TOSHIBA

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INSTRUCTION MANUAL

TRANSFORMER PROTECTION RELAY

GRT100 - ∗∗∗D

TOSHIBA CORPORATION

(Ver. 4.0)

Safety Precautions

Before using this product, be sure to read this chapter carefully.

This chapter describes safety precautions when using the GRT100. Before installing and using the equipment, read and understand this chapter thoroughly.

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 instructions.
⚠WARNING	Indicates a potentially hazardous situation which could result in death or serious injury if you do not follow 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.

⚠ 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 dangerous 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 about 30 seconds for the voltage to discharge.

- Fiber optic

Do not view directly with optical instruments.

⚠CAUTION

- Earth

Earth the earthing terminal of the equipment securely.

CAUTION

- Operation conditions

Use the equipment within the range of ambient temperature, humidity and dust as detailed in the specification and in an environment free of abnormal vibration.

- Ratings

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

- Printed circuit board

Do not attach and remove the printed circuit board while 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 and prevent the connected circuit from overheating.

- Connection cable

Carefully handle the connection cable without applying excessive force.

- Modification

Do not modify this equipment, as this may cause the equipment to malfunction, and any such modifications will invalidate the warranty.

- 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 product, do so in a safe manner according to local regulations.

This product contains a lithium-ion battery, which should be removed at the end-of-life of the product. The battery must be recycled or disposed of in accordance with local regulations. The battery can be removed by withdrawing the Signal Processing module (SPM) from the relay case, and cutting the connecting leads and plastic strap which hold the battery.

Contents

■ The data given in this manual are subject to change without notice. (Ver.4.0)

1. Introduction

GRT100 provides high-speed transformer and reactor protection, and realises high dependability and security for diverse faults such as single-phase faults, multi-phase faults, overload and over-excitation.

GRT100 is used as a main protection and backup protection of the following transformers and reactors.

- Two-winding or three-winding power transformers
- Auto-transformers
- Generator-transformer units
- Shunt reactors

GRT100 is designed to provide stability under magnetizing inrush and overexcitation conditions. GRT100 is available for mixed 1A/5A inputs

GRT100 provides the following metering and recording functions.

- Metering
- Fault records
- Event records
- Disturbance records

GRT100 provides the following human interfaces for relay setting or viewing of stored data.

- Relay front panel: LCD, LED display and operation keys
- 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 by binary input using the PLC.

GRT100 can provide the following serial interface ports:

- RS232C for a local PC and Relay Setting and Monitoring System (RSM100)
- RS485 for a remote PC, and Relay Setting and Monitoring System (RSM100) or Substation control and Automation System (SAS) with IEC60870-5-103 protocol
- Fibre Optic (FO, option) for a remote PC, and Relay Setting and Monitoring System (RSM100) or Substation control and Automation System (SAS) with IEC60870-5-103 protocol
- 100BASE-TX, or -FX (option) for Substation control and Automation System (SAS) with IEC61850 protocol

Another interface IRIG-B port is provided for an external clock connection.

The RS232C port is located on the front panel of the relay. Other ports (RS485, FO, 100BASE-TX and IRIG-B) are located on the rear of the relay.

Further, the GRT100 provides the following functions.

- Configurable binary inputs and outputs
- Programmable logic for I/O configuration, alarms, indications, recording, etc.
- Automatic supervision

GRT100 has two model series which differ according to the number of three-phase current inputs for differential protection as follows:

Relay Type and Model

Relay Type:
- Type GRT100; Numerical transformer protection relay
Relay Model:
- Model 100 series; 2 three-phase current inputs, applied to two-winding transformers • Model 101; 16 binary inputs, 13 binary outputs, 5 binary outputs for tripping • Model 102; 16 binary inputs, 23 binary outputs, 5 binary outputs for tripping
- Model 200 series; 3 three-phase current inputs, applied to two- and three-winding transformers • Model 201; 16 binary inputs, 13 binary outputs, 5 binary outputs for tripping • Model 202; 16 binary inputs, 23 binary outputs, 5 binary outputs for tripping • Model 203; 15 binary inputs (12-independent), 13 binary outputs, 3 binary outputs for tripping • Model 204; 15 binary inputs (12-independent), 23 binary outputs, 3 binary outputs for tripping

Model 100 series have 2 three-phase current inputs and can be applied to two-winding transformers. Model 200 series have 3 three-phase current inputs and can be applied to two- and three-winding transformers.

2. Application Notes

GRT100 is applied to both main protection and backup protection for the following transformers and reactors:

- Two-winding or three-winding power transformers
- Auto-transformers
- Generator-transformer units
- Shunt reactors

2.1 Protection Scheme

GRT100 provides the following protection schemes with measuring elements in parentheses. Appendix A shows the block diagrams of the GRT100 series.

- Current differential protection (DIFT)
- Restricted earth fault protection (1REF-3REF)
- Time-overcurrent protection (1OC-3OC, 1OCI-3OCI, 1EF-3EF and 1EFI-3EFI)
- Thermal overload protection (THR)
- Frequency protection (FRQ)
- Overexcitation protection (V/F)
- Trip and/or indication of external devices (Buchholtz relay, pressure or temperature sensing devices etc.)

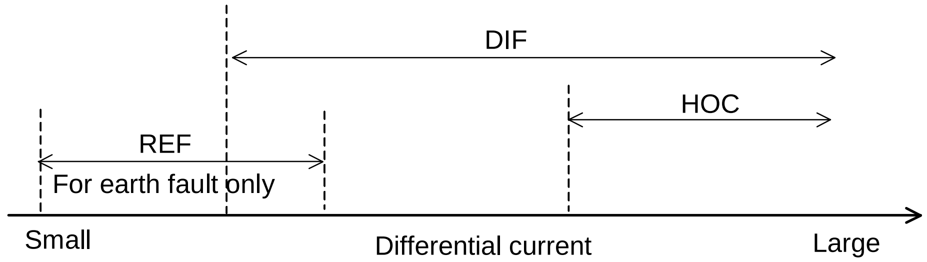
The DIFT, provided with DIF and HOC elements and the REF are applied for main protection. For details, see Sections 2.2, 2.3 and 2.10.

They provide transformer protection coverage as follows:

REF: protection for winding to earth faults of star-winding side

DIF: protection for all internal transformer faults (The DIF can be blocked by 2F or 5F element.)

HOC: protection for all internal transformer faults, specifically for heavy internal faults, high-speed operation (The HOC is not blocked by 2F or 5F element. The sensitivity is set above the estimated maximum inrush current.)



The number of measuring elements for the restricted earth fault protection and time-overcurrent protection is dependent on the relay models.

Figure 2.1.1, 2.1.2 and 2.1.3 show typical application and the relationship between AC inputs and the measuring elements applied in each model.

