DEF | DG.CARRIER SEND FOR BLOCK |
| 871 | UVLGOR | UVLGOR |
| 872 | UVLSOR | UVLSOR |
| 873 | UVFGOR | UVFGOR |
| 874 | UVFSOR | UVFSOR |
| 875 | WI_TRIP | WEAK INFEED TRIP |
| 876 | DISWI_TRIP | WEEK INFEED LOCAL TRIP |
| 877 | DEFWI_TRIP-A | DG CARRIER WEEK INFEED LOCAL TRIP |
| 878 | DISCR_TRIP | DISTANCE CARRIER TRIP |
| 879 | DISCR-A_TRIP | DISTANCE CARRIER TRIP (A ph.) |
| 880 | DISCR-B_TRIP | DISTANCE CARRIER TRIP (B ph.) |

www.ElectricalPartManuals.com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 881 | DISCR-C_TRIP | DISTANCE CARRIER TRIP (C ph.) |
| 882 | DEFCR_TRIP | DG CARRIER TRIP |
| 883 | DEFCR-A_TRIP | DG CARRIER TRIP (A ph.) |
| 884 | DEFCR-B_TRIP | DG CARRIER TRIP (B ph.) |
| 885 | DEFCR-C_TRIP | DG CARRIER TRIP (C ph.) |
| 886 | CAR-S | EXTERNAL CARRIER SEND COMMAND |
| 887 | DEFCAR-S | EXTERNAL DG CARRIER SEND COMMAND |
| 888 | VTF | VTF BLOCK SIGNAL |
| 889 | VTF1_ALARM | 3PH VTF DETECT. |
| 890 | VTF2_ALARM | 1 OR 2PH VTF DETECT |
| 891 | VTF_ALARM | VTF ALARM |
| 892 | CHF-SV_R1 | CARRIER CHANNEL FAILURE (Remote terminal-1) |
| 893 | CHF-SV_R2 | CARRIER CHANNEL FAILURE (Remote terminal-2) |
| 894 | CHF-SV | CARRIER CHANNEL FAILURE |
| 895 | Z1_TRIP | ZONE1 TRIP |
| 896 | Z2_TRIP | ZONE2 TRIP |
| 897 | Z3_TRIP | ZONE3 TRIP |
| 898 | ZR_TRIP | ZONE-R TRIP |
| 899 | CAR-G_TRIP | CARRIER TRIP(G) |
| 900 | CAR-S_TRIP | CARRIER TRIP(S) |
| 901 | CAR-A_TRIP | DISTANCE or DG CARRIER TRIP (A ph.) |
| 902 | CAR-B_TRIP | DISTANCE or DG CARRIER TRIP (B ph.) |
| 903 | CAR-C_TRIP | DISTANCE or DG CARRIER TRIP (C ph.) |
| 904 | CAR_TRIP | DISTANCE or DG CARRIER TRIP |
| 905 | OV/UV_TRIP | OV/UV trip |
| 906 | | |
| 907 | | |
| 908 | | |
| 909 | | |
| 910 | | |
| 911 | | |
| 912 | | |
| 913 | | |
| 914 | | |
| 915 | | |
| 916 | | |
| 917 | | |
| 918 | | |
| 919 | | |
| 920 | | |
| 921 | | |
| 922 | | |
| 923 | | |
| 924 | | |
| 925 | | |
| 926 | | |
| 927 | | |
| 928 | | |
| 929 | | |
| 930 | | |
| 931 | | |
| 932 | | |
| 933 | | |
| 934 | | |
| 935 | | |
| 936 | | |
| 937 | | |
| 938 | | |
| 939 | | |
| 940 | | |
| 941 | | |
| 942 | | |
| 943 | | |
| 944 | | |
| 945 | | |
| 946 | | |
| 947 | | |
| 948 | | |
| 949 | | |
| 950 | MODE0 | Changed to MODE0 |
| 951 | MODE1 | Changed to MODE1 |
| 952 | MODE2A-GPS | Changed to MODE2A due to GPS failure |
| 953 | MODE2A-Td | Changed to MODE2A due to abnormal telecomm. delay time |
| 954 | MODE2A-CF | Changed to MODE2A due to telecomm. failure |
| 955 | MODE2A-ANGLE | Changed to MODE2A due to sync. failure |
| 956 | MODE2A-RMT | Changed to MODE2A due to remote end's request |
| 957 | MODE2B | Changed to MODE2B |
| 958 | | |
| 959 | | |
| 960 | V.COM1-R1 | Comm. data(V0 data frame) receive signal from term-1 |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 961 | V.COM2-R1 | ditto |
| 962 | V.COM3-R1 | ditto |
| 963 | | |
| 964 | S.V.COM1-R1 | Comm. data(V0 data frame) receive signal from term-1 |
| 965 | S.V.COM2-R1 | ditto |
| 966 | S.V.COM3-R1 | ditto |
| 967 | S.V.COM4-R1 | ditto |
| 968 | S.V.COM5-R1 | ditto |
| 969 | S.V.COM6-R1 | ditto |
| 970 | S.V.COM7-R1 | ditto |
| 971 | S.V.COM8-R1 | ditto |
| 972 | S.V.COM9-R1 | ditto |
| 973 | S.V.COM10-R1 | ditto |
| 974 | S.V.COM11-R1 | ditto |
| 975 | S.V.COM12-R1 | ditto |
| 976 | V.COM1-R2 | Comm. data(V0 data frame) receive signal from term-2 |
| 977 | V.COM2-R2 | ditto |
| 978 | V.COM3-R2 | ditto |
| 979 | | |
| 980 | S.V.COM1-R2 | Comm. data(V0 data frame) receive signal from term-2 |
| 981 | S.V.COM2-R2 | ditto |
| 982 | S.V.COM3-R2 | ditto |
| 983 | S.V.COM4-R2 | ditto |
| 984 | S.V.COM5-R2 | ditto |
| 985 | S.V.COM6-R2 | ditto |
| 986 | S.V.COM7-R2 | ditto |
| 987 | S.V.COM8-R2 | ditto |
| 988 | S.V.COM9-R2 | ditto |
| 989 | S.V.COM10-R2 | ditto |
| 990 | S.V.COM11-R2 | ditto |
| 991 | S.V.COM12-R2 | ditto |
| 992 | I.COM1-R1 | Comm. data(I0 data frame) receive signal from term-1 |
| 993 | I.COM2-R1 | ditto |
| 994 | I.COM3-R1 | ditto |
| 995 | | |
| 996 | S.I.COM1-R1 | Comm. data(I0 data frame) receive signal from term-1 |
| 997 | S.I.COM2-R1 | ditto |
| 998 | S.I.COM3-R1 | ditto |
| 999 | S.I.COM4-R1 | ditto |
| 1000 | S.I.COM5-R1 | ditto |
| 1001 | S.I.COM6-R1 | ditto |
| 1002 | S.I.COM7-R1 | ditto |
| 1003 | S.I.COM8-R1 | ditto |
| 1004 | S.I.COM9-R1 | ditto |
| 1005 | S.I.COM10-R1 | ditto |
| 1006 | S.I.COM11-R1 | ditto |
| 1007 | S.I.COM12-R1 | ditto |
| 1008 | I.COM1-R2 | Comm. data(I0 data frame) receive signal from term-2 |
| 1009 | I.COM2-R2 | ditto |
| 1010 | I.COM3-R2 | ditto |
| 1011 | | |
| 1012 | S.I.COM1-R2 | Comm. data(I0 data frame) receive signal from term-2 |
| 1013 | S.I.COM2-R2 | ditto |
| 1014 | S.I.COM3-R2 | ditto |
| 1015 | S.I.COM4-R2 | ditto |
| 1016 | S.I.COM5-R2 | ditto |
| 1017 | S.I.COM6-R2 | ditto |
| 1018 | S.I.COM7-R2 | ditto |
| 1019 | S.I.COM8-R2 | ditto |
| 1020 | S.I.COM9-R2 | ditto |
| 1021 | S.I.COM10-R2 | ditto |
| 1022 | S.I.COM11-R2 | ditto |
| 1023 | S.I.COM12-R2 | ditto |
| 1024 | | |
| 1025 | | |
| 1026 | | |
| 1027 | | |
| 1028 | | |
| 1029 | | |
| 1030 | | |
| 1031 | | |
| 1032 | | |
| 1033 | | |
| 1034 | | |
| 1035 | | |
| 1036 | | |
| 1037 | | |
| 1038 | | |
| 1039 | | |
| 1040 | FAULT_PHA_A | fault_phase_A |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 1041 | FAULT_PHA_B | fault_phase_B |
| 1042 | FAULT_PHA_C | fault_phase_C |
| 1043 | FAULT_PHA_N | fault_phase_N |
| 1044 | FL_ERR | fault location start up error |
| 1045 | FL_OB_FWD | fault location out of bounds(forward) |
| 1046 | FL_OB_BACK | fault location out of bounds(backward) |
| 1047 | FL_NC | fault location not converged |
| 1048 | FL_COMPLETED | fault location completed |
| 1049 | | |
| 1050 | | |
| 1051 | | |
| 1052 | | |
| 1053 | | |
| 1054 | | |
| 1055 | | |
| 1056 | | |
| 1057 | | |
| 1058 | | |
| 1059 | | |
| 1060 | | |
| 1061 | | |
| 1062 | | |
| 1063 | | |
| 1064 | | |
| 1065 | | |
| 1066 | | |
| 1067 | | |
| 1068 | | |
| 1069 | | |
| 1070 | | |
| 1071 | | |
| 1072 | | |
| 1073 | | |
| 1074 | | |
| 1075 | | |
| 1076 | | |
| 1077 | | |
| 1078 | | |
| 1079 | | |
| 1080 | | |
| 1081 | | |
| 1082 | | |
| 1083 | | |
| 1084 | | |
| 1085 | | |
| 1086 | | |
| 1087 | | |
| 1088 | COM1-R1 | Comm. data receive signal from remote term-1 |
| 1089 | COM2-R1 | ditto |
| 1090 | COM3-R1 | ditto |
| 1091 | COM4-R1 | ditto |
| 1092 | COM5-R1 | ditto |
| 1093 | | |
| 1094 | | |
| 1095 | | |
| 1096 | COM1-R1_UF | Comm. data receive signal from remote term-1 (unfiltered) |
| 1097 | COM2-R1_UF | ditto |
| 1098 | COM3-R1_UF | ditto |
| 1099 | COM4-R1_UF | ditto |
| 1100 | COM5-R1_UF | ditto |
| 1101 | | |
| 1102 | | |
| 1103 | | |
| 1104 | SUB_COM1-R1 | Sub comm. data receive signal from term-1 |
| 1105 | SUB_COM2-R1 | ditto |
| 1106 | SUB_COM3-R1 | ditto |
| 1107 | SUB_COM4-R1 | ditto |
| 1108 | SUB_COM5-R1 | ditto |
| 1109 | | |
| 1110 | | |
| 1111 | | |
| 1112 | SUB2_COM1-R1 | Sub comm. data2 receive signal from term-1 |
| 1113 | SUB2_COM2-R1 | ditto |
| 1114 | SUB2_COM3-R1 | ditto |
| 1115 | SUB2_COM4-R1 | ditto |
| 1116 | SUB2_COM5-R1 | ditto |
| 1117 | SUB2_COM6-R1 | ditto |
| 1118 | SUB2_COM7-R1 | ditto |
| 1119 | SUB2_COM8-R1 | ditto |
| 1120 | SUB2_COM9-R1 | ditto |

www.ElectricalPartManuals.com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 1121 | SUB2_COM10-R1 | ditto |
| 1122 | SUB2_COM11-R1 | ditto |
| 1123 | SUB2_COM12-R1 | ditto |
| 1124 | | |
| 1125 | | |
| 1126 | | |
| 1127 | | |
| 1128 | COM1-R2 | Comm. data receive signal from remote term-2 |
| 1129 | COM2-R2 | ditto |
| 1130 | COM3-R2 | ditto |
| 1131 | COM4-R2 | ditto |
| 1132 | COM5-R2 | ditto |
| 1133 | | |
| 1134 | | |
| 1135 | | |
| 1136 | COM1-R2_UF | Comm. data receive signal from remote term-2 (unfiltered) |
| 1137 | COM2-R2_UF | ditto |
| 1138 | COM3-R2_UF | ditto |
| 1139 | COM4-R2_UF | ditto |
| 1140 | COM5-R2_UF | ditto |
| 1141 | | |
| 1142 | | |
| 1143 | | |
| 1144 | SUB_COM1-R2 | Sub comm. data receive signal from term-2 |
| 1145 | SUB_COM2-R2 | ditto |
| 1146 | SUB_COM3-R2 | ditto |
| 1147 | SUB_COM4-R2 | ditto |
| 1148 | SUB_COM5-R2 | ditto |
| 1149 | | |
| 1150 | | |
| 1151 | | |
| 1152 | SUB2_COM1-R2 | Sub comm. data2 receive signal from term-2 |
| 1153 | SUB2_COM2-R2 | ditto |
| 1154 | SUB2_COM3-R2 | ditto |
| 1155 | SUB2_COM4-R2 | ditto |
| 1156 | SUB2_COM5-R2 | ditto |
| 1157 | SUB2_COM6-R2 | ditto |
| 1158 | SUB2_COM7-R2 | ditto |
| 1159 | SUB2_COM8-R2 | ditto |
| 1160 | SUB2_COM9-R2 | ditto |
| 1161 | SUB2_COM10-R2 | ditto |
| 1162 | SUB2_COM11-R2 | ditto |
| 1163 | SUB2_COM12-R2 | ditto |
| 1164 | | |
| 1165 | | |
| 1166 | | |
| 1167 | | |
| 1168 | SUB3_COM1-R1 | Sub comm. data3 receive signal from term-1 |
| 1169 | SUB3_COM2-R1 | ditto |
| 1170 | SUB3_COM3-R1 | ditto |
| 1171 | SUB3_COM4-R1 | ditto |
| 1172 | SUB3_COM5-R1 | ditto |
| 1173 | SUB3_COM6-R1 | ditto |
| 1174 | SUB3_COM7-R1 | ditto |
| 1175 | SUB3_COM8-R1 | ditto |
| 1176 | SUB3_COM9-R1 | ditto |
| 1177 | SUB3_COM10-R1 | ditto |
| 1178 | SUB3_COM11-R1 | ditto |
| 1179 | SUB3_COM12-R1 | ditto |
| 1180 | | |
| 1181 | | |
| 1182 | | |
| 1183 | | |
| 1184 | SUB3_COM1-R2 | Sub comm. data3 receive signal from term-2 |
| 1185 | SUB3_COM2-R2 | ditto |
| 1186 | SUB3_COM3-R2 | ditto |
| 1187 | SUB3_COM4-R2 | ditto |
| 1188 | SUB3_COM5-R2 | ditto |
| 1189 | SUB3_COM6-R2 | ditto |
| 1190 | SUB3_COM7-R2 | ditto |
| 1191 | SUB3_COM8-R2 | ditto |
| 1192 | SUB3_COM9-R2 | ditto |
| 1193 | SUB3_COM10-R2 | ditto |
| 1194 | SUB3_COM11-R2 | ditto |
| 1195 | SUB3_COM12-R2 | ditto |
| 1196 | | |
| 1197 | | |
| 1198 | | |
| 1199 | | |
| 1200 | | |

www.ElectricalPartManuals.com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 1201 | | |
| 1202 | | |
| 1203 | | |
| 1204 | | |
| 1205 | | |
| 1206 | | |
| 1207 | | |
| 1208 | | |
| 1209 | | |
| 1210 | | |
| 1211 | | |
| 1212 | | |
| 1213 | | |
| 1214 | | |
| 1215 | | |
| 1216 | | |
| 1217 | | |
| 1218 | | |
| 1219 | | |
| 1220 | | |
| 1221 | | |
| 1222 | | |
| 1223 | | |
| 1224 | | |
| 1225 | | |
| 1226 | | |
| 1227 | | |
| 1228 | | |
| 1229 | | |
| 1230 | | |
| 1231 | | |
| 1232 | | |
| 1233 | | |
| 1234 | | |
| 1235 | | |
| 1236 | | |
| 1237 | | |
| 1238 | | |
| 1239 | | |
| 1240 | | |
| 1241 | IEC_MDBLK | monitor direction blocked |
| 1242 | IEC_TESTMODE | IEC61870-5-103 testmode |
| 1243 | GROUP1_ACTIVE | group1 active |
| 1244 | GROUP2_ACTIVE | group2 active |
| 1245 | GROUP3_ACTIVE | group3 active |
| 1246 | GROUP4_ACTIVE | group4 active |
| 1247 | GROUP5_ACTIVE | group5 active |
| 1248 | GROUP6_ACTIVE | group6 active |
| 1249 | GROUP7_ACTIVE | group7 active |
| 1250 | GROUP8_ACTIVE | group8 active |
| 1251 | RLY_FAIL_ | RELAY FAILURE |
| 1252 | RLY_OP_BLK_ | RELAY OUTPUT BLOCK |
| 1253 | AMF_OFF_ | SV BLOCK |
| 1254 | | |
| 1255 | | |
| 1256 | IDSV | Id failure signal |
| 1257 | | |
| 1258 | RELAY_FAIL-A | |
| 1259 | | |
| 1260 | | |
| 1261 | TRIP-H | Trip signal hold |
| 1262 | CT_ERR_UF | CT error(unfiltered) |
| 1263 | I0_ERR_UF | I0 error(unfiltered) |
| 1264 | V0_ERR_UF | V0 error(unfiltered) |
| 1265 | V2_ERR_UF | V2 error(unfiltered) |
| 1266 | CT_ERR | CT error |
| 1267 | I0_ERR | I0 error |
| 1268 | V0_ERR | V0 error |
| 1269 | V2_ERR | V2 error |
| 1270 | I0-C_ERR_UF | I0 error(unfiltered)(For center CB on T.F.C model) |
| 1271 | I0-C_ERR | I0 error(For center CB on T.F.C model) |
| 1272 | CT-C_ERR_UF | CT error(unfiltered)(For center CB on T.F.C model) |
| 1273 | CT-C_ERR | CT error(For center CB on T.F.C model) |
| 1274 | | |
| 1275 | | |
| 1276 | 50Hz/60Hz | Frequency pulse signal |
| 1277 | | |
| 1278 | | |
| 1279 | GEN_PICKUP | General start/pick-up |
| 1280 | GEN_TRIP | General trip |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 1281 | | |
| 1282 | | |
| 1283 | | |
| 1284 | BI1_COM_UF | Binary input signal BI1 (unfiltered) |
| 1285 | BI2_COM_UF | Binary input signal BI2 (unfiltered) |
| 1286 | BI3_COM_UF | Binary input signal BI3 (unfiltered) |
| 1287 | BI4_COM_UF | Binary input signal BI4 (unfiltered) |
| 1288 | BI5_COM_UF | Binary input signal BI5 (unfiltered) |
| 1289 | BI6_COM_UF | Binary input signal BI6 (unfiltered) |
| 1290 | BI7_COM_UF | Binary input signal BI7 (unfiltered) |
| 1291 | BI8_COM_UF | Binary input signal BI8 (unfiltered) |
| 1292 | BI9_COM_UF | Binary input signal BI9 (unfiltered) |
| 1293 | BI10_COM_UF | Binary input signal BI10 (unfiltered) |
| 1294 | BI11_COM_UF | Binary input signal BI11 (unfiltered) |
| 1295 | BI12_COM_UF | Binary input signal BI12 (unfiltered) |
| 1296 | BI13_COM_UF | Binary input signal BI13 (unfiltered) |
| 1297 | BI14_COM_UF | Binary input signal BI14 (unfiltered) |
| 1298 | BI15_COM_UF | Binary input signal BI15 (unfiltered) |
| 1299 | | |
| 1300 | | |
| 1301 | | |
| 1302 | | |
| 1303 | | |
| 1304 | | |
| 1305 | | |
| 1306 | | |
| 1307 | | |
| 1308 | | |
| 1309 | | |
| 1310 | | |
| 1311 | | |
| 1312 | | |
| 1313 | | |
| 1314 | | |
| 1315 | | |
| 1316 | | |
| 1317 | | |
| 1318 | | |
| 1319 | | |
| 1320 | | |
| 1321 | | |
| 1322 | | |
| 1323 | | |
| 1324 | | |
| 1325 | | |
| 1326 | | |
| 1327 | | |
| 1328 | | |
| 1329 | | |
| 1330 | | |
| 1331 | | |
| 1332 | | |
| 1333 | | |
| 1334 | | |
| 1335 | | |
| 1336 | | |
| 1337 | | |
| 1338 | | |
| 1339 | | |
| 1340 | | |
| 1341 | | |
| 1342 | | |
| 1343 | | |
| 1344 | | |
| 1345 | | |
| 1346 | | |
| 1347 | | |
| 1348 | | |
| 1349 | | |
| 1350 | | |
| 1351 | | |
| 1352 | | |
| 1353 | | |
| 1354 | | |
| 1355 | | |
| 1356 | | |
| 1357 | | |
| 1358 | | |
| 1359 | | |
| 1360 | | |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 1361 | | |
| 1362 | | |
| 1363 | | |
| 1364 | | |
| 1365 | | |
| 1366 | | |
| 1367 | | |
| 1368 | | |
| 1369 | | |
| 1370 | | |
| 1371 | | |
| 1372 | | |
| 1373 | | |
| 1374 | | |
| 1375 | | |
| 1376 | | |
| 1377 | | |
| 1378 | | |
| 1379 | | |
| 1380 | | |
| 1381 | | |
| 1382 | | |
| 1383 | | |
| 1384 | | |
| 1385 | | |
| 1386 | | |
| 1387 | | |
| 1388 | | |
| 1389 | | |
| 1390 | | |
| 1391 | | |
| 1392 | | |
| 1393 | | |
| 1394 | | |
| 1395 | | |
| 1396 | | |
| 1397 | | |
| 1398 | | |
| 1399 | | |
| 1400 | | |
| 1401 | LOCAL_OP_ACT | local operation active |
| 1402 | REMOTE_OP_ACT | remote operation active |
| 1403 | NORM_LED_ON | IN-SERVICE LED ON |
| 1404 | ALM_LED_ON | ALARM LED ON |
| 1405 | TRIP_LED_ON | TRIP LED ON |
| 1406 | TEST_LED_ON | TEST LED ON |
| 1407 | | |
| 1408 | PRG_LED_RESET | Latched progammable LED RESET |
| 1409 | LED_RESET | TRIP LED RESET |
| 1410 | | |
| 1411 | ARC_COM_ON | IEC103 communication command |
| 1412 | TELE_COM_ON | IEC103 communication command |
| 1413 | PROT_COM_ON | IEC103 communication command |
| 1414 | PRG_LED1_ON | PROGRAMMABLE LED1 ON |
| 1415 | PRG_LED2_ON | PROGRAMMABLE LED2 ON |
| 1416 | PRG_LED3_ON | PROGRAMMABLE LED3 ON |
| 1417 | PRG_LED4_ON | PROGRAMMABLE LED4 ON |
| 1418 | | |
| 1419 | | |
| 1420 | | |
| 1421 | | |
| 1422 | | |
| 1423 | | |
| 1424 | | |
| 1425 | | |
| 1426 | | |
| 1427 | | |
| 1428 | | |
| 1429 | | |
| 1430 | | |
| 1431 | | |
| 1432 | | |
| 1433 | | |
| 1434 | F.Record_DONE | fault location completed |
| 1435 | F.Record_CLR | Fault record clear |
| 1436 | E.Record_CLR | Event record clear |
| 1437 | D.Record_CLR | Disturbance record clear |
| 1438 | | |
| 1439 | | |
| 1440 | | |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 1441 | | |
| 1442 | | |
| 1443 | | |
| 1444 | | |
| 1445 | PLC_data_CHG | PLC data change |
| 1446 | | |
| 1447 | | |
| 1448 | Sys.set_change | System setting change |
| 1449 | Rly.set_change | Relay setting change |
| 1450 | Grp.set_change | Group setting change |
| 1451 | | |
| 1452 | | |
| 1453 | | |
| 1454 | | |
| 1455 | | |
| 1456 | KEY-VIEW | VIEW key status (1:pressed) |
| 1457 | KEY-RESET | RESET key status (2:pressed) |
| 1458 | KEY-ENTER | ENTER key status (3:pressed) |
| 1459 | KEY-END | END key status (4:pressed) |
| 1460 | KEY-CANCEL | CANCEL key status (5:pressed) |
| 1461 | | |
| 1462 | | |
| 1463 | | |
| 1464 | | |
| 1465 | | |
| 1466 | | |
| 1467 | | |
| 1468 | | |
| 1469 | | |
| 1470 | | |
| 1471 | | |
| 1472 | SUM_err | Program ROM checksum error |
| 1473 | | |
| 1474 | SRAM_err | SRAM memory monitoring error |
| 1475 | BU-RAM_err | BU-RAM memory monitoring error |
| 1476 | | |
| 1477 | EEPROM_err | EEPROM memory monitoring error |
| 1478 | | |
| 1479 | A/D_err | A/D accuracy checking error |
| 1480 | | |
| 1481 | | |
| 1482 | | |
| 1483 | | |
| 1484 | DIO_err | DIO card connection error |
| 1485 | | |
| 1486 | LCD_err | LCD panel connection error |
| 1487 | ROM_data_err | Data ROM checksum error |
| 1488 | | |
| 1489 | COM_DPRAMerr1 | DP-RAM memory monitoring error |
| 1490 | | |
| 1491 | COM_SUM_err | |
| 1492 | | |
| 1493 | COM_SRAM_err | |
| 1494 | COM_DPRAMerr2 | |
| 1495 | COM_A/D_err | |
| 1496 | COM_IRQ_err | |
| 1497 | Sync1_fail | |
| 1498 | Sync2_fail | |
| 1499 | Com1_fail | |
| 1500 | Com2_fail | |
| 1501 | Com1_fail-R | |
| 1502 | Com2_fail-R | |
| 1503 | CLK1_fail | |
| 1504 | CLK2_fail | |
| 1505 | Term1_rdy_off | |
| 1506 | Term2_rdy_off | |
| 1507 | TX_level1_err | |
| 1508 | TX_level2_err | |
| 1509 | RX_level1_err | |
| 1510 | RX_level2_err | |
| 1511 | Td1_over | |
| 1512 | Td2_over | |
| 1513 | RYID1_err | |
| 1514 | RYID2_err | |
| 1515 | | |
| 1516 | | |
| 1517 | | |
| 1518 | | |
| 1519 | | |
| 1520 | | |

www . ElectricalPartManuals . com

Signal list

| | No. | Signal Name | Contents |
|---|---|---|---|
| Input for protection | 1536 | CB1 CONT-A | CB1 contact (A-phase) |
| | 1537 | CB1 CONT-B | (B-phase) |
| | 1538 | CB1 CONT-C | (C-phase) |
| | 1539 | CB2 CONT-A | CB2 contact (A-phase) |
| | 1540 | CB2 CONT-B | (B-phase) |
| | 1541 | CB2 CONT-C | (C-phase) |
| | 1542 | DS N/O CONT | DS N/O contact |
| | 1543 | DS N/C CONT | DS N/C contact |
| | 1544 | CRT BLOCK | Command protection out of service command |
| | 1545 | CB CLOSE | External CB close signal |
| | 1546 | DC SUPPLY | DC power supply |
| | 1547 | 85S1 | Transfer trip sending command 1 |
| | 1548 | 85S2 | Transfer trip sending command 2 |
| | 1549 | IND.RESET | Indication reset command |
| | 1550 | BUT BLOCK | Back up protection out of service command |
| | 1551 | | |
| | 1552 | EXT TRIP-A | External trip command (A-Phase) |
| | 1553 | EXT TRIP-B | (B-phase) |
| | 1554 | EXT TRIP-C | (C-phase) |
| | 1555 | | |
| | 1556 | EXT CBFIN-A | External CBF initiation command (A-Phase) |
| | 1557 | EXT CBFIN-B | (B-Phase) |
| | 1558 | EXT CBFIN-C | (C-Phase) |
| | 1559 | | |
| | 1560 | | |
| | 1561 | | |
| | 1562 | | |
| | 1563 | | |
| | 1564 | | |
| | 1565 | | |
| | 1566 | | |
| | 1567 | | |
| | 1568 | INT.LINK1-A | Interlink A with terminal 1 command |
| | 1569 | INT.LINK1-B | Interlink B with terminal 1 command |
| | 1570 | INT.LINK1-C | Interlink C with terminal 1 command |
| | 1571 | CB1 READY | Autoreclosing ready command of bus CB |
| | 1572 | CB2 READY | Autoreclosing ready command of center CB |
| | 1573 | ARC RESET | Autoreclosing block command |
| | 1574 | ARC BLOCK | Autoreclosing block command |
| | 1575 | INT.LINK2-A | Interlink A with terminal 2 command |
| | 1576 | INT.LINK2-B | Interlink B with terminal 2 command |
| | 1577 | INT.LINK2-C | Interlink C with terminal 2 command |
| | 1578 | ARC BLOCK1 | Autoreclosing block command |
| | 1579 | ARC BLOCK2 | Autoreclosing block command |
| | 1580 | | |
| | 1581 | | |
| | 1582 | | |
| | 1583 | | |
| | 1584 | PROT BLOCK | Protection block command |
| | 1585 | DIF BLOCK | DIF trip block command |
| | 1586 | DIFG BLOCK | DIFG trip block command |
| | 1587 | OST BLOCK | OST trip block command |
| | 1588 | CBF BLOCK | CBF trip block command |
| | 1589 | OC BLOCK | OC trip block command |
| | 1590 | OCI BLOCK | OCI trip block command |
| | 1591 | EF BLOCK | EF trip block command |
| | 1592 | EFI BLOCK | EFI trip block command |
| | 1593 | THMA BLOCK | Theremal alarm block command |
| | 1594 | THM BLOCK | Theremal trip block command |
| | 1595 | TR1 BLOCK | TR1 trip block command |
| | 1596 | TR2 BLOCK | TR2 trip block command |
| | 1597 | EXTTP BLOCK | External trip block command |
| | 1598 | RDIF BLOCK | Remote DIF trip block command |
| | 1599 | | |
| | 1600 | ARC OFF | Autoreclosing mode changing command |
| | 1601 | ARC SPAR | ditto |
| | 1602 | ARC TPAR | ditto |
| | 1603 | ARC S&T | ditto |
| | 1604 | ARC MAPR2 | ditto |
| | 1605 | ARC MPAR3 | ditto |
| | 1606 | ARC EXT1P | ditto |
| | 1607 | ARC EXT3P | ditto |
| | 1608 | ARC EXTMP | ditto |
| | 1609 | CTF BLOCK | CTF block command |
| | 1610 | | |
| | 1611 | | |
| | 1612 | | |
| | 1613 | | |
| | 1614 | | |
| | 1615 | | |

www . ElectricalPowerManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 1616 | DIF-A_FS | Fail safe command for DIF-A trip |
| 1617 | DIF-B_FS | Fail safe command for DIF-B trip |
| 1618 | DIF-C_FS | Fail safe command for DIF-C trip |
| 1619 | DIFG_FS | Fail safe command for DIFG trip |
| 1620 | TP-A_DELAY | Trip command off-delay timer setting |
| 1621 | TP-B_DELAY | Trip command off-delay timer setting |
| 1622 | TP-C_DELAY | Trip command off-delay timer setting |
| 1623 | R.DATA_ZERO | Remote term. data zero-ampere control command |
| 1624 | RDIF-A_FS | Fail safe command for RDIF-A trip |
| 1625 | RDIF-B_FS | Fail safe command for RDIF-B trip |
| 1626 | RDIF-C_FS | Fail safe command for RDIF-C trip |
| 1627 | | |
| 1628 | | |
| 1629 | | |
| 1630 | EXT_FL_INIT | External FL initiation command |
| 1631 | INIT_MODE2B | MODE2B initiation command |
| 1632 | DIFG_INST_TP | DIFG instantly trip command |
| 1633 | OC_INST_TP | OC instantly trip command |
| 1634 | EF_INST_TP | EF instantly trip command |
| 1635 | | |
| 1636 | | |
| 1637 | | |
| 1638 | | |
| 1639 | | |
| 1640 | | |
| 1641 | | |
| 1642 | | |
| 1643 | | |
| 1644 | | |
| 1645 | | |
| 1646 | | |
| 1647 | | |
| 1648 | DIF_3PTP | DIF 3-phase trip command |
| 1649 | RDIF_3PTP | RDIF 3-phase trip command |
| 1650 | OC_3PTP | OC 3-phase trip command |
| 1651 | OCI_3PTP | OCI 3-phase trip command |
| 1652 | | |
| 1653 | | |
| 1654 | | |
| 1655 | | |
| 1656 | | |
| 1657 | | |
| 1658 | | |
| 1659 | | |
| 1660 | TR1_3PTP | Transfer trip 1 3-phase trip command |
| 1661 | TR2_3PTP | Transfer trip 2 3-phase trip command |
| 1662 | | |
| 1663 | 3P_TRIP | 3-Phase trip command |
| 1664 | DIF-A-R1 | DIF-A relay operating command from remote term-1 for TFC |
| 1665 | DIF-B-R1 | DIF-B relay operating command from remote term-1 for TFC |
| 1666 | DIF-C-R1 | DIF-C relay operating command from remote term-1 for TFC |
| 1667 | DIFG-R1 | DIFG relay operating command from remote term-1 for TFC |
| 1668 | | |
| 1669 | | |
| 1670 | | |
| 1671 | | |
| 1672 | 85R1-R1 | Transfer command 1 from remote term-1 |
| 1673 | 85R2-R1 | Transfer command 1 from remote term-2 |
| 1674 | ARC_BLOCK-R1 | Auto reclosing block command from remote term-1 |
| 1675 | L.TEST-R1 | Local testing command from remote term-1 |
| 1676 | TFC_ON-R1 | TFC enable command from remote term-1 |
| 1677 | | |
| 1678 | | |
| 1679 | | |
| 1680 | I.LINK-A-R1 | Interlink command from remote term-1 |
| 1681 | I.LINK-B-R1 | ditto |
| 1682 | I.LINK-C-R1 | ditto |
| 1683 | | |
| 1684 | RDIF-A-R1 | RDIF trip command from remote term-1 |
| 1685 | RDIF-B-R1 | ditto |
| 1686 | RDIF-C-R1 | ditto |
| 1687 | RDIF-R1 | ditto |
| 1688 | TR1-A-R1 | Transfer trip-1 command from remote term-1 |
| 1689 | TR1-B-R1 | ditto |
| 1690 | TR1-C-R1 | ditto |
| 1691 | | |
| 1692 | TR2-A-R1 | Transfer trip-2 command from remote term-1 |
| 1693 | TR2-B-R1 | ditto |
| 1694 | TR2-C-R1 | ditto |
| 1695 | | |

www.ElectricalPartManuals.com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 1696 | DIF-A-R2 | DIF-A relay operating command from remote term-2 for TFC |
| 1697 | DIF-B-R2 | DIF-B relay operating command from remote term-2 for TFC |
| 1698 | DIF-C-R2 | DIF-C relay operating command from remote term-2 for TFC |
| 1699 | DIFG-R2 | DIFG relay operating command from remote term-2 for TFC |
| 1700 | | |
| 1701 | | |
| 1702 | | |
| 1703 | | |
| 1704 | 85R1-R2 | Transfer command 1 from remote term-2 |
| 1705 | 85R2-R2 | Transfer command 1 from remote term-2 |
| 1706 | ARC BLOCK-R2 | Auto reclosing block command from remote term-2 |
| 1707 | L.TEST-R2 | Local testing command from remote term-2 |
| 1708 | TFC ON-R2 | TFC enable command from remote term-2 |
| 1709 | | |
| 1710 | | |
| 1711 | | |
| 1712 | I.LINK-A-R2 | Interlink command from remote term-2 |
| 1713 | I.LINK-B-R2 | ditto |
| 1714 | I.LINK-C-R2 | ditto |
| 1715 | | |
| 1716 | RDIF-A-R2 | RDIF trip command from remote term-2 |
| 1717 | RDIF-B-R2 | ditto |
| 1718 | RDIF-C-R2 | ditto |
| 1719 | RDIF-R2 | ditto |
| 1720 | TR1-A-R2 | Transfer trip-1 command from remote term-2 |
| 1721 | TR1-B-R2 | ditto |
| 1722 | TR1-C-R2 | ditto |
| 1723 | | |
| 1724 | TR2-A-R2 | Transfer trip-2 command from remote term-2 |
| 1725 | TR2-B-R2 | ditto |
| 1726 | TR2-C-R2 | ditto |
| 1727 | | |
| 1728 | | |
| 1729 | | |
| 1730 | | |
| 1731 | | |
| 1732 | | |
| 1733 | | |
| 1734 | | |
| 1735 | | |
| 1736 | OC-A FS | Fail safe command for OC-A trip |
| 1737 | OC-B FS | Fail safe command for OC-B trip |
| 1738 | OC-C FS | Fail safe command for OC-C trip |
| 1739 | | |
| 1740 | OCI-A FS | Fail safe command for OCI-A trip |
| 1741 | OCI-B FS | Fail safe command for OCI-B trip |
| 1742 | OCI-C FS | Fail safe command for OCI-C trip |
| 1743 | | |
| 1744 | | |
| 1745 | | |
| 1746 | | |
| 1747 | | |
| 1748 | | |
| 1749 | | |
| 1750 | | |
| 1751 | | |
| 1752 | | |
| 1753 | | |
| 1754 | | |
| 1755 | | |
| 1756 | | |
| 1757 | | |
| 1758 | | |
| 1759 | | |
| 1760 | | |
| 1761 | | |
| 1762 | | |
| 1763 | | |
| 1764 | | |
| 1765 | | |
| 1766 | | |
| 1767 | | |
| 1768 | | |
| 1769 | | |
| 1770 | | |
| 1771 | | |
| 1772 | | |
| 1773 | | |
| 1774 | | |
| 1775 | | |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 1776 | | |
| 1777 | | |
| 1778 | | |
| 1779 | | |
| 1780 | | |
| 1781 | | |
| 1782 | | |
| 1783 | | |
| 1784 | | |
| 1785 | | |
| 1786 | | |
| 1787 | | |
| 1788 | | |
| 1789 | | |
| 1790 | | |
| 1791 | | |
| 1792 | IO#1-TP-A1 | Binary output signal of TP-A1 |
| 1793 | IO#1-TP-B1 | TP-B1 |
| 1794 | IO#1-TP-C1 | TP-C1 |
| 1795 | IO#1-TP-A2 | Binary output signal of TP-A2 |
| 1796 | IO#1-TP-B2 | TP-B2 |
| 1797 | IO#1-TP-C2 | TP-C2 |
| 1798 | | |
| 1799 | | |
| 1800 | | |
| 1801 | | |
| 1802 | | |
| 1803 | | |
| 1804 | | |
| 1805 | | |
| 1806 | | |
| 1807 | | |
| 1808 | | |
| 1809 | | |
| 1810 | | |
| 1811 | | |
| 1812 | | |
| 1813 | | |
| 1814 | | |
| 1815 | | |
| 1816 | | |
| 1817 | | |
| 1818 | | |
| 1819 | | |
| 1820 | | |
| 1821 | | |
| 1822 | | |
| 1823 | | |
| 1824 | SPR.L-REQ | Leader SPAR requirement |
| 1825 | TPR.L-REQ | Leader TPAR requirement |
| 1826 | MPR.L-REQ | Leader MPAR requirement |
| 1827 | SPR.F-REQ | Follower SPAR requirement |
| 1828 | TPR.F-REQ | Follower TPAR requirement |
| 1829 | MPR.F-REQ | Follower MPAR requirement |
| 1830 | SPR.F-ST.REQ | Follower SPAR starting requirement |
| 1831 | TPR.F-ST.REQ | Follower TPAR starting requirement |
| 1832 | MPR.F-ST.REQ | Follower MPAR starting requirement |
| 1833 | | |
| 1834 | | |
| 1835 | | |
| 1836 | R.F-ST.REQ | Follower AR starting requirement |
| 1837 | SPR.F2-ST.REQ | Follower SPAR starting requirement |
| 1838 | TPR.F2-ST.REQ | Follower TPAR starting requirement |
| 1839 | MPR.F2-ST.REQ | Follower MPAR starting requirement |
| 1840 | ARC.L_TERM | Leader terminal of Autoreclosing |
| 1841 | ARC.F_TERM | Follower terminal of Autoreclosing |
| 1842 | | |
| 1843 | | |
| 1844 | | |
| 1845 | | |
| 1846 | | |
| 1847 | Z1_ARC_BLOCK | Autoreclosing block by Z1 command |
| 1848 | | |
| 1849 | | |
| 1850 | | |
| 1851 | | |
| 1852 | | |
| 1853 | | |
| 1854 | | |
| 1855 | | |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 1856 | CAR.R1-1 | Trip carrier from remote terminal-1 |
| 1857 | CAR.R1-2 | Independent DEF carrier from remote terminal-1 |
| 1858 | OPEN_TERM-R1 | Remote terminal-1 out of service command |
| 1859 | | |
| 1860 | | |
| 1861 | | |
| 1862 | | |
| 1863 | | |
| 1864 | CAR.R2-1 | Trip carrier from remote terminal-2 |
| 1865 | CAR.R2-2 | Independent DEF carrier from remote terminal-2 |
| 1866 | OPEN_TERM-R2 | Remote terminal-2 out of service command |
| 1867 | | |
| 1868 | | |
| 1869 | | |
| 1870 | | |
| 1871 | INT.COM | Integral communication command |
| 1872 | | |
| 1873 | DCRT_BLOCK | Carrier trip block command |
| 1874 | DISCRT_BLOCK | Carrier protection out of service command |
| 1875 | DEFCRT_BLOCK | DEF carrier trip block command |
| 1876 | | |
| 1877 | PSB_BLOCK | PSB detection block command |
| 1878 | | |
| 1879 | | |
| 1880 | | |
| 1881 | | |
| 1882 | | |
| 1883 | | |
| 1884 | | |
| 1885 | | |
| 1886 | | |
| 1887 | | |
| 1888 | Z1G_BLOCK | Z1G trip block command |
| 1889 | | |
| 1890 | Z2G_BLOCK | Z2G trip block command |
| 1891 | Z3G_BLOCK | Z3G trip block command |
| 1892 | | |
| 1893 | | |
| 1894 | ZRG_BLOCK | ZRG trip block command |
| 1895 | | |
| 1896 | | |
| 1897 | DEFF_BLOCK | DEF-F trip block command |
| 1898 | | |
| 1899 | DEFR_BLOCK | DEF-R trip block command |
| 1900 | STUBOC_BLOCK | OC stub trip block command |
| 1901 | SOTF_BLOCK | OC or Distance SOTF trip block command |
| 1902 | OCH_BLOCK | OCH trip block command |
| 1903 | | |
| 1904 | Z1S_BLOCK | Z1S trip block command |
| 1905 | | |
| 1906 | Z2S_BLOCK | Z2S trip block command |
| 1907 | Z3S_BLOCK | Z3S trip block command |
| 1908 | | |
| 1909 | | |
| 1910 | ZRS_BLOCK | ZRS trip block command |
| 1911 | | |
| 1912 | BCD_BLOCK | BCD trip block command |
| 1913 | | |
| 1914 | VTF_BLOCK | VTF monitoering block command |
| 1915 | VTF_ONLY_ALM | VTF only alarm command |
| 1916 | EXT_VTF | External VTF command |
| 1917 | | |
| 1918 | | |
| 1919 | | |
| 1920 | OVS1_BLOCK | OVS1 trip block command |
| 1921 | OVS2_BLOCK | OVS2 alarm block command |
| 1922 | | |
| 1923 | | |
| 1924 | OVG1_BLOCK | OVG1 trip block command |
| 1925 | OVG2_BLOCK | OVG2 alarm block command |
| 1926 | | |
| 1927 | | |
| 1928 | UVS1_BLOCK | UVS1 trip block command |
| 1929 | UVS2_BLOCK | UVS2 alarm block command |
| 1930 | | |
| 1931 | | |
| 1932 | UVG1_BLOCK | UVG1 trip block command |
| 1933 | UVG2_BLOCK | UVG2 alarm block command |
| 1934 | | |
| 1935 | | |

www.ElectricalPartManuals.com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 1936 | Z1_INST_TP | Z1 instantly trip command |
| 1937 | | |
| 1938 | Z2_INST_TP | Z2 instantly trip command |
| 1939 | Z3_INST_TP | Z3 instantly trip command |
| 1940 | | |
| 1941 | | |
| 1942 | | |
| 1943 | | |
| 1944 | | |
| 1945 | DEFF_INST_TP | DEF-F instantly trip command |
| 1946 | | |
| 1947 | DEFR_INST_TP | DEF-R instantly trip command |
| 1948 | ZR_INST_TP | ZR instantly trip command |
| 1949 | | |
| 1950 | | |
| 1951 | | |
| 1952 | OVS1_INST_TP | OVS1 instantly trip command |
| 1953 | OVS2_INST_TP | OVS2 instantly alarm command |
| 1954 | | |
| 1955 | | |
| 1956 | OVG1_INST_TP | OVG1 instantly trip command |
| 1957 | OVG2_INST_TP | OVG2 instantly alarm command |
| 1958 | | |
| 1959 | | |
| 1960 | UVS1_INST_TP | UVS1 instantly trip command |
| 1961 | UVS2_INST_TP | UVS2 instantly alarm command |
| 1962 | | |
| 1963 | | |
| 1964 | UVG1_INST_TP | UVG1 instantly trip command |
| 1965 | UVG2_INST_TP | UVG2 instantly alarm command |
| 1966 | | |
| 1967 | | |
| 1968 | Z1_3PTP | Z1 3-phase trip command |
| 1969 | | |
| 1970 | Z2_3PTP | Z2 3-phase trip command |
| 1971 | | |
| 1972 | | |
| 1973 | | |
| 1974 | | |
| 1975 | | |
| 1976 | DISCAR_3PTP | Distance CAR 3-phase trip command |
| 1977 | DEFCAR_3PTP | DG.CAR 3-phase trip command |
| 1978 | | |
| 1979 | | |
| 1980 | | |
| 1981 | | |
| 1982 | | |
| 1983 | | |
| 1984 | | |
| 1985 | STUB_CB | CB close command for stub protection |
| 1986 | OCHTP_ON | OCH trip pemmisive command |
| 1987 | PSB.F_RESET | PSB forcibly reset command |
| 1988 | DEF_PHSEL-A | Fault phase selection command for DEF |
| 1989 | DEF_PHSEL-B | ditto |
| 1990 | DEF_PHSEL-C | ditto |
| 1991 | | |
| 1992 | Z2G-A_FS | Z2G-A fail-safe command |
| 1993 | Z2G-B_FS | Z2G-B fail-safe command |
| 1994 | Z2G-C_FS | Z2G-C fail-safe command |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | | |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | | |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | Z2G-A_BLOCK | Z2G-A block command |
| 2009 | Z2G-B_BLOCK | ditto |
| 2010 | Z2G-C_BLOCK | ditto |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | DIF_OUT | DIF protection out-of-service condition for Z1 control |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 2016 | | |
| 2017 | | |
| 2018 | | |
| 2019 | | |
| 2020 | | |
| 2021 | | |
| 2022 | | |
| 2023 | | |
| 2024 | | |
| 2025 | | |
| 2026 | | |
| 2027 | | |
| 2028 | | |
| 2029 | | |
| 2030 | | |
| 2031 | | |
| 2032 | | |
| 2033 | | |
| 2034 | | |
| 2035 | | |
| 2036 | | |
| 2037 | | |
| 2038 | | |
| 2039 | | |
| 2040 | | |
| 2041 | | |
| 2042 | | |
| 2043 | | |
| 2044 | | |
| 2045 | | |
| 2046 | | |
| 2047 | | |
| 2048 | COM1-S | Communication on/off data send command |
| 2049 | COM2-S | ditto |
| 2050 | COM3-S | ditto |
| 2051 | COM4-S | ditto |
| 2052 | COM5-S | ditto |
| 2053 | | |
| 2054 | | |
| 2055 | | |
| 2056 | SUB_COM1-S | Sub communication on/off data send command |
| 2057 | SUB_COM2-S | ditto |
| 2058 | SUB_COM3-S | ditto |
| 2059 | SUB_COM4-S | ditto |
| 2060 | SUB_COM5-S | ditto |
| 2061 | | |
| 2062 | | |
| 2063 | | |
| 2064 | SUB2_COM1-S | Sub communication on/off data 2 send command |
| 2065 | SUB2_COM2-S | ditto |
| 2066 | SUB2_COM3-S | ditto |
| 2067 | SUB2_COM4-S | ditto |
| 2068 | SUB2_COM5-S | ditto |
| 2069 | SUB2_COM6-S | ditto |
| 2070 | SUB2_COM7-S | ditto |
| 2071 | SUB2_COM8-S | ditto |
| 2072 | SUB2_COM9-S | ditto |
| 2073 | SUB2_COM10-S | ditto |
| 2074 | SUB2_COM11-S | ditto |
| 2075 | SUB2_COM12-S | ditto |
| 2076 | | |
| 2077 | | |
| 2078 | | |
| 2079 | | |
| 2080 | SUB3_COM1-S | Sub communication on/off data 3 send command |
| 2081 | SUB3_COM2-S | ditto |
| 2082 | SUB3_COM3-S | ditto |
| 2083 | SUB3_COM4-S | ditto |
| 2084 | SUB3_COM5-S | ditto |
| 2085 | SUB3_COM6-S | ditto |
| 2086 | SUB3_COM7-S | ditto |
| 2087 | SUB3_COM8-S | ditto |
| 2088 | SUB3_COM9-S | ditto |
| 2089 | SUB3_COM10-S | ditto |
| 2090 | SUB3_COM11-S | ditto |
| 2091 | SUB3_COM12-S | ditto |
| 2092 | | |
| 2093 | | |
| 2094 | | |
| 2095 | | |

www.ElectricalPartManuals.com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 2096 | V.COM1-S | Communiation on/off data(V0 data frame) send command |
| 2097 | V.COM2-S | ditto |
| 2098 | V.COM3-S | ditto |
| 2099 | | |
| 2100 | S.V.COM1-S | Communiation on/off data(V0 data frame) send command |
| 2101 | S.V.COM2-S | ditto |
| 2102 | S.V.COM3-S | ditto |
| 2103 | S.V.COM4-S | ditto |
| 2104 | S.V.COM5-S | ditto |
| 2105 | S.V.COM6-S | ditto |
| 2106 | S.V.COM7-S | ditto |
| 2107 | S.V.COM8-S | ditto |
| 2108 | S.V.COM9-S | ditto |
| 2109 | S.V.COM10-S | ditto |
| 2110 | S.V.COM11-S | ditto |
| 2111 | S.V.COM12-S | ditto |
| 2112 | I.COM1-S | Communiation on/off data(I0 data frame) send command |
| 2113 | I.COM2-S | ditto |
| 2114 | I.COM3-S | ditto |
| 2115 | | |
| 2116 | S.I.COM1-S | Communiation on/off data(I0 data frame) send command |
| 2117 | S.I.COM2-S | ditto |
| 2118 | S.I.COM3-S | ditto |
| 2119 | S.I.COM4-S | ditto |
| 2120 | S.I.COM5-S | ditto |
| 2121 | S.I.COM6-S | ditto |
| 2122 | S.I.COM7-S | ditto |
| 2123 | S.I.COM8-S | ditto |
| 2124 | S.I.COM9-S | ditto |
| 2125 | S.I.COM10-S | ditto |
| 2126 | S.I.COM11-S | ditto |
| 2127 | S.I.COM12-S | ditto |
| 2128 | | |
| 2129 | | |
| 2130 | | |
| 2131 | | |
| 2132 | | |
| 2133 | | |
| 2134 | | |
| 2135 | | |
| 2136 | | |
| 2137 | | |
| 2138 | | |
| 2139 | | |
| 2140 | | |
| 2141 | | |
| 2142 | | |
| 2143 | | |
| 2144 | | |
| 2145 | | |
| 2146 | | |
| 2147 | | |
| 2148 | | |
| 2149 | | |
| 2150 | | |
| 2151 | | |
| 2152 | | |
| 2153 | | |
| 2154 | | |
| 2155 | | |
| 2156 | | |
| 2157 | | |
| 2158 | | |
| 2159 | | |
| 2160 | | |
| 2161 | | |
| 2162 | | |
| 2163 | | |
| 2164 | | |
| 2165 | | |
| 2166 | | |
| 2167 | | |
| 2168 | | |
| 2169 | | |
| 2170 | | |
| 2171 | | |
| 2172 | | |
| : | | |
| : | | |
| 2575 | | |

www.ElectricalPartManuals.com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 2576 | | |
| 2577 | | |
| 2578 | | |
| 2579 | | |
| 2580 | | |
| 2581 | | |
| 2582 | | |
| 2583 | | |
| 2584 | | |
| 2585 | | |
| 2586 | | |
| 2587 | | |
| 2588 | | |
| 2589 | | |
| 2590 | | |
| 2591 | | |
| 2592 | | |
| 2593 | | |
| 2594 | | |
| 2595 | | |
| 2596 | | |
| 2597 | | |
| 2598 | | |
| 2599 | | |
| 2600 | | |
| 2601 | | |
| 2602 | | |
| 2603 | | |
| 2604 | | |
| 2605 | | |
| 2606 | | |
| 2607 | | |
| 2608 | | |
| 2609 | | |
| 2610 | ALARM_LED_SET | Alarm LED set |
| 2611 | | |
| 2612 | | |
| 2613 | | |
| 2614 | | |
| 2615 | | |
| 2616 | | |
| 2617 | | |
| 2618 | | |
| 2619 | | |
| 2620 | | |
| 2621 | | |
| 2622 | | |
| 2623 | | |
| 2624 | F.RECORD1 | Fault record stored command 1 |
| 2625 | F.RECORD2 | 2 |
| 2626 | F.RECORD3 | 3 |
| 2627 | F.RECORD4 | 4 |
| 2628 | | |
| 2629 | | |
| 2630 | | |
| 2631 | | |
| 2632 | D.RECORD1 | Disturbance record stored command 1 |
| 2633 | D.RECORD2 | 2 |
| 2634 | D.RECORD3 | 3 |
| 2635 | D.RECORD4 | 4 |
| 2636 | | |
| 2637 | | |
| 2638 | | |
| 2639 | | |
| 2640 | SET.GROUP1 | Active setting group changed commamd (Change to group1) |
| 2641 | SET.GROUP2 | 2 |
| 2642 | SET.GROUP3 | 3 |
| 2643 | SET.GROUP4 | 4 |
| 2644 | SET.GROUP5 | 5 |
| 2645 | SET.GROUP6 | 6 |
| 2646 | SET.GROUP7 | 7 |
| 2647 | SET.GROUP8 | 8 |
| 2648 | | |
| 2649 | | |
| 2650 | | |
| 2651 | | |
| 2652 | | |
| 2653 | | |
| 2654 | | |
| 2655 | | |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 2656 | CON_TPMD1 | User configurable trip mode in fault record |
| 2657 | CON_TPMD2 | ditto |
| 2658 | CON_TPMD3 | ditto |
| 2659 | CON_TPMD4 | ditto |
| 2660 | CON_TPMD5 | ditto |
| 2661 | CON_TPMD6 | ditto |
| 2662 | CON_TPMD7 | ditto |
| 2663 | CON_TPMD8 | ditto |
| 2664 | | |
| 2665 | | |
| 2666 | | |
| 2667 | | |
| 2668 | | |
| 2669 | | |
| 2670 | | |
| 2671 | | |
| 2672 | | |
| 2673 | | |
| 2674 | | |
| 2675 | | |
| 2676 | | |
| 2677 | | |
| 2678 | | |
| 2679 | | |
| 2680 | | |
| 2681 | | |
| 2682 | | |
| 2683 | | |
| 2684 | ARC_COM_RECV | Auto-recloser inactivate command received |
| 2685 | TEL_COM_RECV | Teleprotection inactivate command received |
| 2686 | PROT_COM_RECV | protection inactivate command received |
| 2687 | | |
| 2688 | TPLED_RST_RCV | TRIP LED RESET command received |
| 2689 | | |
| 2690 | | |
| 2691 | | |
| 2692 | | |
| 2693 | | |
| 2694 | | |
| 2695 | | |
| 2696 | | |
| 2697 | | |
| 2698 | | |
| 2699 | | |
| 2700 | | |
| 2701 | | |
| 2702 | | |
| 2703 | | |
| 2704 | | |
| 2705 | | |
| 2706 | | |
| 2707 | | |
| 2708 | | |
| 2709 | | |
| 2710 | | |
| 2711 | | |
| 2712 | | |
| 2713 | | |
| 2714 | | |
| 2715 | | |
| 2716 | | |
| 2717 | | |
| 2718 | | |
| 2719 | | |
| 2720 | | |
| 2721 | | |
| 2722 | | |
| 2723 | | |
| 2724 | | |
| 2725 | | |
| 2726 | | |
| 2727 | | |
| 2728 | | |
| 2729 | | |
| 2730 | | |
| 2731 | | |
| 2732 | | |
| : | | |
| : | | |
| 2815 | | |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 2816 | TEMP001 | |
| 2817 | TEMP002 | |
| 2818 | TEMP003 | |
| 2819 | TEMP004 | |
| 2820 | TEMP005 | |
| 2821 | TEMP006 | |
| 2822 | TEMP007 | |
| 2823 | TEMP008 | |
| 2824 | TEMP009 | |
| 2825 | TEMP010 | |
| 2826 | TEMP011 | |
| 2827 | TEMP012 | |
| 2828 | TEMP013 | |
| 2829 | TEMP014 | |
| 2830 | TEMP015 | |
| 2831 | TEMP016 | |
| 2832 | TEMP017 | |
| 2833 | TEMP018 | |
| 2834 | TEMP019 | |
| 2835 | TEMP020 | |
| 2836 | TEMP021 | |
| 2837 | TEMP022 | |
| 2838 | TEMP023 | |
| 2839 | TEMP024 | |
| 2840 | TEMP025 | |
| 2841 | TEMP026 | |
| 2842 | TEMP027 | |
| 2843 | TEMP028 | |
| 2844 | TEMP029 | |
| 2845 | TEMP030 | |
| 2846 | TEMP031 | |
| 2847 | TEMP032 | |
| 2848 | TEMP033 | |
| 2849 | TEMP034 | |
| 2850 | TEMP035 | |
| 2851 | TEMP036 | |
| 2852 | TEMP037 | |
| 2853 | TEMP038 | |
| 2854 | TEMP039 | |
| 2855 | TEMP040 | |
| 2856 | TEMP041 | |
| 2857 | TEMP042 | |
| 2858 | TEMP043 | |
| 2859 | TEMP044 | |
| 2860 | TEMP045 | |
| 2861 | TEMP046 | |
| 2862 | TEMP047 | |
| 2863 | TEMP048 | |
| 2864 | TEMP049 | |
| 2865 | TEMP050 | |
| 2866 | TEMP051 | |
| 2867 | TEMP052 | |
| 2868 | TEMP053 | |
| 2869 | TEMP054 | |
| 2870 | TEMP055 | |
| 2871 | TEMP056 | |
| 2872 | TEMP057 | |
| 2873 | TEMP058 | |
| 2874 | TEMP059 | |
| 2875 | TEMP060 | |
| 2876 | TEMP061 | |
| 2877 | TEMP062 | |
| 2878 | TEMP063 | |
| 2879 | TEMP064 | |
| 2880 | TEMP065 | |
| 2881 | TEMP066 | |
| 2882 | TEMP067 | |
| 2883 | TEMP068 | |
| 2884 | TEMP069 | |
| 2885 | TEMP070 | |
| 2886 | TEMP071 | |
| 2887 | TEMP072 | |
| 2888 | TEMP073 | |
| 2889 | TEMP074 | |
| 2890 | TEMP075 | |
| 2891 | TEMP076 | |
| 2892 | TEMP077 | |
| 2893 | TEMP078 | |
| 2894 | TEMP079 | |
| 2895 | TEMP080 | |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 2896 | TEMP081 | |
| 2897 | TEMP082 | |
| 2898 | TEMP083 | |
| 2899 | TEMP084 | |
| 2900 | TEMP085 | |
| 2901 | TEMP086 | |
| 2902 | TEMP087 | |
| 2903 | TEMP088 | |
| 2904 | TEMP089 | |
| 2905 | TEMP090 | |
| 2906 | TEMP091 | |
| 2907 | TEMP092 | |
| 2908 | TEMP093 | |
| 2909 | TEMP094 | |
| 2910 | TEMP095 | |
| 2911 | TEMP096 | |
| 2912 | TEMP097 | |
| 2913 | TEMP098 | |
| 2914 | TEMP099 | |
| 2915 | TEMP100 | |
| 2916 | TEMP101 | |
| 2917 | TEMP102 | |
| 2918 | TEMP103 | |
| 2919 | TEMP104 | |
| 2920 | TEMP105 | |
| 2921 | TEMP106 | |
| 2922 | TEMP107 | |
| 2923 | TEMP108 | |
| 2924 | TEMP109 | |
| 2925 | TEMP110 | |
| 2926 | TEMP111 | |
| 2927 | TEMP112 | |
| 2928 | TEMP113 | |
| 2929 | TEMP114 | |
| 2930 | TEMP115 | |
| 2931 | TEMP116 | |
| 2932 | TEMP117 | |
| 2933 | TEMP118 | |
| 2934 | TEMP119 | |
| 2935 | TEMP120 | |
| 2936 | TEMP121 | |
| 2937 | TEMP122 | |
| 2938 | TEMP123 | |
| 2939 | TEMP124 | |
| 2940 | TEMP125 | |
| 2941 | TEMP126 | |
| 2942 | TEMP127 | |
| 2943 | TEMP128 | |
| 2944 | TEMP129 | |
| 2945 | TEMP130 | |
| 2946 | TEMP131 | |
| 2947 | TEMP132 | |
| 2948 | TEMP133 | |
| 2949 | TEMP134 | |
| 2950 | TEMP135 | |
| 2951 | TEMP136 | |
| 2952 | TEMP137 | |
| 2953 | TEMP138 | |
| 2954 | TEMP139 | |
| 2955 | TEMP140 | |
| 2956 | TEMP141 | |
| 2957 | TEMP142 | |
| 2958 | TEMP143 | |
| 2959 | TEMP144 | |
| 2960 | TEMP145 | |
| 2961 | TEMP146 | |
| 2962 | TEMP147 | |
| 2963 | TEMP148 | |
| 2964 | TEMP149 | |
| 2965 | TEMP150 | |
| 2966 | TEMP151 | |
| 2967 | TEMP152 | |
| 2968 | TEMP153 | |
| 2969 | TEMP154 | |
| 2970 | TEMP155 | |
| 2971 | TEMP156 | |
| 2972 | TEMP157 | |
| 2973 | TEMP158 | |
| 2974 | TEMP159 | |
| 2975 | TEMP160 | |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 2976 | TEMP161 | |
| 2977 | TEMP162 | |
| 2978 | TEMP163 | |
| 2979 | TEMP164 | |
| 2980 | TEMP165 | |
| 2981 | TEMP166 | |
| 2982 | TEMP167 | |
| 2983 | TEMP168 | |
| 2984 | TEMP169 | |
| 2985 | TEMP170 | |
| 2986 | TEMP171 | |
| 2987 | TEMP172 | |
| 2988 | TEMP173 | |
| 2989 | TEMP174 | |
| 2990 | TEMP175 | |
| 2991 | TEMP176 | |
| 2992 | TEMP177 | |
| 2993 | TEMP178 | |
| 2994 | TEMP179 | |
| 2995 | TEMP180 | |
| 2996 | TEMP181 | |
| 2997 | TEMP182 | |
| 2998 | TEMP183 | |
| 2999 | TEMP184 | |
| 3000 | TEMP185 | |
| 3001 | TEMP186 | |
| 3002 | TEMP187 | |
| 3003 | TEMP188 | |
| 3004 | TEMP189 | |
| 3005 | TEMP190 | |
| 3006 | TEMP191 | |
| 3007 | TEMP192 | |
| 3008 | TEMP193 | |
| 3009 | TEMP194 | |
| 3010 | TEMP195 | |
| 3011 | TEMP196 | |
| 3012 | TEMP197 | |
| 3013 | TEMP198 | |
| 3014 | TEMP199 | |
| 3015 | TEMP200 | |
| 3016 | TEMP201 | |
| 3017 | TEMP202 | |
| 3018 | TEMP203 | |
| 3019 | TEMP204 | |
| 3020 | TEMP205 | |
| 3021 | TEMP206 | |
| 3022 | TEMP207 | |
| 3023 | TEMP208 | |
| 3024 | TEMP209 | |
| 3025 | TEMP210 | |
| 3026 | TEMP211 | |
| 3027 | TEMP212 | |
| 3028 | TEMP213 | |
| 3029 | TEMP214 | |
| 3030 | TEMP215 | |
| 3031 | TEMP216 | |
| 3032 | TEMP217 | |
| 3033 | TEMP218 | |
| 3034 | TEMP219 | |
| 3035 | TEMP220 | |
| 3036 | TEMP221 | |
| 3037 | TEMP222 | |
| 3038 | TEMP223 | |
| 3039 | TEMP224 | |
| 3040 | TEMP225 | |
| 3041 | TEMP226 | |
| 3042 | TEMP227 | |
| 3043 | TEMP228 | |
| 3044 | TEMP229 | |
| 3045 | TEMP230 | |
| 3046 | TEMP231 | |
| 3047 | TEMP232 | |
| 3048 | TEMP233 | |
| 3049 | TEMP234 | |
| 3050 | TEMP235 | |
| 3051 | TEMP236 | |
| 3052 | TEMP237 | |
| 3053 | TEMP238 | |
| 3054 | TEMP239 | |
| 3055 | TEMP240 | |

www . ElectricalPartManuals . com

Signal list

| No. | Signal Name | Contents |
|---|---|---|
| 3056 | TEMP241 | |
| 3057 | TEMP242 | |
| 3058 | TEMP243 | |
| 3059 | TEMP244 | |
| 3060 | TEMP245 | |
| 3061 | TEMP246 | |
| 3062 | TEMP247 | |
| 3063 | TEMP248 | |
| 3064 | TEMP249 | |
| 3065 | TEMP250 | |
| 3066 | TEMP251 | |
| 3067 | TEMP252 | |
| 3068 | TEMP253 | |
| 3069 | TEMP254 | |
| 3070 | TEMP255 | |
| 3071 | TEMP256 | |

www . ElectricalPartManuals . com

# Appendix C

# Variable Timer List

www . ElectricalPartManuals . com

### Variable Timer List

| Timer | Timer No. | Contents | Timer | Timer No. | Contents |
|---|---|---|---|---|---|
| TDIFG | 1 | DIFG delayed trip | TDEFC | 71 | DEF carrier trip delay time (forward) |
| TBF1A | 2 | BF retrip (phase A) | TDERC | 72 | DEF carrier trip delay time(reverse) |
| TBF1B | 3 | BF retrip (phase B) | TSOTF | 73 | CB open detect timer for SOTF |
| TBF1C | 4 | BF retrip (phase C) | TPSB | 74 | PS detection time |
| TBF2A | 5 | BF trip (phase A) | TCHD | 75 | Coordination time |
| TBF2B | 6 | BF trip (phase B) | TREBK | 76 | Current reverse blocking time |
| TBF2C | 7 | BF trip (phase C) | TECCB | 77 | ECHO enable timer from CB opened |
| TOC | 8 | OC delayed trip | TSBCT | 78 | SBCNT time |
| TEF | 9 | EF delayed trip | | | |
| TIDSV | 10 | IDSV detected time | | | |
| TEVLV | 16 | Autoreclose to developing fault | | | |
| TRDY1 | 17 | Reclaim time (leader breaker) | | | |
| TSPR1 | 18 | Dead time for single-phase and multi-phase autoreclose (leader breaker) | | | |
| TTPR1 | 19 | Dead time for three-phase autoreclose (leader breaker) | | | |
| TW1 | 20 | Duration of reclosing command output (leader breaker) | | | |
| TRR1 | 21 | Autoreclose reset (leader breaker) | | | |
| TRDY2 | 22 | Reclaim time (follower breaker) | | | |
| TSPR2 | 23 | Dead time for single-phase and multi-phase autoreclose (follower breaker) | | | |
| TTPR2 | 24 | Dead time for three-phase autoreclose (follower breaker) | | | |
| TW2 | 25 | Duration of reclosing command output (follower breaker) | | | |
| TRR2 | 26 | Autoreclose reset (follower breaker) | | | |
| TS2 | 27 | Second shot dead time | | | |
| TS3 | 28 | Third shot dead time | | | |
| TS4 | 29 | Fourth shot dead time | | | |
| TS2R | 30 | Second shot reset time | | | |
| TS3R | 31 | Third shot reset time | | | |
| TS4R | 32 | Fourth shot reset time | | | |
| TSYN1 | 33 | Synchronism check time (busbar breaker) | | | |
| TSYN2 | 34 | Synchronism check time (center breaker) | | | |
| TDBL1 | 35 | Dead bus and live line check (busbar breaker) | | | |
| TDBL2 | 36 | Dead bus and live line check (center breaker) | | | |
| TLBD1 | 37 | Live bus and dead line check (busbar breaker) | | | |
| TLBD2 | 38 | Live bus and dead line check (center breaker) | | | |
| TMPR1 | 39 | MPAR dead line time | | | |
| TMPR2 | 40 | MPAR dead line time | | | |
| T3PLL | 41 | Three phase live line check time | | | |
| TBCD | 46 | BCD definite time | | | |
| TOS1 | 47 | OVS1 definite time | | | |
| TOS2 | 48 | OVS2 definite time | | | |
| TOG1 | 49 | OVG1 definite time | | | |
| TOG2 | 50 | OVG2 definite time | | | |
| TUS1 | 51 | UVS1 definite time | | | |
| TUS2 | 52 | UVS2 definite time | | | |
| TUG1 | 53 | UVG1 definite time | | | |
| TUG2 | 54 | UVG2 definite time | | | |
| TZ1G | 61 | Z1G time-delay trip | | | |
| TZ1S | 62 | Z1S time-delay trip | | | |
| TZ2G | 63 | Z2G back-up trip time | | | |
| TZ2S | 64 | Z2S back-up trip time | | | |
| TZ3G | 65 | Z3G back-up trip time | | | |
| TZ3S | 66 | Z3S back-up trip time | | | |
| TZRG | 67 | ZRG back-up trip time | | | |
| TZRS | 68 | ZRS back-up trip time | | | |
| TDEF | 69 | Forward definite time | | | |
| TDER | 70 | Reverse definite time | | | |

www.FreeElectricalPartManuals.com

# Appendix D

# Binary Output Default Setting List

www.ElectricalPartManuals.com

## Binary Output Default Setting List (1)

| Relay Model | Module Name | BO No. | Terminal No. | Signal Name | Contents | Setting | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Signal No. | LOGIC (OR:1, AND:2) | TIMER (OFF:0, ON:1) |
| GRL100 -701 | IO#2 | | TB3: | | | | | |
| | | BO1 | A2-A1 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO2 | A2-B1 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | | BO3 | A2-B2 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO4 | A3-B3 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO5 | A4-B4 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | | BO6 | A5-B5 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO7 | A6-B6 | TRIP-A*,B*,C* | Trip A, B or C phase | 99, 100, 101, 102, 103, 104 | 1 | 1 |
| | | BO8 | A7-B7 | TRIP-A*,B*,C* | Trip A, B or C phase | 99, 100, 101, 102, 103, 104 | 1 | 1 |
| | | BO9 | A8-B8 | ARC1 | Bus CB autoreclose | 177 | 1 | 0 |
| | | BO10 | A9-B9 | ARC2 | Center CB autoreclose | 178 | 1 | 0 |
| | | BO11 | A10-B10 | COMM1_FAIL | Communication failure | 225 | 1 | 1 |
| | | BO12 | A11-B11 | 85R1.REM1 | Transfer trip 1 receive | 197 | 1 | 1 |
| | | BO13 | A13-B13 | CAR-S | Carrier send command | 886 | 1 | 0 |
| | | (FAIL) | A12-B12 | RELAY FAILURE | -- | -- | -- | -- |
| | IO#3 | | TB2: | | | | | |
| | | BO1 | A1-B1 | 89CB-1AB | Link A phase (A-B terminal) | 146 | 1 | 0 |
| | | BO2 | A2-B2 | 89CB-2AB | Link B phase (A-B terminal) | 147 | 1 | 0 |
| | | BO3 | A3-B3 | 89CB-3AB | Link C phase (A-B terminal) | 148 | 1 | 0 |
| | | BO4 | A4-B4 | DIF-* /DIFG_TRIP | DIF, DIFG relay operating | 82, 83, 84, 86 | 1 | 1 |
| | | BO5 | A5-B5 | CAR/Z1G/Z1S_TRIP | Carrier, Z1S, Z1G trip | 904, 790, 794 | 1 | 1 |
| | | BO6 | A6-B6 | CBFDET | CBF detection | 91 | 1 | 1 |
| GRL100 -702 | IO#2 | | TB2: | | | | | |
| | | BO1 | A2-A1 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO2 | A2-B1 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | | BO3 | A2-B2 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO4 | A3-B3 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO5 | A4-B4 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | | BO6 | A5-B5 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO7 | A6-B6 | TRIP-A*,B*,C* | Trip A, B or C phase | 99, 100, 101, 102, 103, 104 | 1 | 1 |
| | | BO8 | A7-B7 | TRIP-A*,B*,C* | Trip A, B or C phase | 99, 100, 101, 102, 103, 104 | 1 | 1 |
| | | BO9 | A8-B8 | ARC1 | Bus CB autoreclose | 177 | 1 | 0 |
| | | BO10 | A9-B9 | ARC2 | Center CB autoreclose | 178 | 1 | 0 |
| | | BO11 | A10-B10 | COMM1_FAIL | Communication failure | 225 | 1 | 1 |
| | | BO12 | A11-B11 | 85R1.REM1 | Transfer trip 1 receive | 197 | 1 | 1 |
| | | BO13 | A13-B13 | CAR-S | Carrier send command | 886 | 1 | 0 |
| | | (FAIL) | A12-B12 | RELAY FAILURE | -- | -- | -- | -- |
| | IO#4 | | TB3: | | | | | |
| | | BO1 | A2-A1 | 89CB-1AB | Link A phase (A-B terminal) | 146 | 1 | 0 |
| | | BO2 | A2-B1 | 89CB-2AB | Link B phase (A-B terminal) | 147 | 1 | 0 |
| | | BO3 | A2-B2 | 89CB-3AB | Link C phase (A-B terminal) | 148 | 1 | 0 |
| | | BO4 | A3-B3 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO5 | A4-B4 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | | BO6 | A5-B5 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO7 | A6-B6 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO8 | A7-B7 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | | BO9 | A8-B8 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO10 | A9-B9 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO11 | A10-B10 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | | BO12 | A11-B11 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO13 | A12-B12 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO14 | A13-B13 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | IO#3 | | TB5: | | | | | |
| | | BO1 | A1-B1 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO2 | A2-B2 | DIF-A, -B, -C_TRIP | DIF relay operating | 82, 83, 84 | 1 | 1 |
| | | BO3 | A3-B3 | DIFG_TRIP | DIFG relay operating | 86 | 1 | 1 |
| | | BO4 | A4-B4 | CAR_TRIP | Distance or DG carrier trip | 904 | 1 | 1 |
| | | BO5 | A5-B5 | Z1G_TRIP/Z1S_TRIP | Z1G, Z1S trip | 790, 794 | 1 | 1 |
| | | BO6 | A6-B6 | CBFDET | CBF detection | 91 | 1 | 1 |
| | | BO7 | A7-B7 | SPAR1 | Bus CB single pole ARC | 173 | 1 | 1 |
| | | BO8 | A8-B8 | TPAR1 | Bus CB three pole ARC | 175 | 1 | 1 |
| | | BO9 | A9-B9 | SPAR2 | Center CB single pole ARC | 174 | 1 | 1 |
| | | BO10 | A10-B10 | TPAR2 | Center CB three pole ARC | 176 | 1 | 1 |

www.ElectricalPartManuals.com

## Binary Output Default Setting List (2)

| Relay Model | Module Name | BO No. | Terminal No. | Signal Name | Contents | Setting | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Signal No. | LOGIC (OR:1, AND:2) | TIMER (OFF:0, ON:1) |
| GRL100 -711 | IO#2 | | TB3: | | | | | |
| | | BO1 | A2-A1 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO2 | A2-B1 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | | BO3 | A2-B2 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO4 | A3-B3 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO5 | A4-B4 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | | BO6 | A5-B5 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO7 | A6-B6 | TRIP-A*,B*,C* | Trip A, B or C phase | 99, 100, 101, 102, 103, 104 | 1 | 1 |
| | | BO8 | A7-B7 | TRIP-A*,B*,C* | Trip A, B or C phase | 99, 100, 101, 102, 103, 104 | 1 | 1 |
| | | BO9 | A8-B8 | ARC1 | Bus CB autoreclose | 177 | 1 | 0 |
| | | BO10 | A9-B9 | ARC2 | Center CB autoreclose | 178 | 1 | 0 |
| | | BO11 | A10-B10 | COMM1/2_FAIL | Communication failure | 225, 226 | 1 | 1 |
| | | BO12 | A11-B11 | 85R1.REM1/2 | Transfer trip 1 receive | 197, 202 | 1 | 1 |
| | | BO13 | A13-B13 | CAR-S | Carrier send command | 886 | 1 | 0 |
| | | (FAIL) | A12-B12 | RELAY FAILURE | -- | -- | -- | -- |
| | IO#3 | | TB2: | | | | | |
| | | BO1 | A1-B1 | 89CB-1AB | Link A phase (A-B terminal) | 146 | 1 | 0 |
| | | BO2 | A2-B2 | 89CB-2AB | Link B phase (A-B terminal) | 147 | 1 | 0 |
| | | BO3 | A3-B3 | 89CB-3AB | Link C phase (A-B terminal) | 148 | 1 | 0 |
| | | BO4 | A4-B4 | 89CB-1AC | Link A phase (A-C terminal) | 149 | 1 | 0 |
| | | BO5 | A5-B5 | 89CB-2AC | Link B phase (A-C terminal) | 150 | 1 | 0 |
| | | BO6 | A6-B6 | 89CB-3AC | Link C phase (A-C terminal) | 151 | 1 | 0 |
| GRL100 -712 | IO#2 | | TB2: | | | | | |
| | | BO1 | A2-A1 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO2 | A2-B1 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | | BO3 | A2-B2 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO4 | A3-B3 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO5 | A4-B4 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | | BO6 | A5-B5 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO7 | A6-B6 | TRIP-A*,B*,C* | Trip A, B or C phase | 99, 100, 101, 102, 103, 104 | 1 | 1 |
| | | BO8 | A7-B7 | TRIP-A*,B*,C* | Trip A, B or C phase | 99, 100, 101, 102, 103, 104 | 1 | 1 |
| | | BO9 | A8-B8 | ARC1 | Bus CB autoreclose | 177 | 1 | 0 |
| | | BO10 | A9-B9 | ARC2 | Center CB autoreclose | 178 | 1 | 0 |
| | | BO11 | A10-B10 | COMM1/2_FAIL | Communication failure | 225, 226 | 1 | 1 |
| | | BO12 | A11-B11 | 85R1.REM1/2 | Transfer trip 1 receive | 197, 202 | 1 | 1 |
| | | BO13 | A13-B13 | CAR-S | Carrier send command | 886 | 1 | 0 |
| | | (FAIL) | A12-B12 | RELAY FAILURE | -- | -- | -- | -- |
| | IO#4 | | TB3: | | | | | |
| | | BO1 | A2-A1 | 89CB-1AB | Link A phase (A-B terminal) | 146 | 1 | 0 |
| | | BO2 | A2-B1 | 89CB-2AB | Link B phase (A-B terminal) | 147 | 1 | 0 |
| | | BO3 | A2-B2 | 89CB-3AB | Link C phase (A-B terminal) | 148 | 1 | 0 |
| | | BO4 | A3-B3 | 89CB-1AC | Link A phase (A-C terminal) | 149 | 1 | 0 |
| | | BO5 | A4-B4 | 89CB-2AC | Link B phase (A-C terminal) | 150 | 1 | 0 |
| | | BO6 | A5-B5 | 89CB-3AC | Link C phase (A-C terminal) | 151 | 1 | 0 |
| | | BO7 | A6-B6 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO8 | A7-B7 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | | BO9 | A8-B8 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO10 | A9-B9 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO11 | A10-B10 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | | BO12 | A11-B11 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO13 | A12-B12 | TRIP-A1/A2 | Trip A phase | 99, 102 | 1 | 1 |
| | | BO14 | A13-B13 | TRIP-B1/B2 | Trip B phase | 100, 103 | 1 | 1 |
| | IO#3 | | TB5: | | | | | |
| | | BO1 | A1-B1 | TRIP-C1/C2 | Trip C phase | 101, 104 | 1 | 1 |
| | | BO2 | A2-B2 | DIF-A, -B, -C_TRIP | DIF relay operating | 82, 83, 84 | 1 | 1 |
| | | BO3 | A3-B3 | DIFG_TRIP | DIFG relay operating | 86 | 1 | 1 |
| | | BO4 | A4-B4 | CAR_TRIP | Distance or DG carrier trip | 904 | 1 | 1 |
| | | BO5 | A5-B5 | Z1G_TRIP/Z1S_TRIP | Z1G, Z1S trip | 790, 794 | 1 | 1 |
| | | BO6 | A6-B6 | CBFDET | CBF detection | 91 | 1 | 1 |
| | | BO7 | A7-B7 | SPAR1 | Bus CB single pole ARC | 173 | 1 | 1 |
| | | BO8 | A8-B8 | TPAR1 | Bus CB three pole ARC | 175 | 1 | 1 |
| | | BO9 | A9-B9 | SPAR2 | Center CB single pole ARC | 174 | 1 | 1 |
| | | BO10 | A10-B10 | TPAR2 | Center CB three pole ARC | 176 | 1 | 1 |

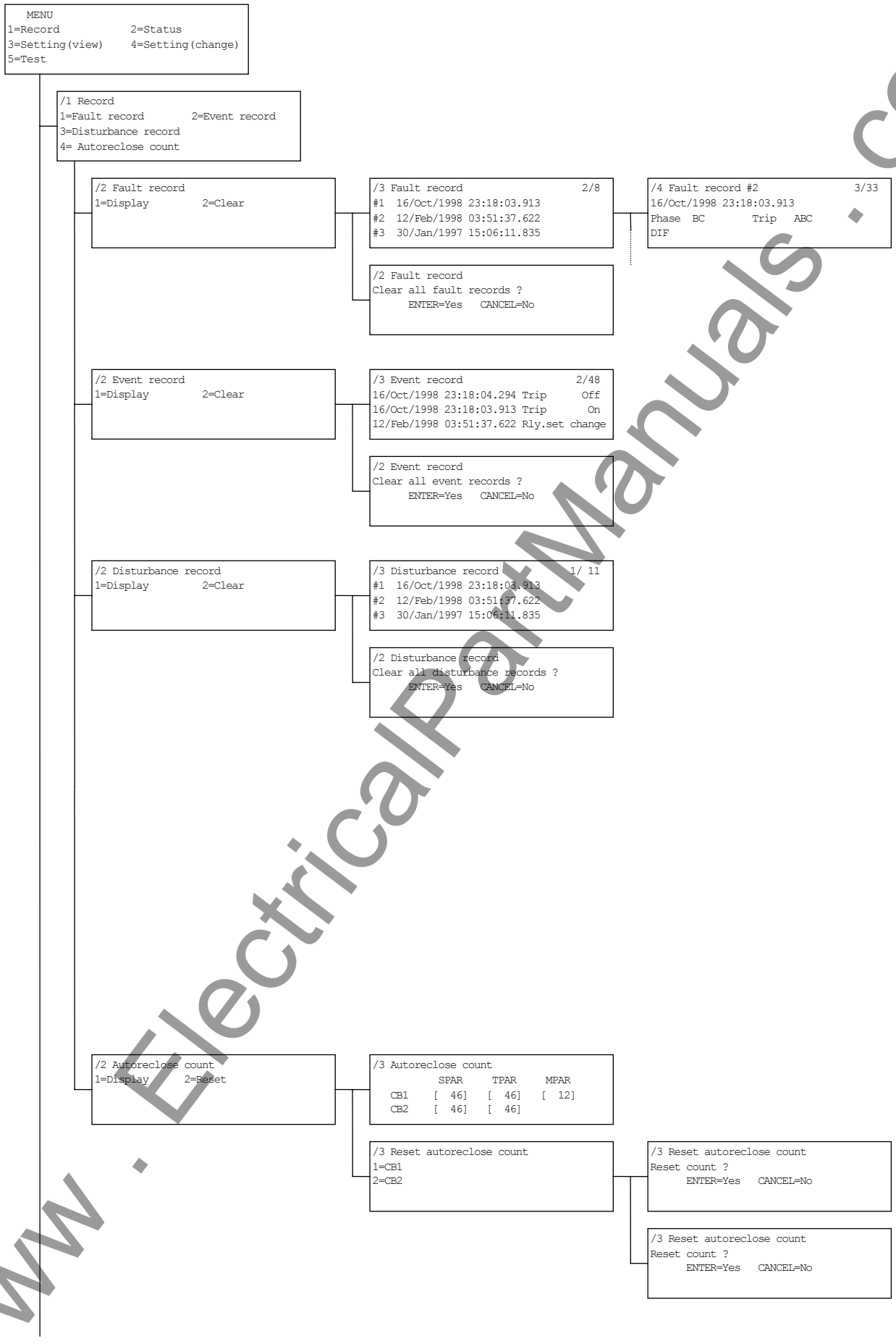
www.ElectricalPartManuals.com

www . ElectricalPartManuals . com

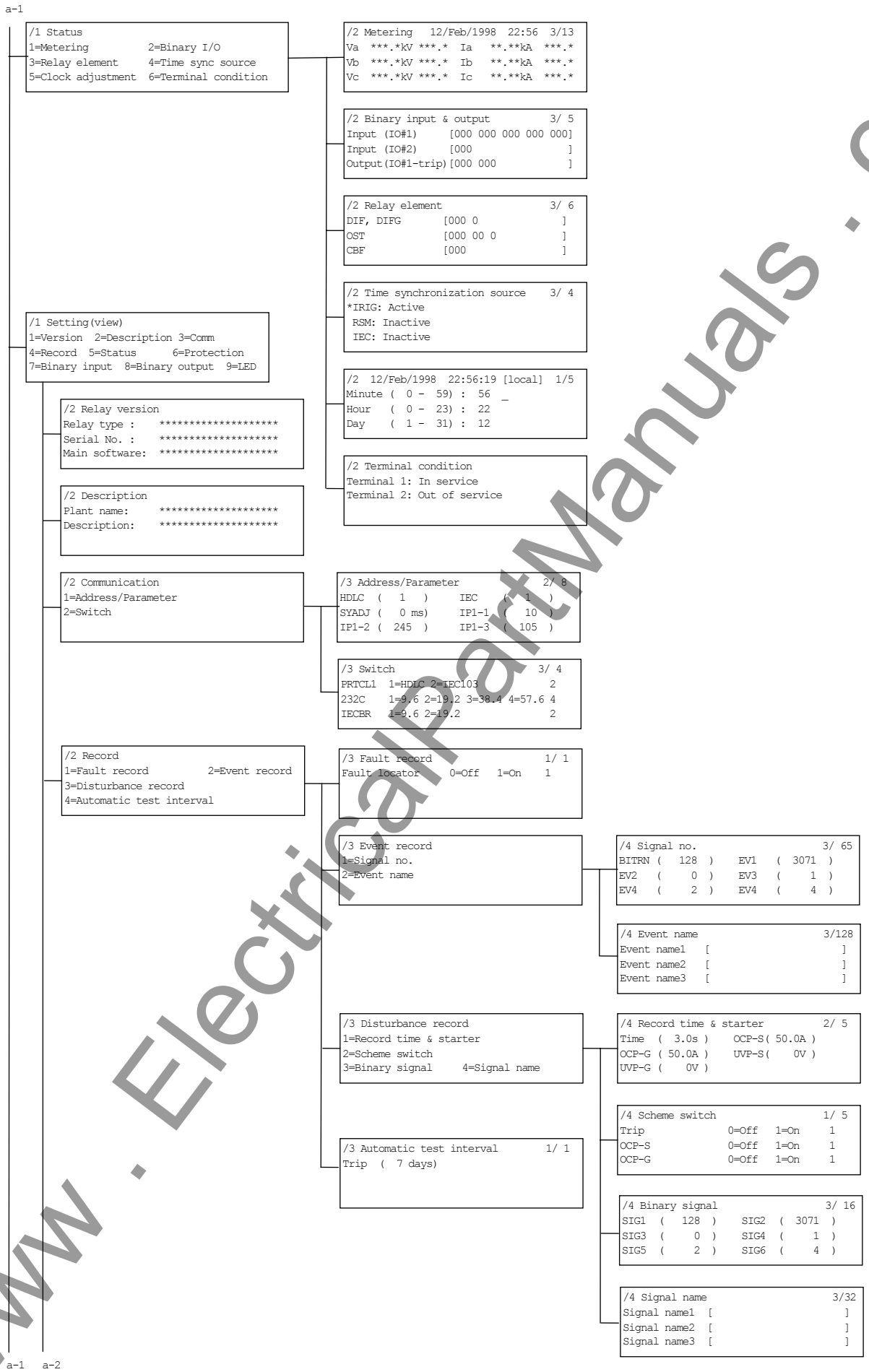
# Appendix E

# Details of Relay Menu and LCD & Button Operation

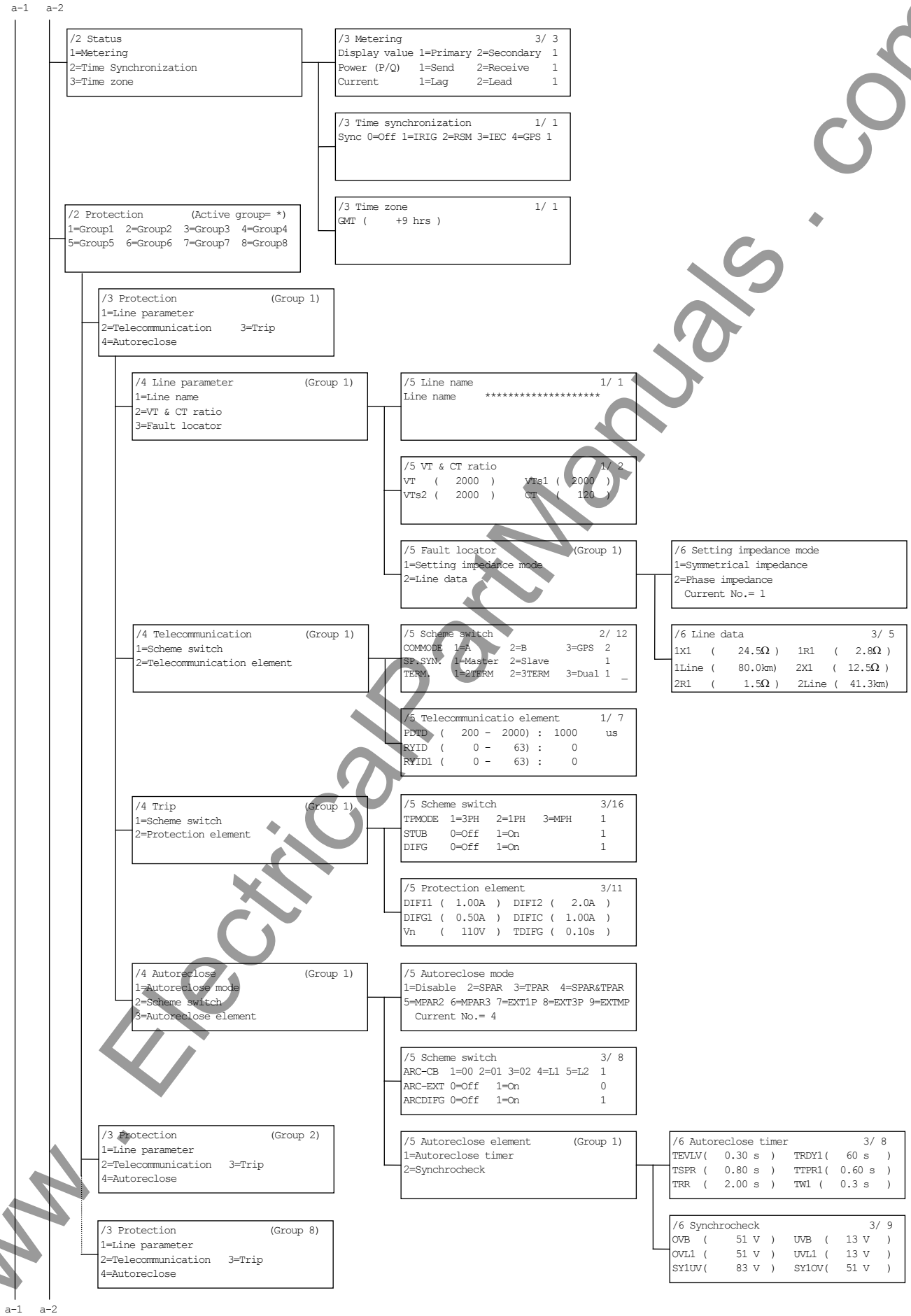
www . ElectricalPartManuals . com



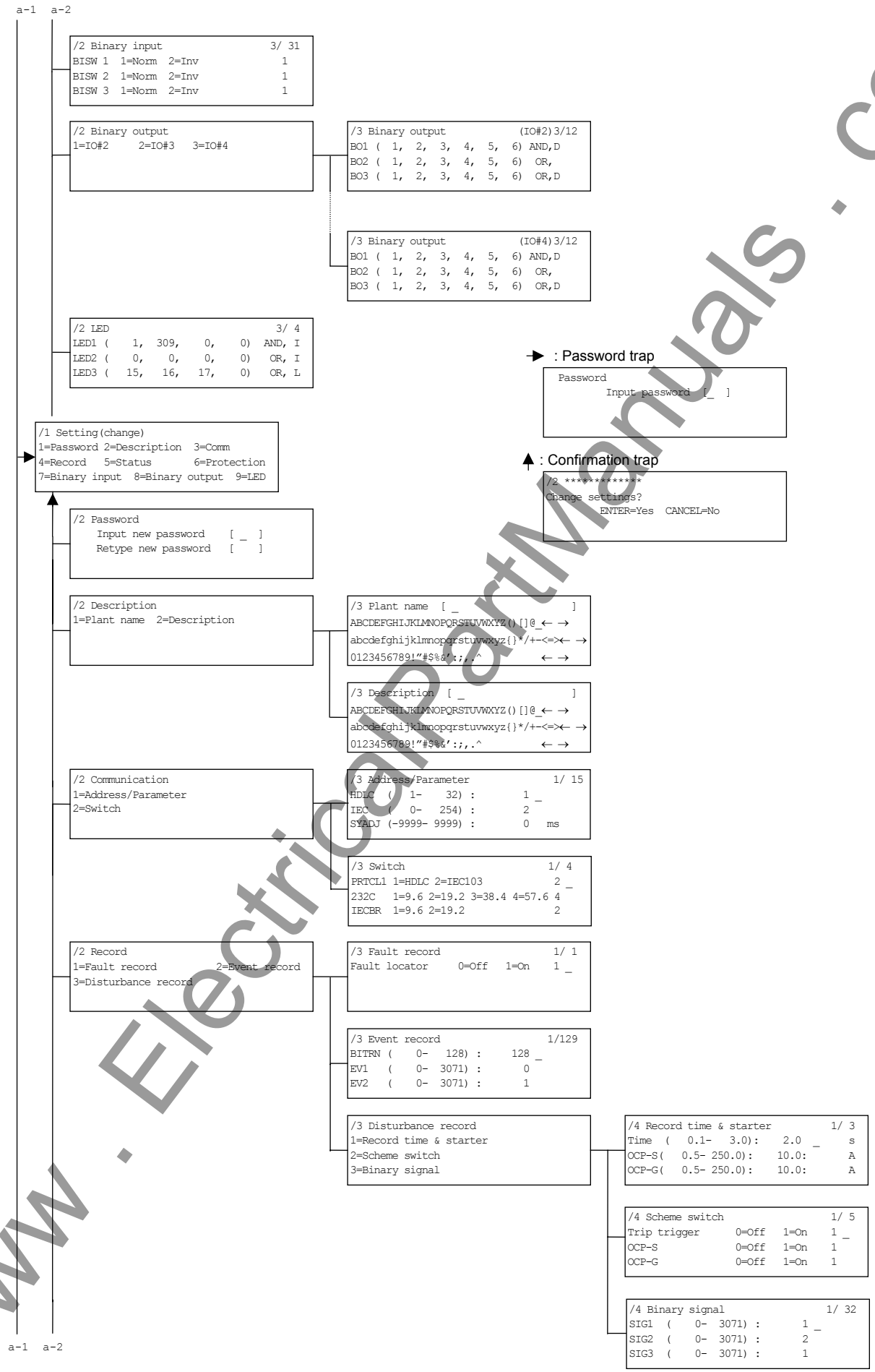

www.ElectricalPartManuals.com



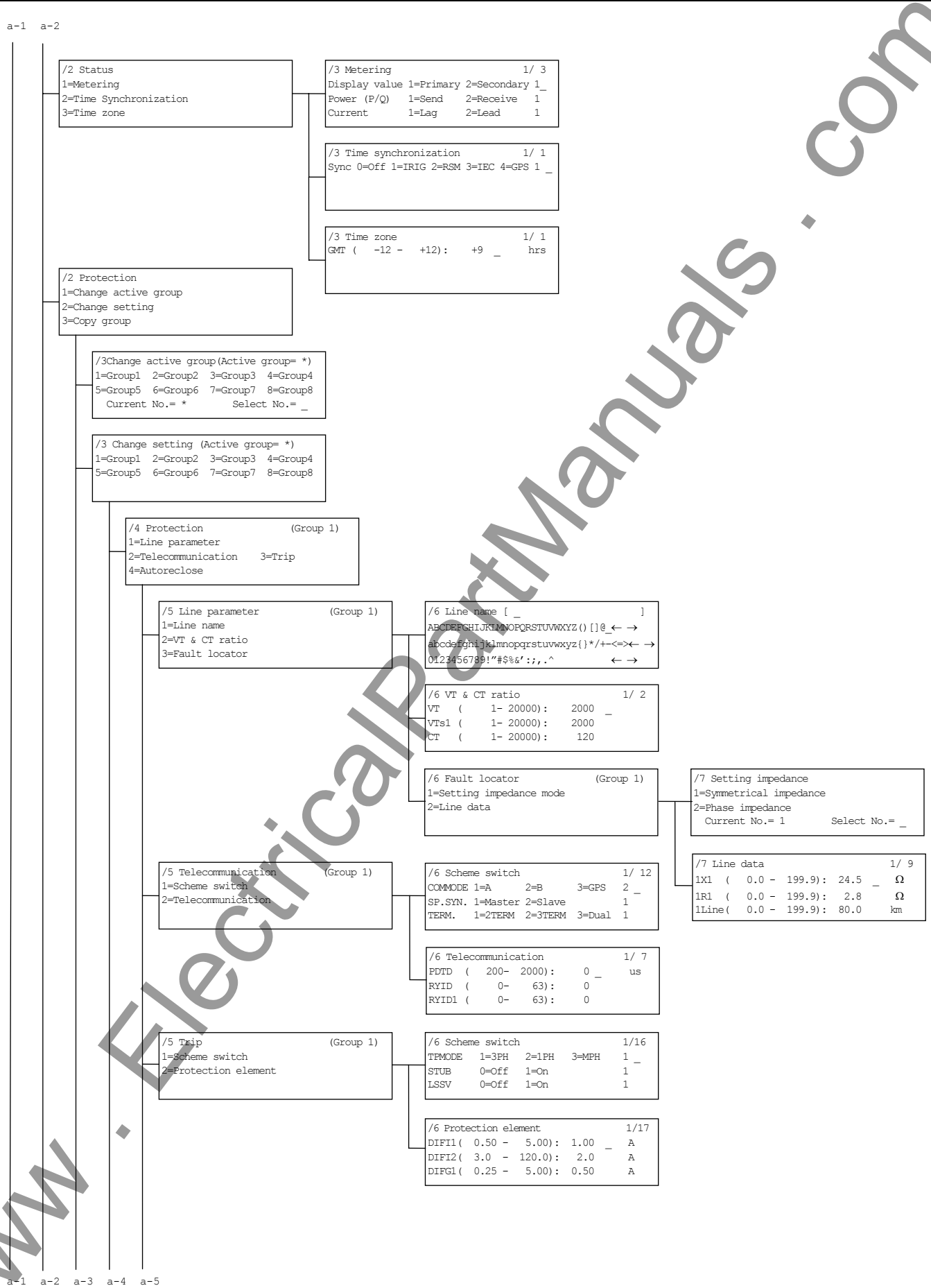

www . ElectricalPartManuals . com



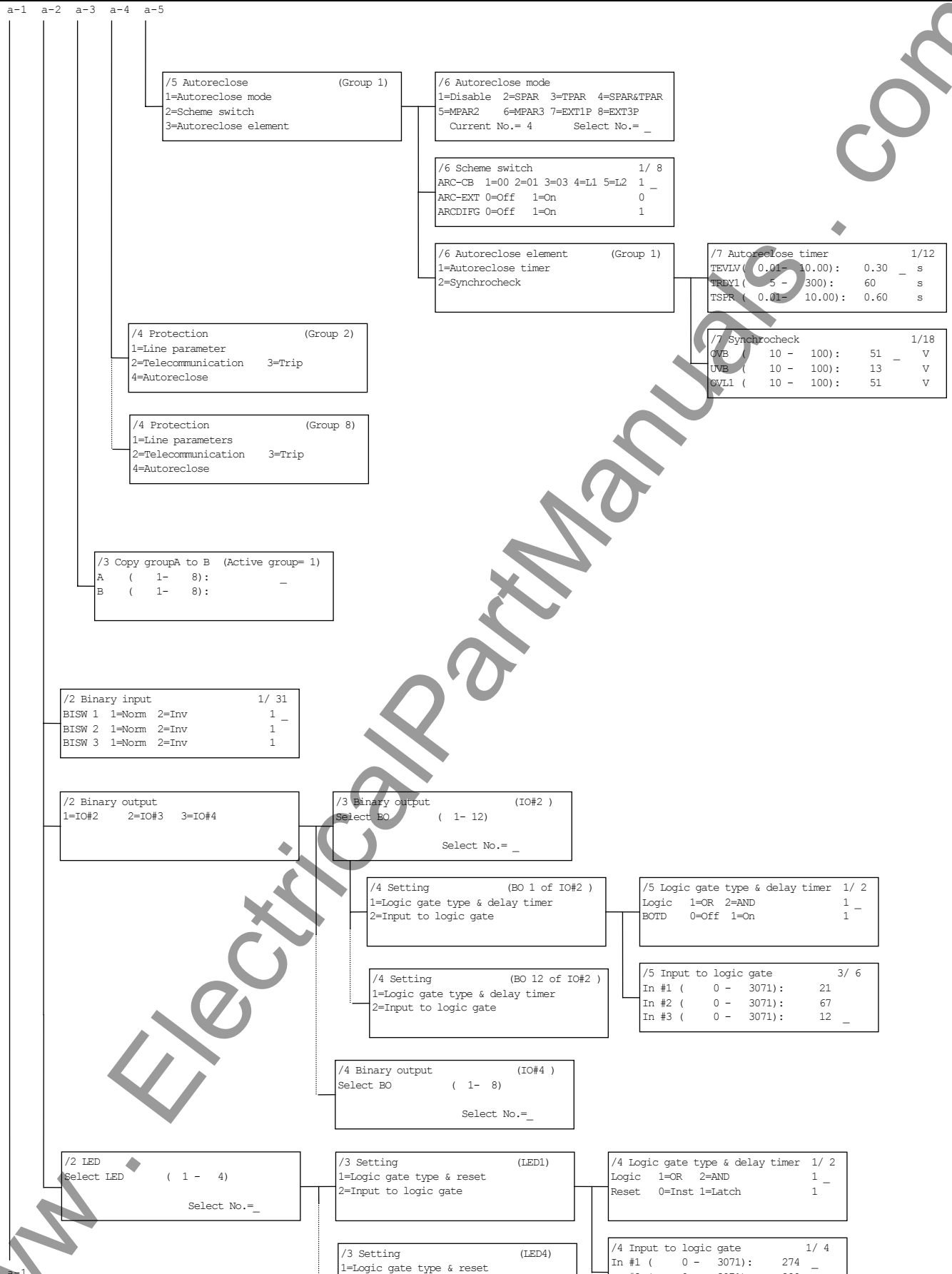

www.ElectricalPartManuals.com



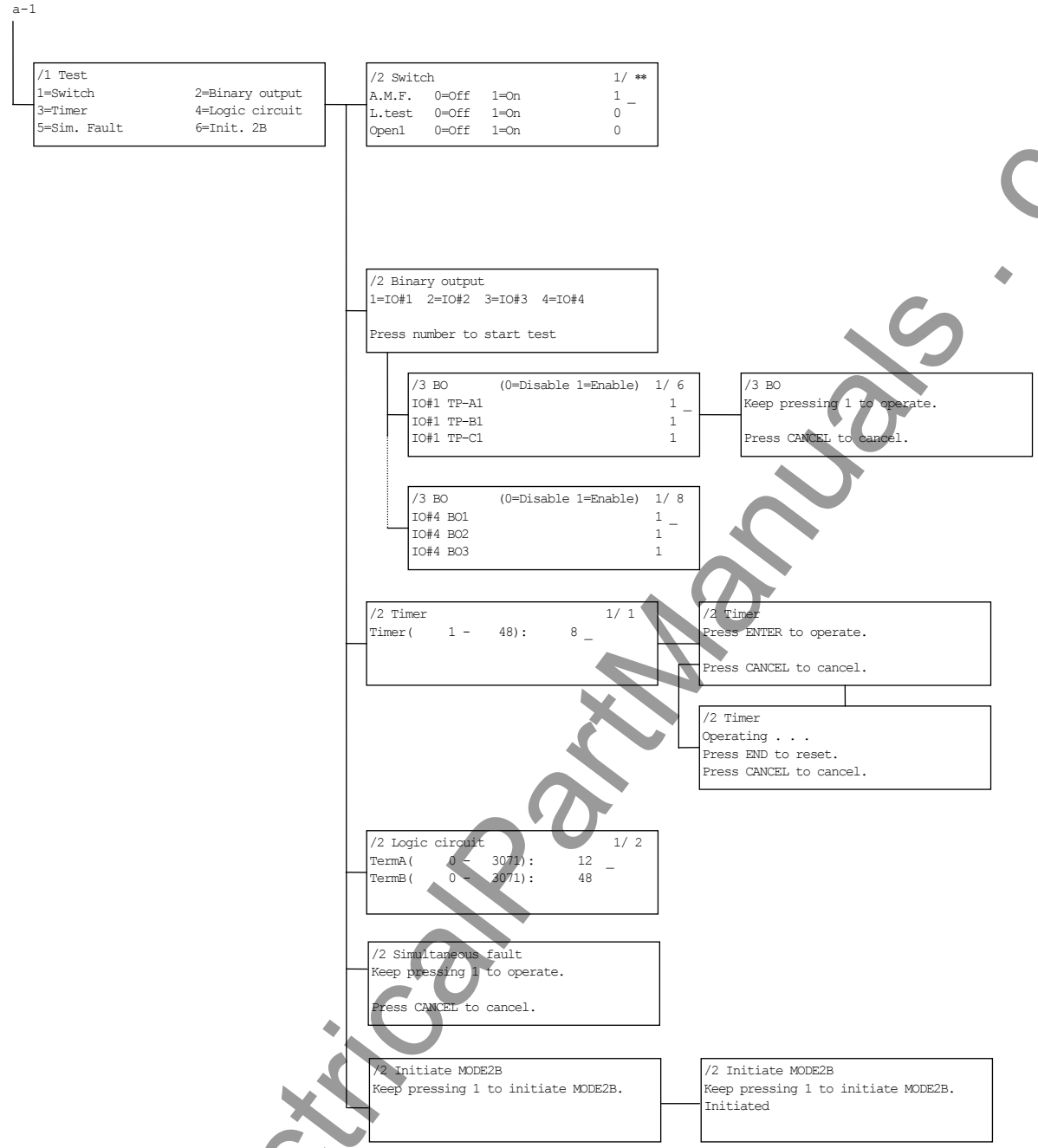

www . ElectricalPartManuals . com




www . ElectricalPartManuals . com

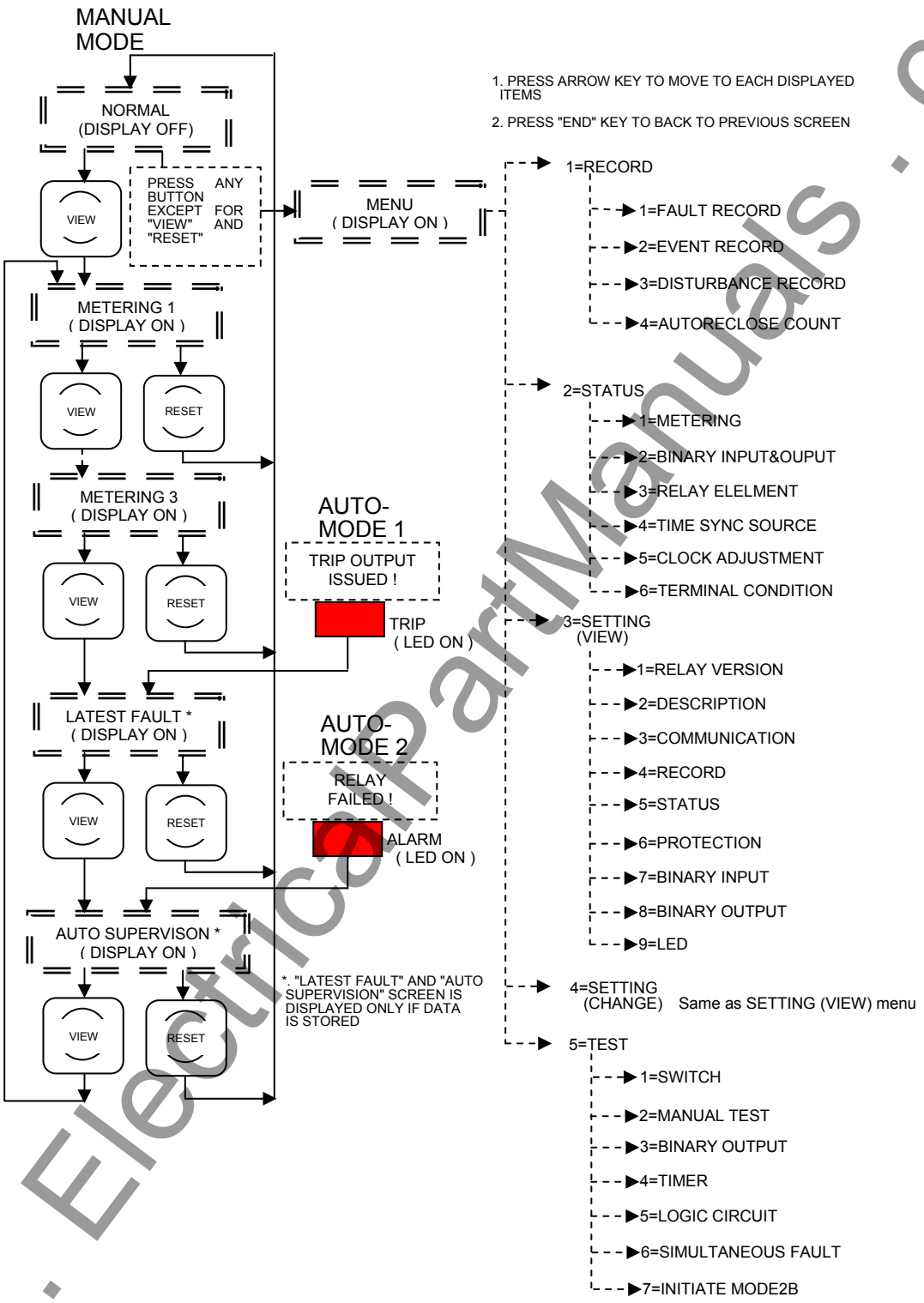



www.ElectricalPartManuals.com




www . ElectricalPartManuals . com

## LCD AND BUTTON OPERATION INSTRUCTION




www . ElectricalPartManuals . com

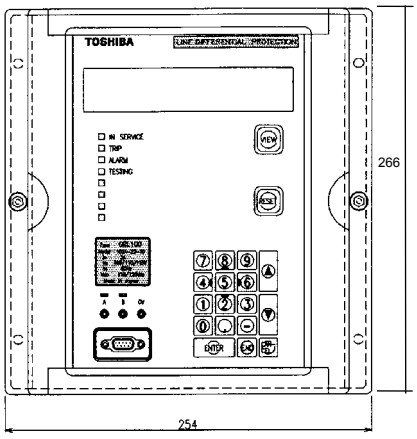
www . ElectricalPartManuals . com

# Appendix F

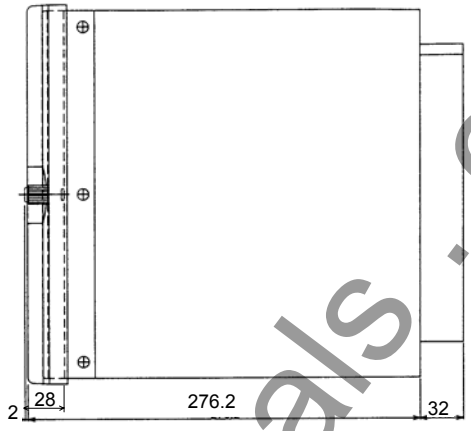
# Case Outline

- Case Type-A: Flush Mount Type
- Case Type-B: Flush Mount Type
- Case Type-A, B: Rack Mount Type