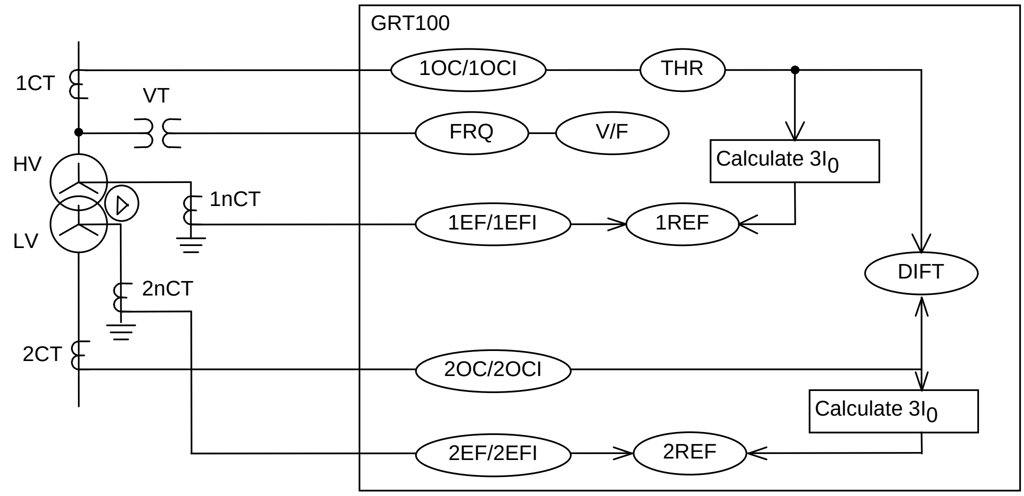


Figure 2.1.1 Measuring Elements of Model 100 series

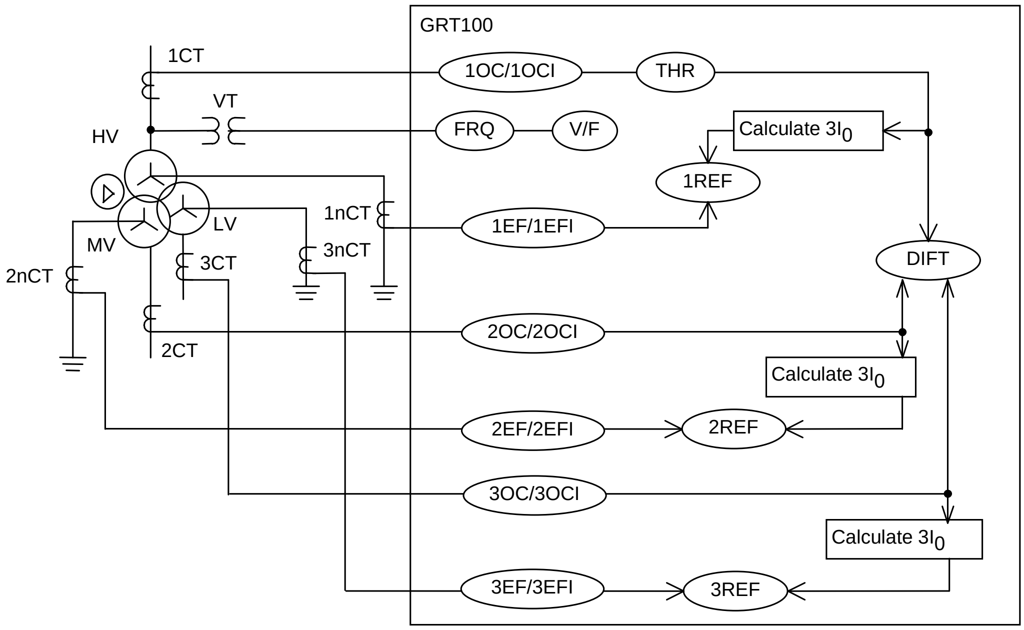


Figure 2.1.2 Measuring Elements of Model 200 series

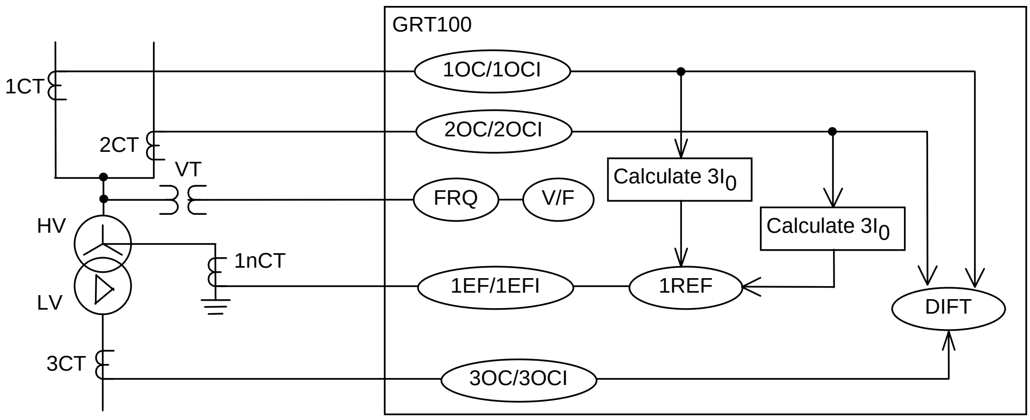


Figure 2.1.3 Measuring Elements of Model 200 series

2.2 Current Differential Protection

2.2.1 Differential Scheme

Current differential protection DIFT provides an overall transformer protection deriving phase current from each transformer winding, calculating the differential current on a per phase basis and detecting phase-to-phase and phase-to-earth faults.

The current differential protection is based on Kirchhoff's first law that the vector summation of all currents flowing into a protected zone must be zero. Figure 2.2.1.1 shows the principle of current differential protection. Differential current (id) is the vector summation of all terminal current of the transformer. The differential current (id=i1+i2) is zero because the current (i1) equals current (–i2) during a load condition or an external fault. During an internal fault, the differential current (id) is not zero because the current (i1) does not equal to the current (–i2), and the DIFT operates.

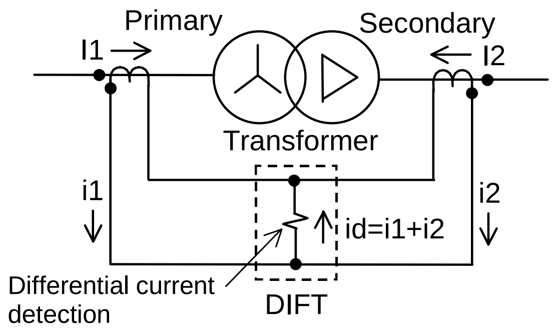


Figure 2.2.1.1 Current Differential Protection

Scheme logic

Figure 2.2.1.2 shows the scheme logic of the current differential protection. Current differential element DIFT comprises sub-elements HOC, DIF, 2F and 5F which operate for differential current on a per phase basis.

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

HOC is a high-set overcurrent element operating for differential current. It provides high-speed protection for heavy internal faults.

DIF is a percentage restraining element and has dual restraining characteristics, a weak restraint in the small current region and a strong restraint in the large current region, to cope with erroneous differential current which may be caused due to output imbalance of the CTs in case of an external fault. (For the characteristics, see Section 2.10.)

The DIF output signal can be blocked when the 2F or 5F elements detect second harmonic inrush current during transformer energization or fifth harmonic components during transformer overexcitation. Blocking is enabled by setting scheme switch [2F-LOCK] or [5F-LOCK] to "ON". The following two or three blocking schemes are selectable by scheme switch [DIFTPMD].

"3POR": When any one phase of the 2F or 5F element operates, tripping by the DIF element is blocked in all 3 phases. "3POR" is recommended for transformers with large capacity whose second harmonic component may be low. Its blocking function is stronger than that of the "1P" or "2PAND" below.

"1P": When any phase of the 2F or 5F elements operate, only the corresponding phase output of the DIF element is blocked.

"2PAND": Even if 2F or 5F element operates during manetising inrush, the trip by DIF element is allowed when any two phases or more of DIF element operate.

"2PAND" is recommended for a transformer with small or midium capacity whose second harmonic component in inrush current is genarally higher than that of transformer with large capacity. This mode is applicable if [Phase matching] is set to "Beta".

Protection by DIF and HOC can perform instantaneous three-phase tripping of up to five breakers. Any of the five breaker tripping signals DIFT-1 to DIFT-5 are enabled or disabled by the scheme switch [DIF1] to [DIF5] settings.

Note: Models 203 and 204 are not provided with DIFT-4 and DIFT-5, and perform tripping of up to three breakers.

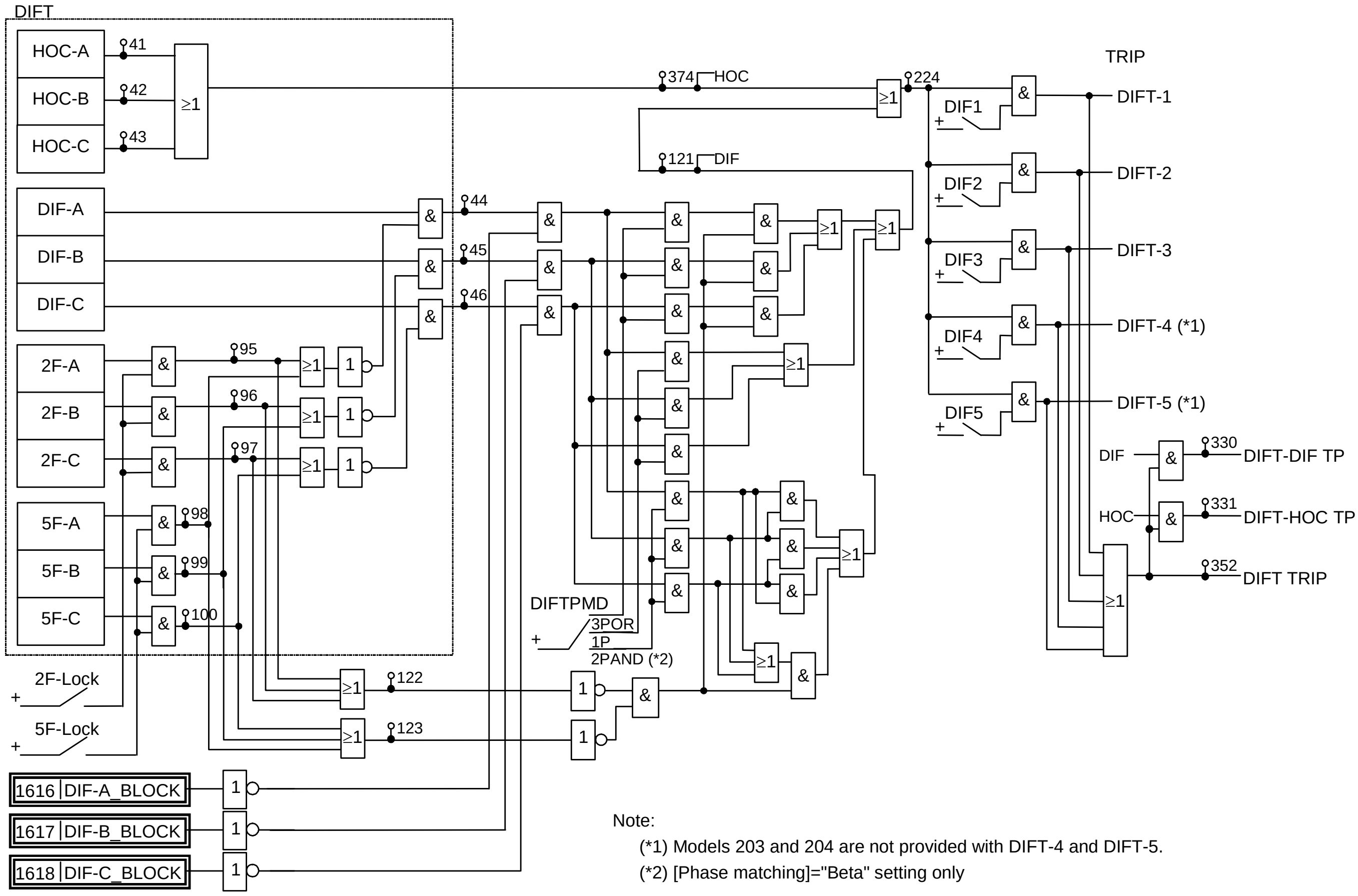


Figure 2.2.1.2 Scheme Logic of Current Differential Protection

Display mode following differential tripping

Following a trip output, GRT100 can display either the operating phase or the faulted phase according to the user's requirements as shown in Table 2.2.1.1. The operating phase or faulted phase display is selectable by a setting in the Record menu.

Table 2.2.1.1 Operating Phase / Faulted Phase Display

	Operating phase display	Faulted phase display
Setting (Setting/Record/Fault record/Phase mode)	1 = Operating	2 = Fault
Displayed phase	Operating phase Generally, the operating phase of the DIF element does not correspond with the faulted phase, but depends on the transformer configuration and the electrical quantities that are input to the GRT100 current differential calculation.	Faulted phase (for single-phase to earth, phase to phase, two-phase to earth and three-phase to earth faults)
Application	All two- and three-winding transformers	• Faults at primary side or secondary side of Yy0 and Yy6 transformers • Faults at primary side of Yd1, Yd3, Yd5, Yd7, Yd9, Yd11, Yy2, Yy4, Yy8 and Yy10 transformers • Faults at secondary side of Dy1, Dy3, Dy5, Dy7, Dy9 and Dy11 transformers • Faults on Dd2, Dd4, Dd6, Dd8 and Dd10 transformers, faults at Zig-zag connected side of transformers and faults at tertiary side of three-winding transformers are not supported.
Logic	Refer to Figure 2.2.1.4. ∗ Phase (A/B/C) display is based on the operating signal of DIF or HOC element, and "N" display is based on the operating signal of REF and DIFT elements. If the REF is not used, "N" is not displayed.	Refer to Figure 2.2.1.4. ∗ Phase (A/B/C) display is based on the operating signal of DIF or HOC element and a differential current value, and "N" display is based on the operating signal of REF and DIFT elements. If the REF is not used, "N" is not displayed.

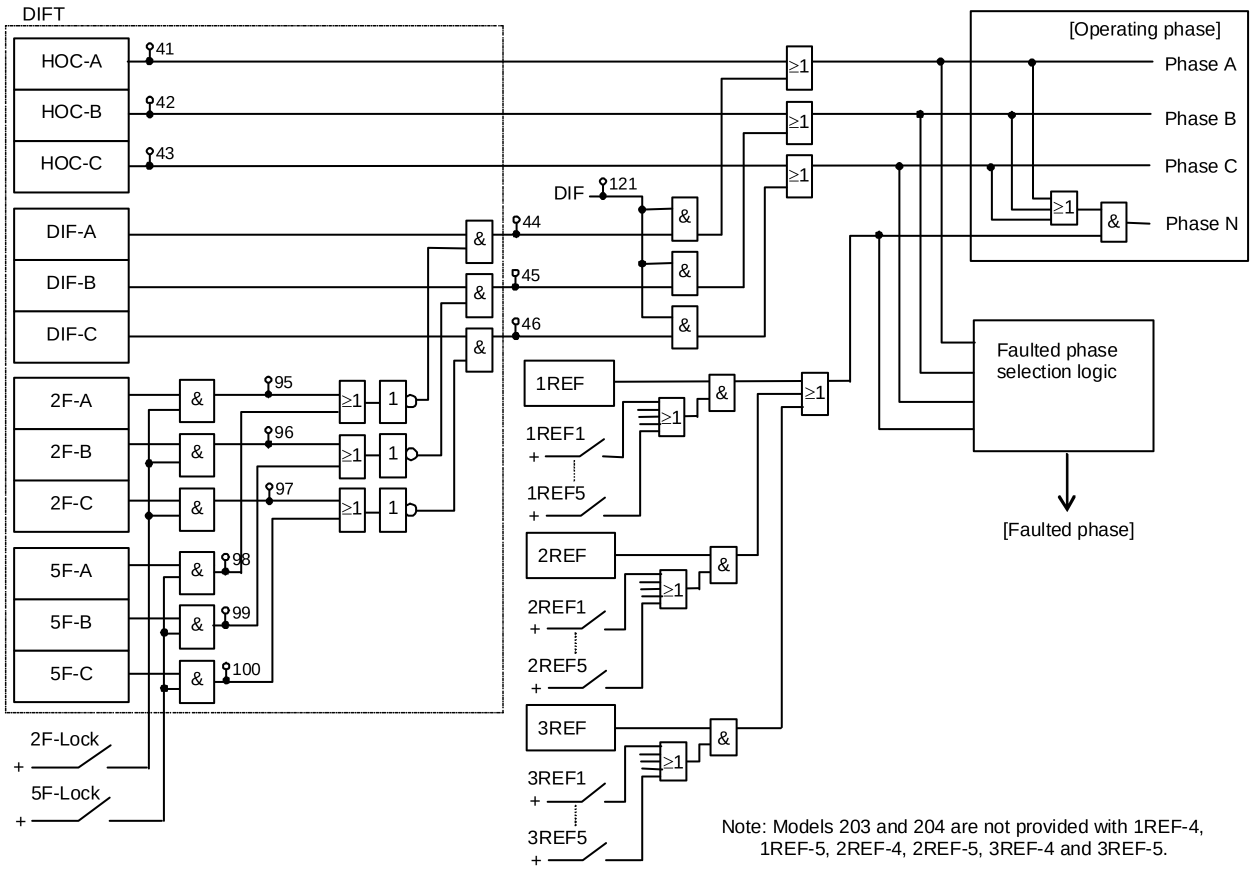


Figure 2.2.1.4 Operating Phase and Faulted Phase Selection Logic

2.2.2 Stability for CT Saturation during Through-fault Conditions

For current differential protection of transformers, GRT100 has a strong restraint characteristic in the large current region for erroneous differential current due to CT saturation. Further, GRT100 provides a CT saturation countermeasure function. If any CTs saturate due to a large through-fault current, an apparent differential current is generated in the differential circuit and may cause false operation of the differential protection.

Operation Principle

Even when a CT saturates under very large primary currents, the waveform of the saturated CT secondary current has two identifiable periods in each cycle: a non-saturated period and a saturated period. The GRT100 utilizes this phenomenon and provides very secure operation for external faults with a large through-fault current.

Figure 2.2.2.1 shows a block diagram of the CT saturation countermeasure (CTS). The CTS has a waveform discriminating element (WDE) and starting element (SE). WDE operates if the change in the instantaneous value of the differential current is less than a specified percentage of the change in the instantaneous value of the restraining current. In the CTs non-saturated period, the differential current is theoretically zero for through-fault currents. The element operates in this period.

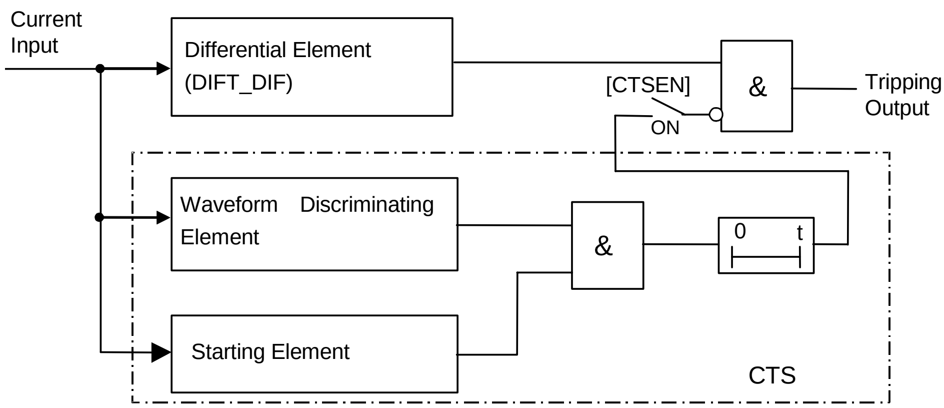


Figure 2.2.2.1 Differential Element with CT Saturation Countermeasure

The algorithm of this element is given by the following equation:

$$\Delta Id < 0.15 \times (\Delta Ip + \Delta In)$$

where,

ΔId : Change in the differential current Id

$(\Delta Ip + \Delta In)$: Change in the restraining current in the positive and negative cycles

Id : Differential current

Ip : Sum of positive input currents

In : Sum of negative input currents

SE operates when the sum of the absolute values of the difference between the instantaneous values of current data at each current input from one cycle is greater than 0.5 × (CT secondary rated current).

SE discriminates between healthy and faulty power system conditions and blocks the output of WDE which may otherwise operate during healthy conditions.

Figure 2.2.2.2 shows CT secondary current waveforms of the incoming and outgoing terminals, and also the differential current at the time of an external fault with outgoing terminal CT saturation.

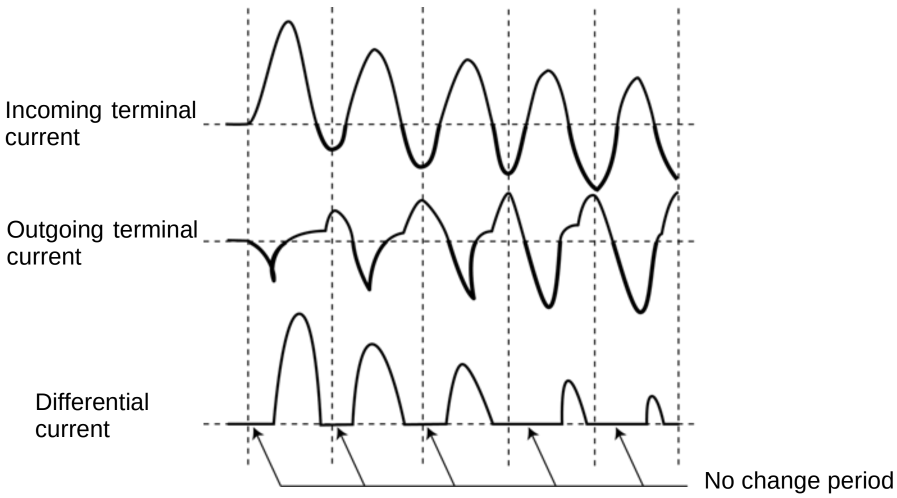


Figure 2.2.2.2 CT Secondary Current Waveforms and Differential Current for an External Fault with CT Saturation

From the inception of the fault until the CT secondary current at the outgoing terminal saturates, the differential current Id is zero and the change in the differential current ΔId obtained from equation (2) is also zero. However, the change in the restraining current given by equation (3) is a sufficiently large positive value, so equation (1) is met and WDE operates.

SE detects changes in the terminal currents and rapidly operates, producing an AND output with WDE. After this, since there is a period during which equation (1) is not satisfied, a certain time delay is inserted to reliably block the operation of the DIFT_DIF differential element.

If, during an internal fault, there is a period during which the change in the instantaneous value of the differential current is small due to CT saturation, WDE will not operate because the change in the restraining current is also small during that period. Thus, during an internal fault, operation of the differential element is not blocked falsely.

The CTS function can be disabled by the scheme switch [CTSEN].

2.2.3 Matching of CT Secondary Currents

The currents supplied to the differential elements must be matched in phase displacement and amplitude under through-load and through-fault conditions.

Generally, it is difficult to completely match the incoming current with the outgoing current for the relay input because the CT ratios at the primary, secondary and tertiary sides of a transformer are not matched in terms of the CT ratio, phase angle and cancelling of zero-sequence current.

GRT100 provides the following matching method:

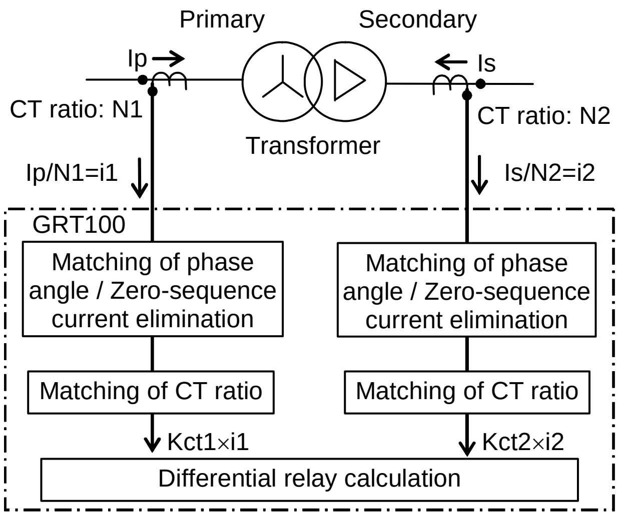


Figure 2.2.2.1 Matching Method

GRT100 supports selectable two matching methods, α-method (Alpha) and β-method (Beta). The method is selected by the scheme switch [Phase matching].