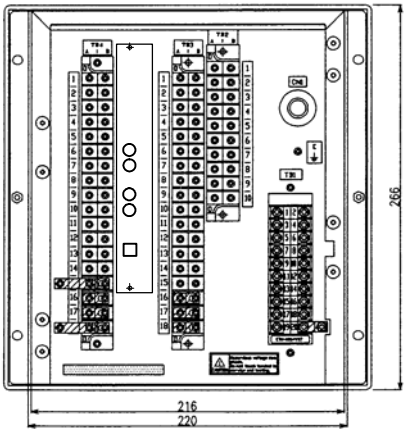
www.ElectricalPartManuals.com



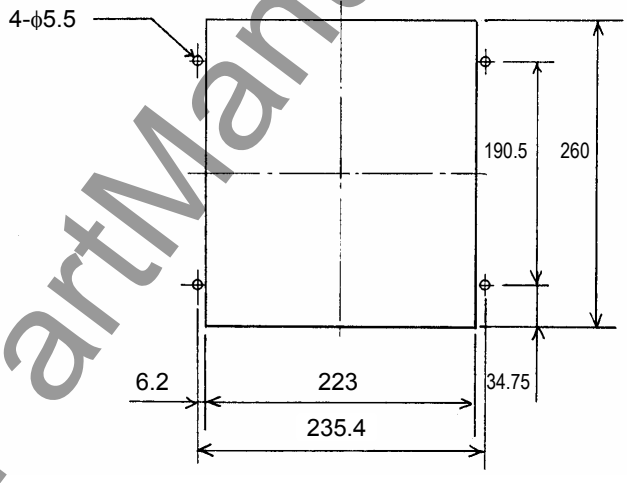

**Front View**



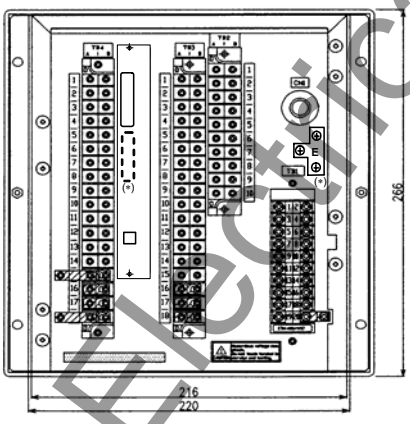

**Side View**




Optical interface



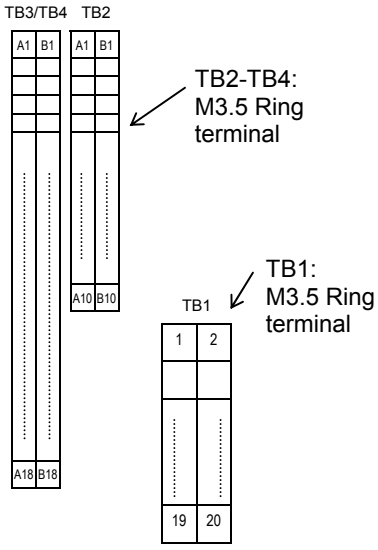

**Panel Cut-out**




(*): Provided with GRL100-*1**-*9-**

Electrical interface

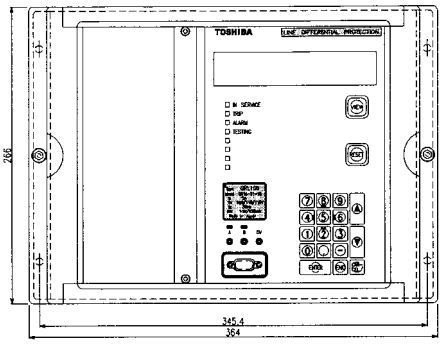
**Rear View**



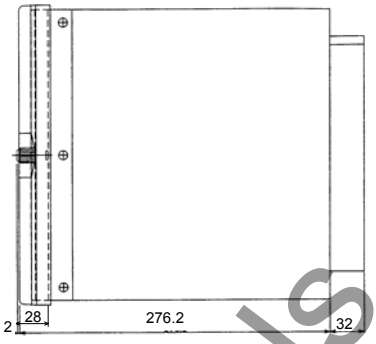

**Terminal Block**

**Case Type-A: Flush Mount Type for Models 701 and 711**

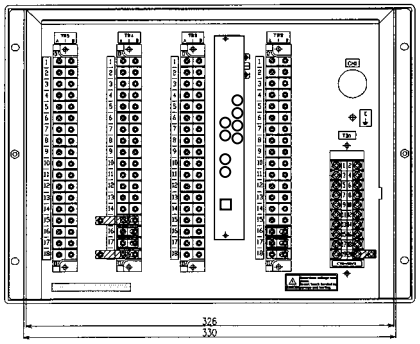
www.ElectricalPartManuals.com



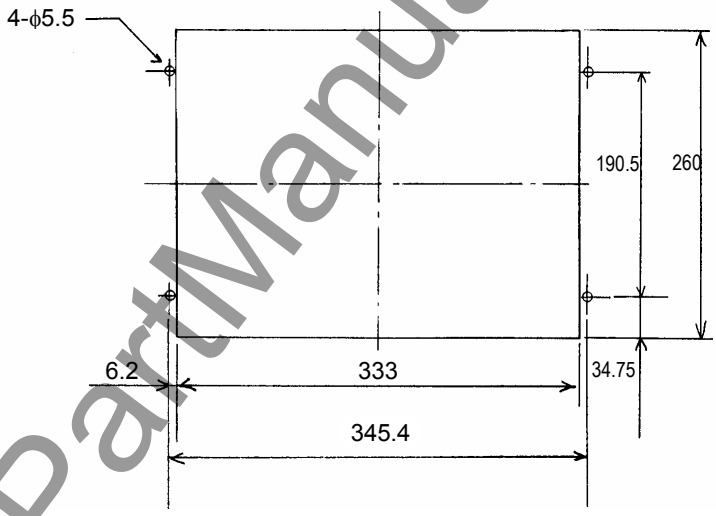

**Front View**



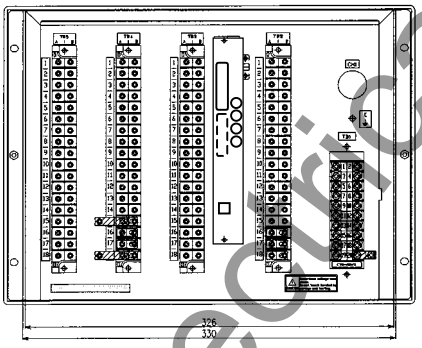

**Side View**




Optical interface

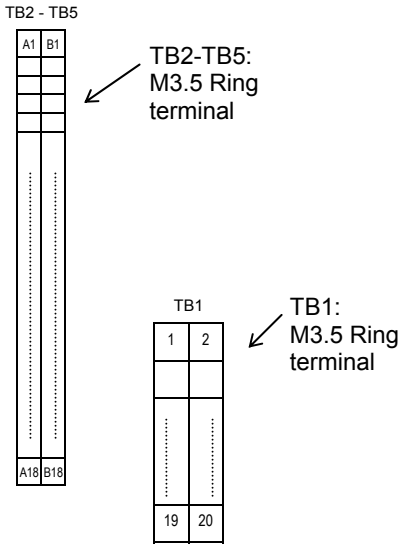



**Panel Cut-out**




Electrical interface

**Rear View**

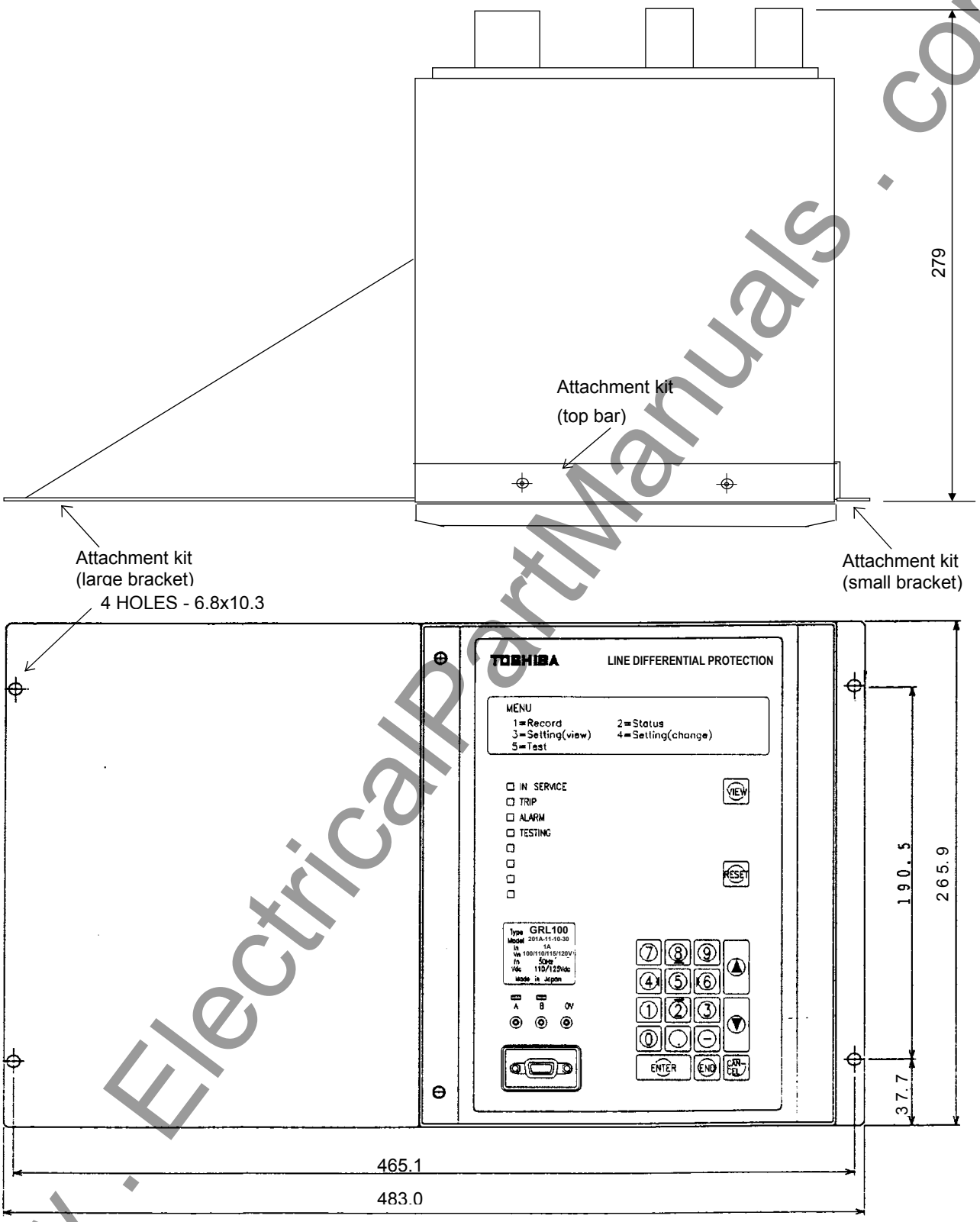



**Terminal Block**

**Case Type-B: Flush Mount Type for Models 702 and 712**

www . ElectricalPartManuals . com

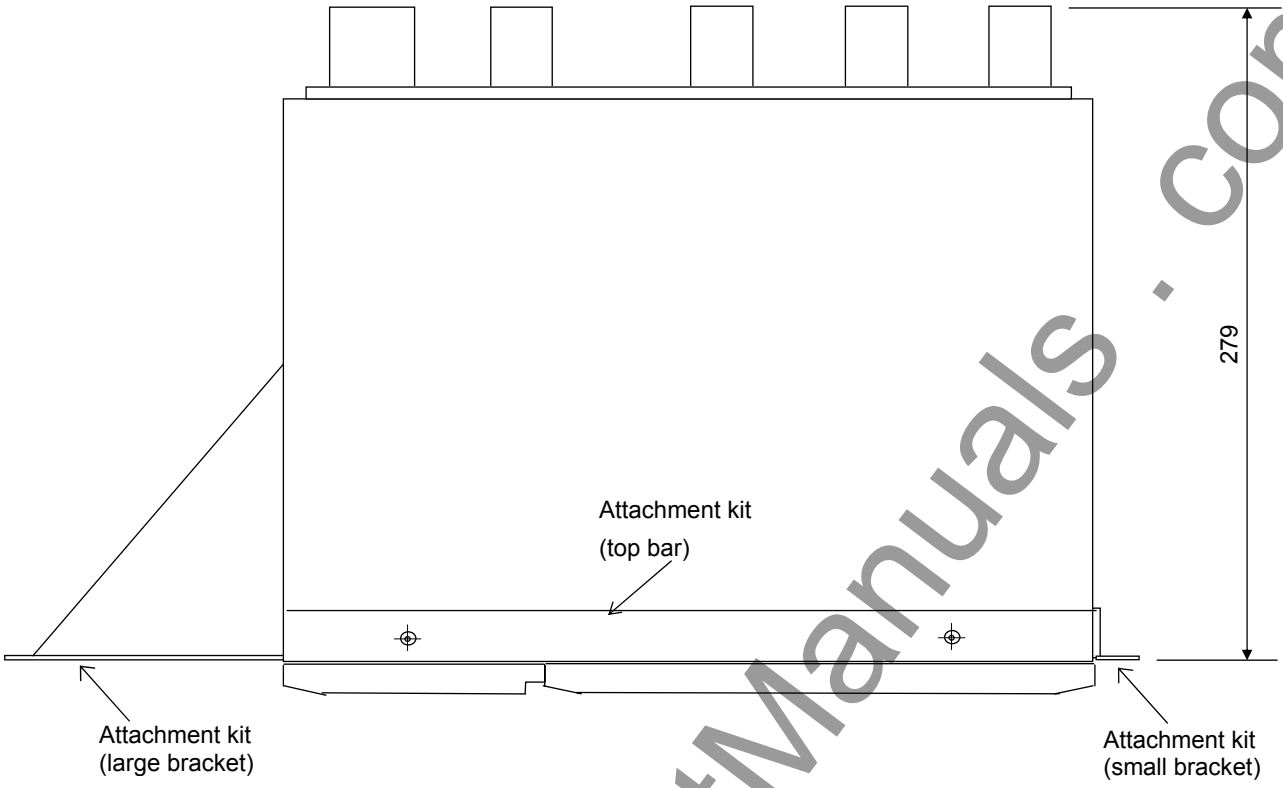
**Top View**



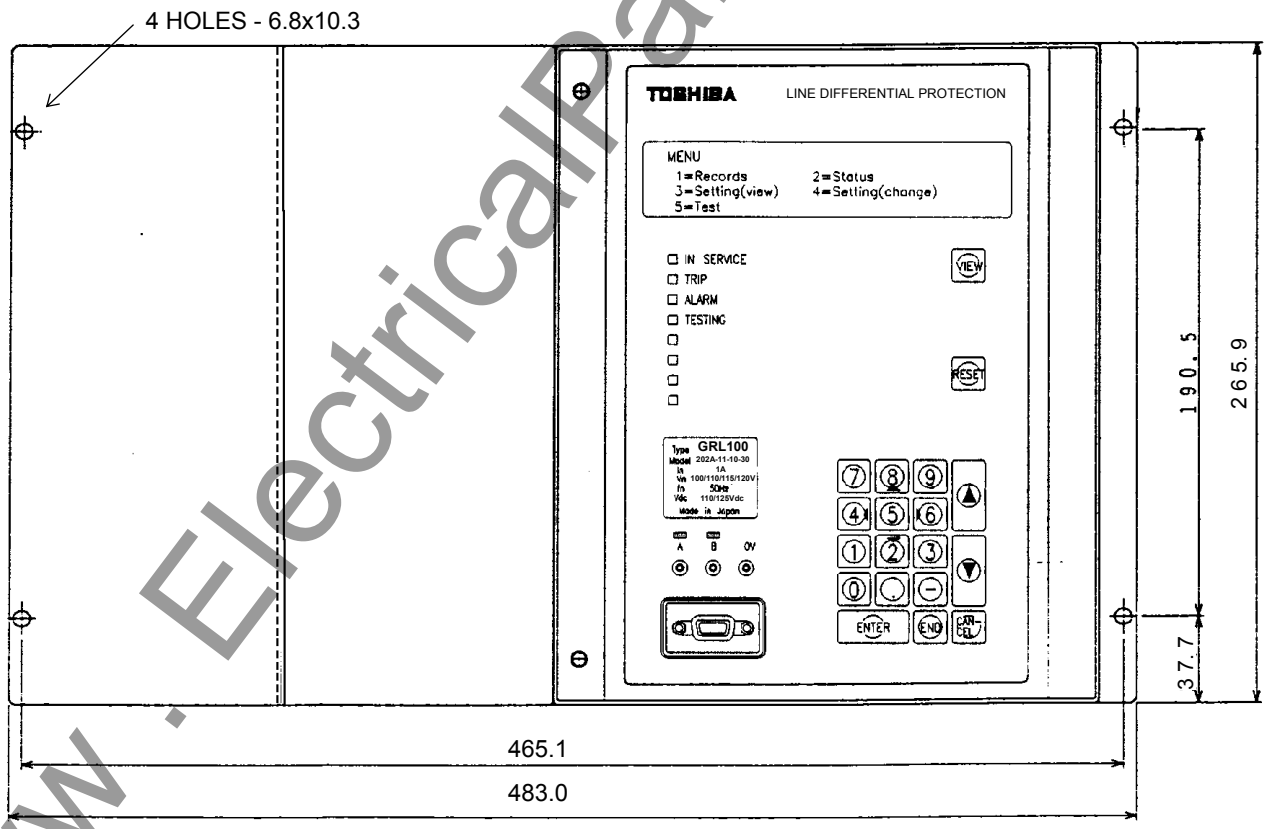

**Front View**

**Rack Mount Type: Case Type-A**

www.ElectricalPartManuals.com



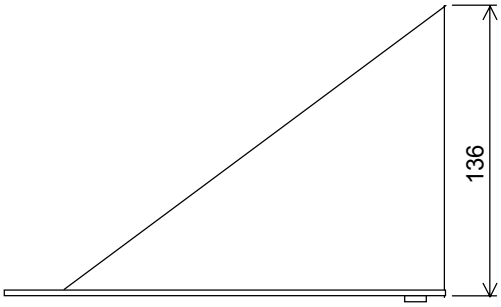

**Top View**

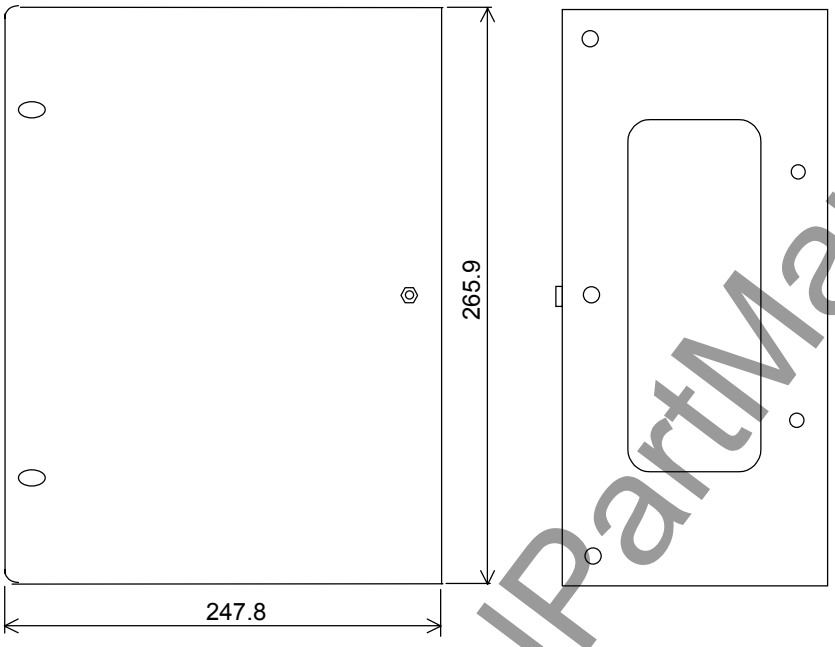



**Front View**

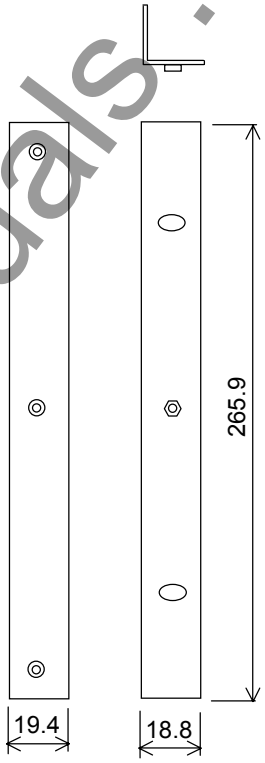
**Rack Mount: Case Type-B**

www.ElectricalPartManuals.com

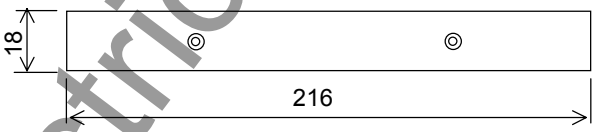



**(a) Large Bracket**




**(b) Small Bracket**

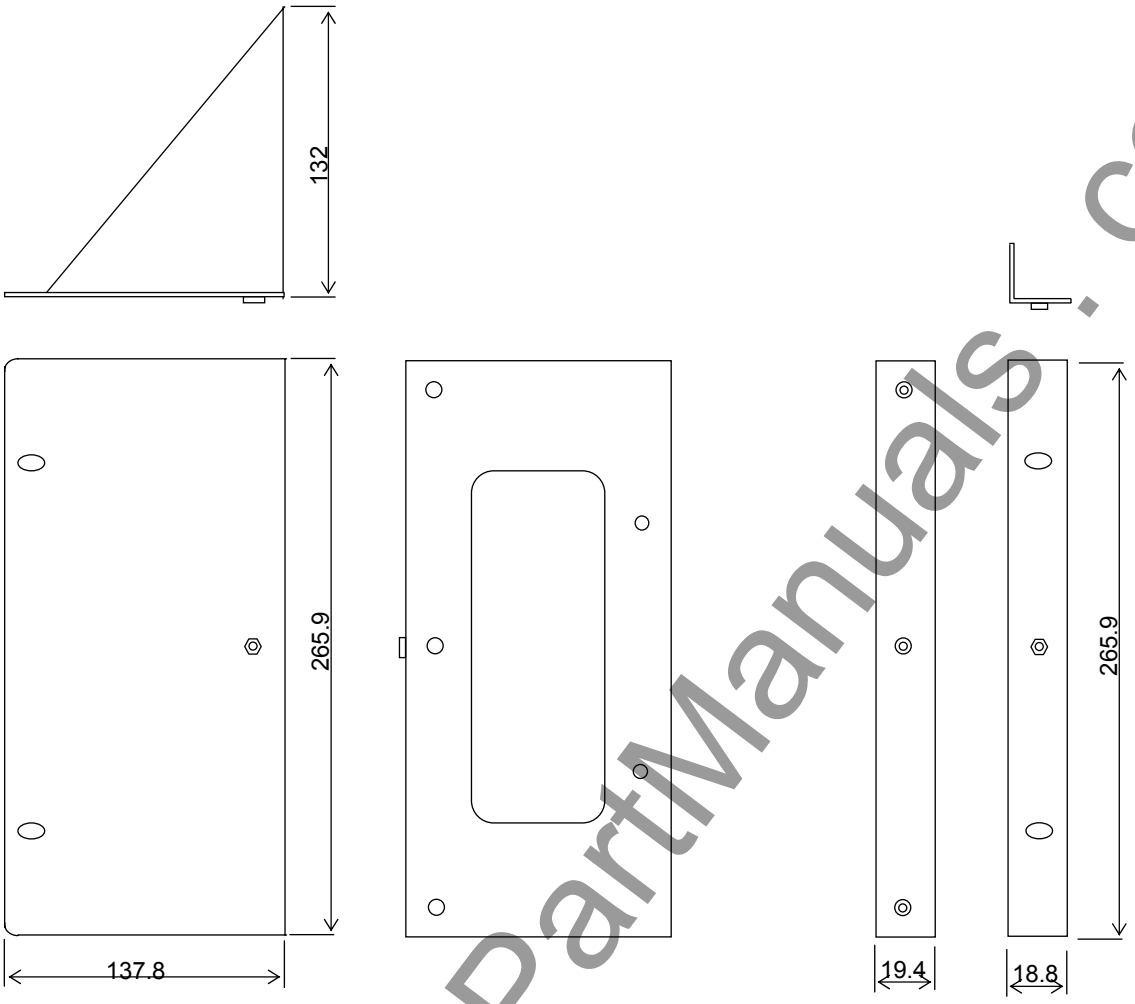



**(c) Bar for Top and Bottom of Relay**

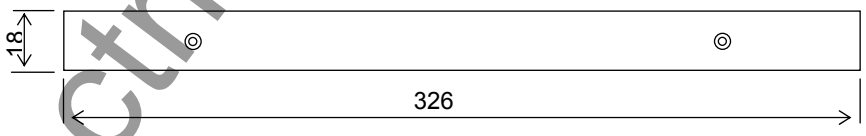
| | Parts |
|---|---|
| (a) | 1 Large bracket, 5 Round head screws with spring washers and washers (M4x10) |
| (b) | 1 Small bracket, 3 Countersunk head screws (M4x6) |
| (c) | 2 Bars, 4 Countersunk head screws (M3x8) |

**Dimensions of Attachment Kit EP-101**

www.ElectricalPartManuals.com




**(a) Large Bracket** **(b) Small Bracket**




**(c) Bar for Top and Bottom of Relay**

| | Parts |
|---|---|
| (a) | 1 Large bracket, 5 Round head screws with spring washers and washers (M4x10) |
| (b) | 1 Small bracket, 3 Countersunk head screws (M4x6) |
| (c) | 2 Bars, 4 Countersunk head screws (M3x8) |

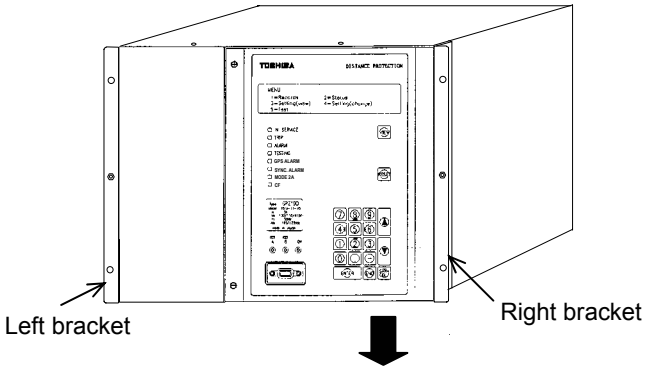
**Dimensions of Attachment Kit EP-102**

www . ElectricalPartManuals . com

## How to Mount Attachment Kit for Rack-Mounting

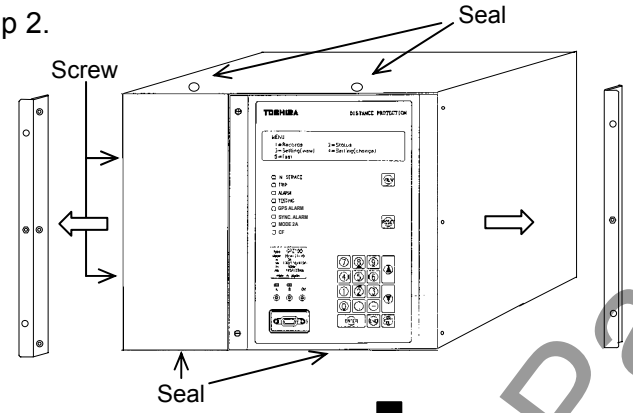
Caution: Be careful that the relay modules or terminal blocks, etc., are not damage while mounting.
Tighten screws to the specified torque according to the size of screw.

Step 1.



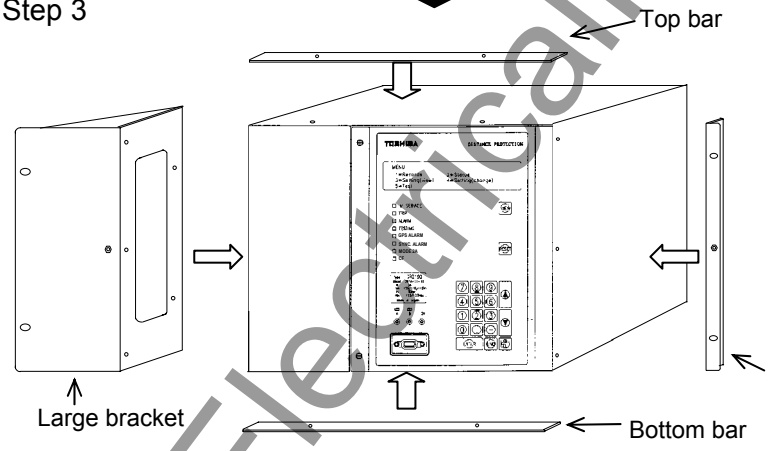

Remove case cover.

Step 2.



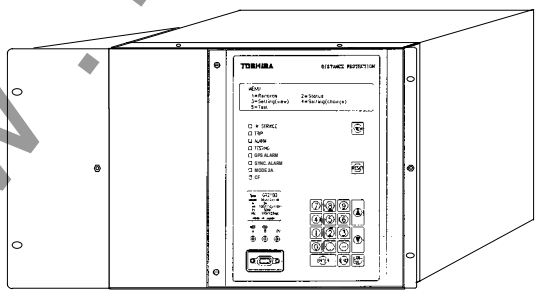

Remove the left and right brackets by unscrewing the three screws respectively, then remove two screws on left side of the relay.
And then, remove four seals on the top and bottom of the relay.

Step 3




Mount the small bracket by screwing three countersunk head screws(M4x6) and apply adhesives to the screws to prevent them from loosening.
Mount the large bracket by five round head screws(M4x10) with washer and spring washer.
And then, mount the top and bottom bars by

Step 4



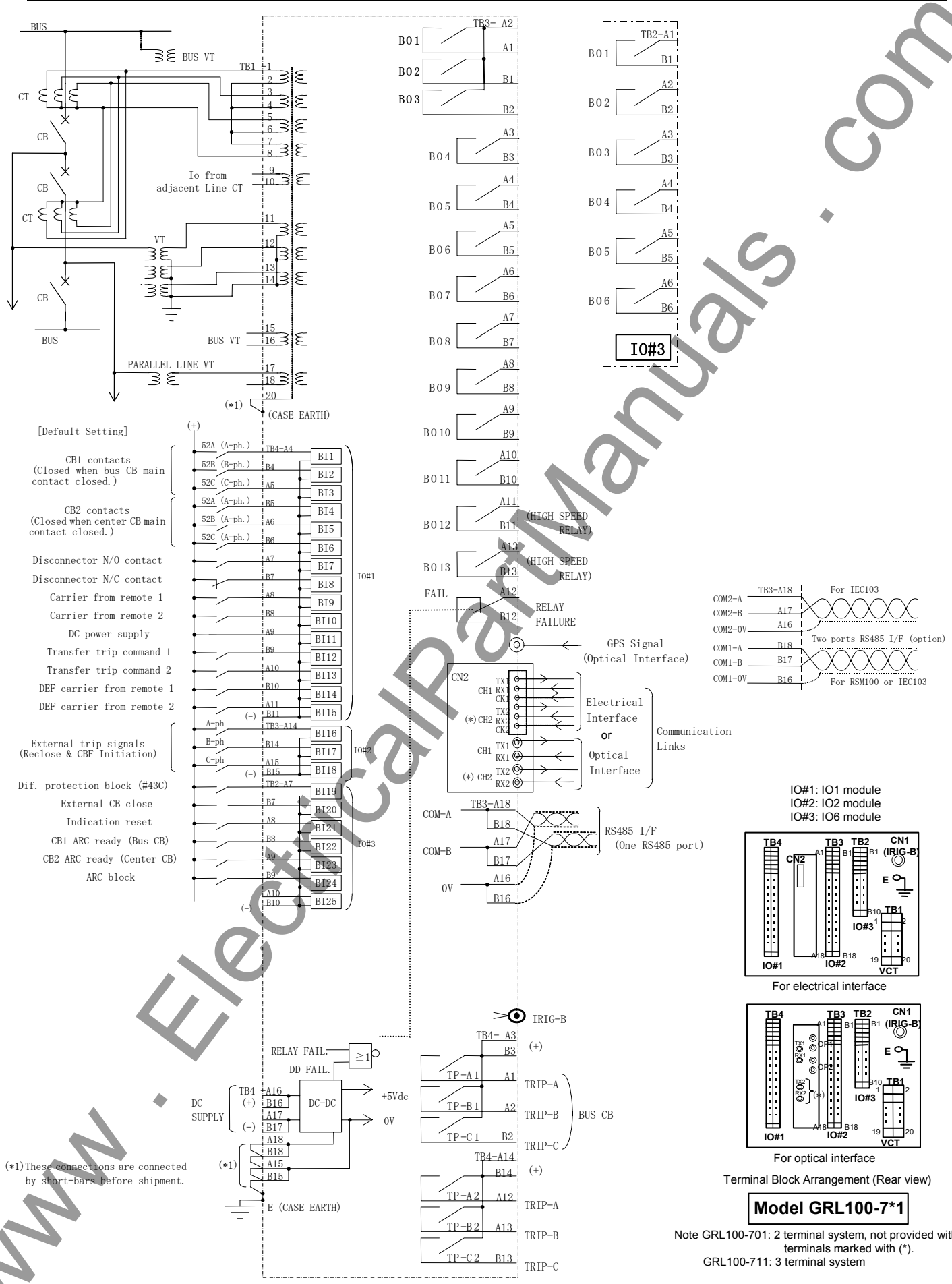
Completed.

www.ElectricalPartManuals.com

# Appendix G

# Typical External Connection

www . ElectricalPartManuals . com




IO#1: IO1 module
IO#2: IO2 module
IO#3: IO6 module




For electrical interface



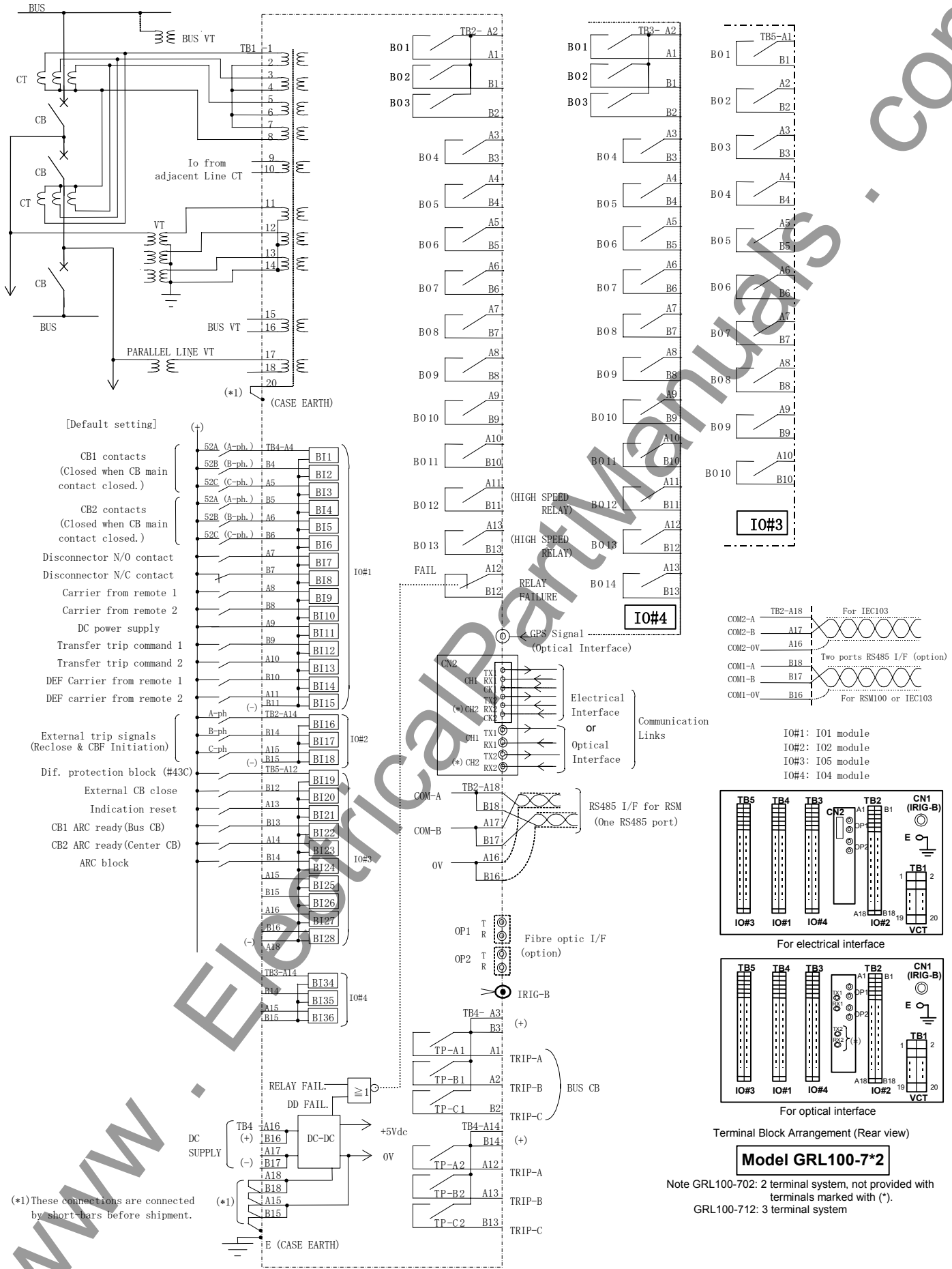

For optical interface

Terminal Block Arrangement (Rear view)

**Model GRL100-7*1**

Note GRL100-701: 2 terminal system, not provided with terminals marked with (*).
GRL100-711: 3 terminal system

www.ElectricalPartManuals.com




www.ElectricalPartManuals.com

www . ElectricalPartManuals . com

# Appendix H

# Relay Setting Sheet

- Relay Identification
- Transmission line parameters
- Protection
- Autoreclose scheme
- Contacts setting
- Contacts setting (continued)
- Relay and Protection Scheme Setting Sheets

www . ElectricalPartManuals . com

## Relay Setting Sheets

### 1. Relay Identification

Date:

| | | | |
|---|---|---|---|
| Relay type | | Serial Number | |
| Frequency | | CT rating | |
| VT rating | | dc supply voltage | |
| Password | | | |
| Active setting group | | | |

### 2. Transmission line parameters

| | | | |
|---|---|---|---|
| Line type | | Line length | |
| Line impedance | Z1 = | | |
| | Z0 = | Z0 (mutual) = | |
| | Zm = | | |
| VT ratio | | CT ratio | |
| Tripping mode | 1 + 3 phase/3 phase | | |

### 3. Protection

| | |
|---|---|
| Master | |
| Slave | |
| 2 Term | |
| 3 Term | |

### 4. Autoreclose scheme

| | |
|---|---|
| Not used | |
| SPAR | |
| SPAR + TPAR | |
| TPAR | |
| MPAR 2 (for two-phase interlinking) | |
| MPAR 3 (for three-phase interlinking) | |
| EX1P (external autoreclose SPAR + TPAR scheme) | |
| EX3P (external autoreclose TPAR scheme) | |
| 1CB or 2CB reclosing | |
| Multi-shot autoreclose | |
| 1 shot, 2 shots, 3 shots or 4 shots | |

www . ElectricalPartManuals . com

### 5. Contacts setting

(1) IO#2 BO1 _____
BO2 _____
BO3 _____
BO4 _____
BO5 _____
BO6 _____
BO7 _____
BO8 _____
BO9 _____
BO10 _____
BO11 _____
BO12 _____
BO13 _____

(2) IO#3 BO1 _____
BO2 _____
BO3 _____
BO4 _____
BO5 _____
BO6 _____
BO7 _____
BO8 _____
BO9 _____
BO10 _____
BO11 _____
BO12 _____
BO13 _____
BO14 _____

(3) IO#4 BO1 _____
BO2 _____
BO3 _____
BO4 _____
BO5 _____
BO6 _____
BO7 _____
BO8 _____
BO9 _____
BO10 _____
BO11 _____
BO12 _____
BO13 _____
BO14 _____

(Memo: For relay elements and scheme logic settings, the setting list as shown on the next page is made.)

www . ElectricalPartManuals . com

| № | Name | Range | | Units | Contents | Default Setting of Relay Series(5A rating / 1A rating) | | | | User Settiing |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2CB-ARC, NO-FD, With Distance | | | | |
| | | | | | | 2TERM | | 3TERM | | |
| | | 5A rating | 1A rating | | | 701 | 702 | 711 | 712 | |
| 1 | Active group | 1 - 8 | | – | Active setting group | 1 | | | | |
| 2 | Line name | Specified by user | | – | Line name | Specified by user | | | | |
| 3 | VT | 1 - 20000 | | – | VT ratio | 2000 | | | | |
| 4 | VTs1 | 1 - 20000 | | – | VT ratio | 2000 | | | | |
| 5 | VTs2 | 1 - 20000 | | – | VT ratio | 2000 | | | | |
| 6 | CT | 1 - 20000 | | – | CT ratio | 400 | | | | |
| 7 | Setting impedance mode | Symmetrical impedance - Phase impedance | | – | Fault location | Symmetrical impedance | | | | |
| 8 | 1X1 | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 2.00 / 10.0 | | | | |
| 9 | 1X0 | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 6.80 / 34.0 | | | | |
| 10 | 1R1 | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 0.20 / 1.0 | | | | |
| 11 | 1R0 | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 0.70 / 3.5 | | | | |
| 12 | Kab | 80 - 120 | | % | ditto | 100 | | | | |
| 13 | Kbc | 80 - 120 | | % | ditto | 100 | | | | |
| 14 | Kca | 80 - 120 | | % | ditto | 100 | | | | |
| 15 | Ka | 80 - 120 | | % | ditto | 100 | | | | |
| 16 | Kb | 80 - 120 | | % | ditto | 100 | | | | |
| 17 | Kc | 80 - 120 | | % | ditto | 100 | | | | |
| 18 | 2X1 | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 2.00 / 10.0 | | |
| 19 | 2R1 | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.20 / 1.0 | | |
| 20 | 3X1 | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 2.00 / 10.0 | | |
| 21 | 3R1 | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.20 / 1.0 | | |
| 22 | 1Xaa | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 2.10 / 10.5 | | | | |
| 23 | 1Xbb | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 2.10 / 10.5 | | | | |
| 24 | 1Xcc | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 2.10 / 10.5 | | | | |
| 25 | 1Xab | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 0.10 / 0.5 | | | | |
| 26 | 1Xbc | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 0.10 / 0.5 | | | | |
| 27 | 1Xca | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 0.10 / 0.5 | | | | |
| 28 | 1Raa | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 0.21 / 1.1 | | | | |
| 29 | 1Rbb | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 0.21 / 1.1 | | | | |
| 30 | 1Rcc | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 0.21 / 1.1 | | | | |
| 31 | 1Rab | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 0.01 / 0.1 | | | | |
| 32 | 1Rbc | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 0.01 / 0.1 | | | | |
| 33 | 1Rca | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 0.01 / 0.1 | | | | |
| 34 | 2Xaa | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 2.10 / 10.5 | | |
| 35 | 2Xbb | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 2.10 / 10.5 | | |
| 36 | 2Xcc | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 2.10 / 10.5 | | |
| 37 | 2Xab | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.10 / 0.5 | | |
| 38 | 2Xbc | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.10 / 0.5 | | |
| 39 | 2Xca | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.10 / 0.5 | | |
| 40 | 2Raa | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.21 / 1.1 | | |
| 41 | 2Rbb | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.21 / 1.1 | | |
| 42 | 2Rcc | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.21 / 1.1 | | |
| 43 | 2Rab | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.01 / 0.1 | | |
| 44 | 2Rbc | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.01 / 0.1 | | |
| 45 | 2Rca | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.01 / 0.1 | | |
| 46 | 3Xaa | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 2.10 / 10.5 | | |
| 47 | 3Xbb | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 2.10 / 10.5 | | |
| 48 | 3Xcc | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 2.10 / 10.5 | | |
| 49 | 3Xab | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.10 / 0.5 | | |
| 50 | 3Xbc | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.10 / 0.5 | | |
| 51 | 3Xca | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.10 / 0.5 | | |
| 52 | 3Raa | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.21 / 1.1 | | |
| 53 | 3Rbb | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.21 / 1.1 | | |
| 54 | 3Rcc | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.21 / 1.1 | | |
| 55 | 3Rab | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.01 / 0.1 | | |
| 56 | 3Rbc | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.01 / 0.1 | | |
| 57 | 3Rca | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | -- | | 0.01 / 0.1 | | |
| 58 | 1X0m | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 2.00 / 10.0 | | | | |
| 59 | 1R0m | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 0.20 / 1.0 | | | | |
| 60 | Z0B-L | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 2.00 / 10.0 | | | | |
| 61 | Z0B-R | 0.00 - 199.99 | 0.0 - 999.9 | Ω | ditto | 2.00 / 10.0 | | | | |
| 62 | 1Line | 0.0 - 399.9 | | km | ditto | 50.0 | | | | |
| 63 | 2Line | 0.0 - 399.9 | | km | ditto | -- | | 50.0 | | |
| 64 | 3Line | 0.0 - 399.9 | | km | ditto | -- | | 50.0 | | |
| 65 | COMMODE | A - B - GPS | | – | communication mode | B | | | | |
| 66 | SP.SYN. | Master - Slave | | – | SP synchronization setting | Master | | | | |
| 67 | TERM | 2TERM - 3TERM - Dual | | – | Terminal selection | -- | | 3TERM | | |
| 68 | CH.CON | Normal - Exchange | | – | CH connection | -- | | Normal | | |
| 69 | RYIDSV | Off - On | | – | Relay address supervision | On | | | | |
| 70 | T.SFT1 | Off - On | | – | CH#1 bit shifter for multiplexer link | Off | | | | |
| 71 | T.SFT2 | Off - On | | – | CH#2 bit shifter for multiplexer link | -- | | Off | | |
| 72 | B.SYN1 | Off - On | | – | CH#1 bit sync. for multiplexer | On | | | | |
| 73 | B.SYN2 | Off - On | | – | CH#2 bit sync. for multiplexer | -- | | On | | |
| 74 | GPSBAK | Off - On | | – | GPS backup mode | On | | | | |
| 75 | AUTO2B | Off - On | | – | Automatic transfer to MODE2B | Off | | | | |

www.ElectricalPartManuals.com

| № | Name | | Range | | Units | Contents | Default Setting of Relay Series(5A rating / 1A rating) | | | | User Settiing |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 2CB-ARC, NO-FD, With Distance | | | | |
| | | | | | | | 2TERM | | 3TERM | | |
| | | | 5A rating | 1A rating | | | 701 | 702 | 711 | 712 | |
| 76 | SRCθ | | Disable - I | | – | Phase detector selection | I | | | | |
| 77 | PDTD | | 200 - 2000 | | us | Permissible telecom. delay time | 1000 | | | | |
| 78 | RYID | | 0 - 63 | | – | Relay address (local) | 0 | | | | |
| 79 | RYID1 | | 0 - 63 | | – | Relay address (remote1) | 0 | | | | |
| 80 | RYID2 | | 0 - 63 | | – | Relay address (remote2) | 0 | | | | |
| 81 | TDSV | | 100 - 16000 | | us | SV for telecom. delay time | 6000 | | | | |
| 82 | TCDT1 | | -10000 - +10000 | | us | CH1 delay time difference | 0 | | | | |
| 83 | TCDT2 | | -10000 - +10000 | | us | CH2 delay time difference | -- | | 0 | | |
| 84 | DIF | | Off - On | | – | DIF trip | On | | | | |
| 85 | STUB | | Off - On | | – | Stub protection | Off | | | | |
| 86 | DIFG | | Off - On | | – | DIFG trip | On | | | | |
| 87 | OST | | Off - Trip - BO | | – | Out of step trip | Off | | | | |
| 88 | OCBT | | Off - On | | – | OC back-up trip | On | | | | |
| 89 | OCIBT | | Off - On | | – | OCI back-up trip | On | | | | |
| 90 | MOCI | | Long - Std - Very - Ext | | – | | Std | | | | |
| 91 | EFBT | | Off - On | | – | EF back-up trip | On | | | | |
| 92 | EFBTAL | | Off - On | | – | EF back-up trip alarm | On | | | | |
| 93 | EFIBT | | Off - NOD - F - R | | – | EFI back-up trip | NOD | | | | |
| 94 | MEFI | | Long - Std - Very - Ext | | – | | Std | | | | |
| 95 | BF1 | | Off - T - TOC | | – | CBF re-trip | Off | | | | |
| 96 | BF2 | | Off - On | | – | CBF related trip | Off | | | | |
| 97 | BFEXT | | Off - On | | – | CBF initiation by ext. trip | Off | | | | |
| 98 | THMT | | Off - On | | – | Thermal trip enable | Off | | | | |
| 99 | THMAL | | Off - On | | – | Thermal alarm enable | Off | | | | |
| 100 | TTSW1 | | Off - Trip - BO | | – | Transfer trip selection (CH1) | Off | | | | |
| 101 | TTSW2 | | Off - Trip - BO | | – | Transfer trip selection (CH2) | Off | | | | |
| 102 | RDIF | | Off - On | | – | Remote differential protection | On | | | | |
| 103 | OTD | | Off - On | | – | Oepn terminal detection function | Off | | | | |
| 104 | DIF-FS | | Off - OC - OCD - Both | | – | Fail-safe OC use or not | Off | | | | |
| 105 | DIFG-FS | | Off - On | | – | Fail-safe OC use or not | Off | | | | |
| 106 | INTCOM | | Off - On | | – | Integral communicarion function use or not | On | | | | |
| 107 | ZS-C | | Mho - Quad | | – | ZS relay characteristic | Mho | | | | |
| 108 | ZG-C | | Mho - Quad | | – | ZG relay characteristic | Mho | | | | |
| 109 | BLZONE | | COM - IND | | – | Blinder setting mode | COM | | | | |
| 110 | Z1CNT | | 1 - 2 - 3 - 4 - 5 - 6 | | – | Z1 trip mode | 4 | | | | |
| 111 | Z2TP | | Off - On | | – | Z2 trip enable | On | | | | |
| 112 | Z3TP | | Off - On | | – | Z3 trip enable | On | | | | |
| 113 | ZRTP | | Off - On | | – | ZR trip enable | Off | | | | |
| 114 | PSB-Z1 | | Off - On | | – | PSB for Z1 element | On | | | | |
| 115 | PSB-Z2 | | Off - On | | – | PSB for Z2 element | On | | | | |
| 116 | PSB-Z3 | | Off - On | | – | PSB for Z3 element | Off | | | | |
| 117 | PSB-CR | | Off - On | | – | PSB for carrier trip | On | | | | |
| 118 | PSB-ZR | | Off - On | | – | PSB for ZR element | Off | | | | |
| 119 | UVPWIEN | | Off - On | | – | Counter measures for overrech of leading phase at positive phase weak infeed | Off | | | | |
| 120 | STUB-OC | | Off - On | | – | Stub protection | Off | | | | |
| 121 | SOTF-DL | | CB - UV - Both | | – | SOTF condition judged | CB | | | | |
| 122 | SOTF-OC | | Off - On | | – | SOTF OC trip | Off | | | | |
| 123 | SOTF-Z1 | | Off - On | | – | SOTF Zone1 trip | Off | | | | |
| 124 | SOTF-Z2 | | Off - On | | – | SOTF Zone2 trip | Off | | | | |
| 125 | SOTF-Z3 | | Off - On | | – | SOTF Zone3 trip | Off | | | | |
| 126 | SOTF-R | | Off - On | | – | SOTF Zone-R trip | Off | | | | |
| 127 | DEF | DEFFEN | Off - On | | – | Forward DEF back-up trip enable | Off | | | | |
| 128 | BU-trip | DEFREN | Off - On | | – | Reverse DEF back-up trip enable | Off | | | | |
| 129 | OVS | OVS1EN | Off - DT - IDMT | | – | OVS1 enable | Off | | | | |
| 130 | | OVS2EN | Off - On | | – | OVS2 enable | Off | | | | |
| 131 | OVG | OVG1EN | Off - DT - IDMT | | – | OVG1 enable | Off | | | | |
| 132 | | OVG2EN | Off - On | | – | OVG2 enable | Off | | | | |
| 133 | UVS | UVS1EN | Off - DT - IDMT | | – | UVS1 enable | Off | | | | |
| 134 | | UVS2EN | Off - On | | – | UVS2 enable | Off | | | | |
| 135 | UVG | UVG1EN | Off - DT - IDMT | | – | UVG1 enable | Off | | | | |
| 136 | | UVG2EN | Off - On | | – | UVG2 enable | Off | | | | |
| 137 | UVS/UVG | VBLKEN | Off - On | | – | UV block enable | Off | | | | |
| 138 | BCDEN | | Off - On | | – | Broken conductor enable | Off | | | | |
| 139 | Carrier | CRSCM | PUP - POP - UOP - BOP | | – | Carrier protection mode | POP | | | | |
| 140 | | DISCR | Off - On | | – | Distance carrier protection enable | Off | | | | |
| 141 | | DEFCR | Off - On | | – | DEF carreir protection enable | Off | | | | |
| 142 | | ZONESEL | Z2 - Z3 | | – | Carrier control element | Z2 | | | | |
| 143 | | ECHO | Off - On | | – | ECHO carrier send | Off | | | | |
| 144 | | WKIT | Off - On | | – | Weak carrier trip | Off | | | | |
| 145 | | CH-DEF | CH1 - CH2 | | – | DEF carrier channel setting | CH1 | | | | |
| 146 | LSSV | | Off - On | | – | LS monitoring | Off | | | | |
| 147 | SVCNT | | ALM&BLK - ALM | | – | Super visor control | ALM&BLK | | | | |
| 148 | CTSV | | Off - ALM&BLK - ALM | | – | CT supervison control | Off | | | | |
| 149 | IDSV | | Off - ALM&BLK - ALM | | – | Id monitoring control | Off | | | | |
| 150 | CTFEN | | Off - On - OPT-On | | – | CTF detect.function use or not | Off | | | | |

www.ElectricPartManuals.com

| № | Name | | Range | | Units | Contents | Default Setting of Relay Series(5A rating / 1A rating) | | | | User Settiing |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 2CB-ARC, NO-FD, With Distance | | | | |
| | | | | | | | 2TERM | | 3TERM | | |
| | | | 5A rating | 1A rating | | | 701 | 702 | 711 | 712 | |
| 151 | CTFCNT | | NA - BLK | | – | Control by CTF detectinon | NA | | | | |
| 152 | VTF1EN | | Off - On - OPT-On | | – | VTF1 enable | On | | | | |
| 153 | VTF2EN | | Off - On - OPT-On | | – | VTF2 enable | On | | | | |
| 154 | VTF-Z4 | | Off - On | | – | Z4-car blocked by VTF | On | | | | |
| 155 | CHMON | | Off - On | | – | Carrier monitoring/testing | Off | | | | |
| 156 | FL-Z0B | | Off - On | | – | Fault locator | Off | | | | |
| 157 | AOLED | | Off - On | | – | ALARM LED lighting control at alarm output | On | | | | |
| 158 | DIFI1 | | 0.50 - 10.00 | 0.10 - 2.00 | A | Minimum operating current | 5.00 / 1.00 | | | | |
| 159 | DIFI2 | | 3.0 - 120.0 | 0.6 - 24.0 | A | DF2 restraint current setting | 15.0 / 3.0 | | | | |
| 160 | DIFGI | | 0.25 - 5.00 | 0.05 - 1.00 | A | Minimum operating current | 2.50 / 0.50 | | | | |
| 161 | DIFIC | | 0.00 - 5.00 | 0.00 - 1.00 | A | Charging current compensation | 0.00 / 0.00 | | | | |
| 162 | Vn | | 100 - 120 | | V | Rated line voltage | 110 | | | | |
| 163 | TDIFG | | 0.00 - 10.00 | | s | DIFG delay trip timer | 0.50 | | | | |
| 164 | DIFSV | | 0.25 - 10.00 | 0.05 - 2.00 | A | Minimum operating current of DIFSV | 0.50 / 0.10 | | | | |
| 165 | TIDSV | | 0 - 60 | | s | Id err detected timer | 10 | | | | |
| 166 | CBF | OCBF | 0.5 - 10.0 | 0.1 - 2.0 | A | Minimum operating current | 4.0 /0.8 | | | | |
| 167 | | TBF1 | 50 - 500 (1ms step) | | ms | CBF timer for re-trip | 150 | | | | |
| 168 | | TBF2 | 50 - 500 (1ms step) | | ms | CBF timer for related trip | 200 | | | | |
| 169 | OC | OC | 0.5 - 100.0 | 0.1 - 20.0 | A | OC element | 10.0 / 2.0 | | | | |
| 170 | | TOC | 0.00 - 10.00 | | s | | 3.00 | | | | |
| 171 | OC1 | | 0.5 - 100.0 | 0.1 - 20.0 | A | OC element for DIF fail-safe | 1.0 / 0.2 | | | | |
| 172 | OCD | | 0.40 (fixed) | 0.08 (fixed) | % | OCD element for DIF fail-safe | -- | | | | |
| 173 | EFD | | 0.20 (fixed) | 0.04 (fixed) | % | EFD element for DIFG fail-safe | -- | | | | |
| 174 | OCI | OCI | 0.5 -25.0 | 0.10 - 5.00 | A | IDMT OC element | 10.0 / 2.0 | | | | |
| 175 | | TOCI | 0.05 - 1.00 | | – | ditto | 0.50 | | | | |
| 176 | | TOCIR | 0.0 - 10.0 | | s | OC definite time reset delay | 0.0 | | | | |
| 177 | EF | EF | 0.5 - 5.0 | 0.10 - 1.00 | A | Earth fault OC element | 5.0 / 1.0 | | | | |
| 178 | | TEF | 0.00 - 10.00 | | s | | 3.00 | | | | |
| 179 | EFI | EFI | 0.5 - 5.0 | 0.10 - 1.00 | A | IDMT earth fault OC element | 5.0 / 1.0 | | | | |
| 180 | | TEFI | 0.05 - 1.00 | | – | ditto | 0.50 | | | | |
| 181 | | TEFIR | 0.0 - 10.0 | | s | EF definite time reset delay | 0.0 | | | | |
| 182 | Thermal | THM | 2.0 - 10.0 | 0.40 - 2.00 | A | Thermal overload setting | 5.0 / 1.00 | | | | |
| 183 | | THMIP | 0.0 - 5.0 | 0.00 - 1.00 | A | Prior load setting | 0.0 / 0.00 | | | | |
| 184 | | TTHM | 0.5 - 300.0 | | min | Thermal Time Constant | 10.0 | | | | |
| 185 | | THMA | 50 - 99 | | % | Thermal alarm setting | 80 | | | | |
| 186 | OCCHK | | 0.5 - 5.0 | 0.10 - 1.00 | A | Minimum current for θ calc. | 0.5 / 0.10 | | | | |
| 187 | HYSθ | | 1 - 5 | | deg | Hysteresis of phase difference | 1 | | | | |
| 188 | CFID | | 0.25 - 5.00 | 0.05 - 1.00 | A | Id revel of CTF scheme | 0.50 / 0.10 | | | | |
| 189 | CFUV | | 20 - 60 | | V | UV revel of CTF scheme | 20 | | | | |
| 190 | CFDV | | 1 - 10 | | % | UVD revel of CTF scheme | 7 | | | | |
| 191 | CFOVG | | 0.1 - 10.0 | | V | Zero phase overvoltage of CTF scheme | 1.0 | | | | |
| 192 | ZS | Z1S | 0.01 - 50.00 | 0.10 - 250.00 | Ω | Z1S reactance | 1.60 / 8.00 | | | | |
| 193 | | Z1BS | 1.5 (fixed) | 7.5 (fixed) | Ω | Z1S mho offset (back) | -- | | | | |
| 194 | | Z1S-Uvm | 5.5 (fixed) | | V | Minimum voltage phase detector | -- | | | | |
| 195 | | Z1Sθ1 | 0 - 45 | | deg | Z1S angle with reference to an X-axis | 0 | | | | |
| 196 | | Z1Sθ2 | 45 - 90 | | deg | Angle for Z1S hooked point with reference to an R-axis | 90 | | | | |
| 197 | | BFR1S | 0.10 - 20.00 | 0.5 - 100.0 | Ω | Blinder for Z1S forward ( R) | 5.10 / 25.5 | | | | |
| 198 | | Z2S | 0.01 - 50.00 | 0.10 - 250.00 | Ω | Z2S reactance | 3.00 / 15.00 | | | | |
| 199 | | BFR2S | 0.10 - 20.00 | 0.5 - 100.0 | Ω | Blinder for Z2S forward ( R) | 5.10 / 25.5 | | | | |
| 200 | | Z3S | 0.01 - 50.00 | 0.1 - 250.0 | Ω | Z3S mho | 6.00 / 30.0 | | | | |
| 201 | | Z3Sθ | 45 - 90 | | deg | Line angle for Z3S(Mho) element | 85 | | | | |
| 202 | | ZBSθ | 0 - 45 | | deg | Angle of direction(Quad) element | 5 | | | | |
| 203 | | BFRS | 0.10 - 20.00 | 0.5 - 100.0 | Ω | Blinder for ZS forward ( R) | 5.10 / 25.5 | | | | |
| 204 | | BFRSθ | 75 (fixed) | | deg | Angle of BFRS | -- | | | | |
| 205 | | BFLS | 0 (fixed) | | Ω | Blinder for ZS reverse (-R) | -- | | | | |
| 206 | | BFLSθ | 90 - 135 | | deg | Angle of BFLS | 120 | | | | |
| 207 | | ZRS | 0.01 - 50.00 | 0.1 - 250.0 | Ω | ZRS reactance | 4.00 / 20.0 | | | | |
| 208 | | Z4S | 0.01 - 50.00 | 0.1 - 250.0 | Ω | Z4S mho | 8.00 / 40.0 | | | | |
| 209 | | Z4BS | 1.5 (fixed) | 7.5 (fixed) | Ω | Z4S offset-mho (back) | -- | | | | |
| 210 | | Z4Sθ | 45 - 90 | | deg | Line angle for Z4S(Mho) element | -- (Linked with Z3Sθ) | | | | |
| 211 | | Z4BSθ | 0 - 45 | | deg | Angle of Z4S(Quad) offset | -- (Linked with ZBSθ) | | | | |
| 212 | | BRRS | 0.10 - 20.00 | 0.5 - 100.0 | Ω | Blinder for ZS reverse (-R) | 5.10 / 25.5 | | | | |
| 213 | | BRRSθ | 75 (fixed) | | deg | Angle of BRRS | -- | | | | |
| 214 | | BRLS | 0.10 - 20.00 | 0.5 - 100.0 | Ω | Blinder for ZS reverse (-R) | -- (Linked with BRRS) | | | | |
| 215 | | BRLSθ | 90 - 135 | | deg | Angle of BRLS | --(Linked with BFLSθ) | | | | |
| 216 | | TZ1S | 0.00 - 10.00 | | s | Z1S time-delay trip | 0.00 | | | | |
| 217 | | TZ2S | 0.00 - 10.00 | | s | Z2S back-up trip timer | 0.30 | | | | |
| 218 | | TZ3S | 0.00 - 10.00 | | s | Z3S back-up trip timer | 0.40 | | | | |
| 219 | | TZRS | 0.00 - 10.00 | | s | ZRS back-up trip timer | 0.60 | | | | |
| 220 | ZG | Z1G | 0.01 - 50.00 | 0.10 - 250.00 | Ω | Z1G reactance | 1.60 / 8.00 | | | | |
| 221 | | Z1Gθ1 | 0 - 45 | | deg | Z1G angle with reference to an X-axis | 0 | | | | |
| 222 | | Z1Gθ2 | 45 - 90 | | deg | Angle for Z1G hooked point with reference to an R-axis | 90 | | | | |
| 223 | | BFR1G | 0.10 - 20.00 | 0.5 - 100.0 | Ω | Blinder for Z1G forward ( R) | 5.10 / 25.5 | | | | |
| 224 | | Z2G | 0.01 - 50.00 | 0.10 - 250.00 | Ω | Z2G reactance | 4.00 / 20.00 | | | | |
| 225 | | BFR2G | 0.10 - 20.00 | 0.5 - 100.0 | Ω | Blinder for Z2G forward ( R) | 5.10 / 25.5 | | | | |