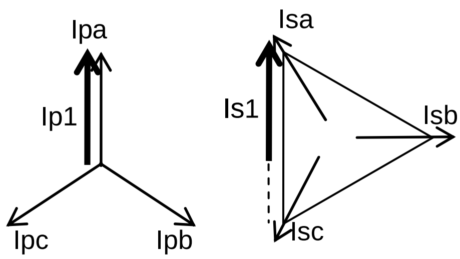
Phase matching is performed by setting according to the hands of a clock and the transformer connections described in IEC60076-1. For details of the setting, refer to 2.2.5.

2.2.3.1 α-method phase matching

This method corrects the phase angle by using each winding current calculated as follows:

- Current substructed zero-sequence current from each phase current in Star- winding side of transformer
- Phase-to-phase Current in Delta-winding side of transformer

The followings show calculation formula and current vectors in an example of a transformer Yd11.



$$\dot{I}p1 = \frac{2\dot{I}pa - \dot{I}pb - \dot{I}pc}{3}, \quad \dot{I}s1 = \frac{\dot{I}sa - \dot{I}sc}{\sqrt{3}} \quad (1)$$

$$\dot{I}p2 = \frac{2\dot{I}pb - \dot{I}pc - \dot{I}pa}{3}, \quad \dot{I}s2 = \frac{\dot{I}sb - \dot{I}sa}{\sqrt{3}} \quad (2)$$

$$\dot{I}p3 = \frac{2\dot{I}pc - \dot{I}pa - \dot{I}pb}{3}, \quad \dot{I}s3 = \frac{\dot{I}sc - \dot{I}sb}{\sqrt{3}} \quad (3)$$

where,

$\dot{I}pa, \dot{I}pb, \dot{I}pc$: Primary side terminal current of transformer

$\dot{I}sa, \dot{I}sb, \dot{I}sc$: Secondary side terminal current of transformer

Further, zero-sequence current is eliminated from the relay input current (Ip∗) for the calculation of the differential current as follows:

$$\dot{I}p1 = \frac{2\dot{I}pa - \dot{I}pb - \dot{I}pc}{3} = \frac{3Ipa - (Ipa + Ipb + Ipc)}{3} = Ipa - Ipo$$

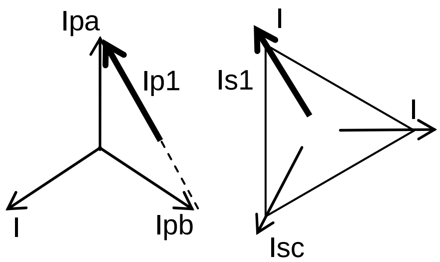
$$\dot{I}p2 = \frac{2\dot{I}pb - \dot{I}pc - \dot{I}pa}{3} = \frac{3Ipb - (Ipa + Ipb + Ipc)}{3} = Ipb - Ipo$$

$$\dot{I}p3 = \frac{2\dot{I}pc - \dot{I}pa - \dot{I}pb}{3} = \frac{3Ipa - (Ipa + Ipb + Ipc)}{3} = Ipc - Ipo$$

2.2.3.2 β-method (Traditional method) phase matching

This is a traditional method that delta current (phase-to-phase current) on the Star-winding side of a Star/Delta transformer and phase current on the Delta-winding side of that is introduced into a relay input for the calculation of the differential current. Traditionally, the phase matching is realized by Delta connecting the CTs on the Star-winding side and by Star connecting the CTs on the Delta-winding side. In GRT100, however, it is realized by software.

The followings show calculation formula and current vectors in an example of a transformer Yd11.



$$\dot{I}p1 = \frac{\dot{I}pa - \dot{I}pb}{\sqrt{3}}, \ \dot{I}s1 = \dot{I}sa \quad (4)$$

$$\dot{I}p2 = \frac{\dot{I}pb - \dot{I}pc}{\sqrt{3}}, \ \dot{I}s2 = \dot{I}sb \quad (5)$$

$$\dot{I}p3 = \frac{\dot{I}pc - \dot{I}pa}{\sqrt{3}}, \ \dot{I}s3 = \dot{I}sc \quad (6)$$

2.2.3.3 Zero-sequence current elimination

In addition to compensating for the phase angle between the primary and secondary currents of the transforemer, also phase angle matching prevents unnecessary operation due to zero-sequence current during an external earth fault, such as in the following cases.

Case 1:

When an external fault occurs at the star-connected side of the transformer shown in Figure 2.2.3.2, a zero-sequence current flows in star-connected side, but the zero-sequence current at the delta-side circulates in the delta winding. The zero-sequence current is only fed into the star winding side of the DIFT which is star-connected at the CT secondary, thus causing the DIFT to operate incorrectly. In α-method phase matching, the zero-sequence current is eliminated from a relay input current as described above. In β-method phase matching, the zero-sequence current is eliminated from the relay input current by Delta connection on the Star-winding side.

Since the DIFT provides a function to eliminate the zero-sequence current by software, the DIFT is insensitive the fault described.

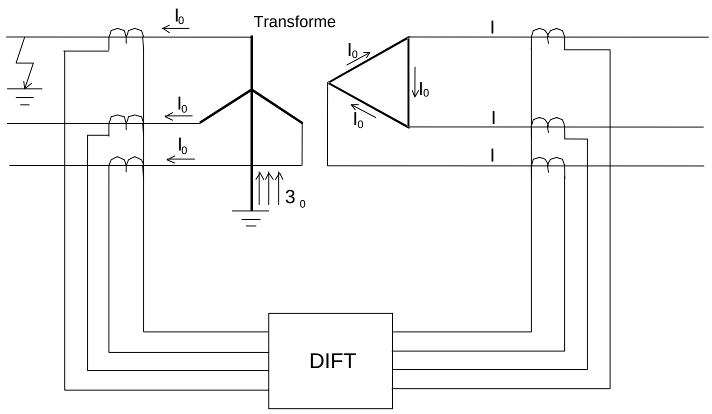


Figure 2.2.3.2 External Earth Fault at the Star-connected side of a Transformer

Case 2:

When the delta winding of a power transformer is earthed through an earthing transformer as shown in Figure 2.2.3.3 and the earthing transformer is located within the differential protection zone, in case of an external earth fault the zero-sequence current flows only on the delta side of the power transformer and appears as a differential current.

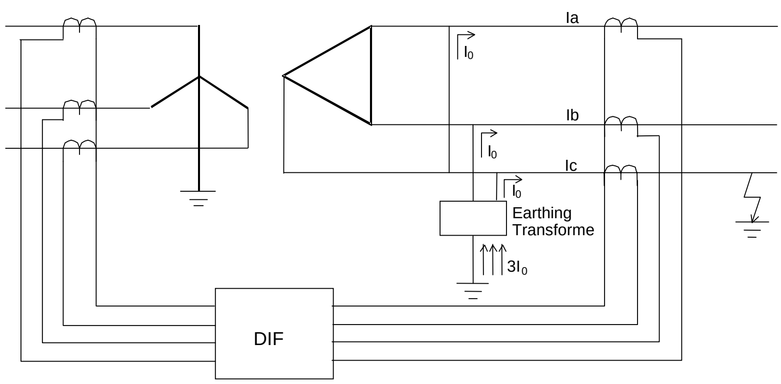


Figure 2.2.3.3 External Earth Fault at the Delta-winding side of a Transformer with in-zone Earthing Transformer

In α-method phase matching, since the DIFT provides a function to eliminate the zero-sequence current by software, the DIFT is insensitive to the fault described.

In β-method phase matching, however, since the zero-sequence current is not eliminated because of Star connection on the Delta-winding side, the DIFT may operate unnecessary.

In case the GRT100 is applied to a transformer with in-zone earthing transformer, the [Phase matching] = “Alpha” setting is recommended.

2.2.3.4 Matching of CT Ratio

If I_1 to I_3 correspond to 1CT to 3CT secondary currents, differential current I_d is calculated according to the following equation,

$$I_d = kct1 \cdot I_1 + kct2 \cdot I_2 + kct3 \cdot I_3$$

where kct1 to kct3 are settings corresponding to 1CT to 3CT.

Setting kct1 is obtained by using the following equation.

$$kct1 = I_n/I_{base1}$$

$$= I_n/(\sqrt{3} \times I_{base1}) \text{ if 1CT is delta-connected.}$$

where

I_n = rated secondary current of 1CT (1A or 5A)

I_{base1} = secondary current of 1CT based on the kVA rating of the power transformer.

= transformer capacity(kVA)/($\sqrt{3}$ × rated voltage(kV)) × CT ratio of 1CT

If the 1CT secondary circuit is delta-connected, $\sqrt{3} \times I_{base1}$ is used instead of I_{base1} in the equation above.

Settings kct2 and kct3 are obtained in the same way.

The differential current I_d is zero under through-load and through-fault conditions.

kct1 × I_1 to kct3 × I_3 are equal to the rated secondary current of each CT when the rated line currents based on the kVA rating of the power transformer flow.

2.2.4 Connection between CT Secondary Circuit and the GRT100

GRT100 is provided with 2 or 3 three-phase current input terminals depending on the relay model.

To validate the phase angle matching described previously and apply in-phase current from each winding to the relay, connect the CT secondary circuits to the current input terminals of the relay as follows;

As shown below, the phases used in the phase angle setting (indicated by an arrowhead) must be connected to the AC input terminals with the lowest number in the terminal group such as 1, 9, 17, then the other two phases should be connected to the terminals with a larger number clockwise from the setting phase, such as 3 and 5, 11 and 13, or 19 and 21.