www.ElectricalPartManuals.com

| № | Name | | Range | | Units | Contents | Default Setting of Relay Series(5A rating / 1A rating) | | | | User Settiing |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 2CB-ARC, NO-FD, With Distance | | | | |
| | | | | | | | 2TERM | | 3TERM | | |
| | | | 5A rating | 1A rating | | | 701 | 702 | 711 | 712 | |
| 226 | ZG | Z3G | 0.01 - 100.00 | 0.1 - 500.0 | Ω | Z3G mho | 8.00 / 40.0 | | | | |
| 227 | | Z3Gθ | 45 - 90 | | deg | Line angle for Z3S(Mho) element | 85 | | | | |
| 228 | | ZBGθ | 0 - 45 | | deg | Angle of direction(Quad) element | 30 | | | | |
| 229 | | BFRG | 0.10 - 20.00 | 0.5 - 100.0 | Ω | Blinder for ZG forward ( R) | 5.10 / 25.5 | | | | |
| 230 | | BFRGθ | 75 (fixed) | | deg | Angle of BFRG | -- | | | | |
| 231 | | BFLG | 0 (fixed) | | Ω | Blinder for ZG forward (-R) | -- | | | | |
| 232 | | BFLGθ | 90 - 135 | | deg | Angle of BFLG | 120 | | | | |
| 233 | | ZRG | 0.01 - 100.00 | 0.1 - 500.0 | Ω | ZRG reactance | 4.00 / 20.0 | | | | |
| 234 | | Z4G | 0.01 - 100.00 | 0.1 - 500.0 | Ω | Z4G mho | 8.00 / 40.0 | | | | |
| 235 | | Z4Gθ | 45 - 90 | | deg | Line angle for Z4G(Mho) element | -- (Linked with Z3Gθ) | | | | |
| 236 | | Z4BGθ | 0 - 45 | | deg | Angle of Z4G(Quad) offset | -- (Linked with ZBGθ) | | | | |
| 237 | | BRRG | 0.10 - 20.00 | 0.5 - 100.0 | Ω | Blinder for ZG reverse (-R) | 5.10 / 25.5 | | | | |
| 238 | | BRRGθ | 75 (fixed) | | deg | Angle of BRRG | -- | | | | |
| 239 | | BRLG | 0.10 - 20.00 | 0.5 - 100.0 | Ω | Blinder for ZG reverse ( R) | -- (Linked with BRRG) | | | | |
| 240 | | BRLGθ | 90 - 135 | | deg | Angle of BRLG | -- (Linked with BFLGθ) | | | | |
| 241 | | Krs | 0 - 1000 | | % | Zero phase current factor: Self line "R0/R1" | 340 | | | | |
| 242 | | Kxs | 0 - 1000 | | % | Zero phase current factor: Self line "X0/X1" | 340 | | | | |
| 243 | | Krm | 0 - 1000 | | % | Zero phase current factor: Adjacent line "Rom/R1" | 300 | | | | |
| 244 | | Kxm | 0 - 1000 | | % | Zero phase current factor: Adjacent line "Xom/X1" | 300 | | | | |
| 245 | | KrsR | 0 - 1000 | | % | Zero phase current factor for ZR element: Self line "R0/R1" | 100 | | | | |
| 246 | | KxsR | 0 - 1000 | | % | Zero phase current factor for ZR element: Self line "X0/X1" | 100 | | | | |
| 247 | | TZ1G | 0.00 - 10.00 | | s | Z1G time-delay trip | 0.00 | | | | |
| 248 | | TZ2G | 0.00 - 10.00 | | s | Z2G back-up trip timer | 0.30 | | | | |
| 249 | | TZ3G | 0.00 - 10.00 | | s | Z3G back-up trip timer | 0.40 | | | | |
| 250 | | TZRG | 0.00 - 10.00 | | s | ZRG back-up trip timer | 0.60 | | | | |
| 251 | | ZIC | 0.00 - 5.00 | 0.00 - 1.00 | A | Charging current compensation | 0.00 | | | | |
| 252 | ZPCC | ZPCC | 0.8 (Sensitivity ratio) | | — | Zero phase current | -- | | | | |
| 253 | | OCG | 0.2 (fixed) | 0.04 (fixed) | A | compensation controller | -- | | | | |
| 254 | PSB | PSBSZ | 0.50 - 15.00 | 2.5 - 75.0 | Ω | Power swing block for Ph-Ph | 2.00 / 10.0 | | | | |
| 255 | | PSBGZ | 0.50 - 15.00 | 2.5 - 75.0 | Ω | Power swing block for Ph-G | 2.00 / 10.0 | | | | |
| 256 | | PSBRθ | 75 (fixed) | | deg | ditto | -- | | | | |
| 257 | | PSBLθ | 105 (fixed) | | deg | ditto | -- | | | | |
| 258 | | TPSB | 20 - 60 | | ms | PS detection timer | 40 | | | | |
| 259 | OCH | | 2.0 - 15.0 | 0.4 - 3.0 | A | Overcurrent element | 6.0 / 1.2 | | | | |
| 260 | TSOTF | | 0 - 300 | | s | CB open detect timer for SOTF | 5 | | | | |
| 261 | OCD1 | | 0.5 (fixed) | 0.1 (fixed) | A | Curr. change detector | -- | | | | |
| 262 | OCCR | | 0.4 (fixed) | 0.08 (fixed) | A | OC element | -- | | | | |
| 263 | DEF | DEFFI | 0.5 - 5.0 | 0.10 - 1.00 | A | Directional earth fault element | 1.0 / 0.20 | | | | |
| 264 | | DEFFV | 1.7 - 21.0 | | V | ditto | 2.0 | | | | |
| 265 | | DEFRI | 0.5 - 5.0 | 0.10 - 1.00 | A | ditto | 1.0 / 0.20 | | | | |
| 266 | | DEFRV | 1.7 - 21.0 | | V | ditto | 2.0 | | | | |
| 267 | | DEFθ | 0 - 90 | | deg | ditto | 85 | | | | |
| 268 | DEF | TDEF | 0.00 - 10.00 | | s | Forward definite timer | 3.00 | | | | |
| 269 | BU-trip | TDER | 0.00 - 10.00 | | s | Reverse definite timer | 3.00 | | | | |
| 270 | EFL | | 0.5 - 5.0 | 0.10 - 1.00 | A | EF element for ZG fail safe | 1.0 / 0.20 | | | | |
| 271 | UVC | UVCV | 10 - 60 | | V | Undervoltage element with current compensation | 48 | | | | |
| 272 | | UVCZ | 0.0 - 50.0 | 0.0 - 250.0 | Ω | ditto | 2.0 / 10.0 | | | | |
| 273 | | UVCθ | 45 - 90 | | deg | ditto | 85 | | | | |
| 274 | | UVCKrs | 0 - 1000 | | % | ditto | -- (Linked with Krs of ZG) | | | | |
| 275 | | UVCKxs | 0 - 1000 | | % | ditto | -- (Linked with Kxs of ZG) | | | | |
| 276 | OVGF | | 20 (fixed) | | V | OV element for VTF detect. function | -- | | | | |
| 277 | UVFS | | 50 - 100 | | V | UV ph-ph element | 88 | | | | |
| 278 | UVLS | | 50 - 100 | | V | UV ph-ph element "L" level | 77 | | | | |
| 279 | UVFG | | 10 - 60 | | V | UV ph-g element | 51 | | | | |
| 280 | UVLG | | 10 - 60 | | V | UV ph-g element "L" level | 45 | | | | |
| 281 | UVPWI | | 30 (fixed) | | V | UV for positive weak infeed | -- | | | | |
| 282 | OVS | OVS1 | 5.0 - 150.0 | | V | OVS1 element | 120.0 | | | | |
| 283 | | TOS1I | 0.05 - 100.00 | | — | OVS1 IDMT timer | 10.00 | | | | |
| 284 | | TOS1 | 0.00 - 300.00 | | s | OVS1 deninite timer | 0.10 | | | | |
| 285 | | TOS1R | 0.0 - 300.0 | | s | OVS1 deninite time reset delay | 0.0 | | | | |
| 286 | | OS1DP | 10 - 98 | | % | OVS1 DO/PU ratio | 95 | | | | |
| 287 | | OVS2 | 5.0 - 150.0 | | V | OVS2 element | 140.0 | | | | |
| 288 | | TOS2 | 0.00 - 300.00 | | s | OVS2 deninite timer | 0.10 | | | | |
| 289 | | OS2DP | 10 - 98 | | % | OVS2 DO/PU ratio | 95 | | | | |
| 290 | OVG | OVG1 | 5.0 - 150.0 | | V | OVG1 element | 70.0 | | | | |
| 291 | | TOG1I | 0.05 - 100.00 | | — | OVG1 IDMT timer | 10.00 | | | | |
| 292 | | TOG1 | 0.00 - 300.00 | | s | OVG1 deninite timer | 0.10 | | | | |
| 293 | | TOG1R | 0.0 - 300.0 | | s | OVG1 deninite time reset delay | 0.0 | | | | |
| 294 | | OG1DP | 10 - 98 | | % | OVG1 DO/PU ratio | 95 | | | | |
| 295 | | OVG2 | 5.0 - 150.0 | | V | OVG2 element | 80.0 | | | | |

www.ElectricalPartManuals.com

| № | Name | | Range | | Units | Contents | Default Setting of Relay Series(5A rating / 1A rating) | | | | User Settiing |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 2CB-ARC, NO-FD, With Distance | | | | |
| | | | | | | | 2TERM | | 3TERM | | |
| | | | 5A rating | 1A rating | | | 701 | 702 | 711 | 712 | |
| 296 | OVG | TOG2 | 0.00 - 300.00 | | s | OVG2 deninite timer | 0.10 | | | | |
| 297 | | OG2DP | 10 - 98 | | % | OVG2 DO/PU ratio | 95 | | | | |
| 298 | UVS | UVS1 | 5.0 - 150.0 | | V | UVS1 element | 60.0 | | | | |
| 299 | | TUS1I | 0.05 - 100.00 | | – | UVS1 IDMT timer | 10.00 | | | | |
| 300 | | TUS1 | 0.00 - 300.00 | | s | UVS1 deninite timer | 0.10 | | | | |
| 301 | | TUS1R | 0.0 - 300.0 | | s | UVS1 deninite time reset delay | 0.0 | | | | |
| 302 | | UVS2 | 5.0 - 150.0 | | V | UVS2 element | 40.0 | | | | |
| 303 | | TUS2 | 0.00 - 300.00 | | s | UVS2 deninite timer | 0.10 | | | | |
| 304 | | VSBLK | 5.0 - 20.0 | | V | UVS blocking threshold | 10.0 | | | | |
| 305 | UVG | UVG1 | 5.0 - 150.0 | | V | UVG1 element | 35.0 | | | | |
| 306 | | TUG1I | 0.05 - 100.00 | | – | UVG1 IDMT timer | 10.00 | | | | |
| 307 | | TUG1 | 0.00 - 300.00 | | s | UVG1 deninite timer | 0.10 | | | | |
| 308 | | TUG1R | 0.0 - 300.0 | | s | UVG1 deninite time reset delay | 0.0 | | | | |
| 309 | | UVG2 | 5.0 - 150.0 | | V | UVG2 element | 25.0 | | | | |
| 310 | | TUG2 | 0.00 - 300.00 | | s | UVG2 deninite timer | 0.10 | | | | |
| 311 | | VGBLK | 5.0 - 20.0 | | V | UVG blocking threshold | 10.0 | | | | |
| 312 | BCD | BCD | 0.10 - 1.00 | | – | Broken conductor threshold | 0.20 | | | | |
| 313 | | TBCD | 0.00 - 300.00 | | s | BCD definite timer | 1.00 | | | | |
| 314 | Carrier | TDEFC | 0.00 - 0.30 | | s | DEF carrier trip delay timer(forward) | 0.15 | | | | |
| 315 | | TDERC | 0.00 - 0.30 | | s | DEF carrier trip delay timer(reverse) | 0.15 | | | | |
| 316 | | TCHD | 0 - 50 | | ms | Cordination timer | 12 | | | | |
| 317 | | TREBK | 0.00 - 10.00 | | s | Current reverse blocking timer | 0.10 | | | | |
| 318 | | TECCB | 0.00 - 200.00 | | s | ECHO enable timer from CB opened | 0.10 | | | | |
| 319 | | TSBCT | 0.00 - 1.00 | | s | SBCNT timer | 0.10 | | | | |
| 320 | Autoreclose mode | | (Off) - Disable - SPAR - TPAR - SPAR&TPAR - MPAR2 - MPAR3 - EXT1P - EXT3P - EXTMP | | – | Autoreclosing mode | SPAR&TPAR | | | | |
| 321 | ARC-CB | | ONE - 01 - 02 - L1 - L2 | | – | ARC mode for 1.5CB system | ONE | | | | |
| 322 | ARC-EXT | | Off - On | | – | ARC initiated by ext. trip | Off | | | | |
| 323 | ARC-BU | | Off - On | | – | ARC by back-up trip | Off | | | | |
| 324 | ARCDIFG | | Off - On | | – | ARC by DIFG trip | Off | | | | |
| 325 | ARCDEFC | | Off - On | | – | ARC by DEF-carrier trip | Off | | | | |
| 326 | VCHK | 1CB | Off - LB - DB - SY | | – | TPAR condition | -- (SYN) | | | | |
| | | 2CB | Off - LB1 - LB2 - DB - SY | | | | LB1 | | | | |
| 327 | ARC-SM | | Off - S2 - S3 - S4 | | – | Multi. shot ARC mode | Off | | | | |
| 328 | ARC-CCB | | Off - TPAR - MPAR | | – | Center CB ARC mode at multi-phase ARC mode selected | Off | | | | |
| 329 | ARC-SUC | | Off - On | | – | ARC success reset | Off | | | | |
| 330 | MA-NOLK | | FT - T - S+T | | – | Multi ARC NO-LINK condition | FT | | | | |
| 331 | VTPHSEL | | A - B - C | | – | VT phase selection | A | | | | |
| 332 | VT-RATE | | PH/G - PH/PH | | – | VT rating | PH/G | | | | |
| 333 | 3PH-VT | | Bus - Line | | – | 3ph. VT location | Line | | | | |
| 334 | UARCSW | | P1 - P2 - P3 | | – | User ARC switch | P1 | | | | |
| 335 | TEVLV | | 0.01 - 10.00 | | s | Dead timer reset timing | 0.30 | | | | |
| 336 | TRDY1 | | 5 - 300 | | s | Reclaim timer | 60 | | | | |
| 337 | TSPR1 | | 0.01 - 10.00 | | s | SPAR dead line timer | 0.80 | | | | |
| 338 | TTPR1 | | 0.01 - 100.00 | | s | TPAR dead line timer | 0.60 | | | | |
| 339 | TMPR1 | | 0.01 - 10.00 | | s | MPAR dead line timer | 0.80 | | | | |
| 340 | TRR | | 0.01 - 100.00 | | s | ARC reset timer | 2.00 | | | | |
| 341 | TW1 | | 0.1 - 10.0 | | s | ARC reset timer | 0.2 | | | | |
| 342 | TRDY2 | | 5 - 300 | | s | Reclaim timer | 60 | | | | |
| 343 | TSPR2 | | 0.01 - 10.00 | | s | SPAR dead line timer | 0.80 | | | | |
| 344 | TTPR2 | | 0.1 - 10.0 | | s | ARC timing for follower CB | 0.1 | | | | |
| 345 | TMPR2 | | 0.01 - 10.00 | | s | MPAR dead line timer | 0.80 | | | | |
| 346 | TW2 | | 0.1 - 10.0 | | s | ARC reset timer | 0.2 | | | | |
| 347 | TS2 | | 5.0 - 300.0 | | s | Multi. shot dead timer | 20.0 | | | | |
| 348 | TS2R | | 5.0 - 300.0 | | s | Multi. shot reset timer | 30.0 | | | | |
| 349 | TS3 | | 5.0 - 300.0 | | s | Multi. shot dead timer | 20.0 | | | | |
| 350 | TS3R | | 5.0 - 300.0 | | s | Multi. shot reset timer | 30.0 | | | | |
| 351 | TS4 | | 5.0 - 300.0 | | s | Multi. shot dead timer | 20.0 | | | | |
| 352 | TS4R | | 5.0 - 300.0 | | s | Multi. shot reset timer | 30.0 | | | | |
| 353 | TSUC | | 0.1 - 10.0 | | s | ARC success reset timer | 3.0 | | | | |
| 354 | OVB | | 10 - 150 | | V | OV element | 51 | | | | |
| 355 | UVB | | 10 - 150 | | V | UV element | 13 | | | | |
| 356 | OVL1 | | 10 - 150 | | V | OV element | 51 | | | | |
| 357 | UVL1 | | 10 - 150 | | V | UV element | 13 | | | | |
| 358 | SY1UV | | 10 - 150 | | V | Synchro. check (UV) | 83 | | | | |
| 359 | SY1OV | | 10 - 150 | | V | Synchro. check (OV) | 51 | | | | |
| 360 | SY1θ | | 5 - 75 | | deg | Synchro. check (ph. diff.) | 30 | | | | |
| 361 | TSYN1 | | 0.01 - 10.00 | | s | Synchronism check timer | 1.00 | | | | |
| 362 | TDBL1 | | 0.01 - 1.00 | | s | Voltage check timer | 0.05 | | | | |
| 363 | TLBD1 | | 0.01 - 1.00 | | s | Voltage check timer | 0.05 | | | | |
| 364 | T3PLL | | 0.01 - 1.00 | | s | three phase live line check timer | 0.05 | | | | |
| 365 | OVL2 | | 10 - 150 | | V | OV element | 51 | | | | |
| 366 | UVL2 | | 10 - 150 | | V | UV element | 13 | | | | |
| 367 | SY2UV | | 10 - 150 | | V | Synchro. check (UV) | 83 | | | | |
| 368 | SY2OV | | 10 - 150 | | V | Synchro. check (OV) | 51 | | | | |

www.ElectricalPartManuals.com

| № | Name | | Range | | Units | Contents | Default Setting of Relay Series(5A rating / 1A rating) | | | | User Settiing |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 2CB-ARC, NO-FD, With Distance | | | | |
| | | | | | | | 2TERM | | 3TERM | | |
| | | | 5A rating | 1A rating | | | 701 | 702 | 711 | 712 | |
| 369 | SYΘ | | 5 - 75 | | deg | Synchro. check (ph. diff.) | 30 | | | | |
| 370 | TSYN2 | | 0.01 - 10.00 | | s | Synchronism check timer | 1.00 | | | | |
| 371 | TDBL2 | | 0.01 - 1.00 | | s | Voltage check timer | 0.05 | | | | |
| 372 | TLBD2 | | 0.01 - 1.00 | | s | Voltage check timer | 0.05 | | | | |
| 373 | BISW1 | | Norm - Inv | | — | Binary input | Norm | | | | |
| 374 | BISW2 | | Norm - Inv | | — | ditto | Norm | | | | |
| 375 | BISW3 | | Norm - Inv | | — | ditto | Norm | | | | |
| 376 | BISW4 | | Norm - Inv | | — | ditto | Norm | | | | |
| 377 | BISW5 | | Norm - Inv | | — | ditto | Norm | | | | |
| 378 | BISW6 | | Norm - Inv | | — | ditto | Norm | | | | |
| 379 | BISW7 | | Norm - Inv | | — | ditto | Norm | | | | |
| 380 | BISW8 | | Norm - Inv | | — | ditto | Norm | | | | |
| 381 | BISW9 | | Norm - Inv | | — | ditto | Norm | | | | |
| 382 | BISW10 | | Norm - Inv | | — | ditto | Norm | | | | |
| 383 | BISW11 | | Norm - Inv | | — | ditto | Norm | | | | |
| 384 | BISW12 | | Norm - Inv | | — | ditto | Norm | | | | |
| 385 | BISW13 | | Norm - Inv | | — | ditto | Norm | | | | |
| 386 | BISW14 | | Norm - Inv | | — | ditto | Norm | | | | |
| 387 | BISW15 | | Norm - Inv | | — | ditto | Norm | | | | |
| 388 | BISW16 | | Norm - Inv | | — | ditto | Norm | | | | |
| 389 | BISW17 | | Norm - Inv | | — | ditto | Norm | | | | |
| 390 | BISW18 | | Norm - Inv | | — | ditto | Norm | | | | |
| 391 | BISW19 | | Norm - Inv | | — | ditto | Norm | | | | |
| 392 | BISW20 | | Norm - Inv | | — | ditto | Norm | | | | |
| 393 | BISW21 | | Norm - Inv | | — | ditto | Norm | | | | |
| 394 | BISW22 | | Norm - Inv | | — | ditto | Norm | | | | |
| 395 | BISW23 | | Norm - Inv | | — | ditto | Norm | | | | |
| 396 | BISW24 | | Norm - Inv | | — | ditto | Norm | | | | |
| 397 | BISW25 | | Norm - Inv | | — | ditto | Norm | | | | |
| 398 | BISW26 | | Norm - Inv | | — | ditto | -- | Norm | -- | Norm | |
| 399 | BISW27 | | Norm - Inv | | — | ditto | -- | Norm | -- | Norm | |
| 400 | BISW28 | | Norm - Inv | | — | ditto | -- | Norm | -- | Norm | |
| 401 | BISW34 | | Norm - Inv | | — | ditto | -- | Norm | -- | Norm | |
| 402 | BISW35 | | Norm - Inv | | — | ditto | -- | Norm | -- | Norm | |
| 403 | BISW36 | | Norm - Inv | | — | ditto | -- | Norm | -- | Norm | |
| 404 | LED1 | Logic | OR / AND | | — | LED* Logic Gate Type | OR | | | | |
| 405 | | Reset | Inst / Latch | | — | LED* Reset operation | Inst | | | | |
| 406 | | In #1 | 0 - 3071 | | — | LED Functions | 0 | | | | |
| 407 | | In #2 | 0 - 3071 | | — | ditto | 0 | | | | |
| 408 | | In #3 | 0 - 3071 | | — | ditto | 0 | | | | |
| 409 | | In #4 | 0 - 3071 | | — | ditto | 0 | | | | |
| 410 | LED2 | Logic | OR / AND | | — | LED* Logic Gate Type | OR | | | | |
| 411 | | Reset | Inst / Latch | | — | LED* Reset operation | Inst | | | | |
| 412 | | In #1 | 0 - 3071 | | — | LED Functions | 0 | | | | |
| 413 | | In #2 | 0 - 3071 | | — | ditto | 0 | | | | |
| 414 | | In #3 | 0 - 3071 | | — | ditto | 0 | | | | |
| 415 | | In #4 | 0 - 3071 | | — | ditto | 0 | | | | |
| 416 | LED3 | Logic | OR / AND | | — | LED* Logic Gate Type | OR | | | | |
| 417 | | Reset | Inst / Latch | | — | LED* Reset operation | Inst | | | | |
| 418 | | In #1 | 0 - 3071 | | — | LED Functions | 0 | | | | |
| 419 | | In #2 | 0 - 3071 | | — | ditto | 0 | | | | |
| 420 | | In #3 | 0 - 3071 | | — | ditto | 0 | | | | |
| 421 | | In #4 | 0 - 3071 | | — | ditto | 0 | | | | |
| 422 | LED4 | Logic | OR / AND | | — | LED* Logic Gate Type | OR | | | | |
| 423 | | Reset | Inst / Latch | | — | LED* Reset operation | Inst | | | | |
| 424 | | In #1 | 0 - 3071 | | — | LED Functions | 0 | | | | |
| 425 | | In #2 | 0 - 3071 | | — | ditto | 0 | | | | |
| 426 | | In #3 | 0 - 3071 | | — | ditto | 0 | | | | |
| 427 | | In #4 | 0 - 3071 | | — | ditto | 0 | | | | |
| 428 | Plant name | | Specified by user | | — | Plant name | Specified by user | | | | |
| 429 | Description | | ditto | | — | Memorandum for user | Specified by user | | | | |
| 430 | HDLC | | 1 - 32 | | — | Relay ID No. for RSM | 1 | | | | |
| 431 | IEC | | 0 - 254 | | — | Station address for IEC103 | 2 | | | | |
| 432 | SYADJ | | -9999 - 9999 | | ms | Time sync. Compensation | 0 | | | | |
| 433 | PRTCL1 | | HDLC - IEC103 | | — | CH1 Communication protocol | HDLC | | | | |
| 434 | IP1-1 | | 0 - 254 | | — | CH1 IP address | 192 | | | | |
| 435 | IP1-2 | | 0 - 254 | | — | CH1 IP address | 168 | | | | |
| 436 | IP1-3 | | 0 - 254 | | — | CH1 IP address | 19 | | | | |
| 437 | IP1-4 | | 0 - 254 | | — | CH1 IP address | 172 | | | | |
| 438 | SM1-1 | | 0 - 255 | | — | CH1 Subnet mask | 255 | | | | |
| 439 | SM1-2 | | 0 - 255 | | — | CH1 Subnet mask | 255 | | | | |
| 440 | SM1-3 | | 0 - 255 | | — | CH1 Subnet mask | 255 | | | | |
| 441 | SM1-4 | | 0 - 255 | | — | CH1 Subnet mask | 0 | | | | |
| 442 | GW1-1 | | 0 - 254 | | — | CH1 Gateway | 192 | | | | |
| 443 | GW1-2 | | 0 - 254 | | — | CH1 Gateway | 168 | | | | |

www.ElectricalPartManuals.com

| № | Name | Range | | Units | Contents | Default Setting of Relay Series(5A rating / 1A rating) | | | | User Settiing |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2CB-ARC, NO-FD, With Distance | | | | |
| | | | | | | 2TERM | | 3TERM | | |
| | | 5A rating | 1A rating | | | 701 | 702 | 711 | 712 | |
| 444 | GW1-3 | 0 - 254 | | – | CH1 Gateway | 19 | | | | |
| 445 | GW1-4 | 0 - 254 | | – | CH1 Gateway | 1 | | | | |
| 446 | 232C | 9.6 - 19.2 - 38.4 - 57.6 | | – | RS-232C baud rate | 9.6 | | | | |
| 447 | IECBR | 9.6 - 19.2 | | – | IEC103 baud rate | 19.2 | | | | |
| 448 | IECBLK | Normal - Blocked | | – | Monitor direction blocked | Normal | | | | |
| 449 | Fault locator | Off - On | | – | FL function use or not | On | | | | |
| 450 | BITRN | 0 - 128 | | – | Number of bi-trigger (on/off) events | 100 | | | | |
| 451 | Time | 0.1 - 3.0 | | s | Disturbance record | 1.0 | | | | |
| 452 | OCP-S | 0.5 - 250.0 | 0.1 - 50.0 | A | OC element for disturbance | 10.0 / 2.0 | | | | |
| 453 | OCP-G | 0.5 - 250.0 | 0.1 - 50.0 | A | recorder initiation | 5.0 / 1.0 | | | | |
| 454 | UVP-S | 0 - 132 | | V | UV element for disturbance | 88 | | | | |
| 455 | UVP-G | 0 - 76 | | V | recorder initiation | 51 | | | | |
| 456 | TRIP | Off - On | | – | Disturbance trigger | On | | | | |
| 457 | OCP-S | Off - On | | – | ditto | On | | | | |
| 458 | OCP-G | Off - On | | – | ditto | On | | | | |
| 459 | UVP-S | Off - On | | – | ditto | On | | | | |
| 460 | UVP-G | Off - On | | – | ditto | On | | | | |
| 461 | Trip(Automatic test interval) | 1 - 7 | | days | AUTO. checking timer | -- | | | | |
| 462 | Display value | Primary - Secondary | | – | Metering | Primary | | | | |
| 463 | Power(P/Q) | Send - Receive | | – | Metering | Send | | | | |
| 464 | Current | Lag - Lead | | – | Metering | Lead | | | | |
| 465 | Sync | Off - IRIG - RSM - IEC - GPS | | – | Time | Off | | | | |
| 466 | GMT | -12 - +12 | | hrs | Time | 0 | | | | |

www . ElectricalPartManuals . com

Event record

| No. | Name | Range | Unit | Contents | Signal No. | Signal name | Type |
|---|---|---|---|---|---|---|---|
| 1 | EV1 | 0 - 3071 | — | Event record signal | 1536 | CB1 A | On/Off |
| 2 | EV2 | 0 - 3071 | — | ditto | 1537 | CB1 B | On/Off |
| 3 | EV3 | 0 - 3071 | — | ditto | 1538 | CB1 C | On/Off |
| 4 | EV4 | 0 - 3071 | — | ditto | 1539 | CB2 A | On/Off |
| 5 | EV5 | 0 - 3071 | — | ditto | 1540 | CB2 B | On/Off |
| 6 | EV6 | 0 - 3071 | — | ditto | 1541 | CB2 C | On/Off |
| 7 | EV7 | 0 - 3071 | — | ditto | 1542 | DS | On/Off |
| 8 | EV8 | 0 - 3071 | — | ditto | 1544 | Dif.block | On/Off |
| 9 | EV9 | 0 - 3071 | — | ditto | 1550 | BU block | On/Off |
| 10 | EV10 | 0 - 3071 | — | ditto | 1545 | Ext.close | On/Off |
| 11 | EV11 | 0 - 3071 | — | ditto | 1546 | DC supply | On/Off |
| 12 | EV12 | 0 - 3071 | — | ditto | 1547 | Trans.trip1 | On/Off |
| 13 | EV13 | 0 - 3071 | — | ditto | 1548 | Trans.trip2 | On/Off |
| 14 | EV14 | 0 - 3071 | — | ditto | 1549 | Ind. reset | On/Off |
| 15 | EV15 | 0 - 3071 | — | ditto | 1552 | Ext.trip A | On/Off |
| 16 | EV16 | 0 - 3071 | — | ditto | 1553 | Ext.trip B | On/Off |
| 17 | EV17 | 0 - 3071 | — | ditto | 1554 | Ext.trip C | On/Off |
| 18 | EV18 | 0 - 3071 | — | ditto | 1571 | CB1 ready | On/Off |
| 19 | EV19 | 0 - 3071 | — | ditto | 1572 | CB2 ready | On/Off |
| 20 | EV20 | 0 - 3071 | — | ditto | 1573 | ARC block | On/Off |
| 21 | EV21 | 0 - 3071 | — | ditto | 446 | Trip | On/Off |
| 22 | EV22 | 0 - 3071 | — | ditto | 177 | CB1 ARC | On/Off |
| 23 | EV23 | 0 - 3071 | — | ditto | 178 | CB2 ARC | On/Off |
| 24 | EV24 | 0 - 3071 | — | ditto | 231 | Relay fail | On/Off |
| 25 | EV25 | 0 - 3071 | — | ditto | 1268 | V0 err | On/Off |
| 26 | EV26 | 0 - 3071 | — | ditto | 1269 | V2 err | On/Off |
| 27 | EV27 | 0 - 3071 | — | ditto | 1267 | I0 err | On/Off |
| 28 | EV28 | 0 - 3071 | — | ditto | 235 | DS fail | On/Off |
| 29 | EV29 | 0 - 3071 | — | ditto | 214 | Com1 fail | On/Off |
| 30 | EV30 | 0 - 3071 | — | ditto | 215 | Sync1 fail | On/Off |
| 31 | EV31 | 0 - 3071 | — | ditto | 220 | Com2 fail | On/Off |
| 32 | EV32 | 0 - 3071 | — | ditto | 221 | Sync2 fail | On/Off |
| 33 | EV33 | 0 - 3071 | — | ditto | 447 | Term1 rdy | On/Off |
| 34 | EV34 | 0 - 3071 | — | ditto | 448 | Term2 rdy | On/Off |
| 35 | EV35 | 0 - 3071 | — | ditto | 272 | GPS 1PPS err | On/Off |
| 36 | EV36 | 0 - 3071 | — | ditto | 289 | Angle over | On/Off |
| 37 | EV37 | 0 - 3071 | — | ditto | 1513 | RYID1 err | On/Off |
| 38 | EV38 | 0 - 3071 | — | ditto | 1514 | RYID2 err | On/Off |
| 39 | EV39 | 0 - 3071 | — | ditto | 1511 | Td1 over | On/Off |
| 40 | EV40 | 0 - 3071 | — | ditto | 1512 | Td2 over | On/Off |
| 41 | EV41 | 0 - 3071 | — | ditto | 1503 | CLK1 fail | On/Off |
| 42 | EV42 | 0 - 3071 | — | ditto | 1504 | CLK2 fail | On/Off |
| 43 | EV43 | 0 - 3071 | — | ditto | 1507 | TX level1 err | On/Off |
| 44 | EV44 | 0 - 3071 | — | ditto | 1508 | TX level2 err | On/Off |
| 45 | EV45 | 0 - 3071 | — | ditto | 1509 | RX level1 err | On/Off |
| 46 | EV46 | 0 - 3071 | — | ditto | 1510 | RX level2 err | On/Off |
| 47 | EV47 | 0 - 3071 | — | ditto | 1501 | Com1 fail-R | On/Off |
| 48 | EV48 | 0 - 3071 | — | ditto | 1502 | Com2 fail-R | On/Off |
| 49 | EV49 | 0 - 3071 | — | ditto | 489 | AS1 | On/Off |
| 50 | EV50 | 0 - 3071 | — | ditto | 490 | AS2 | On/Off |
| 51 | EV51 | 0 - 3071 | — | ditto | 228 | RDIF1 | On/Off |
| 52 | EV52 | 0 - 3071 | — | ditto | 229 | RDIF2 | On/Off |
| 53 | EV53 | 0 - 3071 | — | ditto | 1266 | CT err | On/Off |
| 54 | EV54 | 0 - 3071 | — | ditto | 1256 | Id err | On/Off |
| 55 | EV55 | 0 - 3071 | — | ditto | 496 | CTF | On/Off |
| 56 | EV56 | 0 - 3071 | — | ditto | 493 | AF1 | On/Off |
| 57 | EV57 | 0 - 3071 | — | ditto | 494 | AF2 | On/Off |
| 58 | EV58 | 0 - 3071 | — | ditto | 1271 | I0-C err | On/Off |
| 59 | EV59 | 0 - 3071 | — | ditto | 1273 | CT-C err | On/Off |
| 60 | EV60 | 0 - 3071 | — | ditto | 891 | VTF | On/Off |
| 61 | EV61 | 0 - 3071 | — | ditto | 766 | PSB | On/Off |
| 62 | EV62 | 0 - 3071 | — | ditto | 894 | Ch.fail | On/Off |
| 63 | EV63 | 0 - 3071 | — | ditto | 0 | | |
| 64 | EV64 | 0 - 3071 | — | ditto | 0 | | |

www . ElectricalPartManuals . com

Event record

| No. | Name | Range | Unit | Contents | Signal No. | Signal name | Type |
|---|---|---|---|---|---|---|---|
| 65 | EV65 | 0 - 3071 | — | ditto | 0 | | |
| 66 | EV66 | 0 - 3071 | — | ditto | 0 | | |
| 67 | EV67 | 0 - 3071 | — | ditto | 0 | | |
| 68 | EV68 | 0 - 3071 | — | ditto | 0 | | |
| 69 | EV69 | 0 - 3071 | — | ditto | 0 | | |
| 70 | EV70 | 0 - 3071 | — | ditto | 0 | | |
| 71 | EV71 | 0 - 3071 | — | ditto | 0 | | |
| 72 | EV72 | 0 - 3071 | — | ditto | 0 | | |
| 73 | EV73 | 0 - 3071 | — | ditto | 0 | | |
| 74 | EV74 | 0 - 3071 | — | ditto | 0 | | |
| 75 | EV75 | 0 - 3071 | — | ditto | 0 | | |
| 76 | EV76 | 0 - 3071 | — | ditto | 0 | | |
| 77 | EV77 | 0 - 3071 | — | ditto | 0 | | |
| 78 | EV78 | 0 - 3071 | — | ditto | 0 | | |
| 79 | EV79 | 0 - 3071 | — | ditto | 0 | | |
| 80 | EV80 | 0 - 3071 | — | ditto | 0 | | |
| 81 | EV81 | 0 - 3071 | — | ditto | 0 | | |
| 82 | EV82 | 0 - 3071 | — | ditto | 0 | | |
| 83 | EV83 | 0 - 3071 | — | ditto | 0 | | |
| 84 | EV84 | 0 - 3071 | — | ditto | 0 | | |
| 85 | EV85 | 0 - 3071 | — | ditto | 0 | | |
| 86 | EV86 | 0 - 3071 | — | ditto | 0 | | |
| 87 | EV87 | 0 - 3071 | — | ditto | 0 | | |
| 88 | EV88 | 0 - 3071 | — | ditto | 0 | | |
| 89 | EV89 | 0 - 3071 | — | ditto | 0 | | |
| 90 | EV90 | 0 - 3071 | — | ditto | 0 | | |
| 91 | EV91 | 0 - 3071 | — | ditto | 0 | | |
| 92 | EV92 | 0 - 3071 | — | ditto | 0 | | |
| 93 | EV93 | 0 - 3071 | — | ditto | 0 | | |
| 94 | EV94 | 0 - 3071 | — | ditto | 0 | | |
| 95 | EV95 | 0 - 3071 | — | ditto | 0 | | |
| 96 | EV96 | 0 - 3071 | — | ditto | 0 | | |
| 97 | EV97 | 0 - 3071 | — | ditto | 0 | | |
| 98 | EV98 | 0 - 3071 | — | ditto | 0 | | |
| 99 | EV99 | 0 - 3071 | — | ditto | 0 | | |
| 100 | EV100 | 0 - 3071 | — | ditto | 0 | | |
| 101 | EV101 | 0 - 3071 | — | ditto | 2640 | SET.GROUP1 | On |
| 102 | EV102 | 0 - 3071 | — | ditto | 2641 | SET.GROUP2 | On |
| 103 | EV103 | 0 - 3071 | — | ditto | 2642 | SET.GROUP3 | On |
| 104 | EV104 | 0 - 3071 | — | ditto | 2643 | SET.GROUP4 | On |
| 105 | EV105 | 0 - 3071 | — | ditto | 2644 | SET.GROUP5 | On |
| 106 | EV106 | 0 - 3071 | — | ditto | 2645 | SET.GROUP6 | On |
| 107 | EV107 | 0 - 3071 | — | ditto | 2646 | SET.GROUP7 | On |
| 108 | EV108 | 0 - 3071 | — | ditto | 2647 | SET.GROUP8 | On |
| 109 | EV109 | 0 - 3071 | — | ditto | 1448 | Sys. Set change | On |
| 110 | EV110 | 0 - 3071 | — | ditto | 1449 | Rly. Set change | On |
| 111 | EV111 | 0 - 3071 | — | ditto | 1450 | Grp. Set change | On |
| 112 | EV112 | 0 - 3071 | — | ditto | 950 | MODE0 | On |
| 113 | EV113 | 0 - 3071 | — | ditto | 951 | MODE1 | On |
| 114 | EV114 | 0 - 3071 | — | ditto | 952 | MODE2A-GPS | On |
| 115 | EV115 | 0 - 3071 | — | ditto | 953 | MODE2A-Td | On |
| 116 | EV116 | 0 - 3071 | — | ditto | 954 | MODE2A-CF | On |
| 117 | EV117 | 0 - 3071 | — | ditto | 955 | MODE2A-ANGLE | On |
| 118 | EV118 | 0 - 3071 | — | ditto | 957 | MODE2B | On |
| 119 | EV119 | 0 - 3071 | — | ditto | 1445 | PLC data CHG | On |
| 120 | EV120 | 0 - 3071 | — | ditto | 956 | MODE2A-REMOTE | On |
| 121 | EV121 | 0 - 3071 | — | ditto | 1409 | LED RST | On |
| 122 | EV122 | 0 - 3071 | — | ditto | 1435 | F.record_CLR | On |
| 123 | EV123 | 0 - 3071 | — | ditto | 0 | | |
| 124 | EV124 | 0 - 3071 | — | ditto | 1436 | E.record_CLR | On |
| 125 | EV125 | 0 - 3071 | — | ditto | 1437 | D.record_CLR | On |
| 126 | EV126 | 0 - 3071 | — | ditto | 0 | | |
| 127 | EV127 | 0 - 3071 | — | ditto | 0 | | |
| 128 | EV128 | 0 - 3071 | — | ditto | 0 | | |

www . ElectricalPartManuals . com

## Disturbance record

| No. | Name | Range | Unit | Contents | Default | |
|---|---|---|---|---|---|---|
| | | | | | Signal No. | Signal name |
| 1 | SIG1 | 0 - 3071 | — | disturbance record triger | 93 | TRIP-A |
| 2 | SIG2 | 0 - 3071 | — | ditto | 94 | TRIP-B |
| 3 | SIG3 | 0 - 3071 | — | ditto | 95 | TRIP-C |
| 4 | SIG4 | 0 - 3071 | — | ditto | 82 | DIF-A_TRIP |
| 5 | SIG5 | 0 - 3071 | — | ditto | 83 | DIF-B_TRIP |
| 6 | SIG6 | 0 - 3071 | — | ditto | 84 | DIF-C_TRIP |
| 7 | SIG7 | 0 - 3071 | — | ditto | 86 | DIFG_TRIP |
| 8 | SIG8 | 0 - 3071 | — | ditto | 87 | OST_TRIP |
| 9 | SIG9 | 0 - 3071 | — | ditto | 92 | CBF_TRIP |
| 10 | SIG10 | 0 - 3071 | — | ditto | 53 | RELAY_BLOCK |
| 11 | SIG11 | 0 - 3071 | — | ditto | 177 | ARC1 |
| 12 | SIG12 | 0 - 3071 | — | ditto | 178 | ARC2 |
| 13 | SIG13 | 0 - 3071 | — | ditto | 1536 | CB1_CONT-A |
| 14 | SIG14 | 0 - 3071 | — | ditto | 1537 | CB1_CONT-B |
| 15 | SIG15 | 0 - 3071 | — | ditto | 1538 | CB1_CONT-C |
| 16 | SIG16 | 0 - 3071 | — | ditto | 1539 | CB2_CONT-A |
| 17 | SIG17 | 0 - 3071 | — | ditto | 1540 | CB2_CONT-B |
| 18 | SIG18 | 0 - 3071 | — | ditto | 1541 | CB2_CONT-C |
| 19 | SIG19 | 0 - 3071 | — | ditto | 1542 | DS_N/O_CONT |
| 20 | SIG20 | 0 - 3071 | — | ditto | 1571 | CB1_READY |
| 21 | SIG21 | 0 - 3071 | — | ditto | 1572 | CB2_READY |
| 22 | SIG22 | 0 - 3071 | — | ditto | 904 | CAR_TRIP |
| 23 | SIG23 | 0 - 3071 | — | ditto | 895 | Z1_TRIP |
| 24 | SIG24 | 0 - 3071 | — | ditto | 896 | Z2_TRIP |
| 25 | SIG25 | 0 - 3071 | — | ditto | 897 | Z3_TRIP |
| 26 | SIG26 | 0 - 3071 | — | ditto | 118 | BU_TRIP |
| 27 | SIG27 | 0 - 3071 | — | ditto | 766 | PSB_DET |
| 28 | SIG28 | 0 - 3071 | — | ditto | 886 | CAR-S |
| 29 | SIG29 | 0 - 3071 | — | ditto | 1856 | CAR-R1 |
| 30 | SIG30 | 0 - 3071 | — | ditto | 1864 | CAR-R2 |
| 31 | SIG31 | 0 - 3071 | — | ditto | 0 | NA |
| 32 | SIG32 | 0 - 3071 | — | ditto | 0 | NA |

www . ElectricalPartManuals . com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None |
| 1536 | CB1_CONT-A | X | | | | [513]BI1_COMMAND | | | | | | | | | X |
| 1537 | CB1_CONT-B | X | | | | [514]BI2_COMMAND | | | | | | | | | X |
| 1538 | CB1_CONT-C | X | | | | [515]BI3_COMMAND | | | | | | | | | X |
| 1539 | CB2_CONT-A | X | | | | [516]BI4_COMMAND | | | | | | | | | X |
| 1540 | CB2_CONT-B | X | | | | [517]BI5_COMMAND | | | | | | | | | X |
| 1541 | CB2_CONT-C | X | | | | [518]BI6_COMMAND | | | | | | | | | X |
| 1542 | DS_N/O_CONT | X | | | | [519]BI7_COMMAND | | | | | | | | | X |
| 1543 | DS_N/C_CONT | X | | | | [520]BI8_COMMAND | | | | | | | | | X |
| 1544 | CRT_BLOCK | X | | | | [531]BI19_COMMAND | | | | | | | | | X |
| 1545 | CB_CLOSE | X | | | | [532]BI20_COMMAND | | | | | | | | | X |
| 1546 | DC_SUPPLY | X | | | | [523]BI11_COMMAND | | | | | | | | | X |
| 1547 | 85S1 | X | | | | [1295]BI12_COM_UF | | | | | | | | | X |
| 1548 | 85S2 | X | | | | [1296]BI13_COM_UF | | | | | | | | | X |
| 1549 | IND.RESET | X | | | | [533]BI21_COMMAND | | | | | | | | | X |
| 1550 | BUT_BLOCK | | | | | | | | | | | | | | |
| 1551 | | | | | | | | | | | | | | | |
| 1552 | EXT_TRIP-A | X | | | | [528]BI16_COMMAND | | | | | | | | | X |
| 1553 | EXT_TRIP-B | X | | | | [529]BI17_COMMAND | | | | | | | | | X |
| 1554 | EXT_TRIP-C | X | | | | [530]BI18_COMMAND | | | | | | | | | X |
| 1555 | | | | | | | | | | | | | | | |
| 1556 | EXT_CBFIN-A | X | | | | [528]BI16_COMMAND | | | | | | | | | X |
| 1557 | EXT_CBFIN-B | X | | | | [529]BI17_COMMAND | | | | | | | | | X |
| 1558 | EXT_CBFIN-C | X | | | | [530]BI18_COMMAND | | | | | | | | | X |
| 1559 | | | | | | | | | | | | | | | |
| 1560 | | | | | | | | | | | | | | | |
| 1561 | | | | | | | | | | | | | | | |
| 1562 | | | | | | | | | | | | | | | |
| 1563 | | | | | | | | | | | | | | | |
| 1564 | | | | | | | | | | | | | | | |
| 1565 | | | | | | | | | | | | | | | |
| 1566 | | | | | | | | | | | | | | | |
| 1567 | | | | | | | | | | | | | | | |
| 1568 | INT.LINK1-A | | | | | | | | | | | | | | |
| 1569 | INT.LINK1-B | | | | | | | | | | | | | | |
| 1570 | INT.LINK1-C | | | | | | | | | | | | | | |
| 1571 | CB1_READY | X | | | | [534]BI22_COMMAND | | | | | | | | | X |
| 1572 | CB2_READY | X | | | | [535]BI23_COMMAND | | | | | | | | | X |
| 1573 | ARC_RESET | X | | | | [536]BI24_COMMAND | | | | | | | | | X |
| 1574 | ARC_BLOCK | | | X | 2 | [87]OST_TRIP + [91]CBFDET + [98]STUB + [417]THM_TRIP + [418]TR1_TRIP + [426]TR2_TRIP + [859]BCD_TRIP + [905]OV/UV_TRIP | | | | | | | | | X |
| 1575 | INT.LINK2-A | | | | | | | | | | | | | | |
| 1576 | INT.LINK2-B | | | | | | | | | | | | | | |
| 1577 | INT.LINK2-C | | | | | | | | | | | | | | |
| 1578 | ARC_BLOCK1 | | | | | | | | | | | | | | |
| 1579 | ARC_BLOCK2 | | | | | | | | | | | | | | |
| 1580 | | | | | | | | | | | | | | | |
| 1581 | | | | | | | | | | | | | | | |
| 1582 | | | | | | | | | | | | | | | |
| 1583 | | | | | | | | | | | | | | | |
| 1584 | PROT_BLOCK | | | | | | | | | | | | | | |
| 1585 | DIF_BLOCK | | | | | | | | | | | | | | |
| 1586 | DIFG_BLOCK | | | | | | | | | | | | | | |
| 1587 | OST_BLOCK | | | | | | | | | | | | | | |
| 1588 | CBF_BLOCK | | | | | | | | | | | | | | |
| 1589 | OC_BLOCK | | | | | | | | | | | | | | |
| 1590 | OCI_BLOCK | | | | | | | | | | | | | | |
| 1591 | EF_BLOCK | | | | | | | | | | | | | | |
| 1592 | EFI_BLOCK | | | | | | | | | | | | | | |
| 1593 | THMA_BLOCK | | | | | | | | | | | | | | |
| 1594 | THM_BLOCK | | | | | | | | | | | | | | |
| 1595 | TR1_BLOCK | | | | | | | | | | | | | | |
| 1596 | TR2_BLOCK | | | | | | | | | | | | | | |
| 1597 | EXTTP_BLOCK | | | | | | | | | | | | | | |
| 1598 | RDIF_BLOCK | | | | | | | | | | | | | | |
| 1599 | | | | | | | | | | | | | | | |

www.ElectricalArtManuals.com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None |
| 1600 | ARC_OFF | | | | | | | | | | | | | | |
| 1601 | ARC_SPAR | | | | | | | | | | | | | | |
| 1602 | ARC_TPAR | | | | | | | | | | | | | | |
| 1603 | ARC_S&T | | | | | | | | | | | | | | |
| 1604 | ARC_MAPR2 | | | | | | | | | | | | | | |
| 1605 | ARC_MPAR3 | | | | | | | | | | | | | | |
| 1606 | ARC_EXT1P | | | | | | | | | | | | | | |
| 1607 | ARC_EXT3P | | | | | | | | | | | | | | |
| 1608 | ARC_EXTMP | | | | | | | | | | | | | | |
| 1609 | CTF_BLOCK | | | | | | | | | | | | | | |
| 1610 | | | | | | | | | | | | | | | |
| 1611 | | | | | | | | | | | | | | | |
| 1612 | | | | | | | | | | | | | | | |
| 1613 | | | | | | | | | | | | | | | |
| 1614 | | | | | | | | | | | | | | | |
| 1615 | | | | | | | | | | | | | | | |
| 1616 | DIF-A_FS | X | | | | [408]DIFFS_OP | | | | | | | | | X |
| 1617 | DIF-B_FS | X | | | | [408]DIFFS_OP | | | | | | | | | X |
| 1618 | DIF-C_FS | X | | | | [408]DIFFS_OP | | | | | | | | | X |
| 1619 | DIFG_FS | X | | | | [412]DIFGFS_OP | | | | | | | | | X |
| 1620 | TP-A_DELAY | X | | | | [435]TP-A | | | | X | | | 60 | ms | |
| 1621 | TP-B_DELAY | X | | | | [436]TP-B | | | | X | | | 60 | ms | |
| 1622 | TP-C_DELAY | X | | | | [437]TP-C | | | | X | | | 60 | ms | |
| 1623 | R.DATA_ZERO | | | | | | | | | | | | | | |
| 1624 | RDIF-A_FS | X | | | | [408]DIFFS_OP + [412]DIFGFS_OP | | | | | | | | | X |
| 1625 | RDIF-B_FS | X | | | | [408]DIFFS_OP + [412]DIFGFS_OP | | | | | | | | | X |
| 1626 | RDIF-C_FS | X | | | | [408]DIFFS_OP + [412]DIFGFS_OP | | | | | | | | | X |
| 1627 | | | | | | | | | | | | | | | |
| 1628 | | | | | | | | | | | | | | | |
| 1629 | | | | | | | | | | | | | | | |
| 1630 | | | | | | | | | | | | | | | |
| 1631 | INIT_MODE2B | | | | | | | | | | | | | | |
| 1632 | DIFG_INST_TP | | | | | | | | | | | | | | |
| 1633 | OC_INST_TP | | | | | | | | | | | | | | |
| 1634 | EF_INST_TP | | | | | | | | | | | | | | |
| 1635 | | | | | | | | | | | | | | | |
| 1636 | | | | | | | | | | | | | | | |
| 1637 | | | | | | | | | | | | | | | |
| 1638 | | | | | | | | | | | | | | | |
| 1639 | | | | | | | | | | | | | | | |
| 1640 | | | | | | | | | | | | | | | |
| 1641 | | | | | | | | | | | | | | | |
| 1642 | | | | | | | | | | | | | | | |
| 1643 | | | | | | | | | | | | | | | |
| 1644 | | | | | | | | | | | | | | | |
| 1645 | | | | | | | | | | | | | | | |
| 1646 | | | | | | | | | | | | | | | |
| 1647 | | | | | | | | | | | | | | | |
| 1648 | DIF_3PTP | | | | | | | | | | | | | | |
| 1649 | RDIF_3PTP | | | | | | | | | | | | | | |
| 1650 | OC_3PTP | | X | | 0 | [1]CONSTANT_1 | | | | | | | | | X |
| 1651 | OCI_3PTP | | X | | 0 | [1]CONSTANT_1 | | | | | | | | | X |
| 1652 | | | | | | | | | | | | | | | |
| 1653 | | | | | | | | | | | | | | | |
| 1654 | | | | | | | | | | | | | | | |
| 1655 | | | | | | | | | | | | | | | |
| 1656 | | | | | | | | | | | | | | | |
| 1657 | | | | | | | | | | | | | | | |
| 1658 | | | | | | | | | | | | | | | |
| 1659 | | | | | | | | | | | | | | | |
| 1660 | TR1_3PTP | | | | | | | | | | | | | | |
| 1661 | TR2_3PTP | | | | | | | | | | | | | | |
| 1662 | | | | | | | | | | | | | | | |
| 1663 | 3P_TRIP | | | | | | | | | | | | | | |
| 1664 | | | | | | | | | | | | | | | |
| 1665 | | | | | | | | | | | | | | | |
| 1666 | | | | | | | | | | | | | | | |
| 1667 | | | | | | | | | | | | | | | |
| 1668 | | | | | | | | | | | | | | | |
| 1669 | | | | | | | | | | | | | | | |
| 1670 | | | | | | | | | | | | | | | |

www.ElectricalPartManuals.com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None |
| 1671 | | | | | | | | | | | | | | | |
| 1672 | 85R1-R1 | X | | | | [1091]COM4-R1 | | | | | | | | | X |
| 1673 | 85R2-R1 | X | | | | [1092]COM5-R1 | | | | | | | | | X |
| 1674 | ARC_BLOCK-R1 | X | | | | [1104]SUB_COM1-R1 | | | | | | | | | X |
| 1675 | L.TEST-R1 | X | | | | [1105]SUB_COM2-R1 | | | | | | | | | X |
| 1676 | | | | | | | | | | | | | | | |
| 1677 | | | | | | | | | | | | | | | |
| 1678 | | | | | | | | | | | | | | | |
| 1679 | | | | | | | | | | | | | | | |
| 1680 | I.LINK-A-R1 | X | | | | [1112]SUB2_COM1-R1 + [1115]SUB2_COM4-R1 + [1118]SUB2_COM7-R1 + [1121]SUB2_COM10-R1 | | | | | | | | | X |
| 1681 | I.LINK-B-R1 | X | | | | [1113]SUB2_COM2-R1 + [1116]SUB2_COM5-R1 + [1119]SUB2_COM8-R1 + [1122]SUB2_COM11-R1 | | | | | | | | | X |
| 1682 | I.LINK-C-R1 | X | | | | [1114]SUB2_COM3-R1 + [1117]SUB2_COM6-R1 + [1120]SUB2_COM9-R1 + [1123]SUB2_COM12-R1 | | | | | | | | | X |
| 1683 | | | | | | | | | | | | | | | |
| 1684 | RDIF-A-R1 | | | | | | | | | | | | | | |
| 1685 | RDIF-B-R1 | | | | | | | | | | | | | | |
| 1686 | RDIF-C-R1 | | | | | | | | | | | | | | |
| 1687 | RDIF-R1 | | | | | | | | | | | | | | |
| 1688 | TR1-A-R1 | | | | | | | | | | | | | | |
| 1689 | TR1-B-R1 | | | | | | | | | | | | | | |
| 1690 | TR1-C-R1 | | | | | | | | | | | | | | |
| 1691 | | | | | | | | | | | | | | | |
| 1692 | TR2-A-R1 | | | | | | | | | | | | | | |
| 1693 | TR2-B-R1 | | | | | | | | | | | | | | |
| 1694 | TR2-C-R1 | | | | | | | | | | | | | | |
| 1695 | | | | | | | | | | | | | | | |
| 1696 | | | | | | | | | | | | | | | |
| 1697 | | | | | | | | | | | | | | | |
| 1698 | | | | | | | | | | | | | | | |
| 1699 | | | | | | | | | | | | | | | |
| 1700 | | | | | | | | | | | | | | | |
| 1701 | | | | | | | | | | | | | | | |
| 1702 | | | | | | | | | | | | | | | |
| 1703 | | | | | | | | | | | | | | | |
| 1704 | 85R1-R2 | X | | | | [1131]COM4-R2 | | | | | | | | | X |
| 1705 | 85R2-R2 | X | | | | [1132]COM5-R2 | | | | | | | | | X |
| 1706 | ARC_BLOCK-R2 | X | | | | [1144]SUB_COM1-R2 | | | | | | | | | X |
| 1707 | L.TEST-R2 | X | | | | [1145]SUB_COM2-R2 | | | | | | | | | X |
| 1708 | | | | | | | | | | | | | | | |
| 1709 | | | | | | | | | | | | | | | |
| 1710 | | | | | | | | | | | | | | | |
| 1711 | | | | | | | | | | | | | | | |
| 1712 | I.LINK-A-R2 | X | | | | [1152]SUB2_COM1-R2 + [1155]SUB2_COM4-R2 + [1158]SUB2_COM7-R2 + [1161]SUB2_COM10-R2 | | | | | | | | | X |
| 1713 | I.LINK-B-R2 | X | | | | [1153]SUB2_COM2-R2 + [1156]SUB2_COM5-R2 + [1159]SUB2_COM8-R2 + [1162]SUB2_COM11-R2 | | | | | | | | | X |
| 1714 | I.LINK-C-R2 | X | | | | [1154]SUB2_COM3-R2 + [1157]SUB2_COM6-R2 + [1160]SUB2_COM9-R2 + [1163]SUB2_COM12-R2 | | | | | | | | | X |
| 1715 | | | | | | | | | | | | | | | |
| 1716 | RDIF-A-R2 | | | | | | | | | | | | | | |
| 1717 | RDIF-B-R2 | | | | | | | | | | | | | | |
| 1718 | RDIF-C-R2 | | | | | | | | | | | | | | |
| 1719 | RDIF-R2 | | | | | | | | | | | | | | |
| 1720 | TR1-A-R2 | | | | | | | | | | | | | | |
| 1721 | TR1-B-R2 | | | | | | | | | | | | | | |
| 1722 | TR1-C-R2 | | | | | | | | | | | | | | |
| 1723 | | | | | | | | | | | | | | | |
| 1724 | TR2-A-R2 | | | | | | | | | | | | | | |
| 1725 | TR2-B-R2 | | | | | | | | | | | | | | |
| 1726 | TR2-C-R2 | | | | | | | | | | | | | | |
| 1727 | | | | | | | | | | | | | | | |
| 1728 | | | | | | | | | | | | | | | |
| 1729 | | | | | | | | | | | | | | | |
| 1730 | | | | | | | | | | | | | | | |

www.ElectricalPartManuals.com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None |
| 1731 | | | | | | | | | | | | | | | |
| 1732 | | | | | | | | | | | | | | | |
| 1733 | | | | | | | | | | | | | | | |
| 1734 | | | | | | | | | | | | | | | |
| 1735 | | | | | | | | | | | | | | | |
| 1736 | OC-A_FS | | X | | 0 | [1]CONSTANT_1 | | | | | | | | | X |
| 1737 | OC-B_FS | | X | | 0 | [1]CONSTANT_1 | | | | | | | | | X |
| 1738 | OC-C_FS | | X | | 0 | [1]CONSTANT_1 | | | | | | | | | X |
| 1739 | | | | | | | | | | | | | | | |
| 1740 | OCI-A_FS | | X | | 0 | [1]CONSTANT_1 | | | | | | | | | X |
| 1741 | OCI-B_FS | | X | | 0 | [1]CONSTANT_1 | | | | | | | | | X |
| 1742 | OCI-C_FS | | X | | 0 | [1]CONSTANT_1 | | | | | | | | | X |
| 1743 | | | | | | | | | | | | | | | |
| 1744 | | | | | | | | | | | | | | | |
| 1745 | | | | | | | | | | | | | | | |
| 1746 | | | | | | | | | | | | | | | |
| 1747 | | | | | | | | | | | | | | | |
| 1748 | | | | | | | | | | | | | | | |
| 1749 | | | | | | | | | | | | | | | |
| 1750 | | | | | | | | | | | | | | | |
| 1751 | | | | | | | | | | | | | | | |
| 1752 | | | | | | | | | | | | | | | |
| 1753 | | | | | | | | | | | | | | | |
| 1754 | | | | | | | | | | | | | | | |
| 1755 | | | | | | | | | | | | | | | |
| 1756 | | | | | | | | | | | | | | | |
| 1757 | | | | | | | | | | | | | | | |
| 1758 | | | | | | | | | | | | | | | |
| 1759 | | | | | | | | | | | | | | | |
| 1760 | | | | | | | | | | | | | | | |
| 1761 | | | | | | | | | | | | | | | |
| 1762 | | | | | | | | | | | | | | | |
| 1763 | | | | | | | | | | | | | | | |
| 1764 | | | | | | | | | | | | | | | |
| 1765 | | | | | | | | | | | | | | | |
| 1766 | | | | | | | | | | | | | | | |
| 1767 | | | | | | | | | | | | | | | |
| 1768 | | | | | | | | | | | | | | | |
| 1769 | | | | | | | | | | | | | | | |
| 1770 | | | | | | | | | | | | | | | |
| 1771 | | | | | | | | | | | | | | | |
| 1772 | | | | | | | | | | | | | | | |
| 1773 | | | | | | | | | | | | | | | |
| 1774 | | | | | | | | | | | | | | | |
| 1775 | | | | | | | | | | | | | | | |
| 1776 | | | | | | | | | | | | | | | |
| 1777 | | | | | | | | | | | | | | | |
| 1778 | | | | | | | | | | | | | | | |
| 1779 | | | | | | | | | | | | | | | |
| 1780 | | | | | | | | | | | | | | | |
| 1781 | | | | | | | | | | | | | | | |
| 1782 | | | | | | | | | | | | | | | |
| 1783 | | | | | | | | | | | | | | | |
| 1784 | | | | | | | | | | | | | | | |
| 1785 | | | | | | | | | | | | | | | |
| 1786 | | | | | | | | | | | | | | | |
| 1787 | | | | | | | | | | | | | | | |
| 1788 | | | | | | | | | | | | | | | |
| 1789 | | | | | | | | | | | | | | | |
| 1790 | | | | | | | | | | | | | | | |
| 1791 | | | | | | | | | | | | | | | |
| 1792 | IO#1-TP-A1 | X | | | | [99]TRIP-A1 | | | | | | | | | X |
| 1793 | IO#1-TP-B1 | X | | | | [100]TRIP-B1 | | | | | | | | | X |
| 1794 | IO#1-TP-C1 | X | | | | [101]TRIP-C1 | | | | | | | | | X |
| 1795 | IO#1-TP-A2 | X | | | | [102]TRIP-A2 | | | | | | | | | X |
| 1796 | IO#1-TP-B2 | X | | | | [103]TRIP-B2 | | | | | | | | | X |
| 1797 | IO#1-TP-C2 | X | | | | [104]TRIP-C2 | | | | | | | | | X |
| 1798 | | | | | | | | | | | | | | | |
| 1799 | | | | | | | | | | | | | | | |
| 1800 | | | | | | | | | | | | | | | |

www.ElectricalPartManuals.com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None |
| 1801 | | | | | | | | | | | | | | | |
| 1802 | | | | | | | | | | | | | | | |
| 1803 | | | | | | | | | | | | | | | |
| 1804 | | | | | | | | | | | | | | | |
| 1805 | | | | | | | | | | | | | | | |
| 1806 | | | | | | | | | | | | | | | |
| 1807 | | | | | | | | | | | | | | | |
| 1808 | | | | | | | | | | | | | | | |
| 1809 | | | | | | | | | | | | | | | |
| 1810 | | | | | | | | | | | | | | | |
| 1811 | | | | | | | | | | | | | | | |
| 1812 | | | | | | | | | | | | | | | |
| 1813 | | | | | | | | | | | | | | | |
| 1814 | | | | | | | | | | | | | | | |
| 1815 | | | | | | | | | | | | | | | |
| 1816 | | | | | | | | | | | | | | | |
| 1817 | | | | | | | | | | | | | | | |
| 1818 | | | | | | | | | | | | | | | |
| 1819 | | | | | | | | | | | | | | | |
| 1820 | | | | | | | | | | | | | | | |
| 1821 | | | | | | | | | | | | | | | |
| 1822 | | | | | | | | | | | | | | | |
| 1823 | | | | | | | | | | | | | | | |
| 1824 | SPR.L-REQ | X | | | | [1]CONSTANT_1 | | | | | | | | | | X |
| 1825 | TPR.L-REQ | X | | | | [159]SYN-OP | | | | | | | | | | X |
| 1826 | MPR.L-REQ | X | | | | [1]CONSTANT_1 | | | | | | | | | | X |
| 1827 | SPR.F-REQ | X | | | | [1]CONSTANT_1 | | | | | | | | | | X |
| 1828 | TPR.F-REQ | X | | | | [159]SYN-OP | | | | | | | | | | X |
| 1829 | MPR.F-REQ | X | | | | [1]CONSTANT_1 | | | | | | | | | | X |
| 1830 | SPR.F-ST.REQ | X | | | | [1]CONSTANT_1 | | | | | | | | | | X |
| 1831 | TPR.F-ST.REQ | X | | | | [477]ARC-SET + [478]CCB-SET | | | | | | | | | | X |
| 1832 | MPR.F-ST.REQ | X | | | | [1]CONSTANT_1 | | | | | | | | | | X |
| 1833 | | | | | | | | | | | | | | | | |
| 1834 | | | | | | | | | | | | | | | | |
| 1835 | | | | | | | | | | | | | | | | |
| 1836 | R.F-ST.REQ | | | | | | | | | | | | | | | |
| 1837 | SPR.F2-ST.REQ | | | | | | | | | | | | | | | |
| 1838 | TPR.F2-ST.REQ | | | | | | | | | | | | | | | |
| 1839 | MPR.F2-ST.REQ | | | | | | | | | | | | | | | |
| 1840 | ARC.L_TERM | | | | | | | | | | | | | | | |
| 1841 | ARC.F_TERM | | | | | | | | | | | | | | | |
| 1842 | | | | | | | | | | | | | | | | |
| 1843 | | | | | | | | | | | | | | | | |
| 1844 | | | | | | | | | | | | | | | | |
| 1845 | | | | | | | | | | | | | | | | |
| 1846 | | | | | | | | | | | | | | | | |
| 1847 | Z1_ARC_BLOCK | | X | | 1 | [787]Z1CNT_ARCBLK | | | | | | | | | | X |
| 1848 | | | | | | | | | | | | | | | | |
| 1849 | | | | | | | | | | | | | | | | |
| 1850 | | | | | | | | | | | | | | | | |
| 1851 | | | | | | | | | | | | | | | | |
| 1852 | | | | | | | | | | | | | | | | |
| 1853 | | | | | | | | | | | | | | | | |
| 1854 | | | | | | | | | | | | | | | | |
| 1855 | | | | | | | | | | | | | | | | |
| 1856 | CAR.R1-1 | X | | | | [1292]BI9_COM_UF | | | | | | | | | | X |
| 1857 | CAR.R1-2 | X | | | | [1297]BI14_COM_UF | | | | | | | | | | X |
| 1858 | OPEN_TERM-R1 | | | | | | | | | | | | | | | |
| 1859 | | | | | | | | | | | | | | | | |
| 1860 | | | | | | | | | | | | | | | | |
| 1861 | | | | | | | | | | | | | | | | |
| 1862 | | | | | | | | | | | | | | | | |
| 1863 | | | | | | | | | | | | | | | | |
| 1864 | CAR.R2-1 | X | | | | [1293]BI10_COM_UF | | | | | | | | | | X |
| 1865 | CAR.R2-2 | X | | | | [1298]BI15_COM_UF | | | | | | | | | | X |
| 1866 | OPEN_TERM-R2 | | | | | | | | | | | | | | | |
| 1867 | | | | | | | | | | | | | | | | |
| 1868 | | | | | | | | | | | | | | | | |
| 1869 | | | | | | | | | | | | | | | | |
| 1870 | | | | | | | | | | | | | | | | |

www.ElectricalPartManuals.com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None |
| 1871 | INT.COM | | | | | | | | | | | | | | |
| 1872 | | | | | | | | | | | | | | | |
| 1873 | DCRT_BLOCK | | | | | | | | | | | | | | |
| 1874 | DISCRT_BLOCK | | | | | | | | | | | | | | |
| 1875 | DEFCRT_BLOCK | | | | | | | | | | | | | | |
| 1876 | | | | | | | | | | | | | | | |
| 1877 | PSB_BLOCK | | | | | | | | | | | | | | |
| 1878 | | | | | | | | | | | | | | | |
| 1879 | | | | | | | | | | | | | | | |
| 1880 | | | | | | | | | | | | | | | |
| 1881 | | | | | | | | | | | | | | | |
| 1882 | | | | | | | | | | | | | | | |
| 1883 | | | | | | | | | | | | | | | |
| 1884 | | | | | | | | | | | | | | | |
| 1885 | | | | | | | | | | | | | | | |
| 1886 | | | | | | | | | | | | | | | |
| 1887 | | | | | | | | | | | | | | | |
| 1888 | Z1G_BLOCK | | X | | 1 | [788]Z1CNT_TPBLK | | | | | | | | | X |
| 1889 | | | | | | | | | | | | | | | |
| 1890 | Z2G_BLOCK | | | | | | | | | | | | | | |
| 1891 | Z3G_BLOCK | | | | | | | | | | | | | | |
| 1892 | | | | | | | | | | | | | | | |
| 1893 | | | | | | | | | | | | | | | |
| 1894 | ZRG_BLOCK | | | | | | | | | | | | | | |
| 1895 | | | | | | | | | | | | | | | |
| 1896 | | | | | | | | | | | | | | | |
| 1897 | DEFF_BLOCK | | | | | | | | | | | | | | |
| 1898 | | | | | | | | | | | | | | | |
| 1899 | DEFR_BLOCK | | | | | | | | | | | | | | |
| 1900 | STUBOC_BLOCK | | | | | | | | | | | | | | |
| 1901 | SOTF_BLOCK | | | | | | | | | | | | | | |
| 1902 | OCH_BLOCK | | | | | | | | | | | | | | |
| 1903 | | | | | | | | | | | | | | | |
| 1904 | Z1S_BLOCK | | X | | 1 | [788]Z1CNT_TPBLK | | | | | | | | | X |
| 1905 | | | | | | | | | | | | | | | |
| 1906 | Z2S_BLOCK | | | | | | | | | | | | | | |
| 1907 | Z3S_BLOCK | | | | | | | | | | | | | | |
| 1908 | | | | | | | | | | | | | | | |
| 1909 | | | | | | | | | | | | | | | |
| 1910 | ZRS_BLOCK | | | | | | | | | | | | | | |
| 1911 | | | | | | | | | | | | | | | |
| 1912 | BCD_BLOCK | | | | | | | | | | | | | | |
| 1913 | | | | | | | | | | | | | | | |
| 1914 | VTF_BLOCK | | | | | | | | | | | | | | |
| 1915 | VTF_ONLY_ALM | | | | | | | | | | | | | | |
| 1916 | EXT_VTF | | | | | | | | | | | | | | |
| 1917 | | | | | | | | | | | | | | | |
| 1918 | | | | | | | | | | | | | | | |
| 1919 | | | | | | | | | | | | | | | |
| 1920 | OVS1_BLOCK | | | | | | | | | | | | | | |
| 1921 | OVS2_BLOCK | | | | | | | | | | | | | | |
| 1922 | | | | | | | | | | | | | | | |
| 1923 | | | | | | | | | | | | | | | |
| 1924 | OVG1_BLOCK | | | | | | | | | | | | | | |
| 1925 | OVG2_BLOCK | | | | | | | | | | | | | | |
| 1926 | | | | | | | | | | | | | | | |
| 1927 | | | | | | | | | | | | | | | |
| 1928 | UVS1_BLOCK | | | | | | | | | | | | | | |
| 1929 | UVS2_BLOCK | | | | | | | | | | | | | | |
| 1930 | | | | | | | | | | | | | | | |
| 1931 | | | | | | | | | | | | | | | |
| 1932 | UVG1_BLOCK | | | | | | | | | | | | | | |
| 1933 | UVG2_BLOCK | | | | | | | | | | | | | | |
| 1934 | | | | | | | | | | | | | | | |
| 1935 | | | | | | | | | | | | | | | |
| 1936 | Z1_INST_TP | | X | | 1 | [785]Z1CNT_INST | | | | | | | | | X |
| 1937 | | | | | | | | | | | | | | | |
| 1938 | Z2_INST_TP | | | | | | | | | | | | | | |
| 1939 | Z3_INST_TP | | | | | | | | | | | | | | |
| 1940 | | | | | | | | | | | | | | | |

www.ElectricalPartManuals.com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | | None |
| 1941 | | | | | | | | | | | | | | | | |
| 1942 | | | | | | | | | | | | | | | | |
| 1943 | | | | | | | | | | | | | | | | |
| 1944 | | | | | | | | | | | | | | | | |
| 1945 | DEFF_INST_TP | | | | | | | | | | | | | | | |
| 1946 | | | | | | | | | | | | | | | | |
| 1947 | DEFR_INST_TP | | | | | | | | | | | | | | | |
| 1948 | ZR_INST_TP | | | | | | | | | | | | | | | |
| 1949 | | | | | | | | | | | | | | | | |
| 1950 | | | | | | | | | | | | | | | | |
| 1951 | | | | | | | | | | | | | | | | |
| 1952 | OVS1_INST_TP | | | | | | | | | | | | | | | |
| 1953 | OVS2_INST_TP | | | | | | | | | | | | | | | |
| 1954 | | | | | | | | | | | | | | | | |
| 1955 | | | | | | | | | | | | | | | | |
| 1956 | OVG1_INST_TP | | | | | | | | | | | | | | | |
| 1957 | OVG2_INST_TP | | | | | | | | | | | | | | | |
| 1958 | | | | | | | | | | | | | | | | |
| 1959 | | | | | | | | | | | | | | | | |
| 1960 | UVS1_INST_TP | | | | | | | | | | | | | | | |
| 1961 | UVS2_INST_TP | | | | | | | | | | | | | | | |
| 1962 | | | | | | | | | | | | | | | | |
| 1963 | | | | | | | | | | | | | | | | |
| 1964 | UVG1_INST_TP | | | | | | | | | | | | | | | |
| 1965 | UVG2_INST_TP | | | | | | | | | | | | | | | |
| 1966 | | | | | | | | | | | | | | | | |
| 1967 | | | | | | | | | | | | | | | | |
| 1968 | Z1_3PTP | | X | | 1 | [786]Z1CNT_3PTP | | | | | | | | | | X |
| 1969 | | | | | | | | | | | | | | | | |
| 1970 | Z2_3PTP | | X | | 1 | [1]CONSTANT_1 | | | | | | | | | | X |
| 1971 | | | | | | | | | | | | | | | | |
| 1972 | | | | | | | | | | | | | | | | |
| 1973 | | | | | | | | | | | | | | | | |
| 1974 | | | | | | | | | | | | | | | | |
| 1975 | | | | | | | | | | | | | | | | |
| 1976 | DISCAR_3PTP | | | | | | | | | | | | | | | |
| 1977 | DEFCAR_3PTP | | X | | 1 | [1]CONSTANT_1 | | | | | | | | | | X |
| 1978 | | | | | | | | | | | | | | | | |
| 1979 | | | | | | | | | | | | | | | | |
| 1980 | | | | | | | | | | | | | | | | |
| 1981 | | | | | | | | | | | | | | | | |
| 1982 | | | | | | | | | | | | | | | | |
| 1983 | | | | | | | | | | | | | | | | |
| 1984 | | | | | | | | | | | | | | | | |
| 1985 | STUB_CB | | X | | 0 | [1]CONSTANT_1 | | | | | | | | | | X |
| 1986 | OCHTP_ON | | | | | | | | | | | | | | | |
| 1987 | PSB.F_RESET | | | | | | | | | | | | | | | |
| 1988 | DEF_PHSEL-A | | | | | | | | | | | | | | | |
| 1989 | DEF_PHSEL-B | | | | | | | | | | | | | | | |
| 1990 | DEF_PHSEL-C | | | | | | | | | | | | | | | |
| 1991 | | | | | | | | | | | | | | | | |
| 1992 | Z2G-A_FS | | X | | 1 | [1]CONSTANT_1 | | | | | | | | | | X |
| 1993 | Z2G-B_FS | | X | | 1 | [1]CONSTANT_1 | | | | | | | | | | X |
| 1994 | Z2G-C_FS | | X | | 1 | [1]CONSTANT_1 | | | | | | | | | | X |
| 1995 | | | | | | | | | | | | | | | | |
| 1996 | | | | | | | | | | | | | | | | |
| 1997 | | | | | | | | | | | | | | | | |
| 1998 | | | | | | | | | | | | | | | | |
| 1999 | | | | | | | | | | | | | | | | |
| 2000 | | | | | | | | | | | | | | | | |
| 2001 | | | | | | | | | | | | | | | | |
| 2002 | | | | | | | | | | | | | | | | |
| 2003 | | | | | | | | | | | | | | | | |
| 2004 | | | | | | | | | | | | | | | | |
| 2005 | | | | | | | | | | | | | | | | |
| 2006 | | | | | | | | | | | | | | | | |
| 2007 | | | | | | | | | | | | | | | | |
| 2008 | Z2G-A_BLOCK | X | | | | [567]Z3G-B | | | | | | | | | | X |
| 2009 | Z2G-B_BLOCK | X | | | | [568]Z3G-C | | | | | | | | | | X |
| 2010 | Z2G-C_BLOCK | X | | | | [566]Z3G-A | | | | | | | | | | X |

www.ElectricalPartManuals.com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None |
| 2011 | | | | | | | | | | | | | | | |
| 2012 | | | | | | | | | | | | | | | |
| 2013 | | | | | | | | | | | | | | | |
| 2014 | | | | | | | | | | | | | | | |
| 2015 | DIF_OUT | X | | | | [789]DIF_OUT_SERV | | | | | | | | | X |
| 2016 | | | | | | | | | | | | | | | |
| 2017 | | | | | | | | | | | | | | | |
| 2018 | | | | | | | | | | | | | | | |
| 2019 | | | | | | | | | | | | | | | |
| 2020 | | | | | | | | | | | | | | | |
| 2021 | | | | | | | | | | | | | | | |
| 2022 | | | | | | | | | | | | | | | |
| 2023 | | | | | | | | | | | | | | | |
| 2024 | | | | | | | | | | | | | | | |
| 2025 | | | | | | | | | | | | | | | |
| 2026 | | | | | | | | | | | | | | | |
| 2027 | | | | | | | | | | | | | | | |
| 2028 | | | | | | | | | | | | | | | |
| 2029 | | | | | | | | | | | | | | | |
| 2030 | | | | | | | | | | | | | | | |
| 2031 | | | | | | | | | | | | | | | |
| 2032 | | | | | | | | | | | | | | | |
| 2033 | | | | | | | | | | | | | | | |
| 2034 | | | | | | | | | | | | | | | |
| 2035 | | | | | | | | | | | | | | | |
| 2036 | | | | | | | | | | | | | | | |
| 2037 | | | | | | | | | | | | | | | |
| 2038 | | | | | | | | | | | | | | | |
| 2039 | | | | | | | | | | | | | | | |
| 2040 | | | | | | | | | | | | | | | |
| 2041 | | | | | | | | | | | | | | | |
| 2042 | | | | | | | | | | | | | | | |
| 2043 | | | | | | | | | | | | | | | |
| 2044 | | | | | | | | | | | | | | | |
| 2045 | | | | | | | | | | | | | | | |
| 2046 | | | | | | | | | | | | | | | |
| 2047 | | | | | | | | | | | | | | | |
| 2048 | COM1-S | | | | | | | | | | | | | | |
| 2049 | COM2-S | | | | | | | | | | | | | | |
| 2050 | COM3-S | | | | | | | | | | | | | | |
| 2051 | COM4-S | X | | | | [1547]85S1 | | | | | | | | | X |
| 2052 | COM5-S | X | | | | [1548]85S2 | | | | | | | | | X |
| 2053 | | | | | | | | | | | | | | | |
| 2054 | | | | | | | | | | | | | | | |
| 2055 | | | | | | | | | | | | | | | |
| 2056 | SUB_COM1-S | X | | | | [1573]ARC_RESET | | | | | | | | | X |
| 2057 | SUB_COM2-S | X | | | | [434]LOCAL_TEST | | | | | | | | | X |
| 2058 | SUB_COM3-S | | | | | | | | | | | | | | |
| 2059 | SUB_COM4-S | | | | | | | | | | | | | | |
| 2060 | SUB_COM5-S | | | | | | | | | | | | | | |
| 2061 | | | | | | | | | | | | | | | |
| 2062 | | | | | | | | | | | | | | | |
| 2063 | | | | | | | | | | | | | | | |
| 2064 | SUB2_COM1-S | X | | | | [443]I.LINK-A | | | | | | | | | X |
| 2065 | SUB2_COM2-S | X | | | | [444]I.LINK-B | | | | | | | | | X |
| 2066 | SUB2_COM3-S | X | | | | [445]I.LINK-C | | | | | | | | | X |
| 2067 | SUB2_COM4-S | X | | | | [443]I.LINK-A | | | | | | | | | X |
| 2068 | SUB2_COM5-S | X | | | | [444]I.LINK-B | | | | | | | | | X |
| 2069 | SUB2_COM6-S | X | | | | [445]I.LINK-C | | | | | | | | | X |
| 2070 | SUB2_COM7-S | X | | | | [443]I.LINK-A | | | | | | | | | X |
| 2071 | SUB2_COM8-S | X | | | | [444]I.LINK-B | | | | | | | | | X |
| 2072 | SUB2_COM9-S | X | | | | [445]I.LINK-C | | | | | | | | | X |
| 2073 | SUB2_COM10-S | X | | | | [443]I.LINK-A | | | | | | | | | X |
| 2074 | SUB2_COM11-S | X | | | | [444]I.LINK-B | | | | | | | | | X |
| 2075 | SUB2_COM12-S | X | | | | [445]I.LINK-C | | | | | | | | | X |
| 2076 | | | | | | | | | | | | | | | |
| 2077 | | | | | | | | | | | | | | | |
| 2078 | | | | | | | | | | | | | | | |
| 2079 | | | | | | | | | | | | | | | |
| 2080 | SUB3_COM1-S | | | | | | | | | | | | | | |

www.ElectricalPartManuals.com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None |
| 2081 | SUB3_COM2-S | | | | | | | | | | | | | | |
| 2082 | SUB3_COM3-S | | | | | | | | | | | | | | |
| 2083 | SUB3_COM4-S | | | | | | | | | | | | | | |
| 2084 | SUB3_COM5-S | | | | | | | | | | | | | | |
| 2085 | SUB3_COM6-S | | | | | | | | | | | | | | |
| 2086 | SUB3_COM7-S | | | | | | | | | | | | | | |
| 2087 | SUB3_COM8-S | | | | | | | | | | | | | | |
| 2088 | SUB3_COM9-S | | | | | | | | | | | | | | |
| 2089 | SUB3_COM10-S | | | | | | | | | | | | | | |
| 2090 | SUB3_COM11-S | | | | | | | | | | | | | | |
| 2091 | SUB3_COM12-S | | | | | | | | | | | | | | |
| 2092 | | | | | | | | | | | | | | | |
| 2093 | | | | | | | | | | | | | | | |
| 2094 | | | | | | | | | | | | | | | |
| 2095 | | | | | | | | | | | | | | | |
| 2096 | V.COM1-S | | | | | | | | | | | | | | |
| 2097 | V.COM2-S | | | | | | | | | | | | | | |
| 2098 | V.COM3-S | | | | | | | | | | | | | | |
| 2099 | | | | | | | | | | | | | | | |
| 2100 | S.V.COM1-S | | | | | | | | | | | | | | |
| 2101 | S.V.COM2-S | | | | | | | | | | | | | | |
| 2102 | S.V.COM3-S | | | | | | | | | | | | | | |
| 2103 | S.V.COM4-S | | | | | | | | | | | | | | |
| 2104 | S.V.COM5-S | | | | | | | | | | | | | | |
| 2105 | S.V.COM6-S | | | | | | | | | | | | | | |
| 2106 | S.V.COM7-S | | | | | | | | | | | | | | |
| 2107 | S.V.COM8-S | | | | | | | | | | | | | | |
| 2108 | S.V.COM9-S | | | | | | | | | | | | | | |
| 2109 | S.V.COM10-S | | | | | | | | | | | | | | |
| 2110 | S.V.COM11-S | | | | | | | | | | | | | | |
| 2111 | S.V.COM12-S | | | | | | | | | | | | | | |
| 2112 | I.COM1-S | | | | | | | | | | | | | | |
| 2113 | I.COM2-S | | | | | | | | | | | | | | |
| 2114 | I.COM3-S | | | | | | | | | | | | | | |
| 2115 | | | | | | | | | | | | | | | |
| 2116 | S.I.COM1-S | | | | | | | | | | | | | | |
| 2117 | S.I.COM2-S | | | | | | | | | | | | | | |
| 2118 | S.I.COM3-S | | | | | | | | | | | | | | |
| 2119 | S.I.COM4-S | | | | | | | | | | | | | | |
| 2120 | S.I.COM5-S | | | | | | | | | | | | | | |
| 2121 | S.I.COM6-S | | | | | | | | | | | | | | |
| 2122 | S.I.COM7-S | | | | | | | | | | | | | | |
| 2123 | S.I.COM8-S | | | | | | | | | | | | | | |
| 2124 | S.I.COM9-S | | | | | | | | | | | | | | |
| 2125 | S.I.COM10-S | | | | | | | | | | | | | | |
| 2126 | S.I.COM11-S | | | | | | | | | | | | | | |
| 2127 | S.I.COM12-S | | | | | | | | | | | | | | |
| 2128 | | | | | | | | | | | | | | | |
| 2129 | | | | | | | | | | | | | | | |
| 2130 | | | | | | | | | | | | | | | |
| 2131 | | | | | | | | | | | | | | | |
| 2132 | | | | | | | | | | | | | | | |
| 2133 | | | | | | | | | | | | | | | |
| 2134 | | | | | | | | | | | | | | | |
| 2135 | | | | | | | | | | | | | | | |
| 2136 | | | | | | | | | | | | | | | |
| 2137 | | | | | | | | | | | | | | | |
| 2138 | | | | | | | | | | | | | | | |
| 2139 | | | | | | | | | | | | | | | |
| 2140 | | | | | | | | | | | | | | | |
| 2141 | | | | | | | | | | | | | | | |
| 2142 | | | | | | | | | | | | | | | |
| 2143 | | | | | | | | | | | | | | | |
| 2144 | | | | | | | | | | | | | | | |
| 2145 | | | | | | | | | | | | | | | |
| 2146 | | | | | | | | | | | | | | | |
| : | | | | | | | | | | | | | | | |
| : | | | | | | | | | | | | | | | |
| : | | | | | | | | | | | | | | | |
| 2600 | | | | | | | | | | | | | | | |

www.ElectricalPartManuals.com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None |
| 2601 | | | | | | | | | | | | | | | |
| 2602 | | | | | | | | | | | | | | | |
| 2603 | | | | | | | | | | | | | | | |
| 2604 | | | | | | | | | | | | | | | |
| 2605 | | | | | | | | | | | | | | | |
| 2606 | | | | | | | | | | | | | | | |
| 2607 | | | | | | | | | | | | | | | |
| 2608 | | | | | | | | | | | | | | | |
| 2609 | | | | | | | | | | | | | | | |
| 2610 | ALARM_LED_SET | X | | | | [237]CFSV1-R + [239]CFSV2-R | | | | | | | | | X |
| 2611 | | | | | | | | | | | | | | | |
| 2612 | | | | | | | | | | | | | | | |
| 2613 | | | | | | | | | | | | | | | |
| 2614 | | | | | | | | | | | | | | | |
| 2615 | | | | | | | | | | | | | | | |
| 2616 | | | | | | | | | | | | | | | |
| 2617 | | | | | | | | | | | | | | | |
| 2618 | | | | | | | | | | | | | | | |
| 2619 | | | | | | | | | | | | | | | |
| 2620 | | | | | | | | | | | | | | | |
| 2621 | | | | | | | | | | | | | | | |
| 2622 | | | | | | | | | | | | | | | |
| 2623 | | | | | | | | | | | | | | | |
| 2624 | F.RECORD1 | | | | | | | | | | | | | | |
| 2625 | F.RECORD2 | | | | | | | | | | | | | | |
| 2626 | F.RECORD3 | | | | | | | | | | | | | | |
| 2627 | F.RECORD4 | | | | | | | | | | | | | | |
| 2628 | | | | | | | | | | | | | | | |
| 2629 | | | | | | | | | | | | | | | |
| 2630 | | | | | | | | | | | | | | | |
| 2631 | | | | | | | | | | | | | | | |
| 2632 | D.RECORD1 | | | | | | | | | | | | | | |
| 2633 | D.RECORD2 | | | | | | | | | | | | | | |
| 2634 | D.RECORD3 | | | | | | | | | | | | | | |
| 2635 | D.RECORD4 | | | | | | | | | | | | | | |
| 2636 | | | | | | | | | | | | | | | |
| 2637 | | | | | | | | | | | | | | | |
| 2638 | | | | | | | | | | | | | | | |
| 2639 | | | | | | | | | | | | | | | |
| 2640 | SET.GROUP1 | | | | | | | | | | | | | | |
| 2641 | SET.GROUP2 | | | | | | | | | | | | | | |
| 2642 | SET.GROUP3 | | | | | | | | | | | | | | |
| 2643 | SET.GROUP4 | | | | | | | | | | | | | | |
| 2644 | SET.GROUP5 | | | | | | | | | | | | | | |
| 2645 | SET.GROUP6 | | | | | | | | | | | | | | |
| 2646 | SET.GROUP7 | | | | | | | | | | | | | | |
| 2647 | SET.GROUP8 | | | | | | | | | | | | | | |
| 2648 | | | | | | | | | | | | | | | |
| 2649 | | | | | | | | | | | | | | | |
| 2650 | | | | | | | | | | | | | | | |
| 2651 | | | | | | | | | | | | | | | |
| 2652 | | | | | | | | | | | | | | | |
| 2653 | | | | | | | | | | | | | | | |
| 2654 | | | | | | | | | | | | | | | |
| 2655 | | | | | | | | | | | | | | | |
| 2656 | CON_TPMD1 | | | | | | | | | | | | | | |
| 2657 | CON_TPMD2 | | | | | | | | | | | | | | |
| 2658 | CON_TPMD3 | | | | | | | | | | | | | | |
| 2659 | CON_TPMD4 | | | | | | | | | | | | | | |
| 2660 | CON_TPMD5 | | | | | | | | | | | | | | |
| 2661 | CON_TPMD6 | | | | | | | | | | | | | | |
| 2662 | CON_TPMD7 | | | | | | | | | | | | | | |
| 2663 | CON_TPMD8 | | | | | | | | | | | | | | |
| 2664 | | | | | | | | | | | | | | | |
| 2665 | | | | | | | | | | | | | | | |
| 2666 | | | | | | | | | | | | | | | |
| 2667 | | | | | | | | | | | | | | | |
| 2668 | | | | | | | | | | | | | | | |
| 2669 | | | | | | | | | | | | | | | |
| 2670 | | | | | | | | | | | | | | | |

www.ElectricalPartManuals.com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None |
| 2671 | | | | | | | | | | | | | | | |
| 2672 | | | | | | | | | | | | | | | |
| 2673 | | | | | | | | | | | | | | | |
| 2674 | | | | | | | | | | | | | | | |
| 2675 | | | | | | | | | | | | | | | |
| 2676 | | | | | | | | | | | | | | | |
| 2677 | | | | | | | | | | | | | | | |
| 2678 | | | | | | | | | | | | | | | |
| 2679 | | | | | | | | | | | | | | | |
| 2680 | | | | | | | | | | | | | | | |
| 2681 | | | | | | | | | | | | | | | |
| 2682 | | | | | | | | | | | | | | | |
| 2683 | ARC_COM_RECV | | | | | | | | | | | | | | |
| 2684 | TEL_COM_RECV | | | | | | | | | | | | | | |
| 2685 | PROT_COM_RECV | | | | | | | | | | | | | | |
| 2686 | | | | | | | | | | | | | | | |
| 2687 | TPLED_RST_RCV | | | | | | | | | | | | | | |
| 2688 | | | | | | | | | | | | | | | |
| 2689 | | | | | | | | | | | | | | | |
| 2690 | | | | | | | | | | | | | | | |
| 2691 | | | | | | | | | | | | | | | |
| 2692 | | | | | | | | | | | | | | | |
| 2693 | | | | | | | | | | | | | | | |
| 2694 | | | | | | | | | | | | | | | |
| 2695 | | | | | | | | | | | | | | | |
| 2696 | | | | | | | | | | | | | | | |
| 2697 | | | | | | | | | | | | | | | |
| 2698 | | | | | | | | | | | | | | | |
| 2699 | | | | | | | | | | | | | | | |
| 2700 | | | | | | | | | | | | | | | |
| 2701 | | | | | | | | | | | | | | | |
| 2702 | | | | | | | | | | | | | | | |
| 2703 | | | | | | | | | | | | | | | |
| 2704 | | | | | | | | | | | | | | | |
| 2705 | | | | | | | | | | | | | | | |
| 2706 | | | | | | | | | | | | | | | |
| 2707 | | | | | | | | | | | | | | | |
| 2708 | | | | | | | | | | | | | | | |
| 2709 | | | | | | | | | | | | | | | |
| 2710 | | | | | | | | | | | | | | | |
| 2711 | | | | | | | | | | | | | | | |
| 2712 | | | | | | | | | | | | | | | |
| 2713 | | | | | | | | | | | | | | | |
| 2714 | | | | | | | | | | | | | | | |
| 2715 | | | | | | | | | | | | | | | |
| 2716 | | | | | | | | | | | | | | | |
| 2717 | | | | | | | | | | | | | | | |
| 2718 | | | | | | | | | | | | | | | |
| 2719 | | | | | | | | | | | | | | | |
| 2720 | | | | | | | | | | | | | | | |
| 2721 | | | | | | | | | | | | | | | |
| 2722 | | | | | | | | | | | | | | | |
| 2723 | | | | | | | | | | | | | | | |
| 2724 | | | | | | | | | | | | | | | |
| 2725 | | | | | | | | | | | | | | | |
| 2726 | | | | | | | | | | | | | | | |
| 2727 | | | | | | | | | | | | | | | |
| 2728 | | | | | | | | | | | | | | | |
| 2729 | | | | | | | | | | | | | | | |
| 2730 | | | | | | | | | | | | | | | |
| 2731 | | | | | | | | | | | | | | | |
| 2732 | | | | | | | | | | | | | | | |
| 2733 | | | | | | | | | | | | | | | |
| 2734 | | | | | | | | | | | | | | | |
| 2735 | | | | | | | | | | | | | | | |
| 2736 | | | | | | | | | | | | | | | |
| 2737 | | | | | | | | | | | | | | | |
| 2738 | | | | | | | | | | | | | | | |
| 2739 | | | | | | | | | | | | | | | |
| 2740 | | | | | | | | | | | | | | | |

www . ElectricalPartManuals . com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None |
| 2741 | | | | | | | | | | | | | | | |
| 2742 | | | | | | | | | | | | | | | |
| 2743 | | | | | | | | | | | | | | | |
| 2744 | | | | | | | | | | | | | | | |
| 2745 | | | | | | | | | | | | | | | |
| 2746 | | | | | | | | | | | | | | | |
| 2747 | | | | | | | | | | | | | | | |
| 2748 | | | | | | | | | | | | | | | |
| 2749 | | | | | | | | | | | | | | | |
| 2750 | | | | | | | | | | | | | | | |
| 2751 | | | | | | | | | | | | | | | |
| 2752 | | | | | | | | | | | | | | | |
| 2753 | | | | | | | | | | | | | | | |
| 2754 | | | | | | | | | | | | | | | |
| 2755 | | | | | | | | | | | | | | | |
| 2756 | | | | | | | | | | | | | | | |
| 2757 | | | | | | | | | | | | | | | |
| 2758 | | | | | | | | | | | | | | | |
| 2759 | | | | | | | | | | | | | | | |
| 2760 | | | | | | | | | | | | | | | |
| 2761 | | | | | | | | | | | | | | | |
| 2762 | | | | | | | | | | | | | | | |
| 2763 | | | | | | | | | | | | | | | |
| 2764 | | | | | | | | | | | | | | | |
| 2765 | | | | | | | | | | | | | | | |
| 2766 | | | | | | | | | | | | | | | |
| 2767 | | | | | | | | | | | | | | | |
| 2768 | | | | | | | | | | | | | | | |
| 2769 | | | | | | | | | | | | | | | |
| 2770 | | | | | | | | | | | | | | | |
| 2771 | | | | | | | | | | | | | | | |
| 2772 | | | | | | | | | | | | | | | |
| 2773 | | | | | | | | | | | | | | | |
| 2774 | | | | | | | | | | | | | | | |
| 2775 | | | | | | | | | | | | | | | |
| 2776 | | | | | | | | | | | | | | | |
| 2777 | | | | | | | | | | | | | | | |
| 2778 | | | | | | | | | | | | | | | |
| 2779 | | | | | | | | | | | | | | | |
| 2780 | | | | | | | | | | | | | | | |
| 2781 | | | | | | | | | | | | | | | |
| 2782 | | | | | | | | | | | | | | | |
| 2783 | | | | | | | | | | | | | | | |
| 2784 | | | | | | | | | | | | | | | |
| 2785 | | | | | | | | | | | | | | | |
| 2786 | | | | | | | | | | | | | | | |
| 2787 | | | | | | | | | | | | | | | |
| 2788 | | | | | | | | | | | | | | | |
| 2789 | | | | | | | | | | | | | | | |
| 2790 | | | | | | | | | | | | | | | |
| 2791 | | | | | | | | | | | | | | | |
| 2792 | | | | | | | | | | | | | | | |
| 2793 | | | | | | | | | | | | | | | |
| 2794 | | | | | | | | | | | | | | | |
| 2795 | | | | | | | | | | | | | | | |
| 2796 | | | | | | | | | | | | | | | |
| 2797 | | | | | | | | | | | | | | | |
| 2798 | | | | | | | | | | | | | | | |
| 2799 | | | | | | | | | | | | | | | |
| 2800 | | | | | | | | | | | | | | | |
| 2801 | | | | | | | | | | | | | | | |
| 2802 | | | | | | | | | | | | | | | |
| 2803 | | | | | | | | | | | | | | | |
| 2804 | | | | | | | | | | | | | | | |
| 2805 | | | | | | | | | | | | | | | |
| 2806 | | | | | | | | | | | | | | | |
| 2807 | | | | | | | | | | | | | | | |
| 2808 | | | | | | | | | | | | | | | |
| 2809 | | | | | | | | | | | | | | | |
| 2810 | | | | | | | | | | | | | | | |

www.ElectricalPartManuals.com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None |
| 2811 | | | | | | | | | | | | | | | |
| 2812 | | | | | | | | | | | | | | | |
| 2813 | | | | | | | | | | | | | | | |
| 2814 | | | | | | | | | | | | | | | |
| 2815 | | | | | | | | | | | | | | | |
| 2816 | TEMP001 | | | | | | | | | | | | | | |
| 2817 | TEMP002 | | | | | | | | | | | | | | |
| 2818 | TEMP003 | | | | | | | | | | | | | | |
| 2819 | TEMP004 | | | | | | | | | | | | | | |
| 2820 | TEMP005 | | | | | | | | | | | | | | |
| 2821 | TEMP006 | | | | | | | | | | | | | | |
| 2822 | TEMP007 | | | | | | | | | | | | | | |
| 2823 | TEMP008 | | | | | | | | | | | | | | |
| 2824 | TEMP009 | | | | | | | | | | | | | | |
| 2825 | TEMP010 | | | | | | | | | | | | | | |
| 2826 | TEMP011 | | | | | | | | | | | | | | |
| 2827 | TEMP012 | | | | | | | | | | | | | | |
| 2828 | TEMP013 | | | | | | | | | | | | | | |
| 2829 | TEMP014 | | | | | | | | | | | | | | |
| 2830 | TEMP015 | | | | | | | | | | | | | | |
| 2831 | TEMP016 | | | | | | | | | | | | | | |
| 2832 | TEMP017 | | | | | | | | | | | | | | |
| 2833 | TEMP018 | | | | | | | | | | | | | | |
| 2834 | TEMP019 | | | | | | | | | | | | | | |
| 2835 | TEMP020 | | | | | | | | | | | | | | |
| 2836 | TEMP021 | | | | | | | | | | | | | | |
| 2837 | TEMP022 | | | | | | | | | | | | | | |
| 2838 | TEMP023 | | | | | | | | | | | | | | |
| 2839 | TEMP024 | | | | | | | | | | | | | | |
| 2840 | TEMP025 | | | | | | | | | | | | | | |
| 2841 | TEMP026 | | | | | | | | | | | | | | |
| 2842 | TEMP027 | | | | | | | | | | | | | | |
| 2843 | TEMP028 | | | | | | | | | | | | | | |
| 2844 | TEMP029 | | | | | | | | | | | | | | |
| 2845 | TEMP030 | | | | | | | | | | | | | | |
| 2846 | TEMP031 | | | | | | | | | | | | | | |
| 2847 | TEMP032 | | | | | | | | | | | | | | |
| 2848 | TEMP033 | | | | | | | | | | | | | | |
| 2849 | TEMP034 | | | | | | | | | | | | | | |
| 2850 | TEMP035 | | | | | | | | | | | | | | |
| 2851 | TEMP036 | | | | | | | | | | | | | | |
| 2852 | TEMP037 | | | | | | | | | | | | | | |
| 2853 | TEMP038 | | | | | | | | | | | | | | |
| 2854 | TEMP039 | | | | | | | | | | | | | | |
| 2855 | TEMP040 | | | | | | | | | | | | | | |
| 2856 | TEMP041 | | | | | | | | | | | | | | |
| 2857 | TEMP042 | | | | | | | | | | | | | | |
| 2858 | TEMP043 | | | | | | | | | | | | | | |
| 2859 | TEMP044 | | | | | | | | | | | | | | |
| 2860 | TEMP045 | | | | | | | | | | | | | | |
| 2861 | TEMP046 | | | | | | | | | | | | | | |
| 2862 | TEMP047 | | | | | | | | | | | | | | |
| 2863 | TEMP048 | | | | | | | | | | | | | | |
| 2864 | TEMP049 | | | | | | | | | | | | | | |
| 2865 | TEMP050 | | | | | | | | | | | | | | |
| 2866 | TEMP051 | | | | | | | | | | | | | | |
| 2867 | TEMP052 | | | | | | | | | | | | | | |
| 2868 | TEMP053 | | | | | | | | | | | | | | |
| 2869 | TEMP054 | | | | | | | | | | | | | | |
| 2870 | TEMP055 | | | | | | | | | | | | | | |
| 2871 | TEMP056 | | | | | | | | | | | | | | |
| 2872 | TEMP057 | | | | | | | | | | | | | | |
| 2873 | TEMP058 | | | | | | | | | | | | | | |
| 2874 | TEMP059 | | | | | | | | | | | | | | |
| 2875 | TEMP060 | | | | | | | | | | | | | | |
| 2876 | TEMP061 | | | | | | | | | | | | | | |
| 2877 | TEMP062 | | | | | | | | | | | | | | |
| 2878 | TEMP063 | | | | | | | | | | | | | | |
| 2879 | TEMP064 | | | | | | | | | | | | | | |
| 2880 | TEMP065 | | | | | | | | | | | | | | |

www.ElectricalPartManuals.com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None |
| 2881 | TEMP066 | | | | | | | | | | | | | | |
| 2882 | TEMP067 | | | | | | | | | | | | | | |
| 2883 | TEMP068 | | | | | | | | | | | | | | |
| 2884 | TEMP069 | | | | | | | | | | | | | | |
| 2885 | TEMP070 | | | | | | | | | | | | | | |
| 2886 | TEMP071 | | | | | | | | | | | | | | |
| 2887 | TEMP072 | | | | | | | | | | | | | | |
| 2888 | TEMP073 | | | | | | | | | | | | | | |
| 2889 | TEMP074 | | | | | | | | | | | | | | |
| 2890 | TEMP075 | | | | | | | | | | | | | | |
| 2891 | TEMP076 | | | | | | | | | | | | | | |
| 2892 | TEMP077 | | | | | | | | | | | | | | |
| 2893 | TEMP078 | | | | | | | | | | | | | | |
| 2894 | TEMP079 | | | | | | | | | | | | | | |
| 2895 | TEMP080 | | | | | | | | | | | | | | |
| 2896 | TEMP081 | | | | | | | | | | | | | | |
| 2897 | TEMP082 | | | | | | | | | | | | | | |
| 2898 | TEMP083 | | | | | | | | | | | | | | |
| 2899 | TEMP084 | | | | | | | | | | | | | | |
| 2900 | TEMP085 | | | | | | | | | | | | | | |
| 2901 | TEMP086 | | | | | | | | | | | | | | |
| 2902 | TEMP087 | | | | | | | | | | | | | | |
| 2903 | TEMP088 | | | | | | | | | | | | | | |
| 2904 | TEMP089 | | | | | | | | | | | | | | |
| 2905 | TEMP090 | | | | | | | | | | | | | | |
| 2906 | TEMP091 | | | | | | | | | | | | | | |
| 2907 | TEMP092 | | | | | | | | | | | | | | |
| 2908 | TEMP093 | | | | | | | | | | | | | | |
| 2909 | TEMP094 | | | | | | | | | | | | | | |
| 2910 | TEMP095 | | | | | | | | | | | | | | |
| 2911 | TEMP096 | | | | | | | | | | | | | | |
| 2912 | TEMP097 | | | | | | | | | | | | | | |
| 2913 | TEMP098 | | | | | | | | | | | | | | |
| 2914 | TEMP099 | | | | | | | | | | | | | | |
| 2915 | TEMP100 | | | | | | | | | | | | | | |
| 2916 | TEMP101 | | | | | | | | | | | | | | |
| 2917 | TEMP102 | | | | | | | | | | | | | | |
| 2918 | TEMP103 | | | | | | | | | | | | | | |
| 2919 | TEMP104 | | | | | | | | | | | | | | |
| 2920 | TEMP105 | | | | | | | | | | | | | | |
| 2921 | TEMP106 | | | | | | | | | | | | | | |
| 2922 | TEMP107 | | | | | | | | | | | | | | |
| 2923 | TEMP108 | | | | | | | | | | | | | | |
| 2924 | TEMP109 | | | | | | | | | | | | | | |
| 2925 | TEMP110 | | | | | | | | | | | | | | |
| 2926 | TEMP111 | | | | | | | | | | | | | | |
| 2927 | TEMP112 | | | | | | | | | | | | | | |
| 2928 | TEMP113 | | | | | | | | | | | | | | |
| 2929 | TEMP114 | | | | | | | | | | | | | | |
| 2930 | TEMP115 | | | | | | | | | | | | | | |
| 2931 | TEMP116 | | | | | | | | | | | | | | |
| 2932 | TEMP117 | | | | | | | | | | | | | | |
| 2933 | TEMP118 | | | | | | | | | | | | | | |
| 2934 | TEMP119 | | | | | | | | | | | | | | |
| 2935 | TEMP120 | | | | | | | | | | | | | | |
| 2936 | TEMP121 | | | | | | | | | | | | | | |
| 2937 | TEMP122 | | | | | | | | | | | | | | |
| 2938 | TEMP123 | | | | | | | | | | | | | | |
| 2939 | TEMP124 | | | | | | | | | | | | | | |
| 2940 | TEMP125 | | | | | | | | | | | | | | |
| 2941 | TEMP126 | | | | | | | | | | | | | | |
| 2942 | TEMP127 | | | | | | | | | | | | | | |
| 2943 | TEMP128 | | | | | | | | | | | | | | |
| 2944 | TEMP129 | | | | | | | | | | | | | | |
| 2945 | TEMP130 | | | | | | | | | | | | | | |
| 2946 | TEMP131 | | | | | | | | | | | | | | |
| 2947 | TEMP132 | | | | | | | | | | | | | | |
| 2948 | TEMP133 | | | | | | | | | | | | | | |
| 2949 | TEMP134 | | | | | | | | | | | | | | |
| 2950 | TEMP135 | | | | | | | | | | | | | | |

www.ElectricalPartManuals.com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None |
| 2951 | TEMP136 | | | | | | | | | | | | | | |
| 2952 | TEMP137 | | | | | | | | | | | | | | |
| 2953 | TEMP138 | | | | | | | | | | | | | | |
| 2954 | TEMP139 | | | | | | | | | | | | | | |
| 2955 | TEMP140 | | | | | | | | | | | | | | |
| 2956 | TEMP141 | | | | | | | | | | | | | | |
| 2957 | TEMP142 | | | | | | | | | | | | | | |
| 2958 | TEMP143 | | | | | | | | | | | | | | |
| 2959 | TEMP144 | | | | | | | | | | | | | | |
| 2960 | TEMP145 | | | | | | | | | | | | | | |
| 2961 | TEMP146 | | | | | | | | | | | | | | |
| 2962 | TEMP147 | | | | | | | | | | | | | | |
| 2963 | TEMP148 | | | | | | | | | | | | | | |
| 2964 | TEMP149 | | | | | | | | | | | | | | |
| 2965 | TEMP150 | | | | | | | | | | | | | | |
| 2966 | TEMP151 | | | | | | | | | | | | | | |
| 2967 | TEMP152 | | | | | | | | | | | | | | |
| 2968 | TEMP153 | | | | | | | | | | | | | | |
| 2969 | TEMP154 | | | | | | | | | | | | | | |
| 2970 | TEMP155 | | | | | | | | | | | | | | |
| 2971 | TEMP156 | | | | | | | | | | | | | | |
| 2972 | TEMP157 | | | | | | | | | | | | | | |
| 2973 | TEMP158 | | | | | | | | | | | | | | |
| 2974 | TEMP159 | | | | | | | | | | | | | | |
| 2975 | TEMP160 | | | | | | | | | | | | | | |
| 2976 | TEMP161 | | | | | | | | | | | | | | |
| 2977 | TEMP162 | | | | | | | | | | | | | | |
| 2978 | TEMP163 | | | | | | | | | | | | | | |
| 2979 | TEMP164 | | | | | | | | | | | | | | |
| 2980 | TEMP165 | | | | | | | | | | | | | | |
| 2981 | TEMP166 | | | | | | | | | | | | | | |
| 2982 | TEMP167 | | | | | | | | | | | | | | |
| 2983 | TEMP168 | | | | | | | | | | | | | | |
| 2984 | TEMP169 | | | | | | | | | | | | | | |
| 2985 | TEMP170 | | | | | | | | | | | | | | |
| 2986 | TEMP171 | | | | | | | | | | | | | | |
| 2987 | TEMP172 | | | | | | | | | | | | | | |
| 2988 | TEMP173 | | | | | | | | | | | | | | |
| 2989 | TEMP174 | | | | | | | | | | | | | | |
| 2990 | TEMP175 | | | | | | | | | | | | | | |
| 2991 | TEMP176 | | | | | | | | | | | | | | |
| 2992 | TEMP177 | | | | | | | | | | | | | | |
| 2993 | TEMP178 | | | | | | | | | | | | | | |
| 2994 | TEMP179 | | | | | | | | | | | | | | |
| 2995 | TEMP180 | | | | | | | | | | | | | | |
| 2996 | TEMP181 | | | | | | | | | | | | | | |
| 2997 | TEMP182 | | | | | | | | | | | | | | |
| 2998 | TEMP183 | | | | | | | | | | | | | | |
| 2999 | TEMP184 | | | | | | | | | | | | | | |
| 3000 | TEMP185 | | | | | | | | | | | | | | |
| 3001 | TEMP186 | | | | | | | | | | | | | | |
| 3002 | TEMP187 | | | | | | | | | | | | | | |
| 3003 | TEMP188 | | | | | | | | | | | | | | |
| 3004 | TEMP189 | | | | | | | | | | | | | | |
| 3005 | TEMP190 | | | | | | | | | | | | | | |
| 3006 | TEMP191 | | | | | | | | | | | | | | |
| 3007 | TEMP192 | | | | | | | | | | | | | | |
| 3008 | TEMP193 | | | | | | | | | | | | | | |
| 3009 | TEMP194 | | | | | | | | | | | | | | |
| 3010 | TEMP195 | | | | | | | | | | | | | | |
| 3011 | TEMP196 | | | | | | | | | | | | | | |
| 3012 | TEMP197 | | | | | | | | | | | | | | |
| 3013 | TEMP198 | | | | | | | | | | | | | | |
| 3014 | TEMP199 | | | | | | | | | | | | | | |
| 3015 | TEMP200 | | | | | | | | | | | | | | |
| 3016 | TEMP201 | | | | | | | | | | | | | | |
| 3017 | TEMP202 | | | | | | | | | | | | | | |
| 3018 | TEMP203 | | | | | | | | | | | | | | |
| 3019 | TEMP204 | | | | | | | | | | | | | | |
| 3020 | TEMP205 | | | | | | | | | | | | | | |

www.ElectricalPartManuals.com

PLC Default Setting

| Output | | Timing | | | | Logic expression | Delay Time / Flip Flop | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cycle | | | | | Flip Flop | | | Timer | | | | | | |
| № | Signal | 30 | 90 | User | Turn | Model 7xx | Norm | Back Up | Release Signal | Off Delay | On Delay | One Shot | Time Value | | None | |
| 3021 | TEMP206 | | | | | | | | | | | | | | | |
| 3022 | TEMP207 | | | | | | | | | | | | | | | |
| 3023 | TEMP208 | | | | | | | | | | | | | | | |
| 3024 | TEMP209 | | | | | | | | | | | | | | | |
| 3025 | TEMP210 | | | | | | | | | | | | | | | |
| 3026 | TEMP211 | | | | | | | | | | | | | | | |
| 3027 | TEMP212 | | | | | | | | | | | | | | | |
| 3028 | TEMP213 | | | | | | | | | | | | | | | |
| 3029 | TEMP214 | | | | | | | | | | | | | | | |
| 3030 | TEMP215 | | | | | | | | | | | | | | | |
| 3031 | TEMP216 | | | | | | | | | | | | | | | |
| 3032 | TEMP217 | | | | | | | | | | | | | | | |
| 3033 | TEMP218 | | | | | | | | | | | | | | | |
| 3034 | TEMP219 | | | | | | | | | | | | | | | |
| 3035 | TEMP220 | | | | | | | | | | | | | | | |
| 3036 | TEMP221 | | | | | | | | | | | | | | | |
| 3037 | TEMP222 | | | | | | | | | | | | | | | |
| 3038 | TEMP223 | | | | | | | | | | | | | | | |
| 3039 | TEMP224 | | | | | | | | | | | | | | | |
| 3040 | TEMP225 | | | | | | | | | | | | | | | |
| 3041 | TEMP226 | | | | | | | | | | | | | | | |
| 3042 | TEMP227 | | | | | | | | | | | | | | | |
| 3043 | TEMP228 | | | | | | | | | | | | | | | |
| 3044 | TEMP229 | | | | | | | | | | | | | | | |
| 3045 | TEMP230 | | | | | | | | | | | | | | | |
| 3046 | TEMP231 | | | | | | | | | | | | | | | |
| 3047 | TEMP232 | | | | | | | | | | | | | | | |
| 3048 | TEMP233 | | | | | | | | | | | | | | | |
| 3049 | TEMP234 | | | | | | | | | | | | | | | |
| 3050 | TEMP235 | | | | | | | | | | | | | | | |
| 3051 | TEMP236 | | | | | | | | | | | | | | | |
| 3052 | TEMP237 | | | | | | | | | | | | | | | |
| 3053 | TEMP238 | | | | | | | | | | | | | | | |
| 3054 | TEMP239 | | | | | | | | | | | | | | | |
| 3055 | TEMP240 | | | | | | | | | | | | | | | |
| 3056 | TEMP241 | | | | | | | | | | | | | | | |
| 3057 | TEMP242 | | | | | | | | | | | | | | | |
| 3058 | TEMP243 | | | | | | | | | | | | | | | |
| 3059 | TEMP244 | | | | | | | | | | | | | | | |
| 3060 | TEMP245 | | | | | | | | | | | | | | | |
| 3061 | TEMP246 | | | | | | | | | | | | | | | |
| 3062 | TEMP247 | | | | | | | | | | | | | | | |
| 3063 | TEMP248 | | | | | | | | | | | | | | | |
| 3064 | TEMP249 | | | | | | | | | | | | | | | |
| 3065 | TEMP250 | | | | | | | | | | | | | | | |
| 3066 | TEMP251 | | | | | | | | | | | | | | | |
| 3067 | TEMP252 | | | | | | | | | | | | | | | |
| 3068 | TEMP253 | | | | | | | | | | | | | | | |
| 3069 | TEMP254 | | | | | | | | | | | | | | | |
| 3070 | TEMP255 | | | | | | | | | | | | | | | |
| 3071 | TEMP256 | | | | | | | | | | | | | | | |

www . ElectricalPartManuals . com

www . ElectricalPartManuals . com

# Appendix I

# Commissioning Test Sheet (sample)

1. Relay identification
2. Preliminary check
3. Hardware check
4. Function test
5. Protection scheme test
6. Metering and recording check
7. Conjunctive test

www . ElectricalPartManuals . com

## 1. Relay identification

Type _____ Serial number _____

Model _____ System frequency _____

Station _____ Date _____

Circuit _____ Engineer _____

Protection scheme _____ Witness _____

Active settings group number _____

## 2. Preliminary check

Ratings ☐

CT shorting contacts ☐

DC power supply ☐

Power up ☐

Wiring ☐

Relay inoperative alarm contact ☐

Calendar and clock ☐

## 3. Hardware check

### 3.1 User interface check ☐

### 3.2 Binary input/Binary output circuit check

Binary input circuit ☐

Binary output circuit ☐

### 3.3 AC input circuit ☐

## 4. Function test

### 4.1 Phase current differential element DIF test

(1) Minimum operating value test

| Tap setting | I | Measured current |
|---|---|---|
| | | |

(2) Charging current compensation test

| Tap setting | Measured current |
|---|---|
| | |

(3) Percentage restraining characteristic test

www . ElectricalPartManuals . com

| Tap setting | I | Measured current ($I_2$) |
|---|---|---|
| | × Tap | |
| | × Tap | |
| | 20 × Tap | |

### 4.2 Residual current differential element DIFG test

(1) Minimum operating value test

| Tap setting | $I_1$ | Measured current ($I_2$) |
|---|---|---|
| | | |

(2) Percentage restraining characteristic test

| Tap setting | $I_1$ | Measured current ($I_2$) |
|---|---|---|
| | 5 × Tap | |
| | 20 × Tap | |

### 4.3 Phase fault element ZS test

| Element | Reach setting (ZS) | IT | 2IT × ZS | Measured voltage ($2V_a$) |
|---|---|---|---|---|
| Z1S | | | | |
| Z2S | | | | |
| Z3S | | | | |
| Z4S | | | | |
| ZRS | | | | |
| PSBSIN | | | | |
| PSBSOUT | | | | |

### 4.4 Earth fault element ZG test

| Element | Reach setting (ZG) | IT | 2IT × ZG | Measured voltage ($2V_a$) |
|---|---|---|---|---|
| Z1G | | | | |
| Z2G | | | | |
| Z3G | | | | |
| Z4G | | | | |
| ZRG | | | | |
| PSBGIN | | | | |
| PSBGOUT | | | | |

### 4.5 Phase selection element UVC test

| Element | Reach setting (UVCZ) | IT | IT × UVCZ + UVCV | Measured voltage |
|---|---|---|---|---|
| UVC | 0 | 0 | | |

www.ElectricalPartManuals.com

### 4.6 Directional earth fault element DEF test

(1)

| Element | Current setting | Measured current |
|---|---|---|
| DEFF | | |
| DEFR | | |

(2)

| Element | Voltage setting | Measured voltage |
|---|---|---|
| DEFF | | |
| DEFR | | |

### 4.7 Inverse definite minimum time overcurrent element (IDMT) EFI and OCI test

| Element | Test current | Measured operating time |
|---|---|---|
| EFI | $1.2 \times I_S$ | |
| | $20 \times I_S$ | |
| OCI | $1.2 \times I_S$ | |
| | $20 \times I_S$ | |

### 4.8 Thermal overload element test

| Element | Test current | Measured operating time |
|---|---|---|
| THM-A | $1.2 \times I_S$ | |
| THM-T | $10 \times I_S$ | |

### 4.9 Current change detection element

| Element | Test current | Result |
|---|---|---|
| OCD | 1.2 × Fixed setting | |
| OCDP | 1.2 × Setting value | |

www . ElectricalPartManuals . com

### 4.10 Level detectors test

| Element | Setting | Measured value |
|---|---|---|
| OCH | | |
| EF | | |
| EFL | | |
| OC | | |
| OVG | | |
| UVLS | | |
| UVLG | | |
| UVFS | | |
| UVFG | | |
| OCBF | | |

### 4.11 BCD element check

### 4.12 Overvoltage and undervoltage elements test

(1) Operating value test

| Element | Voltage setting | Measured voltage | Element | Voltage setting | Measured voltage |
|---|---|---|---|---|---|
| OVS1 | | | OVG1 | | |
| OVS2 | | | OVG2 | | |
| UVS1 | | | UVG1 | | |
| UVS2 | | | UVG2 | | |

(2) Operating time test (IDMT)

| Element | Voltage setting | Multiplier setting | Changed voltage | Measured time |
|---|---|---|---|---|
| OVS1 | | 10.0 | 1.5× Voltage setting | |
| OVG1 | | 10.0 | 1.5 × Voltage setting | |
| UVS1 | | 10.0 | 0.5 × Voltage setting | |
| UVG1 | | 10.0 | 0.5 × Voltage setting | |

### 4.13 Out-of-step element test

| Element | Measured angle |
|---|---|
| OST1-α | |
| OST1-β | |
| OST2-α | |
| OST2-β | |

www . ElectricalPartManuals . com

### 4.14 Voltage and synchronism check elements test

(1) Voltage check element

| Element | Setting | Measured voltage | Element | Setting | Measured voltage |
|---|---|---|---|---|---|
| OVB | | | UVL1 | | |
| UVB | | | OVL2 | | |
| OVL1 | | | UVL2 | | |

(2) Synchronism check element

① Voltage check

| Element | Setting | Measured voltage | Element | Setting | Measured voltage |
|---|---|---|---|---|---|
| SYN1(SY1UV) | | | SYN2(SY2UV) | | |
| SYN1(SY1OV) | | | SYN2(SY2OV) | | |

② Phase angle check

| Element | Setting | Measured angle |
|---|---|---|
| SYN1(SY1θ) | | |
| SYN2(SY2θ) | | |

**5. Protection scheme test** ☐

**6. Metering and recording check** ☐

**7. Conjunctive test**

| Item | Results |
|---|---|
| On load check<br>Tripping circuit<br>Reclosing circuit | |

www . ElectricalPartManuals . com

# Appendix J

# Return Repair Form

www . ElectricalPartManuals . com

## RETURN / REPAIR FORM

Please fill in this form and return it to Toshiba Corporation with the GRL100 to be repaired.