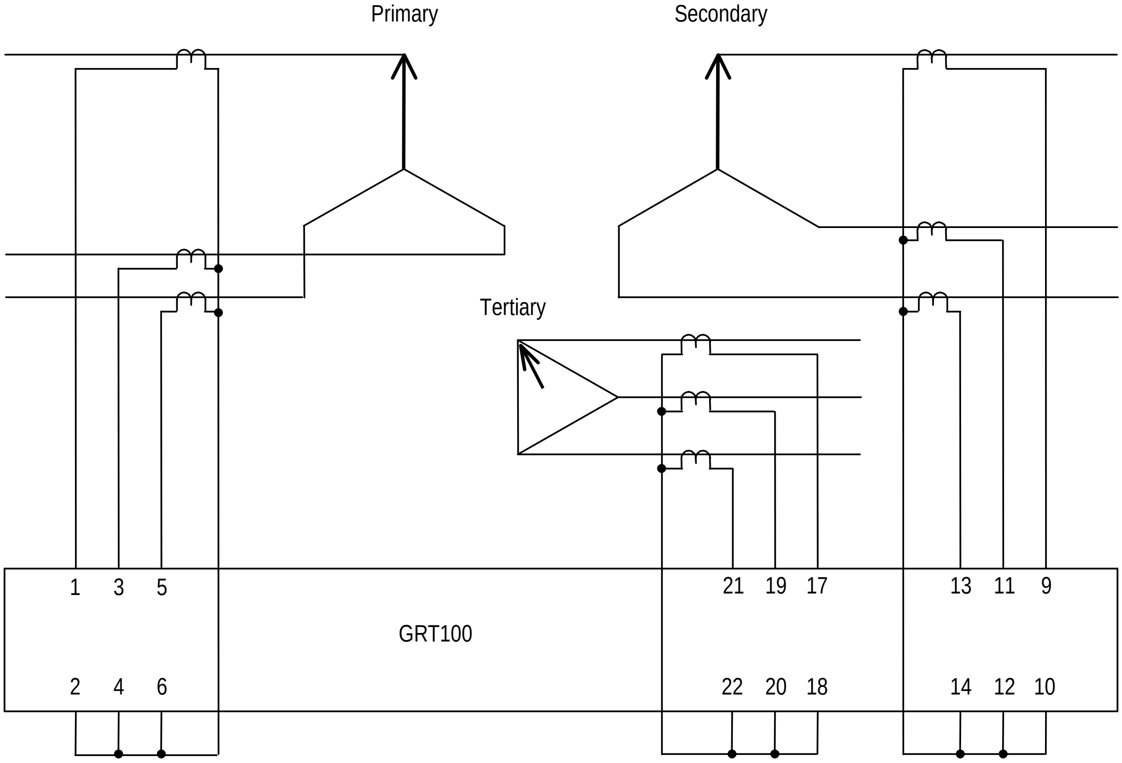


Figure 2.2.4.1 Connection of CT Secondary Circuit and the GRT100

Terminal numbers and corresponding input currents are shown in the following table.

Model	Terminal block	Terminal number	Input current
100 series / 200 series	TB1	1-2 3-4 5-6	Current of primary winding
		9-10 11-12 13-14	Current of secondary winding
		17-18 19-20 21-22	Current of tertiary winding

2.2.5 Setting

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

Element		Range	Step	Default	Remarks
DIFT					
DIF	i_K	0.10 – 1.00 (*)	0.01	0.30	Minimum operating current
	p1	10 – 100%	1%	100%	% slope of small current region
	p2	10 – 200%	1%	200%	% slope of large current region
	kp	1.00 – 20.00(*)	0.01	1.00	Break point of dual characteristics
	k2f	10 – 50%	1%	15%	Second harmonic detection
	k5f	10 – 100%	1%	30%	Fifth harmonic detection
HOC	kh	2.00 – 20.00(*)	0.01	2.00	High-set overcurrent protection
CT matching					
CT ratio	kct1	0.05 – 50.00	0.01	1.00	Primary winding
	kct2	0.05 – 50.00	0.01	1.00	Secondary winding
	kct3	0.05 – 50.00	0.01	1.00	Tertiary winding
Phase angle matching					If [Phase matching]=Alpha setting
(α-method)	yd_p	1(star) / 2(delta)		1	Primary winding
	yd_s	1(star) / 2(delta)		1	Secondary winding
	yd_t	1(star) / 2(delta)		1	Tertiary winding
	vec_s	0 – 11	1	0	Phase angle difference between primary and secondary
	vec_t	0 – 11	1	0	Phase angle difference between primary and tertiary
					If [Phase matching]=Beta setting
(β-method)	d1	0 – 11	1	0	Primary winding
	d2	0 – 11	1	0	Secondary winding
	d3	0 – 11	1	0	Tertiary winding
Scheme switch					
[Phase matching]		Alpha / Beta		Beta	Matching methods of CT secondary currents
[DIFTPMD]		3POR / 1P		3POR	Trip mode (if [Phase matching] = Alpha)
[DIFTPMD]		3POR / 2PAND / 1P		3POR	Trip mode (if [Phase matching] = Beta)
[2F – LOCK]		Off / On		On	Block by second harmonic
[5F - LOCK]		Off / On		On	Block by fifth harmonic
[DIF1] to [DIF5]		Off / On		(**)	Output tripping signal
[CTSEN]		Off / On		Off	CT saturation function

(∗): Multiplier of CT secondary rated current including CT ratio correction.
(**): Default settings are dependent on the models. See Appendix H.

Setting of ik

ik determines the minimum operation sensitivity of the DIF element. ik is set as a ratio to the CT secondary rated current.

The minimum sensitivity setting ik is determined from the maximum erroneous differential current under normal operating conditions.

Setting of p1, p2 and kp

Percentage restraining factor (% slope)

= (Differential current) / (Through current)

= (Differential current) / [{(Incoming current) + (Outgoing current)} /2]

p1 is the percentage restraining factor which defines the DIF restraining characteristic in the small current region. The setting is determined by the sum of:

- CT accuracy error (generally considered as 5%)
- Tap error: Error between maximum/minimum tap and the middle tap when taking the middle tap of the tap changer as a reference.
- Matching error: The error due to CT mismatch may be small enough to be neglected in the setting.
- Relay calculation error, and others (5%)

The recommended setting is “Sum of above” × 1.5 (margin).

p2 is the percentage restraining factor which defines the restraining characteristic in the large current region. The setting is determined from the maximum erroneous differential current which is generated when a large through fault current flows.

kp is the break point of the dual percentage restraining characteristics. It is set above the maximum operating current level of the transformer between the maximum forced-cooled rated current and the maximum emergency overload current level, as a ratio to the CT secondary rated current.

Setting of k2f

k2f is set to detect the second harmonic content in the inrush current during transformer energization and blocks GRT100 to prevent incorrect operation due to the inrush current. A setting of 15% is suggested if there is no data on the minimum second harmonic content.

Setting of k5f

k5f is set to detect the fifth harmonic content during transformer over-excitation and blocks GRT100 to prevent incorrect operation due to transient over-excitation conditions.

A setting of 30% is suggested if there is no data on the minimum fifth harmonic content.

Setting of kh

Kh is the HOC setting and should be set above the estimated maximum inrush current.

The recommended setting is more than “Maximum peak value of Inrush current” × kct.

Setting for CT ratio matching

Taking the transformer shown in Figure 2.2.5.1 as an example, the CT ratio matching settings kct1 to kct3 can be calculated as follows. For transformer capacity, take the maximum of the rated capacites of the three windings.

Calculation steps		Primary	Secondary	Tertiary
(1)	Transformer capacity (kVA)		40×10^3	
(2)	Voltage(kV)	154	66	11
(3)	Rated line current(A) $=(1)/(\sqrt{3} \times (2))$	150	350	2100
(4)	CT ratio	60	120	240
(5)	Secondary rated line current(A) =(3)/(4)	2.50	2.92	8.75
(6)	CT secondary rating(A)	5	5	5
(7)	Setting =(6)/(5)	Kct1=2.00	Kct2=1.71	Kct3=0.57

Note: kct1 to kct3 should be set to 2.00 or less. If more, the CT ratio matching of relay input current may be not stable.

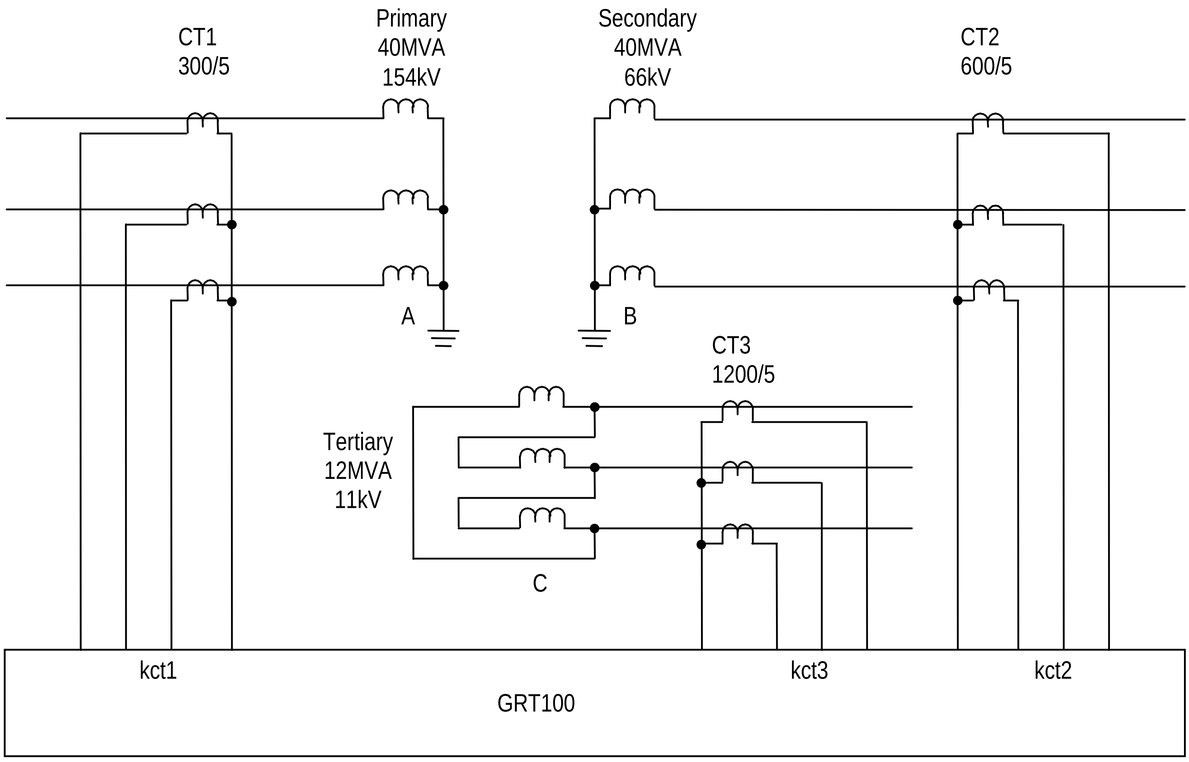


Figure 2.2.5.1 CT Ratio Matching

As explained in Section 2.2.3 for Mathcing of CT Secondary Currents, examples of setting for both α-method and β-method are described as follows:

Setting for phase angle matching

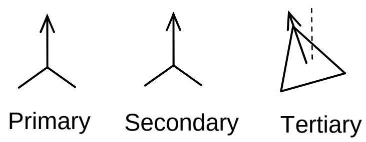
The phase angle difference between line currents on either side of the power transformer are corrected by setting according to the hands of a clock and the transformer connections described in IEC60076-1 as follows:

(When α-method is selected for [Phase matching])

If a winding is star-connected, set 1 (=star) for winding setting yd_p, yd_s, and yd_t. If delta-connected, set 2 (=delta). Next, set the phase angle difference vec_s and vec_t from the primary winding as a lagging angle winding expressed in hours. One hour corresponds to lagging by thirty degrees.