TOSHIBA CORPORATION Fuchu Complex

1, Toshiba-cho, Fuchu-shi, Tokyo, Japan

For: Power Systems Protection & Control Department

Quality Assurance Section

Type: GRL100 Model: _____ Sub No. _____

(Example: Type: GRL100 Model: 701B Sub No. 22-10)

Product No.: _____

Serial No. : _____

Date: _____

1. Why the relay is being returned ?
   - ☐ mal-operation
   - ☐ does not operate
   - ☐ increased error
   - ☐ investigation
   - ☐ others

     _____

     _____

     _____

     _____

2. Fault records, event records or disturbance records stored in the relay and relay settings are very helpful information to investigate the incident.

   Please inform us of this information in respect to the incident on a Floppy Disk, or by completing the Fault Record sheet and Relay Setting sheet attached.

www . ElectricalPartManuals . com

**Fault Record**

Date/Month/Year Time / / / : : .

(Example: 04/ Nov./ 1997 15:09:58.442)

Faulty phase:

Fault Locator : km ( %)

| Prefault values (CT ratio: | kA/: | | A, VT ratio: | kV/: | V) | |
|---|---|---|---|---|---|---|
| $V_a$: | kV or V∠ | ° | $I_a$: | kA or A∠ | | ° |
| $V_b$: | kV or V∠ | ° | $I_b$: | kA or A∠ | | ° |
| $V_c$: | kV or V∠ | ° | $I_c$: | kA or A∠ | | ° |
| $V_{ab}$ | kV or V∠ | ° | $I_{ab}$ | kA or A∠ | | ° |
| $V_{bc}$ | kV or V∠ | ° | $I_{bc}$ | kA or A∠ | | ° |
| $V_{ca}$ | kV or V∠ | ° | $I_{ca}$ | kA or A∠ | | ° |
| $V_{s1}$ | kV or V∠ | ° | | | | |
| $V_{s2}$ | kV or V∠ | ° | | | | |
| $V_1$: | kV or V∠ | ° | $I_1$: | kA or A∠ | | ° |
| $V_2$: | kV or V∠ | ° | $I_2$: | kA or A∠ | | ° |
| $V_0$: | kV or V∠ | ° | $I_0$: | kA or A∠ | | ° |
| | | | $I_{0m}$ | kA or A∠ | | ° |
| $V_{11}$: | kV or V∠ | ° | | | | |
| $V_{12}$: | kV or V∠ | ° | | | | |
| $I_{a1}$: | kA or A∠ | ° | $I_{a2}$: | kA or A∠ | | ° |
| $I_{b1}$: | kA or A∠ | ° | $I_{b2}$: | kA or A∠ | | ° |
| $I_{c1}$: | kA or A∠ | ° | $I_{c2}$: | kA or A∠ | | ° |
| $I_{01}$: | kA or A∠ | ° | $I_{02}$: | kA or A∠ | | ° |
| $I_{da}$: | kA or A∠ | ° | | | | |
| $I_{db}$: | kA or A∠ | ° | | | | |
| $I_{dc}$: | kA or A∠ | ° | | | | |
| $I_{d0}$: | kA or A∠ | ° | | | | |

Fault values

| Prefault values (CT ratio: | kA/: | | A, VT ratio: | kV/: | V) | |
|---|---|---|---|---|---|---|
| $V_a$: | kV or V∠ | ° | $I_a$: | kA or A∠ | | ° |
| $V_b$: | kV or V∠ | ° | $I_b$: | kA or A∠ | | ° |
| $V_c$: | kV or V∠ | ° | $I_c$: | kA or A∠ | | ° |
| $V_{ab}$ | kV or V∠ | ° | $I_{ab}$ | kA or A∠ | | ° |
| $V_{bc}$ | kV or V∠ | ° | $I_{bc}$ | kA or A∠ | | ° |
| $V_{ca}$ | kV or V∠ | ° | $I_{ca}$ | kA or A∠ | | ° |
| $V_{s1}$ | kV or V∠ | ° | | | | |
| $V_{s2}$ | kV or V∠ | ° | | | | |
| $V_1$: | kV or V∠ | ° | $I_1$: | kA or A∠ | | ° |
| $V_2$: | kV or V∠ | ° | $I_2$: | kA or A∠ | | ° |
| $V_0$: | kV or V∠ | ° | $I_0$: | kA or A∠ | | ° |
| | | | $I_{0m}$ | kA or A∠ | | ° |
| $V_{11}$: | kV or V∠ | ° | | | | |
| $V_{12}$: | kV or V∠ | ° | | | | |
| $I_{a1}$: | kA or A∠ | ° | $I_{a2}$: | kA or A∠ | | ° |
| $I_{b1}$: | kA or A∠ | ° | $I_{b2}$: | kA or A∠ | | ° |
| $I_{c1}$: | kA or A∠ | ° | $I_{c2}$: | kA or A∠ | | ° |
| $I_{01}$: | kA or A∠ | ° | $I_{02}$: | kA or A∠ | | ° |
| $I_{da}$: | kA or A∠ | ° | | | | |

www.ElectricalPartManuals.com

| | | | | | |
|---|---|---|---|---|---|
| $I_{db}$: | kA or A∠ | ° | | | |
| $I_{dc}$: | kA or A∠ | ° | | | |
| $I_{d0}$: | kA or A∠ | ° | | | |
| $R_a$: | | Ω | $X_a$: | | Ω |
| $R_b$: | | Ω | $X_b$: | | Ω |
| $R_c$: | | Ω | $X_c$: | | Ω |
| $R_{ab}$ | | Ω | $X_{ab}$ | | Ω |
| $R_{bc}$ | | Ω | $X_{bc}$ | | Ω |
| $R_{ca}$ | | Ω | $X_{ca}$ | | Ω |
| THM | % | | | | |
| Telecomm. delay time 1 | | μs | | | |
| Telecomm. delay time 2 | | μs | | | |

www . ElectricalPartManuals . com

3. What was the message on the LCD display at the time of the incident.

4. Please write the detail of the incident.

5. Date of the incident occurred.
   Day/ Month/ Year: / / /
   (Example: 10/ July/ 2005)

6. Please write any comments on the GRL100, including the document.

www . ElectricalPartManuals . com

Customer

Name: _____

Company Name: _____

Address: _____

_____

_____

Telephone No.: _____

Facsimile No.: _____

Signature: _____

www . ElectricalPartManuals . com

# Appendix K

# Technical Data

www . ElectricalPartManuals . com

## TECHNICAL DATA

| | |
|---|---|
| **Ratings** | |
| AC current $I_n$: | 1A or 5A |
| AC voltage | 100V, 110V, 115V, 120V |
| Frequency: | 50Hz or 60Hz |
| DC power supply: | 110Vdc/125Vdc (Operative range: 88 - 150Vdc)<br>220Vdc/250Vdc (Operative range: 176 - 300Vdc)<br>48Vdc/54Vdc/60Vdc (Operative range: 38.4 - 72Vdc)<br>24Vdc/30Vdc (Operative range: 19.2 – 36Vdc) |
| AC ripple on DC supply IEC60255-11 | maximum 12% |
| DC supply interruption IEC60255-11 | |
| Permissive duration of DC supply voltage interruption to maintain normal operation: | up to 50ms at 110V |
| Restart time: | less than 10s |
| Binary input circuit DC voltage: | 110/125Vdc<br>220/250Vdc<br>48/54/60Vdc<br>24/30Vdc |
| **Overload Ratings** | |
| AC current input | 4 times rated continuous<br>100 times rated for 1s |
| AC voltage input | 2 times rated continuous |
| **Burden** | |
| AC current input | 0.2VA per phase (at rated 5A)<br>0.4 VA at zero-sequence circuit (at rated 5A)<br>0.1VA per phase (at rated 1A)<br>0.3 VA at zero-sequence circuit (at rated 1A) |
| AC voltage input | 0.1VA (at rated voltage) |
| DC power supply: | less than16W (quiescent)<br>less than 25W (operation) |
| Binary input circuit: | ≤ 0.5W per input at 110Vdc |
| **Phase-segregated Current Differential Protection** | |
| DIFI1 (Small current region) | 0.10 to 2.00A in 0.01A steps (1A relay)<br>0.50 to 10.00A in 0.01A steps (5A relay) |
| DIFI2 (Large current region) | 0.6 to 24.0A in 0.1A steps (1A relay)<br>3.0 to 120.0A in 0.1A steps (5A relay) |
| Operating time | less than 1 cycle at 300% of DIFI1 |
| Resetting time | less than 110ms (for tripping output)<br>less than 40ms (for signal output) |
| **Zero-sequence Current Differential Protection for high-resistance earth** | |
| DIFGI | 0.05 to 1.00A in 0.01A steps (1A relay)<br>0.25 to 5.00A in 0.01A steps (5A relay) |
| Timer | 0.00 to 10.00s in 0.01s steps |
| Operating time | less than 45ms |
| Resetting time | less than 100ms |
| **Charging Current Compensation** | |
| DIFIC | 0.00 to 1.00A in 0.01A steps (1A relay)<br>0.00 to 5.00A in 0.01A steps (5A relay) |
| **Differential Current Supervision** | |
| DIFSV | 0.05 to 2.00A in 0.01A steps (1A relay)<br>0.25 to 10.00A in 0.01A steps (5A relay) |
| Timer | 0 to 60s in 1s steps |
| **Out-of-step protection** | |
| Out-of-step trip | OFF / TRIP / BO(separated from other trip signals) |

www.ElectricalPartManuals.com

| | |
|---|---|
| **Telecommunication Interface for current differential protection** | |
| Bit rate | 64kbs |
| Transmission format | IEC60870-5-1 |
| Electrical interface (Telecomm. equipment link) | |
| Applicable standard | CCITT-G703-1.2.1<br>CCITT-G703-1.2.2 or 1.2.3<br>X.21 |
| Type of code | NRZ (Non-Return to Zero) |
| Connector type | D-sub connector |
| 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 |
| **Phase Fault Distance Measuring Element** | |
| Z1S, Z2S | 0.10 to 250.00Ω in 0.01Ω steps (1A relay)<br>0.01 to 50.00Ω in 0.01Ω steps (5A relay) |
| Z3S, ZRS and Z4S | 0.1 to 250.0Ω in 0.1Ω steps (1A relay)<br>0.01 to 50.00 in 0.01Ω steps (5A relay) |
| Characteristic angle | 45° to 90° in 1° steps |
| Z1S and Z4S offset | 7.5Ω fixed (1A relay)<br>1.5Ω fixed (5A relay) |
| Blinder (BFR1S, BFR2S, BFRS, BRRS) | 0.1 to 250.0Ω in 0.1Ω steps (1A relay)<br>0.01 to 50.00 in 0.01Ω steps (5A relay) |
| BRLS: Linked with BRRS | |
| Characteristic angle (BFR1S,BFR2S,BFRS,BRRS) | 75° fixed |
| Characteristic angle (BFLS) | 90° to 135° |
| **Earth Fault Distance Measuring Element** | |
| Z1G, Z2G | 0.10 to 250.00Ω in 0.01Ω steps (1A relay)<br>0.01 to 50.00Ω in 0.01Ω steps (5A relay) |
| Z3G, ZRG and Z4G | 0.1 to 500.0Ω in 0.1Ω steps (1A relay)<br>0.01 to 100.00 in 0.01Ω steps (5A relay) |
| Characteristic angle | 45° to 90° in 1° steps |
| Blinder (BFR1G, BFR2G, BFRG, BRRG) | 0.5 to 100.0Ω in 0.1Ω steps (1A relay)<br>0.10 to 20.00Ω in 0.01Ω steps (5A relay) |
| BRLG: Linked with BRRG | |
| Characteristic angle (BFR1G,BFR2G,BFRG,BRRG) | 75° fixed |
| Characteristic angle (BFLG) | 90° to 135° |
| **Time Setting for Zone Protection** | |
| Time setting of Z1S, Z2S, Z3S, ZRS, Z1G, Z2G, Z3G, ZRG | 0.00 to 10.00s in 0.01s steps |

www.ElectricalPartManuals.com

| | |
|---|---|
| **Minimum Operating Current of Distance Protection** | |
| Current | 0.08A (1A relay), 0.4A (5A relay) |
| **Residual Current Compensation** | |
| Residual current compensation for reactance element of Z1G, Z2G, ZRG | Adjustable as follows: |
| Earth return compensation | 0 to 1000% in 1% steps |
| Mutual coupling compensation (ZRG excluded) | 0 to 1000% in 1% steps |
| **Command Protection** | |
| Coordination time for BOP scheme | 0 to 50ms in 1ms steps |
| **Operating and Resetting Time of Distance Measuring Element** | |
| Typical operating time | 20ms |
| Resetting time | Less than 30ms (for tripping output)<br>Less than 40ms (for signal output) |
| **Power Swing Blocking** | |
| Detection zone (PSBZS, PSBZG) | 2.5 to 75.0Ω in 0.1Ω steps (1A relay)<br>0.50 to 15.00 in 0.01Ω steps (5A relay) |
| Detection time | 20 to 60ms in 1ms steps |
| **Phase Selection Element** | |
| Undervoltage | 10 to 60V in 1V steps |
| Impedance | 0.0 to 250.0Ω in 0.1Ω steps (1A relay)<br>0.0 to 50.0Ω in 0.1Ω steps (5A relay) |
| Characteristic angle | 45° to 90° in 1° steps |
| Residual current compensation | Automatically set according to residual current compensation setting of reactance element |
| **Weak Infeed and Echo Protection** | |
| Phase-to-phase undervoltage element | 50 to 100V in 1V steps |
| Phase-to-earth undervoltage element | 10 to 60V in 1V steps |
| **Directional Earth Fault Protection** | |
| Characteristic angle | 0 to 90° in 1° steps (3I0 lags for −3V0) |
| Polarising voltage (3V0) | 1.7 to 21.0V in 0.1V steps |
| Zero-sequence current (3I0) | 0.10 to 1.00A in 0.01A in 0.01A steps (1A relay)<br>0.5 to 5.0A in 0.1A steps (5A relay) |
| Time for backup trip | 0.00 to 10.00s in 0.01s steps |
| **Directional Earth Fault Command Protection** | |
| Time for delayed trip | 0.00 to 0.30s in 0.01s steps |
| Coordination time | 0 to 50ms in 1ms steps |
| **Inverse Time Overcurrent Protection** | |
| OCI (for phase fault protection) | 0.10 to 5.00A in 0.01A steps (1A relay)<br>0.5 to 25.0A in 0.1A steps (5A relay) |
| OCI time multiplier | 0.05 to 1.00 in 0.01 steps |
| OCI characteristic | Standard / Very / Extremely / Long-time inverse |
| Reset time delay | 0.0 to 10.0s in 0.1s steps |
| EFI (for earth fault protection) | 0.10 to 1.00A in 0.01A steps (1A relay)<br>0.5 to 5.0A in 0.1A steps (5A relay) |
| EFI time multiplier | 0.05 to 1.00 in 0.01 steps |
| EFI characteristic | Standard / Very / Extremely / Long-time inverse |
| Reset time delay | 0.0 to 10.0s in 0.1s steps |
| **Definite Time Overcurrent Protection** | |
| OC (for phase fault protection) | 0.1 to 20.0A in 0.1A steps (1A relay)<br>0.5 to 100.0A in 0.1A steps (5A relay) |
| OC time delay | 0.00 to 10.00s in 0.01s steps |
| EF (for earth fault protection) | 0.10 to 1.00A in 0.01A steps (1A relay)<br>0.5 to 5.0A in 0.1A steps (5A relay) |
| EF time delay | 0.00 to 10.00s in 0.01s steps |

www.ElectricalPartManuals.com

| | |
|---|---|
| **Overvoltage Protection** | |
| Phase-to-phase element (OVS) | |
| 1st, 2nd Overvoltage thresholds: | OFF, 5.0 – 150.0V in 0.1V steps |
| Delay type (1st threshold only): | DTL, IDMTL |
| IDMTL Time Multiplier Setting TMS: | 0.05 - 100.00 in 0.01 steps |
| DTL delay: | Inst, 0.01 - 300.00s in 0.01s steps |
| Dropout / Pickup ratio: | 10 to 98% in 1% steps |
| Phase-to-earth element (OVG) | |
| 1st, 2nd Overvoltage thresholds: | OFF, 5.0 – 150.0V in 0.1V steps |
| Delay type (1st threshold only): | DTL, IDMTL |
| IDMTL Time Multiplier Setting TMS: | 0.05 - 100.00 in 0.01 steps |
| DTL delay: | Inst, 0.01 - 300.00s in 0.01s steps |
| Dropout / Pickup ratio: | 10 to 98% in 1% steps |
| **Undervoltage Protection** | |
| Phase-to-phase element (UVS) | |
| 1st, 2nd Undervoltage thresholds: | OFF, 5.0 – 150.0V in 0.1V steps |
| Delay type (1st threshold only): | DTL, IDMTL |
| IDMTL Time Multiplier Setting TMS: | 0.05 - 100.00 in 0.01 steps |
| DTL delay: | Inst, 0.01 - 300.00s in 0.01s steps |
| Undervoltage block threshold: | 5.0 to 20.0V in 1V steps |
| Phase-to-earth element (UVG) | |
| 1st, 2nd Undervoltage thresholds: | OFF, 5.0 – 150.0V in 0.1V steps |
| Delay type (1st threshold only): | DTL, IDMTL |
| IDMTL Time Multiplier Setting TMS: | 0.05 - 100.00 in 0.01 steps |
| DTL delay: | Inst, 0.01 - 300.00s in 0.01s steps |
| Undervoltage block threshold: | 5.0 to 20.0V in 1V steps |
| **Thermal Overload Protection** | |
| Thermal setting (THM = k.$I_{FLC}$) | OFF, 0.40 – 2.00A in 0.01A steps (1A rating)<br>OFF, 2.0 – 10.0A in 0.1A steps (5A rating) |
| Time constant ($\tau$) | 0.5 – 300.0mins in 0.1min steps |
| Thermal alarm | OFF, 50% to 99% in 1% steps |
| Pre-load current setting | 0.00 – 1.00A in 0.01A steps (1A rating)<br>0.0 – 5.0A in 0.1A steps (5A rating) |
| **Switch-on-to-fault and Stub Protection** | |
| Overcurrent | 0.4 to 3.0A in 0.1A steps (1A relay)<br>2.0 to 15.0A in 0.1A steps (5A relay) |
| **Broken Conductor Detection** | |
| Broken conductor threshold ($I_2/I_1$): | OFF, 0.10 - 1.00 in 0.01 steps |
| DTL delay: | 0.00 to 300.00s in 0.01s steps |
| **Breaker Failure (BF) Protection** | |
| Overcurrent element | 0.1 to 2.0A in 0.1A steps (1A relay)<br>0.5 to 10.0A in 0.1A steps (5A relay) |
| Reset | less than 80% of operating value |
| BF timer for retry-trip of failed circuit breaker | 50 to 500ms in 1ms steps |
| BF timer for adjacent circuit breaker tripping | 50 to 500ms in 1ms steps |
| Operating time of overcurrent element | less than 20ms at 50Hz or 17ms at 60Hz |
| Resetting time of overcurrent element | less than 15ms at 50Hz or 13ms at 60Hz |

www.ElectricalPartManuals.com

| | |
|---|---|
| **Accuracy** | |
| Current differential protection: pick-up | ±5% (±7% at I < 0.3×In) |
| Distance measuring element | |
| Static accuracy | ±5% under SIR < 30, ±10% under 30 < SIR < 50 |
| Static angle accuracy | ±5° |
| Transient overreach | +5% |
| Inverse time overcurrent characteristics | ±5% or 30ms(1.5 to 30 times setting) |
| Definite time overcurrent protection: pick-up | ±5% |
| Overcurrent element for BF: pick-up | ±5% |
| **Autoreclose function** | |
| Number of shots | 1 to 4 shots |
| Timer settings | |
| Dead time for single-phase autoreclose | 0.01 to 10.00s in 0.01s steps |
| Dead time for three-phase autoreclose | 0.01 to 100.00s in 0.01s steps |
| Multi-shot dead line time | 5.0 to 300.0s in 0.1s steps |
| Multi-shot reset time | 5.0 to 300.0s in 0.1s steps |
| Reclaim time | 5 to 300s in 1s steps |
| Pulse width of reclosing signal output | 0.1 to 10.0s in 0.1s steps |
| Autoreclose reset time | 0.01 to 100.00s in 0.01s steps |
| Reset time for developing fault | 0.01 to 10.00s in 0.01s steps |
| One-and-a-half breaker system | |
| Follower breaker autoreclose delay time | 0.1 to 10.0s in 0.1s steps |
| Voltage and synchronism check element | |
| Synchronism check angle | 5° to 75° in 1° steps |
| UV element | 60 to 150V in 1V steps |
| OV element | 10 to 100V in 1V steps |
| Busbar or line dead check | 10 to 100V in 1V steps |
| Busbar or line live check | 10 to 100V in 1V steps |
| Synchronism check time | 0.01 to 10.00s in 0.01s steps |
| Voltage check time | 0.01 to 1.00s 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 relay)<br>0.5A fixed (5A relay) |
| Residual voltage element | 20V fixed |
| Residual current element | Common use with earth fault detection element |
| **Fault Locator** | |
| Line resistance and reactance settings | 0.0 to 999.9Ω in 0.1Ω steps (1A relay)<br>0.00 to 199.99Ω in 0.01Ω steps (5A relay) |
| Line length | 0.0 to 399.9km in 0.1km steps |
| Accuracy | |
| Two terminal | ±1km (up to 100km) or ±1% (up to 399.9km at DIFI=0.5In setting and Id=2In |
| Three terminal | ±2km (up to 100km) or ±2% (up to 399.9km at DIFI=0.25In setting and Id=2In |
| Minimum measuring cycles | 2 cycles |
| **Disturbance Record Initiation** | |
| Overcurrent element | 0.1 to 50.0A in 0.1A steps (1A relay)<br>0.5 to 250.0A in 0.1A steps (5A relay) |
| Undervoltage element | 0 to 132V in 1V steps (for phase fault)<br>0 to 76V in 1V steps (for earth fault) |
| Pre-fault time | 0.3s (fixed) |
| Post-fault time | 0.1 to 3.0 in 0.1s steps |

www.ElectricalPartManuals.com

| | |
|---|---|
| **Communication Port** | |
| Front communication port (local PC) | |
| Connection | Point to point |
| Cable type | Multi-core (straight) |
| Cable length | 15m (max.) |
| Connector | RS232C 9-pin D-sub miniature connector female |
| Rear communication port (remote PC) | |
| RS485 I/F: | |
| Transmission data rate for RSM system | 64kbps |
| Connection | Multidrop mode (max. 32 relays) |
| Connector | Screw terminals |
| Cable and length | Twisted pair cable, max. 1200m |
| Isolation | 2kVac for 1min. |
| Fibre optic I/F: | ST connector, graded-index multi-mode 50/125μm or 62.5/125μm type optical fibres |
| Ethernet LAN I/F: | 10BASE-T, RJ-45 connector |
| **IRIG-B Port** | |
| Connection | BNC connector |
| Cable type | 50 ohm coaxial cable |
| **Binary Inputs** | |
| Operating voltage | Typical 74Vdc(min.70Vdc) for 110V/125Vdc rating<br>Typical 138Vdc(min.125Vdc) for 220V/250Vdc rating<br>Typical 31Vdc(min.28Vdc) for 48V/54V/60Vdc rating<br>Typical 15Vdc(min.14Vdc) for 24Vdc rating |
| **Contact Ratings** | |
| Trip contacts | |
| Make and carry | 5A continuously,<br>30A, 290Vdc for 0.5s (L/R=10ms) |
| Break | 0.15A, 290Vdc (L/R=40ms) |
| Auxiliary contacts | |
| Make and carry | 4A continuously,<br>10A, 220Vdc for 0.5s (L/R≥5ms) |
| Break | 0.1A, 220Vdc (L/R=40ms) |
| Durability | |
| Make and carry | 10,000 operations minimum |
| Break | 100,000 operations minimum |
| **Mechanical design** | |
| Weight | 11kg (Type-A), 14kg (Type-B) |
| Case colour | Munsell No. 10YR8/0.5 |
| Installation | Flush mounting or rack mounting |

www . ElectricalPartManuals . com

## CT REQUIREMENT

Ideally it would be preferable to employ current transformers that did not saturate; this is particularly desirable if operation of the protection is to be avoided during external faults. However, there are circumstances due to accommodation requirements and occasionally on the basis of cost where this is not always possible.

The type GRL100-700 is a current differential with back-up distance protection. CT requirement for GRL100-700 is determined by the requirement for current differential protection and for distance protection.

CASE 1. The case with the distance protection applied as a main protection in addition to the current differential protection

When the distance protection is applied as a main protection the CT requirement for GRL100 must be considered as part of the combined requirements for both protections.

<Step 1> Check the maximum through fault current $I_{fmaxth}$

$$I_{fmaxth} < 65 \text{ X } I_n$$

where,

$I_{fmaxth}$ : Secondary maximum through fault current
$I_n$ :Rated secondary current

<Step 2> Check the CT satisfies the condition given by table K-1 or K-2 depending on CT types. Each table has 4 requirements. Every requirement must be satisfied.

<Knee point voltage of CTs is given>

**Table K-1 CT Requirement defined by $V_k$**

| Td [ms] | Requirement 1 | Requirement 2 |
|---|---|---|
| 35 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 3$ | $V_k \geqq I_{f_z1_max}(R_{ct}+ R_2)\times 6$ |
| 50 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 3$ | $V_k \geqq I_{f_z1_max}(R_{ct}+ R_2)\times 7$ |
| 75 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 4$ | $V_k \geqq I_{f_z1_max}(R_{ct}+ R_2)\times 8$ |
| 100 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 4$ | $V_k \geqq I_{f_z1_max}(R_{ct}+ R_2)\times 8$ |
| 150 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 8$ | $V_k \geqq I_{f_z1_max}(R_{ct}+ R_2)\times 8$ |

| Td [ms] | Requirement 3 | Requirement 4 |
|---|---|---|
| 35 | $V_k \geqq I_{f_rev_max}(Rct+ R_2)\times 2$ | $V_k \geqq I_{Lmax}(Rct+ R_2)\times 14.4$ |
| 50 | $V_k \geqq I_{f_rev_max}(Rct+ R_2)\times 3$ | $V_k \geqq I_{Lmax}(Rct+ R_2)\times 20$ |
| 75 | $V_k \geqq I_{f_rev_max}(Rct+ R_2)\times 6$ | $V_k \geqq I_{Lmax}(Rct+ R_2)\times 28.8$ |
| 100 | $V_k \geqq I_{f_rev_max}(Rct+ R_2)\times 6$ | $V_k \geqq I_{Lmax}(Rct+ R_2)\times 36.8$ |
| 150 | $V_k \geqq I_{f_rev_max}(Rct+ R_2)\times 6$ | $V_k \geqq I_{Lmax}(Rct+ R_2)\times 50.4$ |

$V_k$ : Knee point voltage [V]
$R_{ct}$ : Secondary CT resistance [ohms]
$R_2$ : Actual secondary burden [ohms]
$I_{fmax}$ : Maximum secondary fault current
$I_{f_z1_max}$ : Maximum secondary fault current at the zone 1 reach point
$I_{f_rev_max}$ : Maximum secondary fault current for a close-up reverse fault
$I_{Lmax}$ : Maximum secondary load current

www . ElectricalPartManuals . com

<Accuracy limit factor of CTs is given>

**Table K-2 CT Requirement defined by n'**

| Td [ms] | Requirement 1 | Requirement 2 |
|---|---|---|
| 35 | $n' I_n \geqq 3.75 \times I_{fmax}$ | $n' I_n \geqq 7.5 \times I_{f_z1_max}$ |
| 50 | $n' I_n \geqq 3.75 \times I_{fmax}$ | $n' I_n \geqq 8.75 \times I_{f_z1_max}$ |
| 75 | $n' I_n \geqq 5 \times I_{fmax}$ | $n' I_n \geqq 10 \times I_{f_z1_max}$ |
| 100 | $n' I_n \geqq 5 \times I_{fmax}$ | $n' I_n \geqq 10 \times I_{f_z1_max}$ |
| 150 | $n' I_n \geqq 10 \times I_{fmax}$ | $n' I_n \geqq 10 \times I_{f_z1_max}$ |

| Td [ms] | Requirement 3 | Requirement 4 |
|---|---|---|
| 35 | $n' I_n \geqq 2.5 \times I_{f_rev_max}$ | $n' I_n \geqq I_{Lmax} \times 18$ |
| 50 | $n' I_n \geqq 3.75 \times I_{f_rev_max}$ | $n' I_n \geqq I_{Lmax} \times 25$ |
| 75 | $n' I_n \geqq 7.5 \times I_{f_rev_max}$ | $n' I_n \geqq I_{Lmax} \times 36$ |
| 100 | $n' I_n \geqq 7.5 \times I_{f_rev_max}$ | $n' I_n \geqq I_{Lmax} \times 46$ |
| 150 | $n' I_n \geqq 7.5 \times I_{f_rev_max}$ | $n' I_n \geqq I_{Lmax} \times 63$ |

$$n' = \frac{R_{VA} / I_n^2 + R_{ct}}{R_2 + R_{ct}} \cdot n \qquad \text{(K-1)}$$

n' : Equivalent accuracy limit factor defined by the equation above.
$I_n$ : Secondary rated current
$R_{VA}$ : Rated secondary burden [VA]
$R_{ct}$ : Secondary CT resistance [ohms]
$R_2$ : Actual secondary burden [ohms]
n : Rated accuracy limit factor
$I_{fmax}$ : Maximum secondary fault current
$I_{f_z1_max}$ : Maximum secondary fault current at the zone 1 reach point
$I_{f_rev_max}$ : Maximum secondary fault current for a close-up reverse fault
$I_{Lmax}$ : Maximum secondary load current

Note : The values in the table are based on the following assumption.

- 100% DC component is superimposed.
- Only one CT is saturated.
- No remnance flux is assumed.

CASE 2. The case with the distance protection applied as a back-up protection with time delay

When the distance protection is applied as back-up protection the CT requirement for GRL100 can be ignored. If instantaneous tripping of distance protection is allowed when a communication failure occurs to the current differential protection, it is recommended that the requirement for case 1 should be applied.

<Step 1> Check the maximum through fault current $I_{fmaxth}$

$I_{fmaxth} < 65 \text{ X } I_n$

where,

$I_{fmaxth}$ : Secondary maximum through fault current
$I_n$ : Rated secondary current

www.ElectricalPartManuals.com

<Step 2> Check the CT satisfies the condition given by table K-3 or K-4 depending on CT types. Each table has 2 requirements. Both must be satisfied.

<Knee point voltage of CTs is given>

**Table K-3 CT Requirement defined by $V_k$**

| Td [ms] | Requirement 1 | Requirement 2 |
|---|---|---|
| 35 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 3$ | $V_k \geqq I_{Lmax}(Rct+ R_2)\times 14.4$ |
| 50 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 3$ | $V_k \geqq I_{Lmax}(Rct+ R_2)\times 20$ |
| 75 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 4$ | $V_k \geqq I_{Lmax}(Rct+ R_2)\times 28.8$ |
| 100 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 4$ | $V_k \geqq I_{Lmax}(Rct+ R_2)\times 36.8$ |
| 150 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 8$ | $V_k \geqq I_{Lmax}(Rct+ R_2)\times 50.4$ |

$V_k$ : Knee point voltage [V]
$R_{ct}$ : Secondary CT resistance [ohms]
$R_2$ : Actual secondary burden [ohms]
$I_{fmax}$ : Maximum secondary fault current
$I_{Lmax}$ : Maximum secondary load current

<Accuracy limit factor of CTs is given>

**Table K-4 CT Requirement defined by n'**

| Td [ms] | Requirement 1 | Requirement 2 |
|---|---|---|
| 35 | $n' I_n \geqq 3.75 \times I_{fmax}$ | $n' I_n \geqq I_{Lmax}\times 18$ |
| 50 | $n' I_n \geqq 3.75 \times I_{fmax}$ | $n' I_n \geqq I_{Lmax}\times 25$ |
| 75 | $n' I_n \geqq 5 \times I_{fmax}$ | $n' I_n \geqq I_{Lmax}\times 36$ |
| 100 | $n' I_n \geqq 5 \times I_{fmax}$ | $n' I_n \geqq I_{Lmax}\times 46$ |
| 150 | $n' I_n \geqq 10 \times I_{fmax}$ | $n' I_n \geqq I_{Lmax}\times 63$ |

$$n' = \frac{R_{VA}/I_n^2 + R_{ct}}{R_2 + R_{ct}} \cdot n \qquad \text{(K-1)}$$

n' : Equivalent accuracy limit factor defined by the equation above.
$I_n$ : Secondary rated current
$R_{VA}$ : Rated secondary burden [VA]
$R_{ct}$ : Secondary CT resistance [ohms]
$R_2$ : Actual secondary burden [ohms]
n : Rated accuracy limit factor
$I_{fmax}$ : Maximum secondary fault current
$I_{Lmax}$ : Maximum secondary load current

Note : The values in the table are based on the following assumption.

- 100% DC component is superimposed.
- Only one CT is saturated.
- No remnance flux is assumed.

www.ElectricalPartManuals.com

**Special case**

In the case of a 3 terminal-double circuit line configuration, an additional system condition must be considered. It is possible, under certain circumstances, that when an internal fault occurs, out-flowing fault current can also be experienced.
In this case, the effect of the out-flowing fault current must be considered when calculating DIFI1 and DIFI2. For example, the following application can be considered.

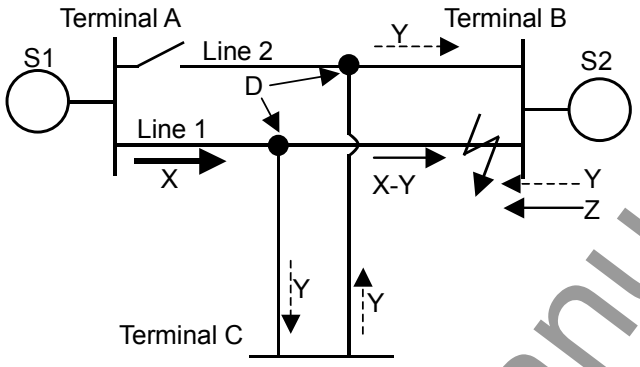



**Fig K-1 Special case**

The following conditions are assumed as shown in Fig.K-1.

- The three terminals, A, B and C, and the two T-connected transmission lines are assumed to be live.
- Terminal C is connected to load only.
- Line 2 CB at terminal A is open.
- An internal fault occurs on the closed line at the opposite terminal, i.e. Line 1, Terminal B.

In this case, fault current will flow as shown in Fig.K-1. Even though the fault is internal, the fault current Y from Line 1 at Terminal C flows out of the protected zone. Assuming the fault current from source S2 is Z, the summation of the fault current for Line1 at Terminal B is equal to Y+Z. Hence, the current at each terminal is as follows:

Terminal A : X

Terminal B : Y+Z

Terminal C : –Y

Therefore the differential and restraint currents can be calculated as follows:

differential current : X+Z

restraint current : X+2Y+Z

This point can be expressed in the Id-Ir plane as shown in Fig.K-2. It can be seen that the effect of the outflow current is to increase the apparent restraint quantity Ir and thereby shift the point to the right of where it would normally fall.

www.ElectricalPartManuals.com

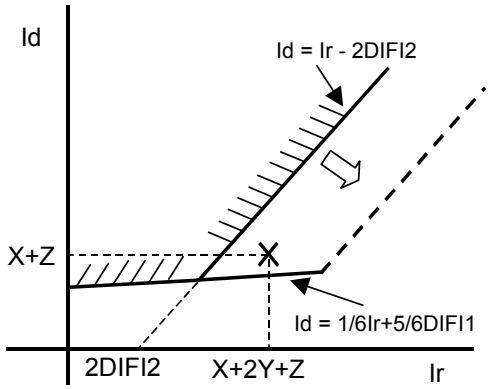



**Fig.K-2 Internal fault in Id-Ir plane including out-flow current**

In order to ensure that the GRL100 relay will operate correctly in this case, the point shown on the plot must fall within the operating zone.
According to this requirement, DIFI2 can be calculated as follows.

$$X + Z > X + 2Y + Z - 2DIFI2$$

$$DIFI2 > Y \qquad \text{(K-2)}$$

This means that DIFI2 must be larger than the amount of out-flowing current.

CASE 1. The case with the distance protection applied as a main protection in addition to the current differential protection for the special case

Therefore the condition shown in Table K-1 and Table K-2 should be replaced by that in Table K-5 and Table K-6 respectively for "CASE 1".

**Table K-5 CT Requirement defined by $V_k$ (Special case)**

| Td [ms] | Requirement 1 | Requirement 2 |
|---|---|---|
| 35 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 3$ | $V_k \geqq I_{f_z1_max}(R_{ct}+ R_2)\times 6$ |
| 50 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 3$ | $V_k \geqq I_{f_z1_max}(R_{ct}+ R_2)\times 7$ |
| 75 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 4$ | $V_k \geqq I_{f_z1_max}(R_{ct}+ R_2)\times 8$ |
| 100 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 4$ | $V_k \geqq I_{f_z1_max}(R_{ct}+ R_2)\times 8$ |
| 150 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 8$ | $V_k \geqq I_{f_z1_max}(R_{ct}+ R_2)\times 8$ |

| Td [ms] | Requirement 3 | Requirement 4 |
|---|---|---|
| 35 | $V_k \geqq I_{f_rev_max}(Rct+ R_2)\times 2$ | $V_k > Max\{I_{Lmax}+ I_{fmin}/2, I_{fmaxout}\}\times(R_{ct}+ R_2)\times 14.4$ |
| 50 | $V_k \geqq I_{f_rev_max}(Rct+ R_2)\times 3$ | $V_k > Max\{I_{Lmax}+ I_{fmin}/2, I_{fmaxout}\}\times(R_{ct}+ R_2)\times 20$ |
| 75 | $V_k \geqq I_{f_rev_max}(Rct+ R_2)\times 6$ | $V_k > Max\{I_{Lmax}+ I_{fmin}/2, I_{fmaxout}\}\times(R_{ct}+ R_2)\times 28.8$ |
| 100 | $V_k \geqq I_{f_rev_max}(Rct+ R_2)\times 6$ | $V_k > Max\{I_{Lmax}+ I_{fmin}/2, I_{fmaxout}\}\times(R_{ct}+ R_2)\times 36.8$ |
| 150 | $V_k \geqq I_{f_rev_max}(Rct+ R_2)\times 6$ | $V_k > Max\{I_{Lmax}+ I_{fmin}/2, I_{fmaxout}\}\times(R_{ct}+ R_2)\times 50.4$ |

$V_k$ : Knee point voltage [V]
$R_{ct}$ : Secondary CT resistance [ohms]
$R_2$ : Actual secondary burden [ohms]
$I_{fmax}$ : Maximum secondary fault current
$I_{f_z1_max}$ : Maximum secondary fault current at the zone 1 reach point
$I_{f_rev_max}$ : Maximum secondary fault current for a close-up reverse fault
$I_{Lmax}$ : Maximum secondary load current

www.ElectricalPartManuals.com

Max {$I_{Lmax}$+ $I_{fmin}$/2, $I_{fmaxout}$}: The larger of ($I_{Lmax}$+ $I_{fmin}$/2) and $I_{fmaxout}$
$I_{fmin}$ : Minimum fault current
$I_{fmaxout}$ : Maximum out-flowing fault current for the special condition

<Accuracy limit factor of CTs is given>

**Table K-6 CT Requirement defined by n'**

| Td [ms] | Requirement 1 | Requirement 2 |
|---|---|---|
| 35 | $n' I_n \geqq 3.75 \times I_{fmax}$ | $n' I_n \geqq 7.5 \times I_{f_z1_max}$ |
| 50 | $n' I_n \geqq 3.75 \times I_{fmax}$ | $n' I_n \geqq 8.75 \times I_{f_z1_max}$ |
| 75 | $n' I_n \geqq 5 \times I_{fmax}$ | $n' I_n \geqq 10 \times I_{f_z1_max}$ |
| 100 | $n' I_n \geqq 5 \times I_{fmax}$ | $n' I_n \geqq 10 \times I_{f_z1_max}$ |
| 150 | $n' I_n \geqq 10 \times I_{fmax}$ | $n' I_n \geqq 10 \times I_{f_z1_max}$ |

| Td [ms] | Requirement 3 | Requirement 4 |
|---|---|---|
| 35 | $n' I_n \geqq 2.5 \times I_{f_rev_max}$ | $n' I_n > Max\{I_{Lmax}+ I_{fmin}/2, I_{fmaxout}\} \times 18$ |
| 50 | $n' I_n \geqq 3.75 \times I_{f_rev_max}$ | $n' I_n > Max\{I_{Lmax}+ I_{fmin}/2, I_{fmaxout}\} \times 25$ |
| 75 | $n' I_n \geqq 7.5 \times I_{f_rev_max}$ | $n' I_n > Max\{I_{Lmax}+ I_{fmin}/2, I_{fmaxout}\} \times 36$ |
| 100 | $n' I_n \geqq 7.5 \times I_{f_rev_max}$ | $n' I_n > Max\{I_{Lmax}+ I_{fmin}/2, I_{fmaxout}\} \times 46$ |
| 150 | $n' I_n \geqq 7.5 \times I_{f_rev_max}$ | $n' I_n > Max\{I_{Lmax}+ I_{fmin}/2, I_{fmaxout}\} \times 63$ |

$$n' = \frac{R_{VA} / I_n^2 + R_{ct}}{R_2 + R_{ct}} \cdot n \qquad \text{(K-1)}$$

n' : Equivalent accuracy limit factor defined by the equation above.
$I_n$ : Secondary rated current
$R_{VA}$ : Rated secondary burden [VA]
$R_{ct}$ : Secondary CT resistance [ohms]
$R_2$ : Actual secondary burden [ohms]
n : Rated accuracy limit factor
$I_{fmax}$ : Maximum secondary fault current
$I_{f_z1_max}$ : Maximum secondary fault current at the zone 1 reach point
$I_{f_rev_max}$ : Maximum secondary fault current for a close-up reverse fault
$I_{Lmax}$ : Maximum secondary load current
Max {$I_{Lmax}$+ $I_{fmin}$/2, $I_{fmaxout}$}: The larger of ($I_{Lmax}$+ $I_{fmin}$/2) and $I_{fmaxout}$
$I_{fmin}$ : Minimum fault current
$I_{fmaxout}$ : Maximum out-flowing fault current for the special condition

CASE 2. The case with the distance protection applied as a back-up protection with time delay

Similarly to the previous case, the condition shown in Table K-3 and Table K-4 should be replaced by that in Table K-7 and Table K-8 respectively for "CASE 2".

www.ElectricalPartManuals.com

**Table K-7 CT Requirement defined by $V_k$ (Special case)**

| Td [ms] | Requirement 1 | Requirement 2 |
|---|---|---|
| 35 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 3$ | $V_k > \text{Max}\{I_{LMAX}+ I_{fmin}/2, I_{fmaxout}\}\times(R_{ct}+ R_2)\times 14.4$ |
| 50 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 3$ | $V_k > \text{Max}\{I_{LMAX}+ I_{fmin}/2, I_{fmaxout}\}\times(R_{ct}+ R_2)\times 20$ |
| 75 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 4$ | $V_k > \text{Max}\{I_{LMAX}+ I_{fmin}/2, I_{fmaxout}\}\times(R_{ct}+ R_2)\times 28.8$ |
| 100 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 4$ | $V_k > \text{Max}\{I_{LMAX}+ I_{fmin}/2, I_{fmaxout}\}\times(R_{ct}+ R_2)\times 36.8$ |
| 150 | $V_k \geqq I_{fmax}(R_{ct}+ R_2)\times 8$ | $V_k > \text{Max}\{I_{LMAX}+ I_{fmin}/2, I_{fmaxout}\}\times(R_{ct}+ R_2)\times 50.4$ |

$V_k$ : Knee point voltage [V]
$R_{ct}$ : Secondary CT resistance [ohms]
$R_2$ : Actual secondary burden [ohms]
$I_{fmax}$ : Maximum secondary fault current
$I_{Lmax}$ : Maximum secondary load current
$\text{Max}\{I_{LMAX}+ I_{fmin}/2, I_{fmaxout}\}$: The larger of $(I_{LMAX}+ I_{fmin}/2)$ and $I_{fmaxout}$
$I_{fmin}$ : Minimum fault current
$I_{fmaxout}$ : Maximum out-flowing fault current for the special condition

<Accuracy limit factor of CTs is given>

**Table K-8 CT Requirement defined by n'**

| Td [ms] | Requirement 1 | Requirement 2 |
|---|---|---|
| 35 | $n' I_n \geqq 3.75 \times I_{fmax}$ | $n' I_n > \text{Max}\{I_{LMAX}+ I_{fmin}/2, I_{fmaxout}\}\times 18$ |
| 50 | $n' I_n \geqq 3.75 \times I_{fmax}$ | $n' I_n > \text{Max}\{I_{LMAX}+ I_{fmin}/2, I_{fmaxout}\}\times 25$ |
| 75 | $n' I_n \geqq 5 \times I_{fmax}$ | $n' I_n > \text{Max}\{I_{LMAX}+ I_{fmin}/2, I_{fmaxout}\}\times 36$ |
| 100 | $n' I_n \geqq 5 \times I_{fmax}$ | $n' I_n > \text{Max}\{I_{LMAX}+ I_{fmin}/2, I_{fmaxout}\}\times 46$ |
| 150 | $n' I_n \geqq 10 \times I_{fmax}$ | $n' I_n > \text{Max}\{I_{LMAX}+ I_{fmin}/2, I_{fmaxout}\}\times 63$ |

$$n' = \frac{R_{VA}/I_n^2 + R_{ct}}{R_2 + R_{ct}} \cdot n \qquad \text{(K-1)}$$

n' : Equivalent accuracy limit factor defined by the equation above.
$I_n$ : Secondary rated current
$R_{VA}$ : Rated secondary burden [VA]
$R_{ct}$ : Secondary CT resistance [ohms]
$R_2$ : Actual secondary burden [ohms]
n : Rated accuracy limit factor
$I_{fmax}$ : Maximum secondary fault current
$I_{Lmax}$ : Maximum secondary load current
$\text{Max}\{I_{LMAX}+ I_{fmin}/2, I_{fmaxout}\}$: The larger of $(I_{LMAX}+ I_{fmin}/2)$ and $I_{fmaxout}$
$I_{fmin}$ : Minimum fault current
$I_{fmaxout}$ : Maximum out-flowing fault current for the special condition

Y is determined by the ratio of the impedance between node D to Terminal C and node D to Terminal B. If their impedance is assumed to be p and q respectively, Y can be obtained using the following equation.

$$Y = X \cdot \frac{q}{2p + 2q} \qquad \text{(K-3)}$$

For example, Y = X/4, if p=q and Y=X/2, if p=0.

www.ElectricalPartManuals.com

Note : The values in the table are based on the following assumption.

- 100% DC component is superimposed.
- Only one CT is saturated.
- No remnance flux is assumed.

www . ElectricalPartManuals . com

## ENVIRONMENTAL PERFORMANCE CLAIMS

| Test | Standards | Details |
|---|---|---|
| **Atmospheric Environment** | | |
| Temperature | IEC60068-2-1/2 | Operating range: -10°C to +55°C.<br>Storage / Transit: -25°C to +70°C. |
| Humidity | IEC60068-2-78 | 56 days at 40°C and 93% relative humidity. |
| Enclosure Protection | IEC60529 | IP51 (Rear: IP20) |
| **Mechanical Environment** | | |
| Vibration | IEC60255-21-1 | Response - Class 1<br>Endurance - Class 1 |
| Shock and Bump | IEC60255-21-2 | Shock Response Class 1<br>Shock Withstand Class 1<br>Bump Class 1 |
| Seismic | IEC60255-21-3 | Class 1 |
| **Electrical Environment** | | |
| Dielectric Withstand | IEC60255-5 | 2kVrms for 1 minute between all terminals and earth.<br>2kVrms for 1 minute between independent circuits.<br>1kVrms for 1 minute across normally open contacts. |
| High Voltage Impulse | IEC60255-5 | Three positive and three negative impulses of 5kV(peak), 1.2/50μs, 0.5J between all terminals and between all terminals and earth. |
| **Electromagnetic Environment** | | |
| High Frequency Disturbance / Damped Oscillatory Wave | IEC60255-22-1 Class 3, IEC61000-4-12 / EN61000-4-12 | 1MHz 2.5kV applied to all ports in common mode.<br>1MHz 1.0kV applied to all ports in differential mode. |
| Electrostatic Discharge | IEC60255-22-2 Class 3, IEC61000-4-2 / EN61000-4-2 | 6kV contact discharge, 8kV air discharge. |
| Radiated RF Electromagnetic Disturbance | IEC60255-22-3 Class 3, IEC61000-4-3 / EN61000-4-3 | Field strength 10V/m for frequency sweeps of 80MHz to 1GHz and 1.7GHz to 2.2GHz. Additional spot tests at 80, 160, 450, 900 and 1890MHz. |
| Fast Transient Disturbance | IEC60255-22-4, IEC61000-4-4 / EN61000-4-4 | 4kV, 2.5kHz, 5/50ns applied to all inputs. |
| Surge Immunity | IEC60255-22-5, IEC61000-4-5 / EN61000-4-5 | 1.2/50μs surge in common/differential modes:<br>HV ports: 2kV/1kV (peak)<br>PSU and I/O ports: 2kV/1kV (peak)<br>RS485 port: 1kV (peak) |
| Conducted RF Electromagnetic Disturbance | IEC60255-22-6 Class 3, IEC61000-4-6 / EN61000-4-6 | 10Vrms applied over frequency range 150kHz to 100MHz. Additional spot tests at 27 and 68MHz. |
| Power Frequency Disturbance | IEC60255-22-7, IEC61000-4-16 / EN61000-4-16 | 300V 50Hz for 10s applied to ports in common mode.<br>150V 50Hz for 10s applied to ports in differential mode.<br>Not applicable to AC inputs. |
| Conducted and Radiated Emissions | IEC60255-25, EN55022 Class A, IEC61000-6-4 / EN61000-6-4 | Conducted emissions:<br>0.15 to 0.50MHz: <79dB (peak) or <66dB (mean)<br>0.50 to 30MHz: <73dB (peak) or <60dB (mean)<br>Radiated emissions (at 30m):<br>30 to 230MHz: <30dB<br>230 to 1000MHz: <37dB |
| CE | 89/336/EEC | Compliance with the European Commission Electromagnetic Compatibility Directive is demonstrated according to EN 61000-6-2 and EN 61000-6-4. |
| | 73/23/EEC | Compliance with the European Commission Low Voltage Directive is demonstrated according to EN 50178 and EN 60255-5. |

www.ElectricalPartManuals.com

# Appendix L

# Symbols Used in Scheme Logic

www . ElectricalPartManuals . com

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

**Signal names**

Marked with ▭ : Measuring element output signal

Marked with ○ : Signal number

Marked with ▭ : Signal number and name of binary input by PLC function

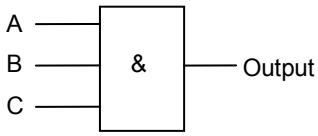
Signal No. Signal name

Marked with [ ] : Scheme switch

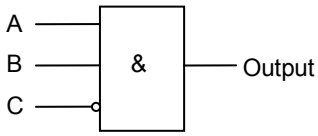
Marked with " " : Scheme switch position

Unmarked : Internal scheme logic signal

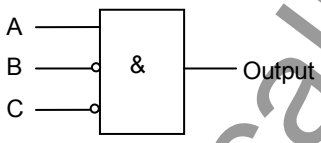
**AND gates**




| A | B | C | Output |
|---|---|---|---|
| 1 | 1 | 1 | 1 |
| Other cases | | | 0 |

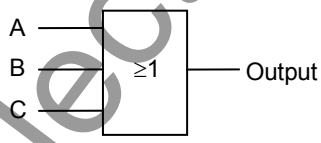



| A | B | C | Output |
|---|---|---|---|
| 1 | 1 | 0 | 1 |
| Other cases | | | 0 |

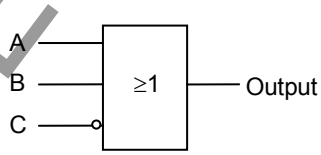



| A | B | C | Output |
|---|---|---|---|
| 1 | 0 | 0 | 1 |
| Other cases | | | 0 |

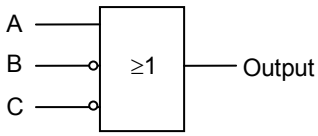
**OR gates**




| A | B | C | Output |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| Other cases | | | 1 |



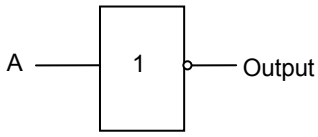

| A | B | C | Output |
|---|---|---|---|
| 0 | 0 | 1 | 0 |
| Other cases | | | 1 |




| A | B | C | Output |
|---|---|---|---|
| 0 | 1 | 1 | 0 |
| Other cases | | | 1 |

www . ElectricalPartManuals . com

### Signal inversion

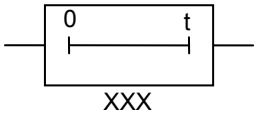



| A | Output |
|---|---|
| 0 | 1 |
| 1 | 0 |

### Timer

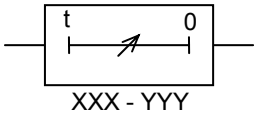
Delayed pick-up timer with fixed setting

XXX: Set time



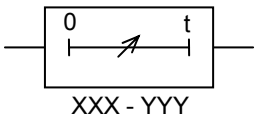

Delayed drop-off timer with fixed setting

XXX: Set time




Delayed pick-up timer with variable setting

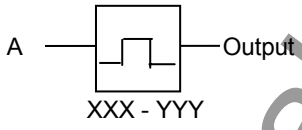
XXX - YYY: Setting range

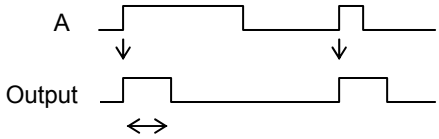



Delayed drop-off timer with variable setting

XXX - YYY: Setting range

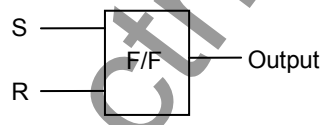
### One-shot timer



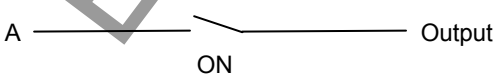

XXX - YYY: Setting range

### Flip-flop

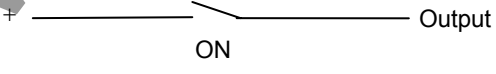



| S | R | Output |
|---|---|---|
| 0 | 0 | No change |
| 1 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 1 | 0 |

### Scheme switch




| A | Switch | Output |
|---|---|---|
| 1 | ON | 1 |
| Other cases | | 0 |




| Switch | Output |
|---|---|
| ON | 1 |
| OFF | 0 |

www.ElectricalPartManuals.com

www . ElectricalPartManuals . com

# Appendix M

# Multi-phase Autoreclose

www . ElectricalPartManuals . com

Tables 1 and 2 show operations of the multi-phase autoreclose for different faults. The operations of the autoreclose depend on the settings of [ARC-M] and [MA-NOLK].