Note: In the case of a zigzag connected winding, set 2 (=delta).

Example: Setting for star/star/delta transformer.



IEC60076-1	Setting				
	yd_p	yd_s	vec_s	yd_t	vec_t
Y y 0 d 11	1	1	0	2	11

yd_p: Because the primary winding is star-connected, set 1.

yd_s: Because the secondary winding is star-connected, set 1.

vec_s: Because the secondary winding is in phase with the primary winding, set 0.

yd_t: Because the tertiary winding is delta-connected, set 2.

vec_t: Because the tertiary winding lags the primary winding by 330°, set 11.

The settings for the transformer connections described in IEC60076-1 are listed in Table 2.2.5.2.

Note: The following calculation is performed in the relay for phase angle correction.

Table 2.2.5.1 Phase Angle Matching Calculation

O'clock	Calculation			Remarks
0	Ia' = (2Ia – Ib – Ic)/ 3	Ib' = (2Ib – Ic – Ia)/ 3	Ic' = (2Ic – Ia – Ib)/ 3	
1	Ia' = (Ia – Ib)/ $\sqrt{3}$	Ib' = (Ib – Ic)/ $\sqrt{3}$	Ic' = (Ic – Ia)/ $\sqrt{3}$	
2	Ia' = (Ia – 2Ib + Ic)/ 3	Ib' = (Ia + Ib – 2Ic)/ 3	Ic' = (Ib + Ic –2Ia)/ 3	
3	Ia' = (Ic – Ib)/ $\sqrt{3}$	Ib' = (Ia – Ic)/ $\sqrt{3}$	Ic' = (Ib – Ia)/ $\sqrt{3}$	
4	Ia' = (2Ic – Ia – Ib)/ 3	Ib' = (2Ia – Ib – Ic)/ 3	Ic' = (2Ib – Ia – Ic)/ 3	
5	Ia' = (Ic – Ia)/ $\sqrt{3}$	Ib' = (Ia – Ib)/ $\sqrt{3}$	Ic' = (Ib – Ic)/ $\sqrt{3}$	
6	Ia' = (Ib + Ic –2Ia)/ 3	Ib' = (Ia – 2Ib + Ic)/ 3	Ic' = (Ia + Ib – 2Ic)/ 3	
7	Ia' = (Ib – Ia)/ $\sqrt{3}$	Ib' = (Ic – Ib)/ $\sqrt{3}$	Ic' = (Ia – Ic)/ $\sqrt{3}$	
8	Ia' = (2Ib – Ia – Ic)/ 3	Ib' = (2Ic – Ia – Ib)/ 3	Ic' = (2Ia – Ib – Ic)/ 3	
9	Ia' = (Ib – Ic)/ $\sqrt{3}$	Ib' = (Ic – Ia)/ $\sqrt{3}$	Ic' = (Ia – Ib)/ $\sqrt{3}$	
10	Ia' = (Ia + Ib – 2Ic)/ 3	Ib' = (Ib + Ic –2Ia)/ 3	Ic' = (Ia – 2Ib + Ic)/ 3	
11	Ia' = (Ia – Ic)/ $\sqrt{3}$	Ib' = (Ib – Ia)/ $\sqrt{3}$	Ic' = (Ic – Ib)/ $\sqrt{3}$	

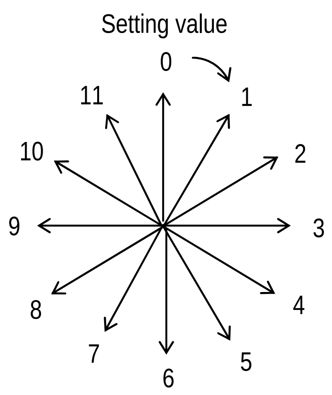
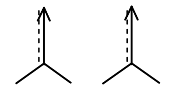
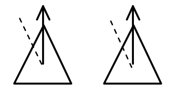
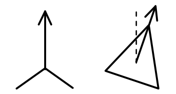
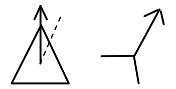
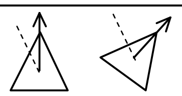
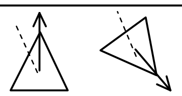
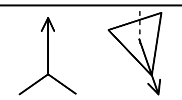
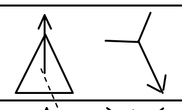
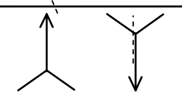
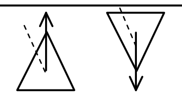
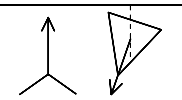
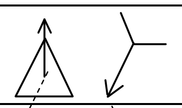
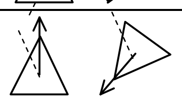
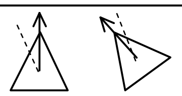
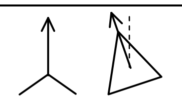
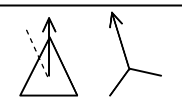
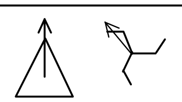


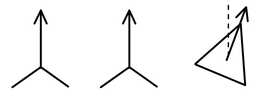
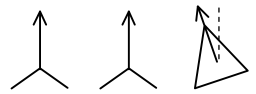
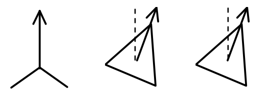
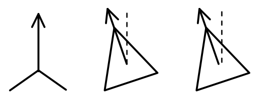
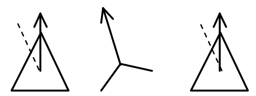
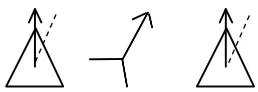
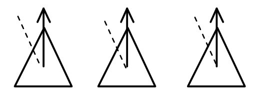
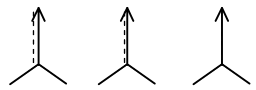
Table 2.2.5.2 Setting for Phase Angle Matching (for α-method)

(a) Settings for typical connections of 2-windings transformer

Transformer connections described in IEC60076-1	Primary, Secondary (P) (S)	Settings for phase angle correction			Remarks
		Primary, (yd_p)	Secondary, (yd_s)	Phase angle Diff. (vec_s)	Phase angle matching calculation (Table 2.2.5.1)
Yy0		1	1	0	P: 0 O'clock S: 0 O'clock
Dd0		2	2	0	P: 1 O'clock S: 1 O'clock
Yd1		1	2	1	P: 0 O'clock S: 1 O'clock
Dy1		2	1	1	P: 11 O'clock S: 0 O'clock
Dd2		2	2	2	P: 1 O'clock S: 3 O'clock
Dd4		2	2	4	P: 1 O'clock S: 5 O'clock
Yd5		1	2	5	P: 0 O'clock S: 5 O'clock
Dy5		2	1	5	P: 7 O'clock S: 0 O'clock
Yy6		1	1	6	P: 0 O'clock S: 6 O'clock
Dd6		2	2	6	P: 1 O'clock S: 7 O'clock
Yd7		1	2	7	P: 0 O'clock S: 7 O'clock
Dy7		2	1	7	P: 5 O'clock S: 0 O'clock
Dd8		2	2	8	P: 1 O'clock S: 9 O'clock
Dd10		2	2	10	P: 1 O'clock S: 11 O'clock
Yd11		1	2	11	P: 0 O'clock S: 11 O'clock
Dy11		2	1	11	P: 1 O'clock S: 0 O'clock
Dz10		2	2	10	P: 1 O'clock S: 11 O'clock

Note: A 2-windings transformer covers a 3-windings transformer with a stabilizing-winding circuit for which 2-windings transformer protection relay can be applied.

(b) Settings for typical connections of 3-windings transformer

Transformer connections described in IEC60076-1 Primary , Secondary, Tertiary	(P) (S) (T)	Settings for phase angle correction Primary, (yd_p)	Secondary, (yd_s)	PA Diff., (vec_s)	Tertiary, (yd_t)	PA Diff. (vec_t)	Remarks Phase angle matching calculation (Table 2.2.5.1)
Yy0d1		1	1	0	2	1	P: 0 O'clock S: 0 O'clock T: 1 O'clock
Yy0d11		1	1	0	2	11	P: 0 O'clock S: 0 O'clock T: 11 O'clock
Yd1d1		1	2	1	2	1	P: 0 O'clock S: 1 O'clock T: 1 O'clock
Yd11d11		1	2	11	2	11	P: 0 O'clock S: 11 O'clock T: 11 O'clock
Dy11d0		2	1	11	2	0	P: 1 O'clock S: 0 O'clock T: 1 O'clock
Dy1d0		2	1	1	2	0	P: 11 O'clock S: 0 O'clock T: 11 O'clock
Dd0d0		2	2	0	2	0	P: 1 O'clock S: 1 O'clock T: 1 O'clock
Yy0y0		1	1	0	1	0	P: 0 O'clock S: 0 O'clock T: 0 O'clock

Note: Dotted line: Reference phase

<How to set phase angle matching for GRT100>

Reference phase for phase angle matching

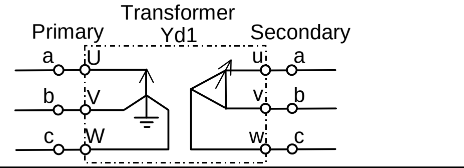
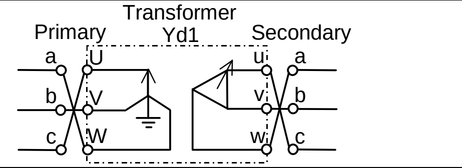
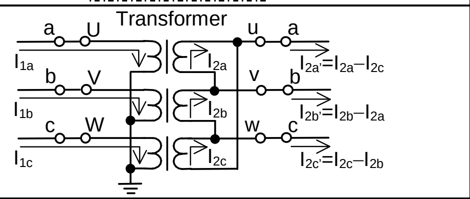
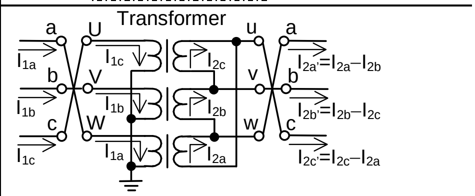
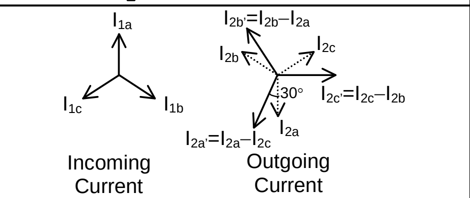
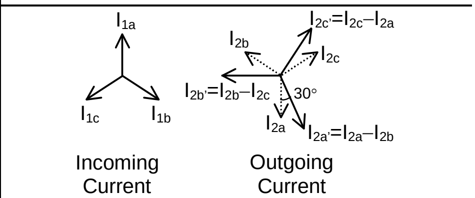
The phase of a star-connected winding side is used as the reference phase for phase angle matching.