Cases 1 to 3 show the case when one of the double circuit lines is out of service. In MPAR2 and [MA-NOLK]=FT, only case 1 results in single-phase tripping and multi-phase reclosing. Other cases result in three-phase final tripping. In MPAR2 and [MA-NOLK]=FT or S+T, case 1 results in single-phase tripping and multi-phase reclosing, and cases 2 and 3 result in three-phase tripping and three-phase reclosing. In MPAR3 and [MA-NOLK]=FT, all cases result in three-phase final tripping. In MPAR3 and [MA-NOLK]=T, all cases result in three-phase tripping and three-phase reclosing. In MPAR3 and [MA-NOLK]=S+T, case 1 results in single-phase tripping and single-phase reclosing, and cases 2 and 3 result in three-phase tripping and three-phase reclosing.

In cases 4, 6, 7, 10 and 11, three different phases remain in the power transmission state, so both MPAR2 and MPAR3 perform fault phase(s) tripping and reclosing.

In case 5, 8, 12 and 13, two different phases remain in the power transmission state, so MPAR2 performs fault phase(s) tripping and multi-phase reclosing. In MPAR3 and [MA-NOLK]=FT, all cases result in three-phase final tripping. In MPAR3 and [MA-NOLK]=T, all cases result in three-phase tripping and three-phase reclosing. In MPAR3 and [MA-NOLK]=S+T, single- or three-phase tripping and single- or three-phase reclosing is performed according to fault phase(s).

In cases 9, 14 and 15, the number of remaining different phases is less than two, so the operations of the autoreclose depends on only the [MA-NOLK] setting. In [MA-NOLK]=FT, all cases result in three-phase final tripping. In [MA-NOLK]=T or S+T, all cases result in three-phase tripping and three-phase reclosing.

**Table M-1 Reclosing in MPAR2 ([ARC-M]=M2 setting)**

| Case | Fault phase | | | | | | Tripping and Reclosing (Tripping mode → Reclosing mode) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | #1 line | | | #2 line | | | [MA-NOLK] = FT setting | | [MA-NOLK] = T setting | | [MA-NOLK] = S+T setting | |
| No. | A | B | C | A | B | C | #1 line | #2 line | #1 line | #2 line | #1 line | #2 line |
| 1 | × | | | — | — | — | 1φT→MPAR | — | 1φT→MPAR | — | 1φT→MPAR | — |
| 2 | × | × | | — | — | — | 3φFT | — | 3φT→TPAR | — | 3φT→TPAR | — |
| 3 | × | × | × | — | — | — | 3φFT | — | 3φT→TPAR | — | 3φT→TPAR | — |
| 4 | × | | | | | | 1φT→MPAR | | 1φT→MPAR | | 1φT→MPAR | |
| 5 | × | | | × | | | 1φT→MPAR | 1φT→MPAR | 1φT→MPAR | 1φT→MPAR | 1φT→MPAR | 1φT→MPAR |
| 6 | × | × | | | | | 2φT→MPAR | | 2φT→MPAR | | 2φT→MPAR | |
| 7 | × | | | | × | | 1φT→MPAR | 1φT→MPAR | 1φT→MPAR | 1φT→MPAR | 1φT→MPAR | 1φT→MPAR |
| 8 | × | × | | × | | | 2φT→MPAR | 1φT→MPAR | 2φT→MPAR | 1φT→MPAR | 2φT→MPAR | 1φT→MPAR |
| 9 | × | × | | × | × | | 3φFT | 3φFT | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR |
| 10 | × | × | × | | | | 3φT→MPAR | | 3φT→MPAR | | 3φT→MPAR | |
| 11 | × | × | | | | × | 2φT→MPAR | 1φT→MPAR | 2φT→MPAR | 1φT→MPAR | 2φT→MPAR | 1φT→MPAR |
| 12 | × | × | | | × | × | 2φT→MPAR | 2φT→MPAR | 2φT→MPAR | 2φT→MPAR | 2φT→MPAR | 2φT→MPAR |
| 13 | × | × | × | × | | | 3φT→MPAR | 1φT→MPAR | 3φT→MPAR | 1φT→MPAR | 3φT→MPAR | 1φT→MPAR |
| 14 | × | × | × | × | × | | 3φFT | 3φFT | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR |
| 15 | × | × | × | × | × | × | 3φFT | 3φFT | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR |

×: Fault, —: The line is out of service
MPAR: Multi-phase reclosing TPAR: Three-phase reclosing
SPAR: Single-phase reclosing 3 φ FT: three-phase final tripping
1 φ T: single-phase tripping 2 φ T: two-phase tripping
3 φ T: three-phase tripping

www.ElectricalPartManuals.com

**Table M-2 Reclosing in MPAR3 ([ARC-M]=M3 setting)**

| Case No. | Fault phase | | | | | | Tripping and Reclosing (Tripping mode → Reclosing mode) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | #1 line | | | #2 line | | | [MA-NOLK] = FT setting | | [MA-NOLK] = T setting | | [MA-NOLK] = S+T setting | |
| | A | B | C | A | B | C | #1 line | #2 line | #1 line | #2 line | #1 line | #2 line |
| 1 | × | | | — | — | — | 3φFT | — | 3φT→TPAR | — | 1φT→SPAR | — |
| 2 | × | × | | — | — | — | 3φFT | — | 3φT→TPAR | — | 3φT→TPAR | — |
| 3 | × | × | × | — | — | — | 3φFT | — | 3φT→TPAR | — | 3φT→TPAR | — |
| 4 | × | | | | | | 1φT→MPAR | | 1φT→MPAR | | 1φT→MPAR | |
| 5 | × | | | × | | | 3φFT | 3φFT | 3φT→TPAR | 3φT→TPAR | 1φT→SPAR | 1φT→SPAR |
| 6 | × | × | | | | | 2φT→MPAR | | 2φT→MPAR | | 2φT→MPAR | |
| 7 | × | | | | × | | 1φT→MPAR | 1φT→MPAR | 1φT→MPAR | 1φT→MPAR | 1φT→MPAR | 1φT→MPAR |
| 8 | × | × | | × | | | 3φFT | 3φFT | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR | 1φT→SPAR |
| 9 | × | × | | × | × | | 3φFT | 3φFT | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR |
| 10 | × | × | × | | | | 3φT→MPAR | | 3φT→MPAR | | 3φT→MPAR | |
| 11 | × | × | | | | × | 2φT→MPAR | 1φT→MPAR | 2φT→MPAR | 1φT→MPAR | 2φT→MPAR | 1φT→MPAR |
| 12 | × | × | | | × | × | 3φFT | 3φFT | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR |
| 13 | × | × | × | × | | | 3φFT | 3φFT | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR | 1φT→SPAR |
| 14 | × | × | × | × | × | | 3φFT | 3φFT | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR |
| 15 | × | × | × | × | × | × | 3φFT | 3φFT | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR | 3φT→TPAR |

www . ElectricalPartManuals . com

www . ElectricalPartManuals . com

# Appendix N

# Data Transmission Format

www . ElectricalPartManuals . com

## Transmission Format

The data transmission format depends on the communication mode.

Figures N-1 and N-2 show the data transmission format that applies to the data transmission between terminals of the transmission lines by the relay. The individual parts of the transmission format are described below.

(1) Frame header

A signal indicating the head of a frame.

(2) Current data

12 bit data (incl. one sign bit) indicating the current value of sampling of each phase.

(3) SA flag and control data

Device data (CB, DS) and control data necessary for the protective function are transmitted by sub-commutation. Sub-commutation is used for signals that may be transmitted at low speed, and has the meaning that 1-bit information is different from frame to frame.

Frames are identified by the SA flag, which is also transmitted by sub-commutation. It detects the signal pattern of 00001 and identifies a frame number. One cycle of frame numbers covers 12 frames.

(4) SP flag and time data

The SP flag and time data for sampling time synchronization are transmitted by sub-commutation. Sub-commutation detects the signal pattern of 00001 and identifies a frame number.

The time data for sampling time synchronization has 16 bits.

(5) CRC (Cyclic Redundancy Check) data

CRC data is added to check transmitting data for transmission errors.

Data without the frame header is divided by a polynomial and the resultant remainder is transmitted as the CRC data.

On the receiving side, the CRC data is subtracted from the transmitted data, the result divided by the same polynomial, and the remainder checked for 0.

Polynomial: $X^{16} + X^{12} + X^5 + 1$

(6) User configurable data

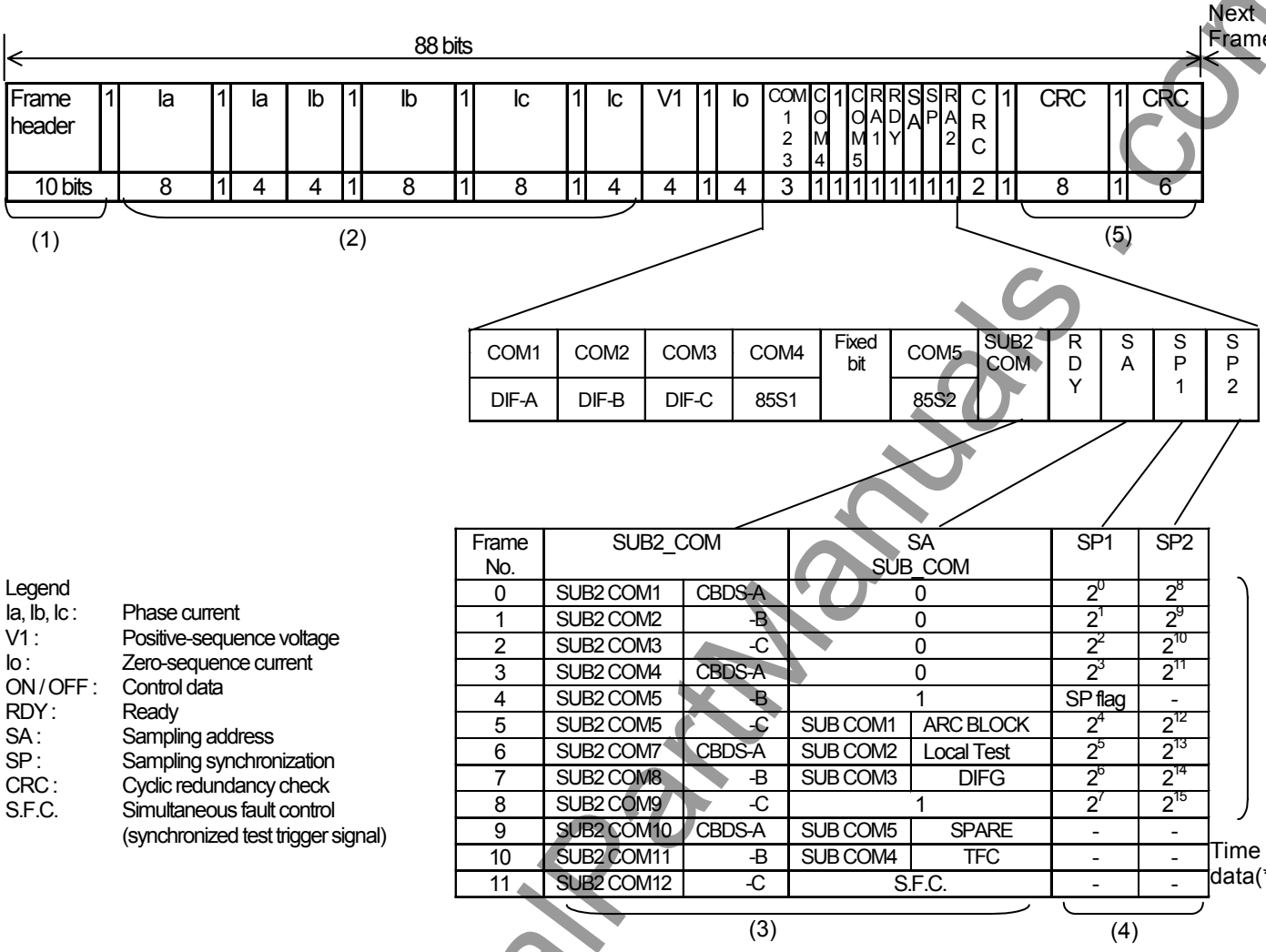
Number of user configurable data depends on the communication mode and whether a function is used or not. The transmission data and user configurable data is shown in Table N-1 and Figures N-1 and N-2.

www . ElectricalPartManuals . com

**Table N-1 User Configurable data**

| Transmission data | Sending side | Receiving side | Remarks |
|---|---|---|---|
| Phase current | 12 bits × (Ia, Ib, Ic) | 12 bits × (Ia, Ib, Ic) | Fixed. |
| Positive-sequence Voltage | A-MODE: V1 fixed. 4 bits / 1 frame (sent it by 3 frame shared)<br>B-/GPS-MODE: V1 for OST/FL. If the OST/FL are not used, the following are configurable.<br>V.COM1-S (Signal No.: 2096)<br>V.COM2-S (Signal No.: 2097)<br>V.COM3-S (Signal No.: 2098)<br>S.V.COM1-S (Signal No.: 2100) to<br>S.V.COM12-S (Signal No.: 2111) | A-MODE: V1 fixed. 4 bits / 1 frame (sent it by 3 frame shared)<br>B-/GPS-MODE: V1 for OST/FL. If the OST/FL are not used, the following are configurable.<br>V.COM1-R1 (Signal No.: 960) / V.COM1-R2 (Signal No.: 976)<br>V.COM2-R1 (Signal No.: 961) / V.COM2-R2 (Signal No.: 977)<br>V.COM3-R2 (Signal No.: 962) / V.COM3-R2 (Signal No.: 978)<br>S.V.COM1-R1 (Sig. No.: 964) to S.V.COM12-R1 (Sig. No.: 975) /<br>S.V.COM1-R2 (Sig. No.: 980) to S.V.COM12-R2 (Sig. No.: 991) | |
| Zero-sequence current | A-MODE: I0 fixed. 4 bits / 1 frame (sent it by 3 frame shared)<br>B-/GPS-MODE: I1 for DIFG is assigned. If the DIFG is not used, the following are configurable.<br>I.COM1-S (Signal No.: 2112)<br>I.COM2-S (Signal No.: 2113)<br>I.COM3-S (Signal No.: 2114)<br>S.I.COM1-S (Signal No.: 2116) to<br>S.I.COM12-S (Signal No.: 2127) | A-MODE: I1 fixed. 4 bits / 1 frame (sent it by 3 frame shared)<br>B-/GPS-MODE: I1 for DIFG. If the DIFG are not used, the following are configurable.<br>I.COM1-R1 (Signal No.: 992) / I.COM1-R2 (Signal No.: 1008)<br>I.COM2-R1 (Signal No.: 993) / I.COM2-R2 (Signal No.: 1009)<br>I.COM3-R2 (Signal No.: 994) / I.COM3-R2 (Signal No.: 1010)<br>S.I.COM1-R1 (Sig. No.: 996) to S.I.COM12-R1 (Sig. No.: 1007) /<br>S.I.COM1-R2 (Sig. No.: 1012) to S.I.COM12-R2 (Sig. No.: 1023) | |
| COM1 – COM3 | A-MODE: DIF-A, -B, -C for model 513 fixed. For other models, these are configurable.<br>COM1-S (Signal No.: 2048)<br>COM2-S (Signal No.: 2049)<br>COM3-S (Signal No.: 2050) | COM1-R1 (Signal No.: 1088) / COM1-R2 (Signal No.: 1128)<br>COM2-R1 (Signal No.: 1089) / COM2-R2 (Signal No.: 1129)<br>COM3-R1 (Signal No.: 1090) / COM2-R2 (Signal No.: 1130)<br>The following are signals without two-time verification:<br>COM1-R1_UF (Sig. No.: 1096) / COM1-R2_UF (Sig. No.: 1136)<br>COM2-R1_UF (Sig. No.: 1097) / COM2-R2_UF (Sig. No.: 1137)<br>COM3-R1_UF (Sig. No.: 1098) / COM2-R2_UF (Sig. No.: 1138) | Available for only A-MODE except for model 513. |
| COM4, COM5 (85S1, 85S2) | Used for transfer signals.<br>COM4-S (Signal No.: 2051)<br>COM5-S (Signal No.: 2052) | COM4-R1 (Signal No.: 1091) / COM4-R2 (Signal No.: 1131)<br>COM5-R1 (Signal No.: 1092) / COM5-R2 (Signal No.: 1132)<br>The following are signals without two-time verification:<br>COM4-R1_UF (Sig. No.: 1099) / COM4-R2_UF (Sig. No.: 1139)<br>COM5-R1_UF (Sig. No.: 1100) / COM5-R2_UF (Sig. No.: 1140) | |
| SUB2-COM (CBDS/RA1) | B-/GPS-MODE: RA* for RYIDSV is assigned. If RYIDSV is not used, the following are configurable.<br>SUB2_COM1-S (Signal No.: 2064) to<br>SUB2_COM12-S (Signal No.: 2075) | SUB2_COM1-R1 (Sig. No.: 1112) to SUB2_COM12-R1 (Sig. No.: 1123) /<br>SUB2_COM1-R2 (Sig. No.: 1152) to SUB2_COM12-R2 (Sig. No.: 1153) | Sent by 12 SSP cycle. |
| SP2/RA2 | SUB3_COM1-S (Signal No.: 2080) to<br>SUB3_COM12-S (Signal No.: 2091) | SUB3_COM1-R1 (Sig. No.: 1168) to SUB3_COM12-R1 (Sig. No.: 1179) /<br>SUB3_COM1-R2 (Sig. No.: 1184) to SUB3_COM12-R2 (Sig. No.: 1195) | |
| SA | Configurable data.<br>SUB_COM1-S (Signal No.: 2056) to<br>SUB_COM5-S (Signal No.: 2060) | SUB_COM1-R1 (Sig. No.: 1104) to SUB_COM5-R1 (Sig. No.: 1108) /<br>SUB_COM1-R2 (Sig. No.: 1144) to SUB_COM5-R2 (Sig. No.: 1148) | No. 2058, 2059 and 2060 in B-/GPS-MODE are not available. |

www.ElectricalPartManuals.com




Legend

| | |
|---|---|
| Ia, Ib, Ic : | Phase current |
| V1 : | Positive-sequence voltage |
| Io : | Zero-sequence current |
| ON / OFF : | Control data |
| RDY : | Ready |
| SA : | Sampling address |
| SP : | Sampling synchronization |
| CRC : | Cyclic redundancy check |
| S.F.C. | Simultaneous fault control (synchronized test trigger signal) |

(*) Time data are transmitted once per two cycles.

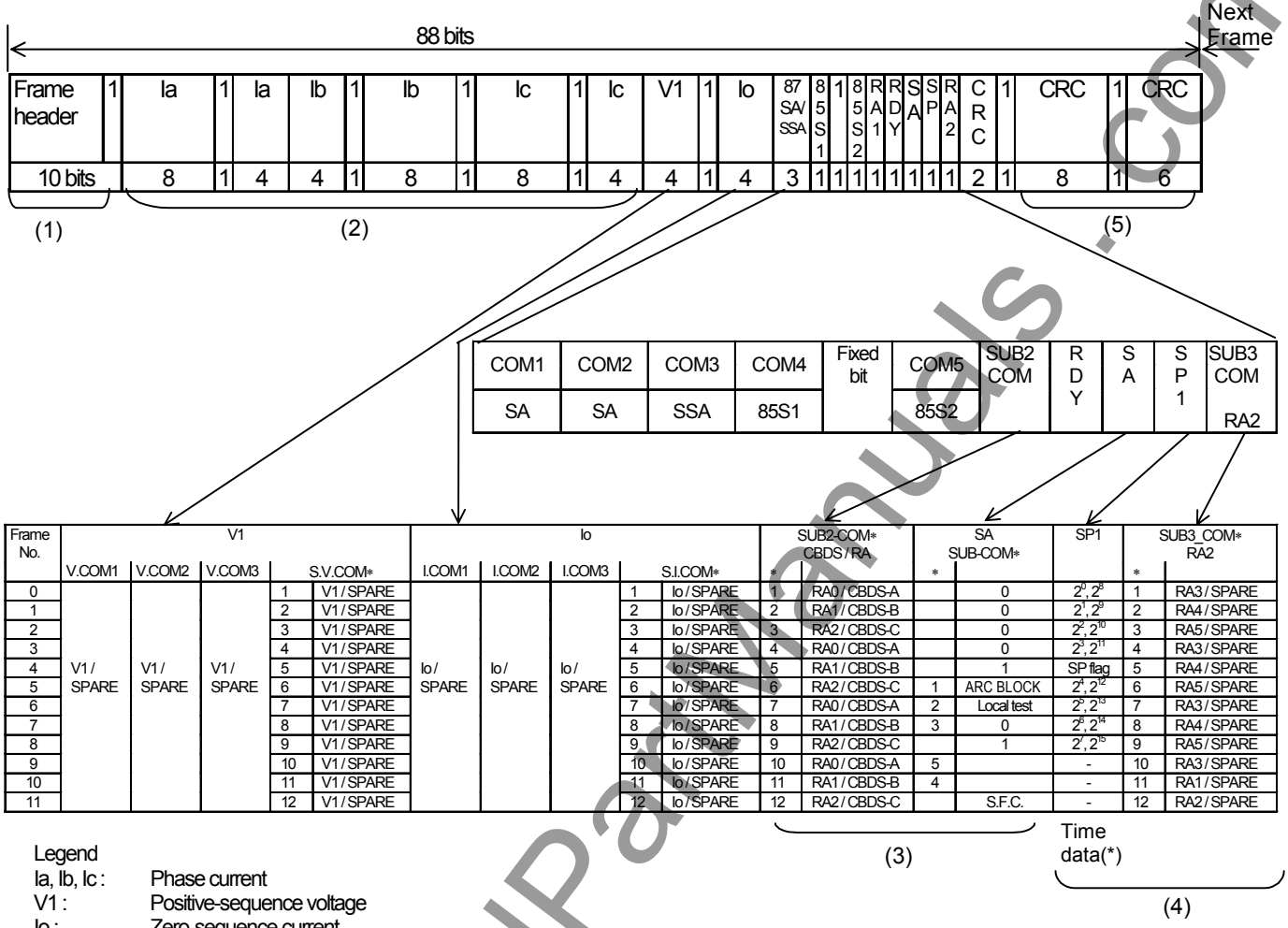
**Figure N-1 Data Transmission Format of A-MODE**

User configurable commands are the followings:

COM1- to COM5-: These commands are sent every frame and used for high-speed signals such as a transfer trip and block signals.

SUB_COM1 to SUB_COM5: These commands are sent every 12 frames. SUB_COM1, SUB_COM2, SUB_COM3 and SUB_COM4 are assigned to ARC_BLOCK, Local test, DIFG, and TFC signals as default setting. If these signals are changed, the related functions cannot be applied.

www . ElectricalPartManuals . com




Legend

| | |
|---|---|
| Ia, Ib, Ic : | Phase current |
| V1 : | Positive-sequence voltage |
| Io : | Zero-sequence current |
| ON / OFF : | Control data |
| RDY : | Ready |
| SA : | Sampling address for a cycle |
| SSA | Sampling address for a second |
| SP : | Sampling synchronization |
| CRC : | Cyclic redundancy check |
| S.F.C. | Simultaneous fault control (synchronized test trigger signal) |

(*) Time data are transmitted once per two cycle.

**Figure N-2 Data Transmission Format of B-MODE and GPS-MODE**

User configurable commands are as:

COM1 to COM3: Used for sampling address.

COM4 and COM5: Used for transfer signals.

SUB_COM: These commands are sent every 12 frames. SUB_COM1 and SUB_COM2 are assigned to ARC_BLOCK and Local test signals as default setting. If these signals are changed, the related functions cannot be applied.

V.COM1 to V.COM3 and S.V.COM1 to S.V.COM12: If the OST and FL functions are not used, the user can use these commands. The V.COM1 to V.COM3 commands are sent every frame. The S.V.COM1 to S.V.COM12 are sent every 12 frames.

I.COM1 to I.COM3 and S.I.COM1 to S.I.COM12: If the DIFG function is not used, the user can use these commands. The I.COM1 to I.COM3 commands are sent every frame. The S.I.COM1 to S.I.COM12 are sent every 12 frames.

www.ElectricalPartManuals.com

SUB2_COM1 to SUB2_COM12: These commands are assigned to bits (RA∗) for relay address monitoring RYIDSV as default setting. If the RYIDSV is not used, the user can use these commands. If multi-phase autoreclosing function is applied, for example, these commands are assigned to CBDS-A, -B and –C such as shown in Figure N-1.

SUB3_COM1 to SUB3_COM12: These commands are also assigned to bits (RA∗) for relay address monitoring RYIDSV as default setting. If the RYIDSV is not used, the user can use these commands.

www . ElectricalPartManuals . com

# Appendix O

## Example of Setting

www . ElectricalPartManuals . com

# 1. Segregated-phase Current Differential Element DIF

### (1) Small current region DIFI1

The characteristic of the DIF for small current region is expressed by the following equation.

$I_d \geq (1/6)I_r + (5/6)DIFI1$

Where, DIFI1 defines the minimum operating current. Therefore, DIFI1 is determined to detect minimum fault current with margin of 1.5.

Examples: Minimum fault current = 3000A, CT ratio = 2000

DIFI1 = 3000A/1.5/2000 = 1 A

### (2) Large current region DIFI2

The characteristic of the DIF for large current region is expressed by the following equation.

$I_d \geq I_r - 2 \times DIFI2$

Where, DIFI2 defines the maximum out-flow current during an internal fault.

The characteristic has stronger restraint and prevents the element from operating falsely in response to the erroneous current caused by the CT saturation. The CT saturation occurs in smaller current than the current determined CT over current constant when the fault current includes transient DC. Therefore, DIFI2 is preferable as small as possible, but it must be larger than the maximum out-flowing current during an internal fault.

In case of two terminal network, the maximum out-flowing current is the maximum load current. In this case, DIFI2 is determined to the maximum load current with margin of 3 or 4.

Examples: Maximum load current = 2000A, CT ratio = 2000

DIFI2 = 2000A × 3/2000 = 3 A

### (3) Zero Sequence Current Differential Element DIFG

The minimum operating sensitivity of DIFGI is determined to detect high impedance earth fault. DIFGI is set to 30 to 50% of the minimum fault current DIFI1 setting.

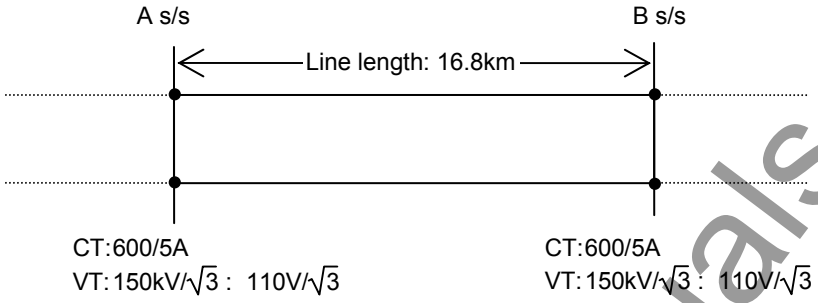
DIFG must not operate in response to the erroneous current caused by transient errors of the CT during an external fault. Therefore, the time delay TDIFG setting is preferable larger than 0.1s.

www . ElectricalPartManuals . com

# 2. Distance protection

## 2.1 Power System Data

[Example system]




- Line impedance of A s/s - Bs/s
  - Positive sequence impedance: 0.0197 + j0.2747 (ohms/km)
  - Zero sequence impedance: 0.4970 + j1.4387 (ohms/km)
  - Mutual impedance: 0.0212 + j0.3729 (ohms/km)
- Back impedance
  - A s/s: 0.94 (%pu) at 100MVA base
  - B s/s: 0.94 (%pu) at 100MVA base
- Normal load current: 594.7A
- Minimum fault current: 2.05kA

## 2.2 Relay Setting

- Relay application:

  Relay type: GRL100-701

  Protection scheme: BOP (Blocking overreach protection), 3 zone time-stepped distance protection

  Autoreclose mode: 1 + 3

## 2.3 Setting Calculation

### Normal load current

To calculate load current, back impedance is converted from a percent unit value to an impedance value.

Base impedance $Zbase = (Vbase)^2/VAbase$

$= (150kV/\sqrt{3})^2/100MVA$

$= 75$ ohms

Therefore, load current $I_L$ is:

$I_L$ = (Source voltage)/(A s/s back impedance + Line impedance + B s/s impedance)

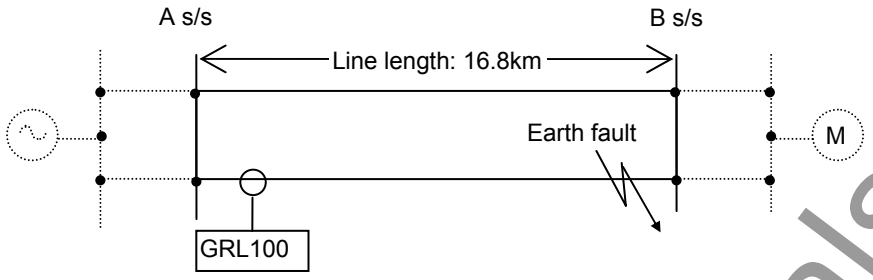
$= (150kV/\sqrt{3})/(0.94 \times 75 + 16.8 \times \sqrt{(0.0197^2 + 0.2747^2)} + 0.94 \times 75)$

$= 594.7A$

www.ElectricalPartManuals.com

### 2.4 Minimum fault current

The minimum fault current $I_{fmin}$ on a protected transmission line is the current of the phase to earth fault on the nearest remote terminal.




To calculate $I_{fmin}$, zero sequence earth fault current ($I_0$), positive sequence earth fault current ($I_1$) and negative earth fault current ($I_2$) are calculated as follows:

$I_0 = I_1 = I_2$ = (Source voltage)/{(Back impedance of A s/s)

+ (Transmission line zero sequence impedance)

+ (Transmission line positive sequence impedance) × 2*}

$$= (150\text{kV}/\sqrt{3})/\{(0.94 \times 75) + 16.8 \times \sqrt{(0.4970^2 + 1.4387^2)} + 2 \times 16.8 \times \sqrt{(0.0197^2 + 0.2747^2)}\}$$

$$= 822.28\text{A}$$

So,

$I_{fmin} = I_0 + I_1 + I_2 = 3 \times 822.28 = 2.47\text{kA}$

***Note:** Assuming that positive sequence impedance = negative sequence impedance.

### 2.5 Scheme setting

| Element | Contents | Setting |
|---|---|---|
| CRSCM | Command protection scheme selection | BOP |
| DISCR | Distance carrier | ON |
| DEFCR | DEF carrier | OFF |
| ZS-C | Mho or Quadrilateral characteristic | Mho or Quad (Note *1) |
| ZG-C | Mho or Quadrilateral characteristic | Mho or Quad (Note *1) |
| CHSEL | Carrier channel configuration | SINGLE |
| BOSW | Carrier sending signal | A |
| ZONESEL | Carrier control element | Z2 |
| ECHO | ECHO carrier send | ON |
| WKIT | Weak carrier trip | ON |
| CH-DEF | DEF carrier channel | -- |
| PSB-Z1 | PSB for Z1 elements | ON |
| PSB-Z2 | PSB for Z2 elements | ON |
| PSB-Z3 | PSB for Z3 elements | ON |
| PSB-CR | PSB for carrier trip | ON |
| PSB-ZR | PSB for ZR elements | OFF |

www.ElectricalPartManuals.com

| Element | Contents | Setting |
|---|---|---|
| PSB-TP | Trip under PSB | ON |
| Z1CNT | Z1 trip mode | 1 |
| TPMODE | Trip mode | 1PH |
| STUB | STUB protection | OFF |
| SOTF-OC | SOTF OC trip | ON |
| SOTF-Z1 | SOTF Z1 trip | OFF |
| SOTF-Z2 | SOTF Z2 trip | OFF |
| SOTF-Z3 | SOTF Z3 trip | OFF |
| SOTF-R | SOTF ZF trip | OFF |
| Z2TP | Z2 element back-up trip | ON |
| Z3TP | Z3 element back-up trip | ON |
| ZRBT | ZR element back-up trip | OFF |
| OCBT | OC back-up trip | OFF |
| OCIBT | OCI back-up trip | OFF |
| EFBT | EF back-up trip | ON |
| EFBTAL | EF back-up trip alarm | ON |
| EFIBT | EFI back-up trip | F |
| DEFFEN | DEFF back-up trip | ON |
| DEFREN | DEFR back-up trip | OFF |
| BF1 | CBF re-trip | OFF |
| BF2 | CBF related trip | OFF |
| BFEXT | CBF initiation by ext. trip | OFF |
| OST | Out of step trip | OFF |
| THMT | Thermal trip | OFF |
| THMAL | Thermal alarm | OFF |
| Autoreclose mode | Autoreclosing mode | SPAR&TPAR |
| ARC-SM | Multi. Shot ARC mode | OFF |
| ARC-CB | ARC mode for 1.5CB system | ONE |
| ARC-DEF | REC. by DG carr. trip | OFF |
| ARC-BU | ARC initiated by back-up trip | OFF |
| ARC-EXT | ARC initiated by ext. trip | OFF |
| VCHK | TPAR condition | LB |
| VTPHSEL | VT phase selection | A |
| VT-RATE | VT rating | PH/G |
| 3PH-VT | 3ph. VT location | BUS |

www.ElectricalPartManuals.com

## 2.6 Impedance setting

| Element | Standard setting (Recommended) | Setting |
|---|---|---|
| Z1S | 80% of protected line reactance | 80% |
| Z2S | 120% or more of protected line reactance | 130% |
| Z3S | 100% of protected line impedance plus 150% of next line section | 300% |
| Z3Sθ | Line angle setting (Note *1) | |
| Z4S | 120% of Z3S | 120% of Z3S setting |
| Z1G | 75% - 80% of protected line reactance | 75% |
| Z2G | 120% or more of protected line reactance | 130% |
| Z3G | 400% - 600% of protected line impedance | 500% |
| Z3Gθ | Line angle setting (Note *1) | |
| Z4G | 120% of Z3G | 120% of Z3G setting |
| PSBSZ | 2 ohms (5A rating) | 2 ohms |
| PSBGZ | 2 ohms (5A rating) | 2 ohms |

**Step 1**

Calculate the setting impedance from the given recommended reach point table.

**Step 2**

Multiply the actual impedance by the factor "k" to calculate the relay impedance:

Relay impedance = k × Actual impedance

Factor "k" is calculated as follows:

$$K = (\text{CT ratio})/(\text{VT ratio}) = (600/5A)/((150kV/\sqrt{3})/(110V)/\sqrt{3})) = 0.088$$

**Note *1:** Z3Sθ and Z3Gθ line angle settings are applicable if [ZS-C] and [ZG-C] are set to "Mho".

Line angle $\theta = \tan^{-1}(0.2747/0.0197) = 85.9°$

The line angle setting is set to 85°. Alternatively set to a smaller angle (e.g. 80°) in consideration of higher levels of fault resistance.

**<Z1S, Z2S, Z3S, Z4S, Z1G, Z2G element>**

Z1S, Z2S, Z3S, Z4S, Z1G, Z2G element settings are calculated as shown in the following table.

**<Z3G, Z4G element>**

Zero sequence current compensation is not applied to Z3 or Z4. Z3G and Z4G settings should be larger than the calculated values because of the underreaching effect without zero sequence current compensation.

a. Setting condition of Z3G element:

The Z3G element must operate on all faults for which the Z2G element operates.

(lower setting limit: Z3G > Z2G)

The Z3G element must not operate on load current. (upper setting limit), so:

X3G setting = [Zline × 130%](Z2G setting) × 2.6(operating margin for no zero phase

www.ElectricalPartManuals.com

sequence current compensation) × 1.5(operating margin)

= 500% of Zline

b. Setting condition of Z4G element

The operation zone of the Z4G element includes the operating zone of the Z3G element remote terminal relay.

| Element | Actual impedance (ohms) | k factor | Relay impedance (ohms) |
|---|---|---|---|
| Z1S | 3.692 | 0.088 | 0.32 |
| Z2S | 5.999 | | 0.53 |
| Z3S | 13.84 | | 1.22 |
| Z4S | 16.61 | | 1.46 |
| Z1G | 3.461 | | 0.30 |
| Z2G | 5.999 | | 0.53 |
| Z3G | 23.07 | | 2.03 |
| Z4G | 27.68 | | 2.44 |
| PSBSZ | ----- | | 2.00 |
| PSBGZ | ----- | | 2.00 |

## 2.7 Blinder setting

Zero sequence compensation is not applied to the blinder elements.

Recommended setting: 5.00 ohms

These elements should not operate under maximum load current:

Rset < load impedance/margin

< V rating/(2.5 times of I rating)

= (110V/$\sqrt{3}$ )/(2.5 × 5A)

= 5.08

| Element | Setting |
|---|---|
| BFRS | 5.00 Ω |
| BFLS θ | 120° |
| BRRS | 5.00 Ω |
| BRLS | Linked with BFRS |
| BFRG | 5.00 Ω |
| BFLG θ | 120° |
| BRRG | 5.00 Ω |
| BRLG | Linked with BRRG |

www . ElectricalPartManuals . com

## 2.8 Zero sequence compensation

In the GRZ100, vector type zero sequence compensation is applied to Zone 1 and Zone 2, and the compensation factor is given in the resistive and reactive components independently.

**Step 1**

Calculate the positive, zero sequence impedance and mutual impedance:

$Z_1 = [R_1: 0.0197] + j[X_1: 0.2747]$ (ohms)

$Z_0 = [R_0: 0.497] + j[X_0: 1.4287]$ (ohms)

$Z_m = [R_m: 0.0212] + j[X_m: 0.3729]$ (ohms)

**Step 2**

Calculate the zero and mutual sequence compensation factor setting according to the following equations:

$K_{RS} = R_0/R_1 \times 100 = 0.497/0.0197 = 2523$*

$K_{XS} = X_0/X_1 \times 100 = 1.4387/0.2747 = 524$

$K_{Rm} = R_m/R_1 \times 100 = 0.0212/0.0197 = 108$

$K_{Xm} = X_m/X_1 \times 100 = 0.3729/0.2747 = 136$

***Note:** If the calculated value exceeds 1000, then a setting of 1000 should be applied, this being considered to be the maximum practical value.

| Element | Setting |
|---|---|
| $K_{RS}$ | 1000 |
| $K_{XS}$ | 524 |
| $K_{Rm}$ | 108 |
| $K_{Xm}$ | 136 |

## 2.9 Current setting

a. Definite time earth fault protection (EF)

The EF element may be used either to provide back-up earth fault protection or, alternatively, open circuit protection. For example, to detect open faults of the CT circuit, the operating value of the detector should be lower than the normal load current on the line:

EF ≤ (normal load current/CT ratio) × 0.5

= (594.7 × 5/600) × 0.5

= 2.48A

| Element | Setting (A) |
|---|---|
| EF | 2.4 |

b. Directional earth fault element (DEF)

The DEF element should not be operated by the unbalance current or voltage present in normal conditions. It is recommended to set the current and voltage after measuring the actual unbalance residual current and voltage on the site.

DEFFI, DEFRI > Max. zero sequence current ($3I_0$) in normal conditions

www . ElectricalPartManuals . com

DEFFV, DEFRV > Max. zero sequence voltage ($3V_O$) in normal conditions

| Element | Setting |
|---|---|
| DEFFI | 2.5 (A) |
| DEFRI | 2.5 (A) |
| DEFFV | 21.0 (V) |
| DEFRV | 21.0 (V) |
| DEFF θ | 85 |
| DEFR θ | 85 |

c. IDMT overcurrent element (EFI)

The EFI element should not be operated by the unbalance current present under normal conditions. It is recommended to set the current after measuring the actual unbalance residual current for the protected line.

EFI > Max. zero sequence current ($3I_O$) in normal condition

| Element | Setting |
|---|---|
| EFI | 2.5 (A) |
| TEFI | 0.5 |
| MEFI | S |

d. Switch-on-to-fault/stub protection (OCH)

The setting of the OCH element should be lower than the minimum fault current ($I_{fmin}$) at the busbar:

OCH $< (I_{fmin}/\text{CT ratio}) \times 0.5$

$= \{(0.8(\text{margin}) \times 2.47\text{kA})/(600/5)\} \times 0.5$

$= 8.23\text{A}$

| Element | Setting |
|---|---|
| OCH | 8.2 (A) |

e. Breaker failure protection (BF)

The setting of the BF element should be lower than the minimum fault current:

OCBF $< (I_{fmin}/\text{CT ratio}) \times 0.5$

$= \{(0.5 \times 2.47\text{kA})/(600/5)\} \times 0.5$

$= 5.14\text{A}$

Setting of TBF1 = Breaker opening time + OCBF reset time + Margin

= 40ms + 10ms + 20ms

= 70ms

Setting of TBF2 = TBF1 + Output relay operating time + Breaker opening time + OCBF reset time + Margin

= 70ms + 10ms + 40ms + 10ms + 10ms

= 140ms

www . ElectricalPartManuals . com

| Element | Setting |
|---|---|
| OCBF | 5.1 (A) |
| TBF1 | 70ms |
| TBF2 | 140ms |

### 2.10 Undervoltage element

a. Undervoltage element with current compensation (Phase selector)

(1) Undervoltage element (UVCV)

The UVCV element should be set not to work with the current of the power system.

UVCV $<$ rated voltage $\times$ 0.7

$= 63.5\text{V} \times 0.7$

$= 44.5$

(2) Reach setting (UVCZ)

The UVCZ element is set to the line impedance value.

UVCZ $= 16.8 \times \sqrt{(0.0197^2 + 0.2747^2)} \times 0.088$

$= 0.41$ ohms

| Element | Setting |
|---|---|
| UVCV | 45V |
| UVCZ | 0.41 |
| UVC $\theta$ | 85 |

b. VT failure supervision

The undervoltage element for VT failure supervision (UVFS, UVFG) is set to about 50% of the rated voltage.

| Element | Setting |
|---|---|
| UVFS | 52V |
| UVFG | 30V |

c. Weak infeed tripping function

The undervoltage element for weak infeed tripping (UVLS, UVLG) is set to 70% of the rated voltage.

| Element | Setting |
|---|---|
| UVLS | 77V |
| UVLG | 45V |

### 2.11 Time setting

a. Time delay setting for zone distance protection

b. Coordination time setting for protection signaling channel

This time setting is required only for the Blocking scheme. The time should be set larger than the time delay of protection signaling equipment (PSE) including propagation time of PLC (Power Line Carrier) or other communication link. The time setting should include an operation margin of 5ms.

www.ElectricalPartManuals.com

Time setting = Time delay of PSE + Margin

= 12ms + 5ms

= 17ms

c. Time setting of earth fault element EF (TEF)

This time setting is for time delay of the EF element. If it is set to 3s, the trip/alarm contact will close 3s after detecting an unbalance current (residual current) such as a CT open circuit fault. In addition to CT open circuit faults, this element can detect a broken conductor condition.

d. Time setting of directional earth fault relay (TDEFB)

Set the time delay for the directional earth fault element for back-up.

| Element | Setting (s) |
|---|---|
| TZ1S | 0.00 |
| TZ2S | 0.30 |
| TZ3S | 0.40 |
| TZ1G | 0.00 |
| TZ2G | 0.30 |
| TZ3G | 0.40 |
| TCHD | 0.017 |
| TEF | 3.00 |
| TDEFB | 3.00 |

## 2.12 Autoreclose setting

a. Dead timer reset timing

b. Dead line timer
The SPAR and TPAR timer are provided to present the deionized time of the line. The SPAR element is initiated simultaneously by the reclose initiation for single-pole autoreclose dead time. TPAR is for three-pole autoreclose dead time.

c. Reclaim timer
The reclosing command signal is blocked during adjusted time set by reclaim timer, after the breaker is closed manually or automatically.

d. ARC reset timer
This time element starts to run upon reclosing initiation.

e. ARC output pulse timer
The duration of the reclosing pulse depends on the operation time of the breaker. The required pulse time is set by this time element.

| Element | Setting (s) |
|---|---|
| TEVLV | 0.30 |
| TSPR | 0.80 |
| TTPR | 0.60 |
| TRDY | 60 |
| TRR | 2.00 |
| TW | 0.2 |

www . ElectricalPartManuals . com

### 2.13 Synchronism check element

The synchronism check element setting is as follows.

| Element | Setting |
|---|---|
| SY1UV | 83V |
| SY10V | 51V |
| SY1 θ | 30deg. |
| TSYN1 | 1.00s |
| TDBL1 | 0.05s |
| TLBD1 | 0.05s |
| OVB | 51V |
| UVB | 13V |
| OVL1 | 51V |
| UVL1 | 13V |

www . ElectricalPartManuals . com

# Appendix P

## Programmable Reset Characteristics and Implementation of Thermal Model to IEC60255-8

www.ElectricalPartManuals.com

# Programmable Reset Characteristics

The overcurrent stages for phase and earth faults, OC1 and EF1, each have a programmable reset feature. Resetting may be instantaneous or definite time delayed.

Instantaneous resetting is normally applied in multi-shot auto-reclosing schemes, to ensure correct grading between relays at various points in the scheme.

The definite time delayed reset characteristic may be used to provide faster clearance of intermittent ('pecking' or 'flashing') fault conditions. An example of where such phenomena may be experienced is in plastic insulated cables, where the fault energy melts the cable insulation and temporarily extinguishes the fault, after which the insulation again breaks down and the process repeats.

An inverse time overcurrent protection with instantaneous resetting cannot detect this condition until the fault becomes permanent, thereby allowing a succession of such breakdowns to occur, with associated damage to plant and danger to personnel. If a definite time reset delay of, for example, 60 seconds is applied, on the other hand, the inverse time element does not reset immediately after each successive fault occurrence. Instead, with each new fault inception, it continues to integrate from the point reached during the previous breakdown, and therefore operates before the condition becomes permanent. Figure P-1 illustrates this theory.

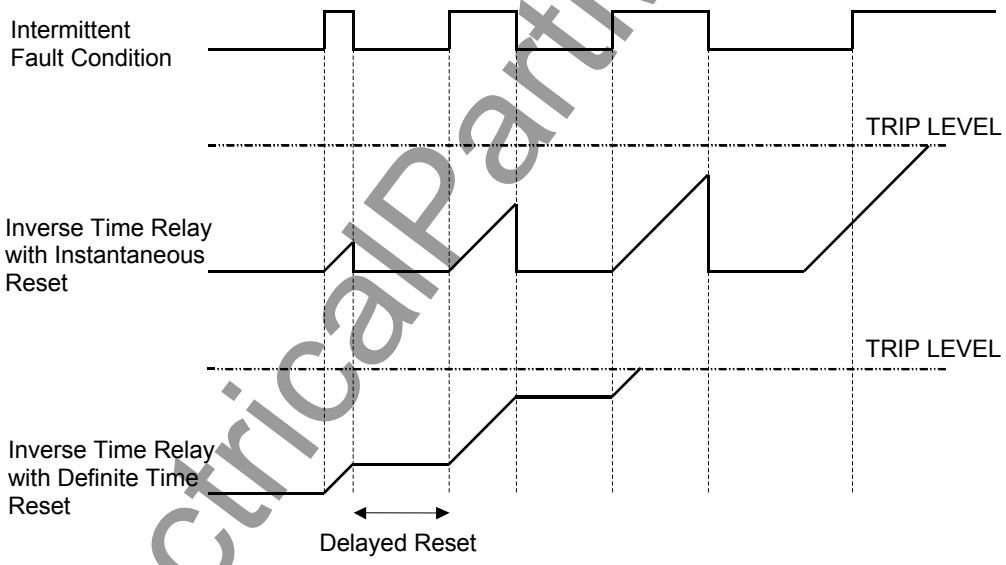



**Figure P-1**

www . ElectricalPartManuals . com

# Implementation of Thermal Model to IEC60255-8

Heating by overload current and cooling by dissipation of an electrical system follow exponential time constants. The thermal characteristics of the electrical system can be shown by equation (1).

$$\theta = \frac{I^2}{I_{AOL}^2}\left(1 - e^{-t/\tau}\right) \times 100\% \qquad (1)$$

where:

$\theta$ = thermal state of the system as a percentage of allowable thermal capacity,

I = applied load current,

$I_{AOL}$ = allowable overload current of the system,

$\tau$ = thermal time constant of the system.

The thermal state $\theta$ is expressed as a percentage of the thermal capacity of the protected system, where 0% represents the cold state and 100% represents the thermal limit, that is the point at which no further temperature rise can be safely tolerated and the system should be disconnected. The thermal limit for any given electrical plant is fixed by the thermal setting $I_{AOL}$. The relay gives a trip output when $\theta$ = 100%.

If current I is applied to a cold system, then $\theta$ will rise exponentially from 0% to ($I^2/I_{AOL}^2 \times 100\%$), with time constant $\tau$, as in Figure P-2. If $\theta$ = 100%, then the allowable thermal capacity of the system has been reached.

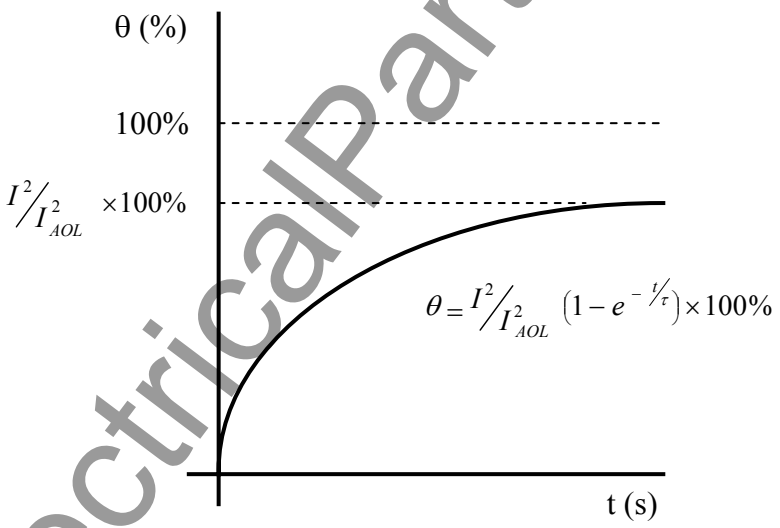



**Figure P-2**

A thermal overload protection relay can be designed to model this function, giving tripping times according to the IEC60255-8 'Hot' and 'Cold' curves.

$$t = \tau \cdot Ln\left[\frac{I^2}{I^2 - I_{AOL}^2}\right] \qquad (1) \quad \cdots\cdots \text{Cold curve}$$

$$t = \tau \cdot Ln\left[\frac{I^2 - I_P{}^2}{I^2 - I_{AOL}^2}\right] \qquad (2) \quad \cdots\cdots \text{Hot curve}$$

where:

$I_P$ = prior load current.

www.ElectricalPartManuals.com

In fact, the cold curve is simply a special case of the hot curve where prior load current $I_P = 0$, catering for the situation where a cold system is switched on to an immediate overload.

Figure P-3 shows a typical thermal profile for a system which initially carries normal load current, and is then subjected to an overload condition until a trip results, before finally cooling to ambient temperature.

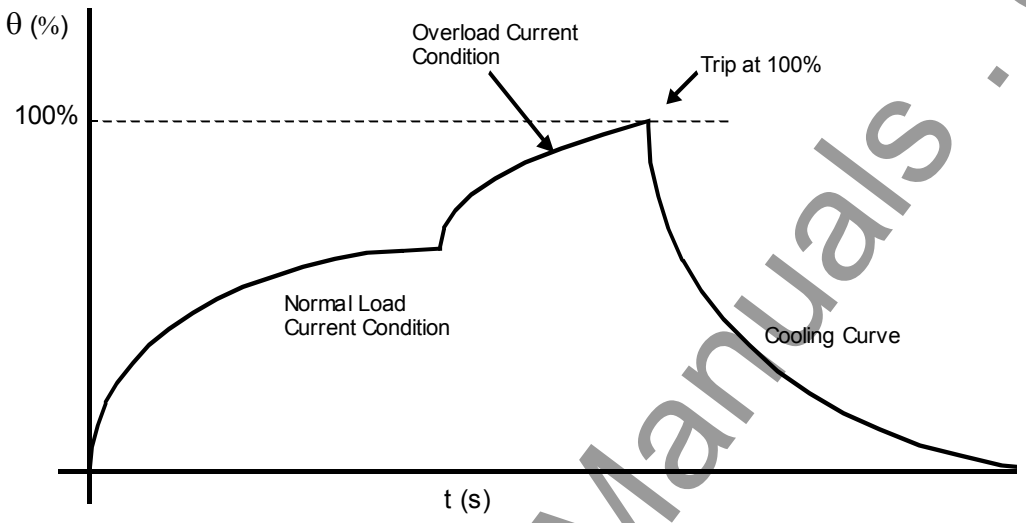



**Figure P-3**

www . ElectricalPartManuals . com

# Appendix Q

# IEC60870-5-103: Interoperability

www . ElectricalPartManuals . com

## IEC60870-5-103 Configurator

IEC103 configurator software is included in a same CD as RSM100, and can be installed easily as follows:

### Installation of IEC103 Configurator

Insert the CD-ROM (RSM100) into a CDROM drive to install this software on a PC.

Double click the "Setup.exe" of the folder "\IEC103Conf" under the root directory, and operate it according to the message.

When installation has been completed, the IEC103 Configurator will be registered in the start menu.

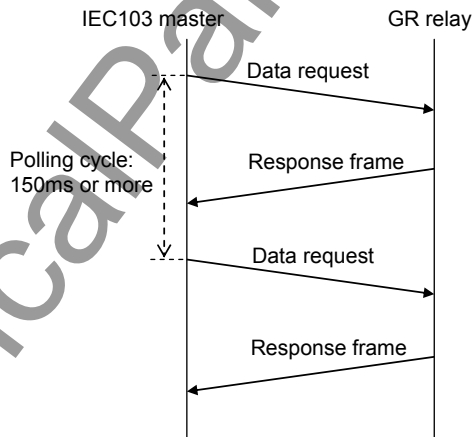
### Starting IEC103 Configurator

Click [Start]→[Programs]→[IEC103 Configurator]→[IECConf] to the IEC103 Configurator software.

Note: The instruction manual of IEC103 Configurator can be viewed by clicking [Help]→[Manual] on IEC103 Configurator.

### Requirements for IEC60870-5-103 master station

Polling cycle: 150ms or more
Timeout time (time till re-sending the request frame to relay): 100ms or more




## IEC60870-5-103: Interoperability

### 1. Physical Layer

1.1 Electrical interface: EIA RS-485

Number of loads, 32 for one protection equipment

1.2 Optical interface

Glass fibre (option)

ST type connector (option)

1.3 Transmission speed

User setting: 9600 or 19200 bit/s

www.ElectricalPartManuals.com

### 2. Application Layer

COMMON ADDRESS of ASDU

One COMMON ADDRESS OF ASDU (identical with station address)

### 3. List of Information

The following items can be customized with the original software tool "IEC103 configurator". (For details, refer to "IEC103 configurator" manual No.6F2S0839.)

- Items for "Time-tagged message": Type ID(1/2), INF, FUN, Transmission condition(Signal number), COT
- Items for "Time-tagged measurands": INF, FUN, Transmission condition(Signal number), COT, Type of measurand quantities
- Items for "General command": INF, FUN, Control condition(Signal number)
- Items for "Measurands": Type ID(3/9), INF, FUN, Number of measurand, Type of measurand quantities
- Common setting
  - Transmission cycle of Measurand frame
  - FUN of System function
  - Test mode, etc.

**CAUTION:** To be effective the setting data written via the RS232C, turn off the DC supply of the relay and turn on again.

### 3.1 IEC60870-5-103 Interface

3.1.1 Spontaneous events

The events created by the relay will be sent using Function type (FUN) / Information numbers (INF) to the IEC60870-5-103 master station.

3.1.2 General interrogation

The GI request can be used to read the status of the relay, the Function types and Information numbers that will be returned during the GI cycle are shown in the table below.

For details, refer to the standard IEC60870-5-103 section 7.4.3.

3.1.3 Cyclic measurements

The relay will produce measured values using Type ID=3 or 9 on a cyclical basis, this can be read from the relay using a Class 2 poll. The rate at which the relay produces new measured values can be customized.

3.1.4 Commands

The supported commands can be customized. The relay will respond to non-supported commands with a cause of transmission (COT) of negative acknowledgement of a command.

For details, refer to the standard IEC60870-5-103 section 7.4.4.

3.1.5 Test mode

In test mode, both spontaneous messages and polled measured values, intended for processing in the control system, are designated by means of the CAUSE OF TRANSMISSION 'test mode'.

www.ElectricalPartManuals.com

This means that CAUSE OF TRANSMISSION = 7 ‘test mode’ is used for messages normally transmitted with COT=1 (spontaneous) or COT=2 (cyclic).

For details, refer to the standard IEC60870-5-103 section 7.4.5.

3.1.6 Blocking of monitor direction

If the blocking of the monitor direction is activated in the protection equipment, all indications and measurands are no longer transmitted.

For details, refer to the standard IEC60870-5-103 section 7.4.6.