Yd: primary
Dy: secondary
Yy: primary
Dd: the reference vector leads the A phase of the primary side by 30°.

Phase rotation

The relationship between each terminal current vector of a transformer, which depends on the transformer connection and the connection between the transformer and the power system, must be checked. The phase displacement of a delta-connected side may not be determined only by the transformer connection described in IEC60076. Table 2.2.5.3 shows an example illustrating the connection of a transformer and power system and their current vectors when a Yd1 type transformer is connected to the power system with both clockwise and anticlockwise phase rotation. In this case, the setting for phase angle correction is not corresponding to that of Table 2.2.5.1.

Table 2.2.5.3 Transformer Connection and Current Vector

	Delta-side connected with 30° lagging	Delta-side connected with 30° leading
Connection between Yd1 Transformer and Power system		
Each winding connection and Incoming/Outgoing current		
Incoming current vector and Outgoing current vector		
Setting	Yd_p=1, yd_s=2, vec_s=1 (Same as Yd1)	Yd_p=1, yd_s=2, vec_s=11 (same as Yd11)

Auto-transformer (with internal delta-winding)

Set Yy0.

Zigzag connected transformer

Set yd_p, yd_s and vec_s to 2 (=delta) for zigzag connected side. Zero-sequence current is canceled.

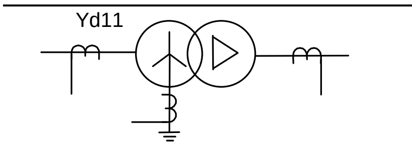
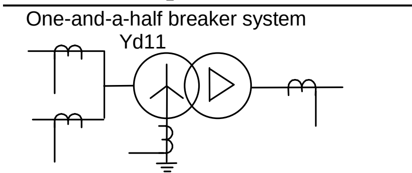
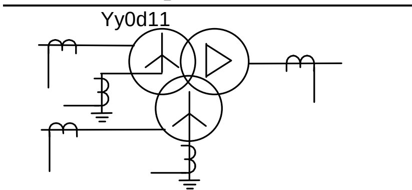
When three-winding model (model 200 series) applied to two-winding transformer:

Keep the settings of "yd_t" and "vec_t" to the default setting values.

One-and-a-half breaker system

When applied to one-and-a-half breaker system, note the DIFT and REF setting as shown in Table 2.2.5.4.

Table 2.2.5.4 Example of DIFT and REF Setting

	Setting			
	DIFT		1REF	2REF
	Yd11	yd_p=1 yd_s=2 vec_s=11	1I0	--
	Yy0d11	yd_p=1 yd_s=1 vec_s=0 yd_t=2 vec_s=11	2Io	--
	Yy0d11	yd_p=1 yd_s=1 vec_s=0 yd_t=2 vec_s=11	1I0	1I0

(When β-method is selected for [Phase matching])

The phase angle differences between line currents on each side of the power transformer are corrected by setting according to the hands of a clock as follows:

Rule 1:

If all the windings are star-connected, then take one of the windings as a reference winding and set 1 (= one o'clock) for it. For other winding(s), set the phase angle difference from the reference winding by the expression of the leading angle. One hour corresponds to leading by thirty degrees.

Example 1 If the setting winding leads the reference winding by 60°, set 3 (= three o'clock).

Example 2 If the setting winding is in phase with the reference winding, set 1 (= one o'clock).

Example 3 If the setting winding lags the reference winding by 60° (that is leading by 300°), set 11 (= eleven o'clock).

Rule 2:

If any of the windings are delta-connected, take one of the delta-connected winding(s) as a reference winding and set 0 (= noon) for it. For other star- or delta-connected winding(s), set according to the Rule 1 mentioned above.

Example 1 If the setting winding leads the reference winding by 60°, set 2 (= two o'clock).

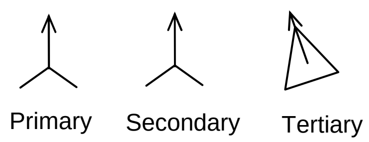
Example 2 If the setting winding is in phase with the reference winding, set 0 (= noon).

Example 3 If the setting winding lags the reference winding by 60° (that is leading by 300°), set 10 (ten o'clock).

The settings for the two-winding transformer connections described in IEC60076-1 are listed in Table 2.2.5.5.

Three-winding transformers are also set according to the above mentioned rules.

Example 4 Setting for star/star/delta transformer.



	Setting (d1 / d2 / d3)
Primary (d1)	11
Secondary (d2)	11
Tertiary (d3)	0

Note: The following calculation is performed in the relay for phase angle correction.

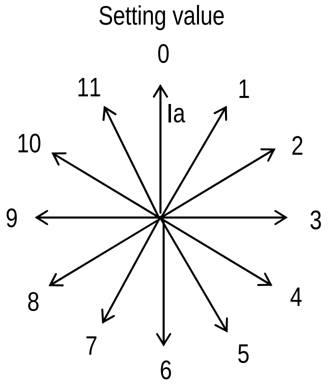
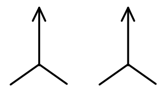
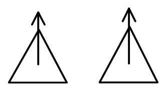
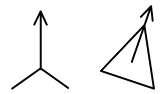
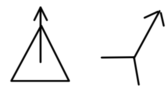
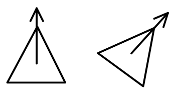
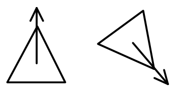
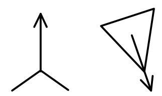
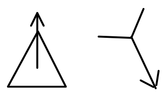
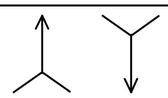
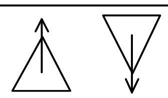
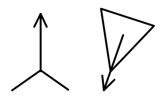
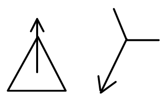
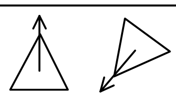
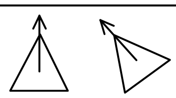
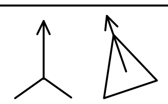
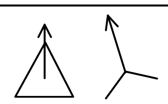
Setting	Calculation	Remarks
0	Ia = Ia	
1	Ia = (Ia – Ic)/ $\sqrt{3}$	
2	Ia = –Ic	
3	Ia = (–Ic + Ib)/ $\sqrt{3}$	
4	Ia = Ib	
5	Ia = (Ib – Ia)/ $\sqrt{3}$	
6	Ia = –Ia	
7	Ia = (–Ia + Ic)/ $\sqrt{3}$	
8	Ia = Ic	
9	Ia = (Ic – Ib)/ $\sqrt{3}$	
10	Ia = –Ib	
11	Ia = (Ia – Ib)/ $\sqrt{3}$	

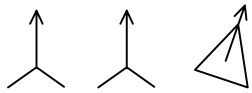
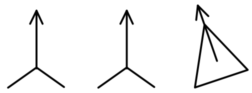
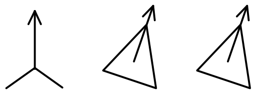
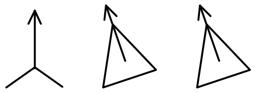
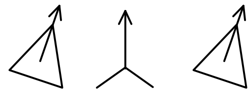
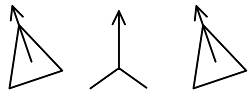
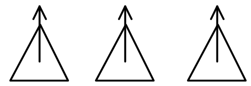
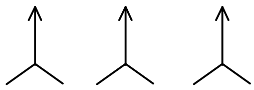
Table 2.2.5.5 Setting for Phase Angle Matching (for β-method)

(a) Settings for typical connections of 2-windings transformer

Transformer connections described in IEC60076-1		Settings for phase angle correction Primary , Secondary (d1) (d2)	Remarks
Yy0		1 , 1	
Dd0		0 , 0	
Yd1		1 , 0	
Dy1		0 , 11	
Dd2		0 , 10 or 2 , 0	Based on primary winding. Based on secondary winding.
Dd4		0 , 8 or 4 , 0	Based on primary winding. Based on secondary winding.
Yd5		5 , 0	
Dy5		0 , 7	
Yy6		1 , 7 or 7 , 1	Based on primary winding. Based on secondary winding.
Dd6		0 , 6 or 6 , 0	
Yd7		7 , 0	
Dy7		0 , 5	
Dd8		0 , 4 or 8 , 0	Based on primary winding. Based on secondary winding.
Dd10		0 , 2 or 10 , 0	Based on primary winding. Based on secondary winding.
Yd11		11 , 0	
Dy11		0 , 1	

Note: A 2-windings transformer covers a 3-windings transformer with a stabilizing-winding circuit for which 2-windings transformer protection relay can be applied.

(b) Settings for typical connections of 3-windings transformer

Transformer connections described in IEC60076-1		Settings for phase angle correction Primary, Secondary, Tertiary (d1) (d2) (d3)	Remarks
Yy0d1		1 , 1 , 0	
Yy0d11		11 , 11 , 0	
Yd1d1		1 , 0 , 0	
Yd11d11		11 , 0 , 0	
Dy11d0		0 , 1 , 0	
Dy1d0		0 , 11 , 0	
Dd0d0		0 , 0 , 0	
Yy0y0		1 , 1 , 1	

Note :

1. If all the windings are star-connected, then take one of the windings as a reference winding and set 1 (= one hour) for it.
2. If any of the windings are delta-connected, take one of the delta-connected winding(s) as a reference winding and set 0 for it.

2.3 Restricted Earth Fault Protection

Restricted earth fault protection (REF) is a zero-phase current differential scheme applied to a star-connected winding whose neutral is earthed directly or through a low impedance. It gives highly sensitive protection for internal earth faults.

REF employs a low impedance current differential scheme which detects the differential current between the zero-sequence current I_0 derived from the three-phase line currents and the neutral current I_N in the neutral conductor as shown in Figure 2.3.1.