### 3.2 List of Information

The followings are the default settings.

www . ElectricalPartManuals . com

## List of Information

| INF | Description | Contents | IEC103 Configurator Default setting | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | GI | Type ID | COT | FUN | DPI | | |
| | | | | | | | Signal No. | OFF | ON |
| Standard Information numbers in monitor direction | | | | | | | | | |
| System Function | | | | | | | | | |
| 0 | End of General Interrogation | Transmission completion of GI items. | -- | 8 | 10 | 255 | -- | -- | -- |
| 0 | Time Synchronization | Time Synchronization ACK. | -- | 6 | 8 | 255 | -- | -- | -- |
| 2 | Reset FCB | Reset FCB(toggle bit) ACK | -- | 5 | 3 | 192 | -- | -- | -- |
| 3 | Reset CU | Reset CU ACK | -- | 5 | 4 | 192 | -- | -- | -- |
| 4 | Start/Restart | Relay start/restart | -- | 5 | 5 | 192 | -- | -- | -- |
| 5 | Power On | Relay power on. | Not supported | | | | -- | -- | -- |
| Status Indications | | | | | | | | | |
| 16 | Auto-recloser active | If it is possible to use auto-recloser, this item is set active, if impossible, inactive. | GI | 1 | 1, 9, 11, 12 | 192 | 1411 | 1 | 2 |
| 17 | Teleprotection active | If protection using telecommunication is available, this item is set to active. If not, set to inactive. | GI | 1 | 1, 9, 12 | 192 | 1412 | 1 | 2 |
| 18 | Protection active | If the protection is available, this item is set to active. If not, set to inactive. | GI | 1 | 1, 9, 12 | 192 | 1413 | 1 | 2 |
| 19 | LED reset | Reset of latched LEDs | -- | 1 | 1, 11, 12 | 192 | 1409 | -- | 2 |
| 20 | Monitor direction blocked | Block the 103 transmission from a relay to control system. IECBLK: "Blocked" settimg. | GI | 1 | 9, 11 | 192 | 1241 | 1 | 2 |
| 21 | Test mode | Transmission of testmode situation froma relay to control system. IECTST "ON" setting. | GI | 1 | 9, 11 | 192 | 1242 | 1 | 2 |
| 22 | Local parameter Setting | When a setting change has done at the local, the event is sent to control system. | Not supported | | | | | | |
| 23 | Characteristic1 | Setting group 1 active | GI | 1 | 1, 9, 11, 12 | 192 | 1243 | 1 | 2 |
| 24 | Characteristic2 | Setting group 2 active | GI | 1 | 1, 9, 11, 12 | 192 | 1244 | 1 | 2 |
| 25 | Characteristic3 | Setting group 3 active | GI | 1 | 1, 9, 11, 12 | 192 | 1245 | 1 | 2 |
| 26 | Characteristic4 | Setting group 4 active | GI | 1 | 1, 9, 11, 12 | 192 | 1246 | 1 | 2 |
| 27 | Auxiliary input1 | Binary input 1 | No set | | | | | | |
| 28 | Auxiliary input2 | Binary input 2 | No set | | | | | | |
| 29 | Auxiliary input3 | Binary input 3 | No set | | | | | | |
| 30 | Auxiliary input4 | Binary input 4 | No set | | | | | | |
| Supervision Indications | | | | | | | | | |
| 32 | Measurand supervision I | Zero sequence current supervision | GI | 1 | 1, 9 | 192 | 1267 | 1 | 2 |
| 33 | Measurand supervision V | Zero sequence voltage supervision | GI | 1 | 1, 9 | 192 | 1268 | 1 | 2 |
| 35 | Phase sequence supervision | Negative sequence voltage supevision | GI | 1 | 1, 9 | 192 | 1269 | 1 | 2 |
| 36 | Trip circuit supervision | Output circuit supervision | Not supported | | | | | | |
| 37 | I>>backup operation | | Not supported | | | | | | |
| 38 | VT fuse failure | VT failure | GI | 1 | 1, 9 | 192 | 891 | 1 | 2 |
| 39 | Teleprotection disturbed | CF(Communication system Fail) supervision | GI | 1 | 1, 9 | 192 | 226 | 1 | 2 |
| 46 | Group warning | Only alarming | GI | 1 | 1, 9 | 192 | 1258 | 1 | 2 |
| 47 | Group alarm | Trip blocking and alarming | GI | 1 | 1, 9 | 192 | 1252 | 1 | 2 |
| Earth Fault Indications | | | | | | | | | |
| 48 | Earth Fault L1 | A phase earth fault | No set | | | | | | |
| 49 | Earth Fault L2 | B phase earth fault | No set | | | | | | |
| 50 | Earth Fault L3 | C phase earth fault | No set | | | | | | |
| 51 | Earth Fault Fwd | Earth fault forward | Not supported | | | | | | |
| 52 | Earth Fault Rev | Earth fault reverse | Not supported | | | | | | |

www . ElectricalPartManuals . com

| INF | Description | Contents | IEC103 Configurator Default setting | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | GI | Type ID | COT | FUN | DPI | | |
| | | | | | | | Signal NO. | OFF | ON |
| Fault Indications | | | | | | | | | |
| 64 | Start/pick-up L1 | A phase, A-B phase or C-A phase element pick-up | No set | | | | | | |
| 65 | Start/pick-up L2 | B phase, A-B phase or B-C phase element pick-up | No set | | | | | | |
| 66 | Start/pick-up L3 | C phase, B-C phase or C-A phase element pick-up | No set | | | | | | |
| 67 | Start/pick-up N | Earth fault element pick-up | No set | | | | | | |
| 68 | General trip | Any trip | -- | 2 | 1 | 192 | 1280 | -- | 2 |
| 69 | Trip L1 | A phase, A-B phase or C-A phase trip | No set | | | | | | |
| 70 | Trip L2 | B phase, A-B phase or B-C phase trip | No set | | | | | | |
| 71 | Trip L3 | C phase, B-C phase or C-A phase trip | No set | | | | | | |
| 72 | Trip I>>(back-up) | Back up trip | No set | | | | | | |
| 73 | Fault location X In ohms | Fault location | -- | 4 | 1 | 192 | 1048 | -- | -- |
| 74 | Fault forward/line | Forward fault | Not supported | | | | | | |
| 75 | Fault reverse/Busbar | Reverse fault | Not supported | | | | | | |
| 76 | Teleprotection Signal transmitted | Carrier signal sending | Not supported | | | | | | |
| 77 | Teleprotection Signal received | Carrier signal receiving | Not supported | | | | | | |
| 78 | Zone1 | Zone 1 trip | -- | 2 | 1 | 192 | 895 | -- | 2 |
| 79 | Zone2 | Zone 2 trip | -- | 2 | 1 | 192 | 896 | -- | 2 |
| 80 | Zone3 | Zone 3 trip | -- | 2 | 1 | 192 | 897 | -- | 2 |
| 81 | Zone4 | Zone 4 trip | No set | | | | | | |
| 82 | Zone5 | Zone 5 trip | No set | | | | | | |
| 83 | Zone6 | Zone 6 trip | No set | | | | | | |
| 84 | General Start/Pick-up | Any elements pick-up | No set | | | | | | |
| 85 | Breaker Failure | CBF trip or CBF retrip | -- | 2 | 1 | 192 | 92 | -- | 2 |
| 86 | Trip measuring system L1 | | Not supported | | | | | | |
| 87 | Trip measuring system L2 | | Not supported | | | | | | |
| 88 | Trip measuring system L3 | | Not supported | | | | | | |
| 89 | Trip measuring system E | | Not supported | | | | | | |
| 90 | Trip I> | Inverse time OC trip | -- | 2 | 1 | 192 | 114 | -- | 2 |
| 91 | Trip I>> | Definite time OC trip | -- | 2 | 1 | 192 | 113 | -- | 2 |
| 92 | Trip IN> | Inverse time earth fault OC trip | -- | 2 | 1 | 192 | 117 | -- | 2 |
| 93 | Trip IN>> | Definite time earth fault OC trip | -- | 2 | 1 | 192 | 115 | -- | 2 |
| Autoreclose indications | | | | | | | | | |
| 128 | CB 'ON' by Autoreclose | CB close command output | -- | 1 | 1 | 192 | 177 | -- | 2 |
| 129 | CB 'ON' by long-time Autoreclose | | Not supported | | | | | | |
| 130 | Autoreclose Blocked | Autoreclose block | GI | 1 | 1, 9 | 192 | 121 | 2 | 1 |

Details of Fault location settings in IEC103 configurator

| INF | Tbl | Offset | Data type | Coeff |
|---|---|---|---|---|
| 73 | 5 | 26 | short | 0.1 |

www . ElectricalPartManuals . com

| INF | Description | Contents | IEC103 configurator Default setting | | | | |
|---|---|---|---|---|---|---|---|
| | | | GI | Type ID | COT | FUN | Max. No. |
| Measurands | | | | | | | |
| 144 | Measurand I | <meaurand I> | No | | | | 0 |
| 145 | Measurand I,V | <meaurand I> | No | | | | 0 |
| 146 | Measurand I,V,P,Q | <meaurand I> | No | | | | 0 |
| 147 | Measurand IN,VEN | <meaurand I> | No | | | | 0 |
| 148 | Measurand IL1,2,3, VL1,2,3, P,Q,f | Ia, Ib, Ic, Va, Vb, Vc, P, Q, f measurand <meaurand II> | -- | 9 | 2, 7 | 192 | 9 |
| Generic Function | | | | | | | |
| 240 | Read Headings | | Not supported | | | | |
| 241 | Read attributes of all entries of a group | | Not supported | | | | |
| 243 | Read directory of entry | | Not supported | | | | |
| 244 | Real attribute of entry | | Not supported | | | | |
| 245 | End of GGI | | Not supported | | | | |
| 249 | Write entry with confirm | | Not supported | | | | |
| 250 | Write entry with execute | | Not supported | | | | |
| 251 | Write entry aborted | | Not supported | | | | |

Details of MEA settings in IEC103 configurator

| INF | MEA | Tbl | Offset | Data type | Limit | | Coeff |
|---|---|---|---|---|---|---|---|
| | | | | | Lower | Upper | |
| 148 | Ia | 1 | 36 | short | 0 | 4096 | 3.41333 |
| | Ib | 1 | 40 | short | 0 | 4096 | 3.41333 |
| | Ic | 1 | 44 | short | 0 | 4096 | 3.41333 |
| | Va | 1 | 0 | short | 0 | 4096 | 0.26877 |
| | Vb | 1 | 4 | short | 0 | 4096 | 0.26877 |
| | Vc | 1 | 8 | short | 0 | 4096 | 0.26877 |
| | P | 2 | 8 | long | -4096 | 4096 | 0.00071661 |
| | Q | 2 | 12 | long | -4096 | 4096 | 0.00071661 |
| | f | 2 | 16 | short | 0 | 4096 | 0.34133 |

www . ElectricalPartManuals . com

| INF | Description | Contents | IEC103 Configurator Default setting | | | |
|---|---|---|---|---|---|---|
| | | | Control direction | Type ID | COT | FUN |
| Selection of standard information numbers in control direction | | | | | | |
| System functions | | | | | | |
| 0 | Initiation of general interrogation | | -- | 7 | 9 | 255 |
| 0 | Time synchronization | | -- | 6 | 8 | 255 |
| General commands | | | | | | |
| 16 | Auto-recloser on/off | | ON/OFF | 20 | 20 | 192 |
| 17 | Teleprotection on/off | | ON/OFF | 20 | 20 | 192 |
| 18 | Protection on/off | (*1) | ON/OFF | 20 | 20 | 192 |
| 19 | LED reset | Reset indication of latched LEDs. | ON | 20 | 20 | 192 |
| 23 | Activate characteristic 1 | Setting Group 1 | ON | 20 | 20 | 192 |
| 24 | Activate characteristic 2 | Setting Group 2 | ON | 20 | 20 | 192 |
| 25 | Activate characteristic 3 | Setting Group 3 | ON | 20 | 20 | 192 |
| 26 | Activate characteristic 4 | Setting Group 4 | ON | 20 | 20 | 192 |
| Generic functions | | | | | | |
| 240 | Read headings of all defined groups | | Not supported | | | |
| 241 | Read values or attributes of all entries of one group | | Not supported | | | |
| 243 | Read directory of a single entry | | Not supported | | | |
| 244 | Read values or attributes of a single entry | | Not supported | | | |
| 245 | General Interrogation of generic data | | Not supported | | | |
| 248 | Write entry | | Not supported | | | |
| 249 | Write entry with confirmation | | Not supported | | | |
| 250 | Write entry with execution | | Not supported | | | |

(*1) Note: While the relay receives the "Protection off" command, "IN SERVICE LED" is off.

Details of Command settings in IEC103 configurator

| INF | DCO | | | |
|---|---|---|---|---|
| | Sig off | Sig on | Rev | Valid time |
| 16 | 2684 | 2684 | ✓ | 0 |
| 17 | 2685 | 2685 | ✓ | 0 |
| 18 | 2686 | 2686 | ✓ | 0 |
| 19 | 0 | 2688 | | 200 |
| 23 | 0 | 2640 | | 1000 |
| 24 | 0 | 2641 | | 1000 |
| 25 | 0 | 2642 | | 1000 |
| 26 | 0 | 2643 | | 1000 |

✓: signal reverse

www . ElectricalPartManuals .com

| | Description | Contents | GRL100 supported | Comment |
|---|---|---|---|---|
| Basic application functions | | | | |
| | Test mode | | Yes | |
| | Blocking of monitor direction | | Yes | |
| | Disturbance data | | No | |
| | Generic services | | No | |
| | Private data | | Yes | |
| Miscellaneous | | | | |
| | Measurand | | Max. MVAL = rated value times | |
| | Current L1 | Ia | Configurable | |
| | Current L2 | Ib | Configurable | |
| | Current L3 | Ic | Configurable | |
| | Voltage L1-E | Va | Configurable | |
| | Voltage L2-E | Vb | Configurable | |
| | Voltage L3-E | Vc | Configurable | |
| | Active power P | P | Configurable | |
| | Reactive power Q | Q | Configurable | |
| | Frequency f | f | Configurable | |
| | Voltage L1 - L2 | Vab | Configurable | |

Details of Common settings in IEC103 configurator

- Setting file's remark: GRL100_1.01
- Remote operation valid time [ms]: 4000
- Local operation valid time [ms]: 4000
- Measurand period [s]: 2
- Function type of System functions: 192
- Signal No. of Test mode: 1242
- Signal No. for Real time and Fault number: 1279

www . ElectricalPartManuals . com

[Legend]

GI: General Interrogation (refer to IEC60870-5-103 section 7.4.3)

Type ID: Type Identification (refer to IEC60870-5-103 section 7.2.1)

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 (refer to IEC60870-5-103 section 7.2.3)

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 (refer to IEC60870-5-103 section 7.2.5.1)

DPI: Double-point Information (refer to IEC60870-5-103 section 7.2.6.5)

DCO: Double Command (refer to IEC60870-5-103 section 7.2.6.4)

www.ElectricalPartManuals.com

**IEC103 setting data is recommended to be saved as follows:**

### (1) Naming for IEC103setting data

The file extension of IEC103 setting data is ".csv". The version name is recommended to be provided with a revision number in order to be changed in future as follows:

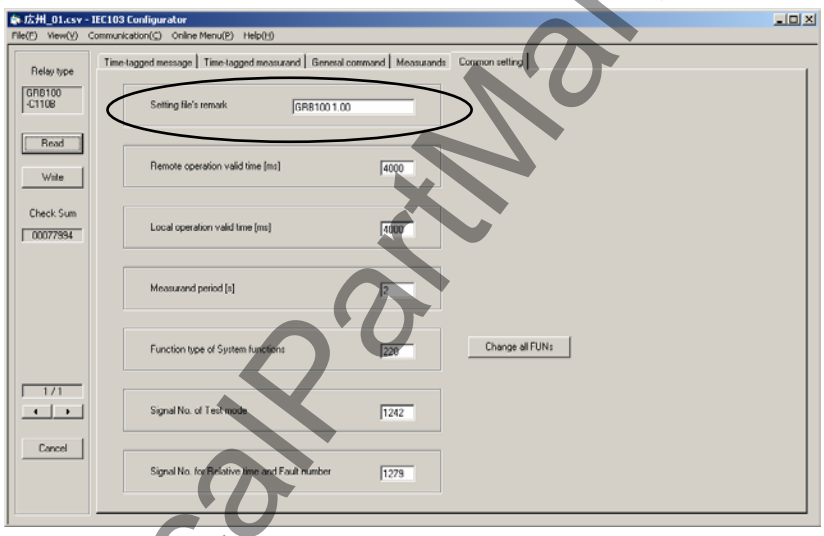
First draft: ******_01.csv

Second draft: ******_02.csv

Third draft: ******_03.csv

↑ Revision number

The name "******" is recommended to be able to discriminate the relay type such as GRZ100 or GRL100, etc. The setting files remark field of IEC103 is able to enter up to 12 one-byte characters. It is utilized for control of IEC103 setting data.




### (2) Saving theIEC103 setting data

The IEC103 setting data is recommended to be saved in external media such as FD (floppy disk) or CD-R, not to remain in the folder.

www . ElectricalPartManuals . com

## Troubleshooting

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Phenomena</th><th rowspan="2">Supposed causes</th><th colspan="2">Check / Confirmation</th></tr>
<tr><th>Object</th><th>Procedure</th></tr>
<tr><td rowspan="10">1</td><td rowspan="10">Communication trouble （IEC103 communication is not available.）</td><td>Address setting is incorrect.</td><td>BCU<br>RY</td><td>Match address setting between BCU and relay.<br>Avoid duplication of address with other relay.</td></tr>
<tr><td>Transmission baud rate setting is incorrect.</td><td>BCU<br>RY</td><td>Match transmission baud rate setting between BCU and relay.</td></tr>
<tr><td>Start bit, stop bit and parity settings of data that BCU transmits to relay is incorrect.</td><td>BCU</td><td>Go over the following settings by BCU. Relay setting is fixed as following settings.<br>- Start bit: 1bit<br>- Stop bit: 1bit<br>- Parity setting: even</td></tr>
<tr><td>The PRTCL1 setting is incorrect. (The model with PRTCL1 setting.)</td><td>RY</td><td>Change the PRTCL1 setting. Relation between PRTCL1 setting and available transmission protocol is referred to the following table.
<table>
<tr><td>RS485 port at the back of the relay</td><td>PRTCL1 =HDLC</td><td>PRTCL1 =IEC</td></tr>
<tr><td>COM1 (CH1)</td><td>HDLC</td><td>IEC</td></tr>
<tr><td>COM2 (CH2)</td><td>IEC</td><td>—</td></tr>
</table></td></tr>
<tr><td>RS485 or optical cable interconnection is incorrect.</td><td>Cable</td><td>- Check the connection port.(CH1/CH2)<br>- Check the interconnection of RS485 A/B/COM<br>- Check the send and received interconnection of optical cable.</td></tr>
<tr><td>The setting of converter is incorrect. (RS485/optic conversion is executed with the transmission channel, etc.)</td><td>Converter</td><td>In the event of using G1IF2, change the DIPSW setting in reference to INSTRUCTION MANUAL (6F2S0794).</td></tr>
<tr><td>The relationship between logical “0/1” of the signal and Sig.on/off is incorrect. (In the event of using optical cable)</td><td>BCU</td><td>Check the following;<br>Logical0 : Sig.on<br>Logical1:Sig.off</td></tr>
<tr><td>Terminal resistor is not offered. (Especially when RS485 cable is long.)</td><td>cable</td><td>Impose terminal resistor (150[ohms]) to both ends of RS 485 cable.</td></tr>
<tr><td>Relay cannot receive the requirement frame from BCU.<br>(The timing coordination of sending and receiving switch control is irregular in half-duplex communication.)</td><td>BCU</td><td>Check to secure the margin more than 15ms between receiving the reply frame from the relay and transmitting the next requirement frame on BCU.</td></tr>
<tr><td>The requirement frame from BCU and the reply frame from relay contend.<br>(The sending and receiving timing coordination is irregular in half-duplex communication.)</td><td>BCU</td><td>Check to set the time-out of reply frame from the relay.<br>Time-out setting: more than 100ms (acceptable value of response time 50ms plus margin)</td></tr>
</table>

www . ElectricalPartManuals . com

| No. | Phenomena | Supposed causes | Check / Confirmation | |
|---|---|---|---|---|
| | | | Object | Procedure |
| 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 IEC103 configurator if there is a setting error. When the setting is correct, check the signal condition by programmable LED, etc. |
| | | The relevant event Information Number (INF) and/or Function Type (FUN) may be different between the relay and SAS. | RY<br>SAS | Match the relevant event Information Number (INF) or Function Type (FUN) between the relay and SAS. |
| | | The relay is not initialised after writing IEC103 configurator setting. | RY | Check the sum value of IEC103 setting data from the LCD screen. When differing from the sum value on IEC103 configurator, initialise the relay. |
| | | It changes to the block mode. | RY | Change the IECBR settling to Normal. |
| 3 | Time can be synchronised with IEC103 communication. | BCU does not transmit the frame of time synchronisation. | BCU | Transmit the frame of time synchronisation. |
| | | The settling of 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

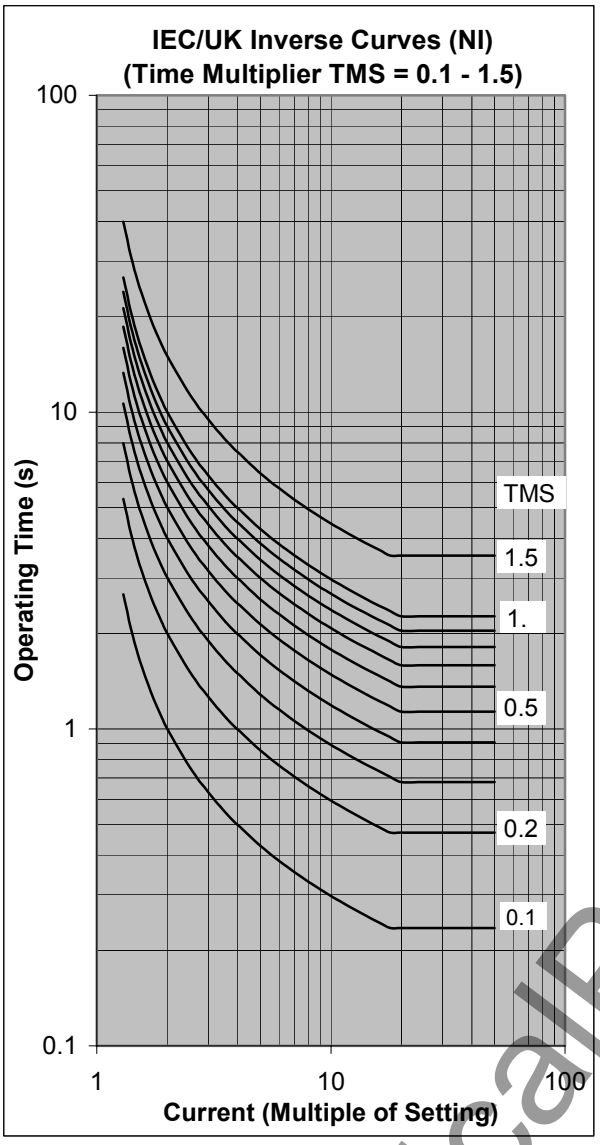
www . ElectricalPartManuals . com

www . ElectricalPartManuals . com

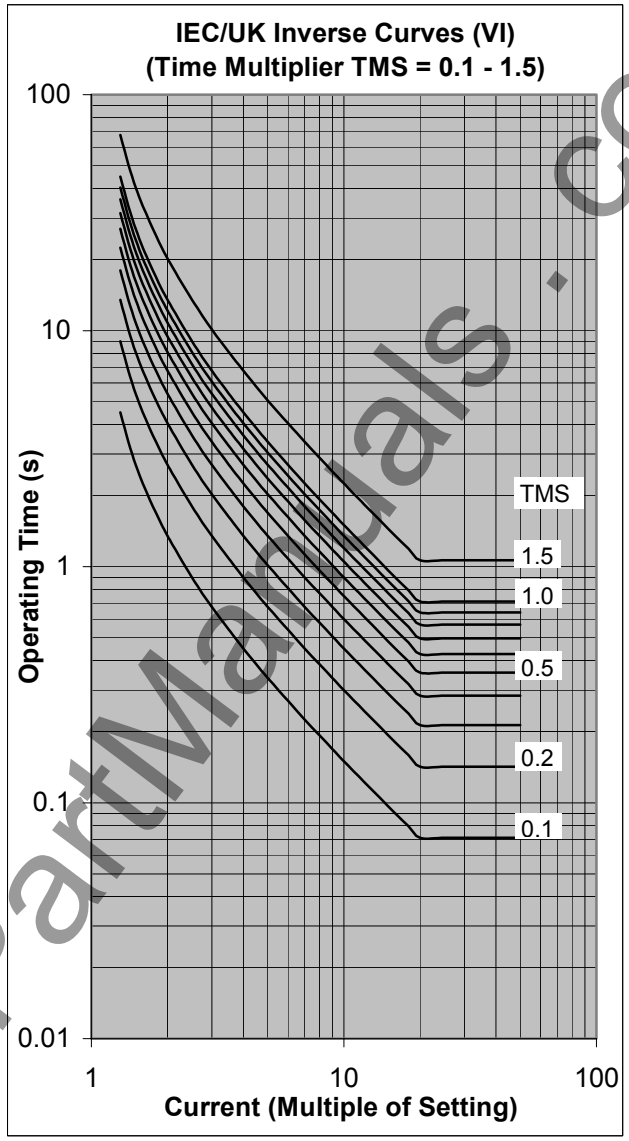
# Appendix R

# Inverse Time Characteristics

www . ElectricalPartManuals . com

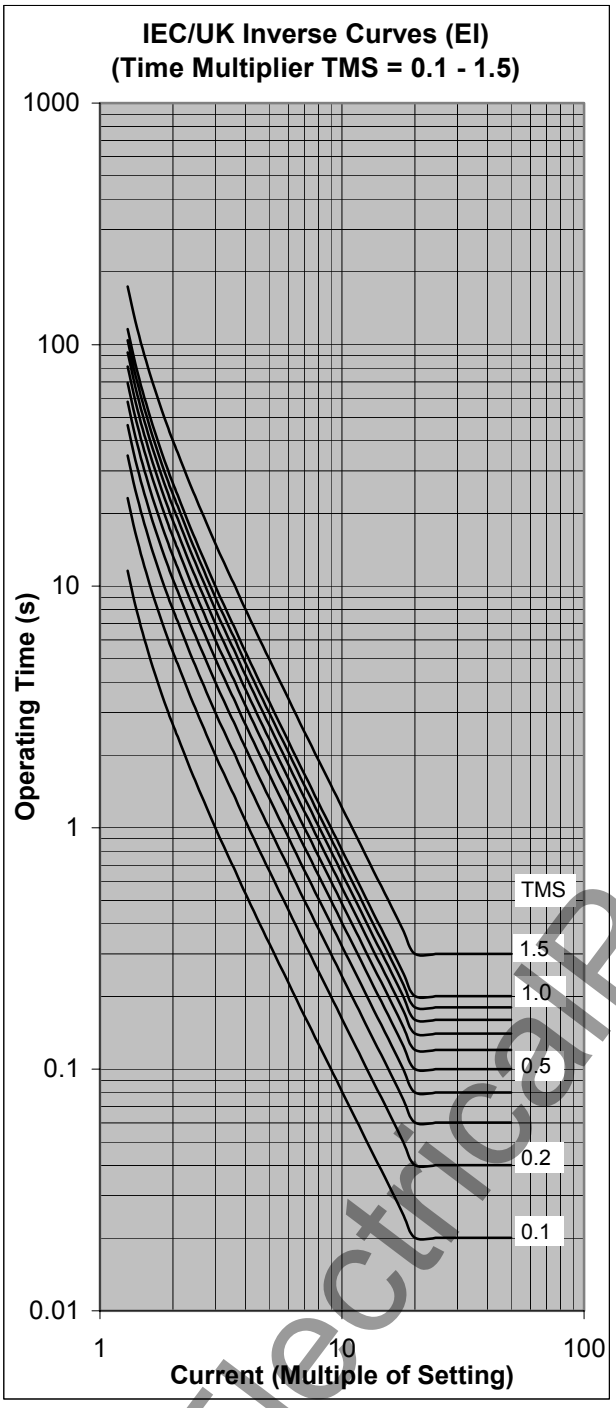



Normal Inverse

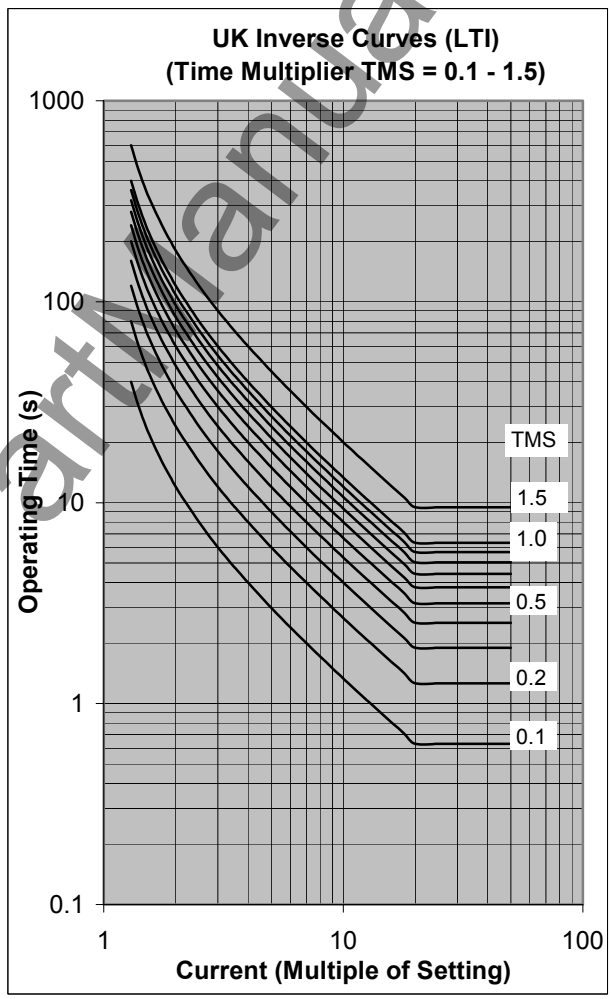



Very Inverse

www . ElectricalPartManuals . com




Extremely Inverse




Long Time Inverse

www . ElectricalPartManuals . com

www . ElectricalPartManuals . com

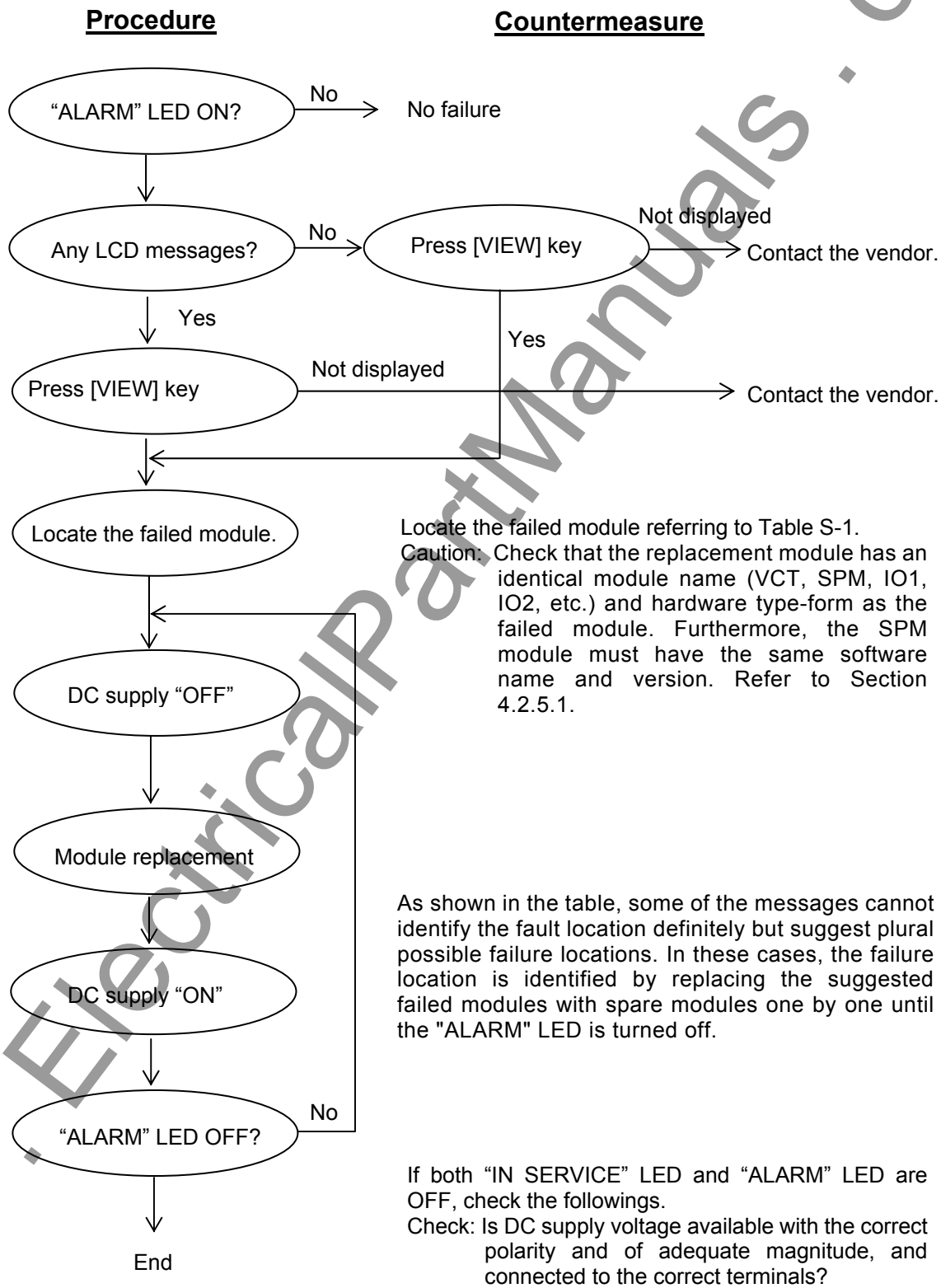
# Appendix S

## Failed Module Tracing and Replacement

www . ElectricalPartManuals . com

## 1. Failed module tracing and its replacement

If the “ALARM” LED is ON, the following procedure is recommended. If not repaired, contact the vendor.




www.ElectricalPartManuals.com

**Table S-1 LCD Message and Failure Location**

| Message | Failure location | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | VCT | SPM (GCOM) | IO1 | IO2 | IO3, IO5, IO6 | IO4 | HMI | Channel | Discon-nector | AC cable |
| Checksum err | | × | | | | | | | | |
| ROM-RAM err | | × | | | | | | | | |
| SRAM err | | × | | | | | | | | |
| BU-RAM err | | × | | | | | | | | |
| DPRAM err | | × | | | | | | | | |
| EEPROM err | | × | | | | | | | | |
| ROM data err | | × | | | | | | | | |
| A/D err | | × | | | | | | | | |
| V0 err | × (2) | × (1) | | | | | | | | × (2) |
| V2 err | × (2) | × (1) | | | | | | | | × (2) |
| I0 err | × (2) | × (1) | | | | | | | | × (2) |
| Id err | × (2) | × (1) | | | | | | | | × (2) |
| CT err | × (2) | × (2) | | | | | | | | × (1) |
| Sampling err | | × | | | | | | | | |
| DIO err | | × (2) | × (1) | × (1) | × (1) | × (1) | | | | |
| RSM err | | × (2) | × (1) | | | | | | | |
| COM_ ....err | | × | | | | | | | | |
| FD: ... err | | × (2) | × (1) | | | | | | | |
| O/P circuit fail | | × (2) | × (1) | | | | | | | |
| DS fail | | × (2) | × (2) | | | | | | × (1) | |
| Com.1 fail, Com.2 fail | | × (2)* | × (2)* | × (2)* | | | | × (1)* | | |
| Sync.1 fail, Sync.2 fail | | × (2)* | × (2)* | × (2)* | | | | × (1)* | | |
| TX1 level err, TX2 level err | | × (1)* | × (2)* | × (2)* | | | | × (1)* | | |
| RX1 level err, RX2 level err | | × (2)* | × (2)* | × (2)* | | | | × (1)* | | |
| CLK 1 fail, CLK 2 fail | | × (2)* | × (2)* | × (2)* | | | | × (1)* | | |
| Term1 rdy off, Term2 rdy off | | × (2)* | | | | | | × (1)* | | |
| RYID1 err, RYID2 err | | × (2)* | | | | | | × (1)* | | |
| CT fail | × (2) | × (2) | | | | | | | | × (1) |
| No-working of LCD | | × (2) | | | | | × (1) | | | |

The location marked with (1) has a higher probability than the location marked with (2).
The item of location marked with (*): also check the remote terminal relays and equipment.

www.ElectricalPartManuals.com

## 2. Methods of Replacing the Modules

**⚠ CAUTION** When handling a module, take anti-static measures such as wearing an earthed wrist band and placing modules on an earthed conductive mat. Otherwise, many of the electronic components could suffer damage.

**CAUTION** After replacing the SPM module, check all of the settings including the PLC and IEC103 setting data are restored the original settings.

The initial replacement procedure is as follows:

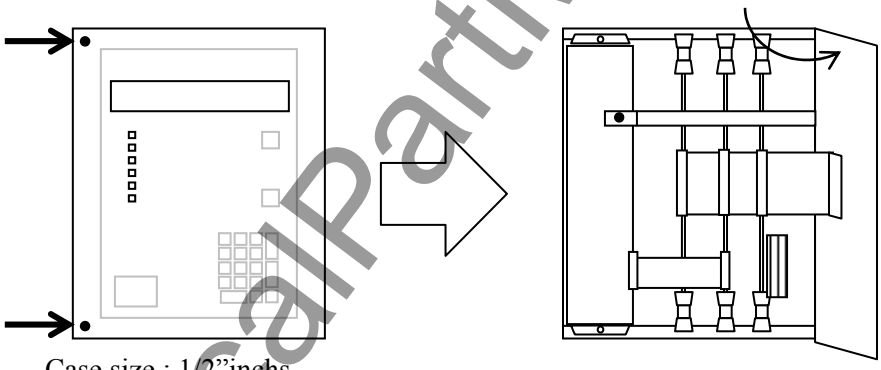
**1). Switch off the DC power supply.**

**⚠ WARNING** 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.

**2). Remove the front panel cover.**

**3). Open the front panel.**

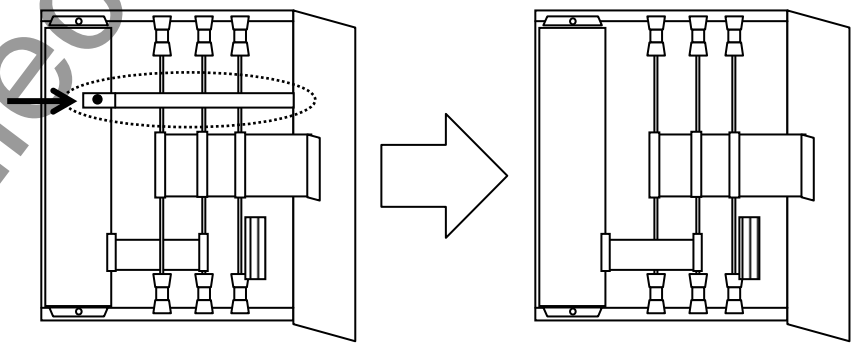
Open the front panel of the relay by unscrewing the binding screw located on the left side of the front panel.



Case size : 1/2"inchs

**4). Detach the holding bar.**

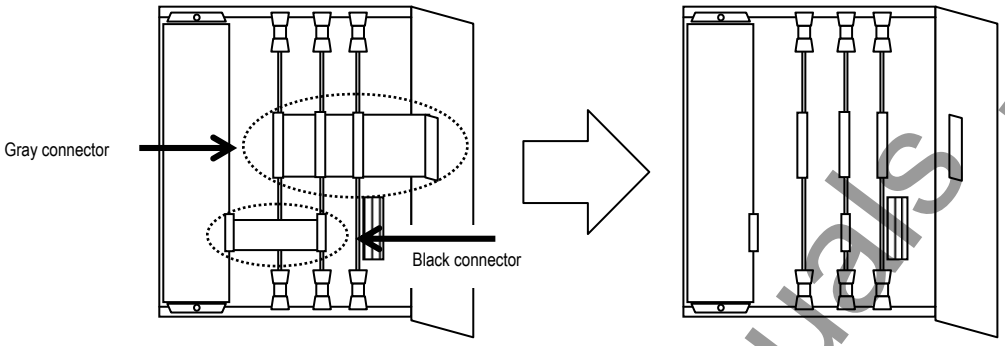
Detach the module holding bar by unscrewing the binding screw located on the left side of the bar.



www . ElectricalPartManuals . com

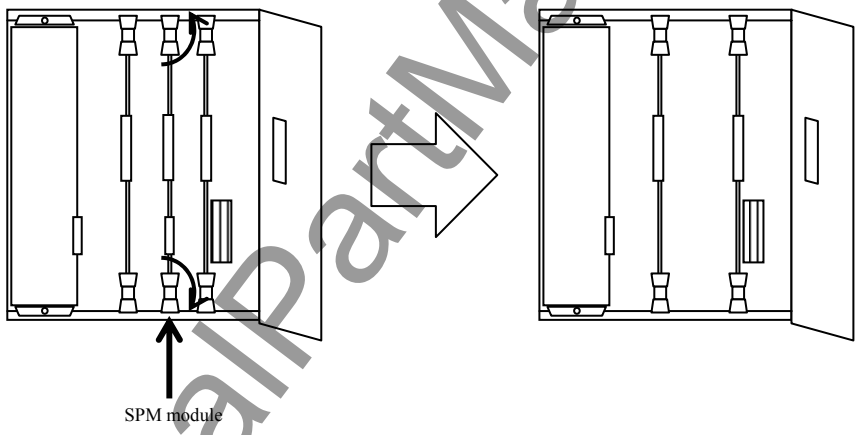
**5). Unplug the cables.**

Unplug the ribbon cable running among the modules by nipping the catch (in case of black connector) and by pushing the catch outside (in case of gray connector) on the connector.




**6). Pull out the module.**

Pull out the failure module by pulling up or down the top and bottom levers (white).



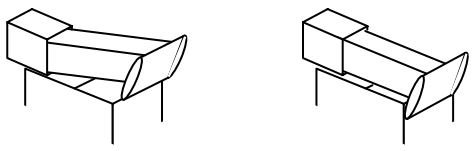

**7). Insert the replacement module.**

Insert the replacement module into the same slots where marked up.

**8). Do the No.5 to No.1 steps in reverse order.**

**⚠ CAUTION** Supply DC power after checking that all the modules are in their original positions and the ribbon cables are plugged in. If the ribbon cables are not plugged in enough (especially the gray connectors), the module could suffer damage.

Details of the gray connector on modules (top side)



×Not enough ○Enough

www . ElectricalPartManuals . com

**9). Lamp Test**

- RESET key is pushed 1 second or more by LCD display off.
- It checks that all LCDs and LEDs light on.

**10). Check the automatic supervision functions.**

- LCD not display “Auto-supervision” screens in turn, and Event Records
- Checking the “IN SERVICE” LED light on and “ALARM LED” light off.

www . ElectricalPartManuals . com

# Appendix T

# PLC Setting Sample

www . ElectricalPartManuals . com

# 1. PLC setting sample for distance protection

To enable the distance protection Z1, Z2, Z3 and ZR tripping only when communication failure and differential protection blocked in current differential protection, assign signals by PLC function as follows:

### (1) Zone 1 Trip Mode Control Circuit

First, disconnect all the default PLC settings of Zone 1 Trip Mode Control Circuit shown in Figure T-1.1. (*)

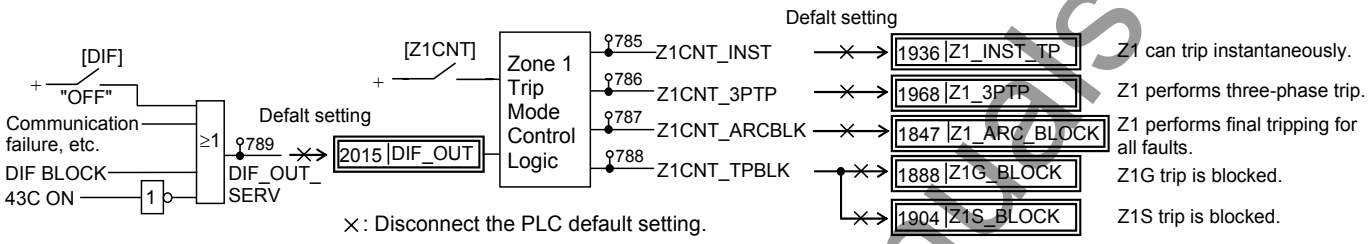



**Figure T-1.1**

And then, assign the invert signal of DIF_OUT_SERV (789) to [Z1G_BLOCK] and [Z1S_BLOCK] by PLC as shown in Figure T-1.2.

### (2) Zone 2, Zone 3 and Zone R Tripping circuit

Next, assign the invert signal of DIF_OUT_SERV (789) to [Z2G_BLOCK] to [ZRS_BLOCK] by PLC as shown in Figure T-1.2.

Note (*): [Z1CNT] does not function, because Zone 1 Trip Mode Control Circuit is disabled due to disconnect all the PLC default settings.

www . ElectricalPartManuals . com

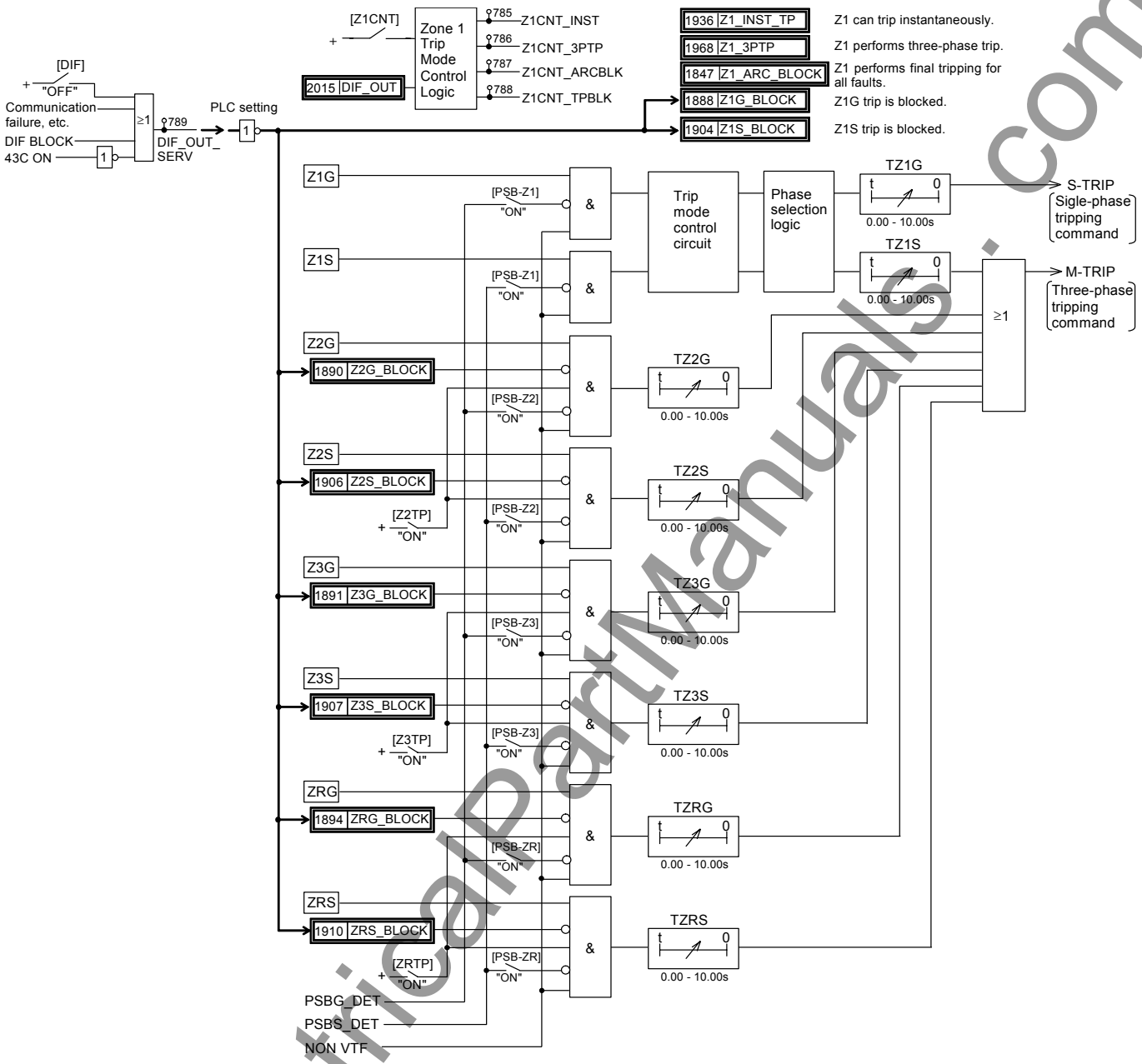
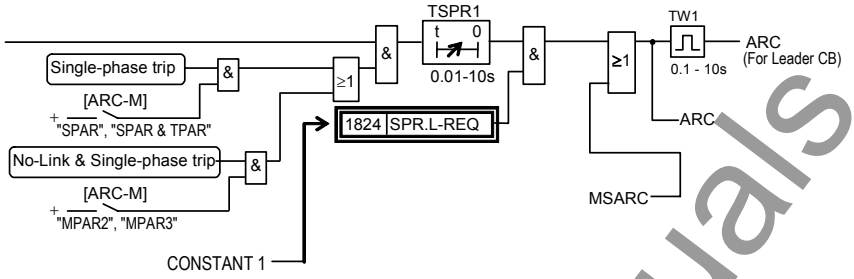



**Figure T-1.2 Assigning Signal by PLC**

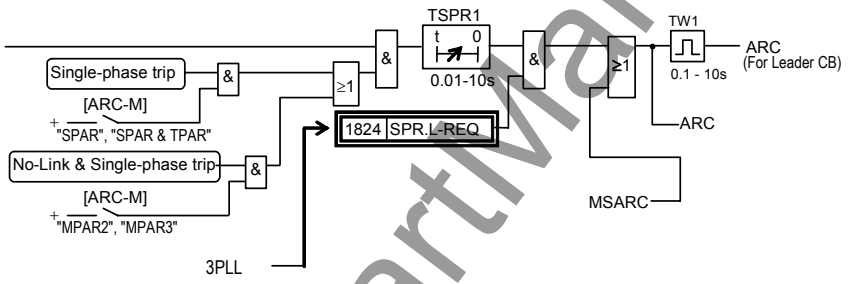
www . ElectricalPartManuals . com

## 2. PLC setting sample for autoreclosing (UARCSW application)

If the follower Terminal is reclosed after checking the leader Terminal reclosed in the autoreclose mode "SPAR", the leader Terminal is assigned to the signal number 1 with signal name "CONSTANT_1" and the follower Terminal assigned to the signal number 498 with signal name "3PLL" as shown in Figure T-2.1.




**Leader Terminal**




**Follower Terminal**

**Figure T-2.1**

In this case, the reclosing condition of [SPR.L-REQ] is the difference between the leader Terminal and the follower Terminal. If the same setting is required for the reclosing condition of [SPR.L-REQ], set the PLC using the [UARCSW] described in 2.10.2 as follows:

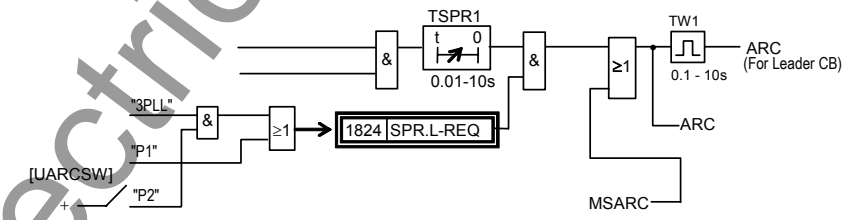



**Figure T-2.2**

The reclose condition can be changed by the position of [UARCSW].

[UARCSW] = P1: (No condition for reclosing)

[UARCSW] = P2: 3PLL (Three phase live line condition for reclosing)

The [UARCSW] is effective when the reclosing condition of PLC setting has the difference between the leader Terminal and the follower Terminal.

www.ElectricalPartManuals.com

# Appendix U

# Ordering

www . ElectricalPartManuals . com

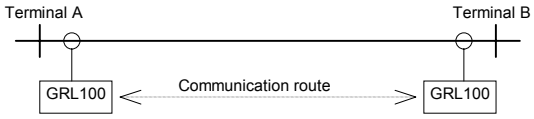
# Ordering

## 1. Line Differential Protection Relay

### a. Two-terminal application

GRL100 – □ B– □□ – □□ - □

| | |
|---|---|
| Relay Type: | |
| Line differential protection relay | GRL100 |
| Relay Model: | |
| -Model700: With distance protection and autoreclose for two-breaker scheme | |
| 25 BIs, 19 BOs, 6 trip BOs | 701 |
| 28 BIs, 37 BOs, 6 trip BOs | 702 |
| Ratings: | |
| 1A, 50Hz, 110V/125Vdc | 1 |
| 1A, 60Hz, 110V/125Vdc | 2 |
| 5A, 50Hz, 110V/125Vdc | 3 |
| 5A, 60Hz, 110V/125Vdc | 4 |
| 1A, 50Hz, 220V/250Vdc | 5 |
| 1A, 60Hz, 220V/250Vdc | 6 |
| 5A, 50Hz, 220V/250Vdc | 7 |
| 5A, 60Hz, 220V/250Vdc | 8 |
| 1A, 50Hz, 48V/54V/60Vdc | A |
| 1A, 60Hz, 48V/54V/60Vdc | B |
| 5A, 50Hz, 48V/54V/60Vdc | C |
| 5A, 60Hz, 48V/54V/60Vdc | D |
| 1A, 50Hz, 24V/54V/60Vdc | E |
| 1A, 60Hz, 24V/30Vdc | F |
| 5A, 50Hz, 24V/30Vdc | G |
| 5A, 60Hz, 24V/30Vdc | H |
| Differential relay communication interface: | |
| Electrical interface (CCITT-G703-1.2.1) | 1 |
| Electrical interface (CCITT-G703-1.2.2 or 1.2.3) | 2 |
| Optical interface(Short wavelength light: GI: 2km class) | 3 |
| Optical interface(Long wavelength light: SM: 30km class) | 6 |
| Optical interface(Long wavelength light: DSF: 80km class) | 7 |
| Electrical interface (RS530, X.21) | 9 |
| Communications: | |
| RS485 | 1 |
| Fibre optic | 2 |
| Dual RS485 | 3 |
| Dual Fibre optic | 4 |
| RS485 + Fibre optic | 9 |
| (*Note) Fibre optic is available for model702. | |
| Miscellaneous: | |
| None | 0 |
| GPS opt.. input | 1 |
| LED label: | |
| Standard | None |
| Option: User configurable LED label | J |

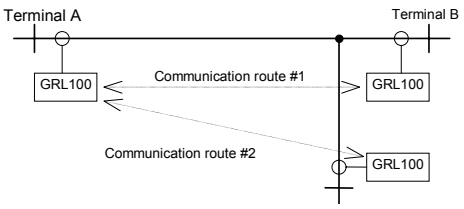



www . ElectricalPartManuals . com

## b. Three-terminal application

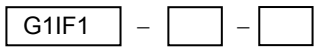
GRL100 – ☐ B– ☐☐ – ☐☐ – ☐

| | |
|---|---|
| Relay Type: | |
| Line differential protection relay | GRL100 |
| Relay Model: | |
| -Model700: With distance protection and autoreclose for two-breaker scheme | |
| 25 BIs, 19 BOs, 6 trip BOs | 711 |
| 28 BIs, 37 BOs, 6 trip BOs | 712 |
| Ratings: | |
| 1A, 50Hz, 110V/125Vdc | 1 |
| 1A, 60Hz, 110V/125Vdc | 2 |
| 5A, 50Hz, 110V/125Vdc | 3 |
| 5A, 60Hz, 110V/125Vdc | 4 |
| 1A, 50Hz, 220V/250Vdc | 5 |
| 1A, 60Hz, 220V/250Vdc | 6 |
| 5A, 50Hz, 220V/250Vdc | 7 |
| 5A, 60Hz, 220V/250Vdc | 8 |
| 1A, 50Hz, 48V/54V/60Vdc | A |
| 1A, 60Hz, 48V/54V/60Vdc | B |
| 5A, 50Hz, 48V/54V/60Vdc | C |
| 5A, 60Hz, 48V/54V/60Vdc | D |
| 1A, 50Hz, 24V/30Vdc | E |
| 1A, 60Hz, 24V/30Vdc | F |
| 5A, 50Hz, 24V/30Vdc | G |
| 5A, 60Hz, 24V/30Vdc | H |
| Differential relay communication interface: | |
| Electrical interface (CCITT-G703-1.2.1) x 2 | 1 |
| Electrical interface (CCITT-G703-1.2.2 or 1.2.3) x 2 | 2 |
| Optical interface(Short wavelength light: GI: 2km class) x 2 | 3 |
| Optical interface(Long wavelength light: SM: 30km class) x 2 | 6 |
| Optical interface(Long wavelength light: DSF: 80km class) x 2 | 7 |
| Electrical interface (RS530, X.21) x 2 | 9 |
| Optical I/F (2km class) + Optical I/F (30km class) | G |
| Optical I/F (2km class) + Optical I/F (80km class) | H |
| Communications: | |
| RS485 | 1 |
| Fibre optic | 2 |
| Dual RS485 | 3 |
| Dual Fibre optic | 4 |
| RS485 + Fibre optic | 9 |
| (*Note) Fibre optic is available for model 712. | |
| Miscellaneous: | |
| None | 0 |
| GPS opt.. input | 1 |
| LED label: | |
| Standard | None |
| Option: User configurable LED label | J |




www . ElectricalPartManuals . com

## 2. Optical Interface Unit (Option)




| Type: | |
|---|---|
| Communication interface box | G1IF1 |
| Model: | |
| For X21 (*) | 01 |
| For CCITT-G703-1.2.1 | 02 |
| For CCITT-G703-1.2.2 or 1.2.3 | 03 |
| For X21 | 04 |
| DC auxiliary power supply: | |
| DC 48V/54V/60V | 01 |
| DC 110V/125V | 02 |
| DC 220V/250V | 03 |

Note (*): With outer case. For details, see the G1IF1 instruction manual.

www . ElectricalPartManuals . com

## Version-up Records

| Version No. | Date | Revised Section | Contents |
|---|---|---|---|
| 0.0 | Feb. 16, 2006 | | First issue. |
| 0.1 | Nov. 20, 2006 | 2.2.8 | Modified the description and added Figure 2.2.8.1. |
| | | 2.3 to 2.5, 2,9, 2.10, 2.12 to 2.14, 2.16, 2.17 | Modified entirely the description related to distance protection, directional earth fault protection and over- and under-voltage protection, etc. |
| | | 3.1 to 3.5 | Modified the description. |
| | | 4.1, 4.2 | Modified the description of LED. |
| | | 6.4, 6.5, 6.7 | Modified the description. |
| | | Appendices | Modified Appendix A to E, G to K, O, Q, S and T. |
| 0.2 | Jul. 09, 2007 | 2.2.13.2 | Modified the description. |
| | | 2.3.1.3 | Modified the description and Figures 2.3.1.11 and 2.3.1.12. |
| | | 2.9.1, 2.9.2 | Modified the description and the setting range table. |
| | | 2.10 | Modified the description the setting range table. |
| | | 2.15.2.2 | Modified the description and Figure 2.15.2.8. |
| | | 2.16.11 | Added the description of OV∗1 – 4 and UV∗1 – 4. |
| | | 4.2.3.1 | Added recording items to fault record screen. |
| | | 4.2.4.6, 4.2.4.7 | Modified the description. |
| | | 4.4 | Modified the description. |
| | | 5.5 | Modified the description. |
| | | 6.7.2 | Modified the description and Table 6.7.2.1. |
| | | 6.7.3 | Modified the description. |
| | | Appendices | Added Appendix R. (Old R→S, S→T, T→U) |
| | | | Modified Appendix E, F, G, K, O, Q, S and U. |
| 0.3 | Sep. 13, 2007 | 2.3.1.3 | Modified the description of 'Blinder setting' and Figure 2.3.1.11. |
| | | 2.4.1 | Modified the description and Figures 2.4.1.3 and 2.4.1.6. |
| | | 4.2.7.5 | Added the description of 'Note'. |
| | | Appendices | Modified Appendix G, K and U. |
| | | | |
| | | | |
| | | | |

www . ElectricalPartManuals . com

TOSHIBA CORPORATION

www . ElectricalPartManuals . com