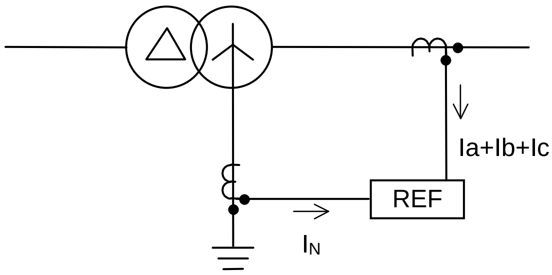


Figure 2.3.1 Restricted Earth Fault Protection

REF and the overall differential protection DIFT use the three-phase line currents in common.

GRT100 has two or three REF elements depending on the model, providing separate protection for all star-connected and neutral-earthed windings.

The elements have the same percentage restraining characteristics and are stable for all faults outside the protected zone.

Figure 2.3.2 shows the block diagram of the REF element which is composed of REF_DIF and REF_DEF. The REF_DIF has a percentage restraining characteristic while the REF_DEF provides a directional check feature to discriminate between internal and external faults. When the REF_DEF is "ON", the REF_DEF element is used. The REF_DEF element provides additional security against incorrect operation of the REF element in the event of saturation of the neutral CT. The REF_DEF is blocked when the maximum phase current exceeds 2 × kct × (Rated current of neutral CT), since the REF element is used for earth fault protection of transformer winding. For details, see Section 2.10.3. In case of terminal current larger than that, the DIFT element provides tripping. The REF_DEF can be disabled by setting the scheme switch [REF_DEF] to "OFF".

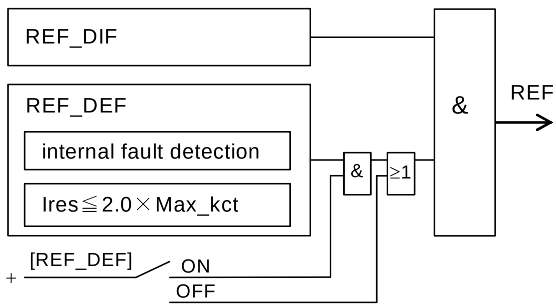
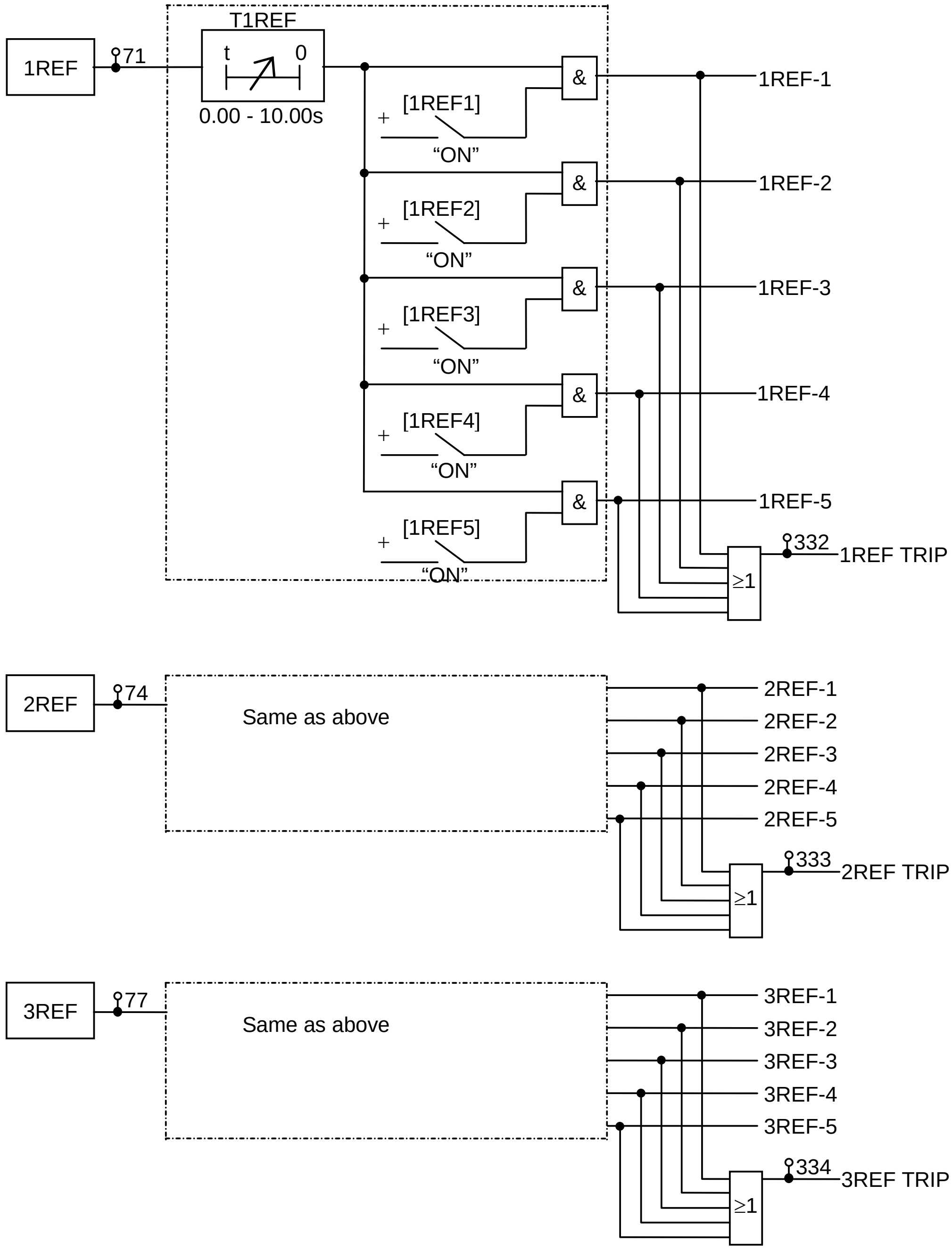


Figure 2.3.2 Block Diagram of REF

Figure 2.3.3 shows the scheme logic of the restricted earth fault protection when three REF elements are applied. Each REF element can perform instantaneous or time-delayed tripping of up to five breakers. Any of the five breaker tripping signals 1REF-1 to 3REF-5 are enabled or disabled by the scheme switch [1REF1] to [3REF5] settings.

Note: Models 203 and 204 are not provided with 1REF-4, 1REF5, 2REF-4, 2REF-5, 3REF-4 and

3REF-5.



Note: Models 203 and 204 are not provided with 1REF-4, 1REF-5, 2REF-4, 2REF-5, 3REF-4 and 3REF-5.

Figure 2.3.3 Scheme Logic of Restricted Earth Fault Protection

Appendix L shows applications of the three REF elements to various types of transformers. When protecting a two- or three-winding transformer, 1REF, 2REF and 3REF elements should be applied to the primary (or high-voltage) winding, secondary (or medium-voltage) winding and tertiary (or low-voltage) winding respectively. This is also valid for auto-transformer protection but the application must comply with Appendix L.

In the application to auto-transformers, one REF element may introduce two or three line currents and one neutral current as shown in Appendix L. 1REF to 3REF elements recognize the number of the line currents according to the scheme switch setting of [1REF] to [3REF].

Setting

The following shows the setting elements for the restricted earth fault protection and their setting ranges.

Element		Range	Step	Default	Remarks
1REF	1ik	0.05 – 0.50(*)	0.01	0.50	Minimum operating current
	1kct1	1.00 – 50.00	0.01	1.00	CT ratio matching
	1kct2	1.00 – 50.00	0.01	1.00	
	1kct3	1.00 – 50.00	0.01	1.00	
	1p2	50 – 100%	1%	100%	% slope of DF2
	1kp	0.50 – 2.00(*)	0.01	1.00	DF2 restraining current section of large current characteristic
2REF	2ik	0.05 – 0.50(*)	0.01	0.50	Minimum operating current
	2kct1	1.00 – 50.00	0.01	1.00	CT ratio matching
	2kct2	1.00 – 50.00	0.01	1.00	
	2kct3	1.00 – 50.00	0.01	1.00	
	2p2	50 – 100%	1%	100%	% slope of DF2
	2kp	0.50 – 2.00(*)	0.01	1.00	DF2 restraining current section of large current characteristic
3REF	3ik	0.05 – 0.50(*)	0.01	0.50	Minimum operating current
	3kct1	1.00 – 50.00	0.01	1.00	CT ratio matching
	3kct2	1.00 – 50.00	0.01	1.00	
	3kct3	1.00 – 50.00	0.01	1.00	
	3p2	50 – 100%	1%	100%	% slope of DF2
	3kp	0.50 – 2.00(*)	0.01	1.00	DF2 restraining current section of large current characteristic
T1REF		0.00 – 10.00s	0.01s	0.00s	Delayed tripping
T2REF		0.00 – 10.00s	0.01s	0.00s	
T3REF		0.00 – 10.00s	0.01s	0.00s	
Scheme switch					
[1REF1] to [1REF5]		Off/On		(**)	Enable or disable to output tripping signal
[2REF1] to [2REF5]		Off/On		(**)	
[3REF1] to [3REF5]		Off/On		(**)	
[1REF] to [3REF]		1Io/2Io/3Io		1Io	Number of line currents input to 1REF, 2REF and 3REF elements
[REF_DEF]		Off/On		Off	

(*): Multiplier of secondary rated current

(**): Default settings are dependent on the models. See Appendix H.

Setting of ik (1ik, 2ik and 3ik)

1ik, 2ik and 3ik are minimum operating current settings and are set as a ratio to the line CT secondary rated current. ik is determined from the maximum erroneous zero sequence differential current under normal operating conditions. A typical setting would be between 10% and 50%.

Setting of kct (1kct1-1kct3, 2kct1-2kct3 and 3kct1-3kct3)

CT ratio matching is performed between the line CT(s) and the neutral CT by setting 1kct1-1kct3 for 1REF element, 2kct1-2kct3 for 2REF element and 3kct1-3kct3 for 3REF element. The settings are obtained as a ratio of the line CTs ratio to the neutral CT ratio and the line CTs have the notations shown in Appendix L according to 1REF to 3REF applications.

For example, the settings of 1kct1, 1kct2, 2kct1 and 2kct2 are calculated;

1kct1 = (CT ratio of line CT 1ct-1)/(CT ratio of neutral CT 1nCT)

1kct2 = (CT ratio of line CT 1ct-2)/(CT ratio of neutral CT 1nCT)

2kct1 = (CT ratio of line CT 2ct-1)/(CT ratio of neutral CT 2nCT)

2kct2 = (CT ratio of line CT 2ct-2)/(CT ratio of neutral CT 2nCT)

where,

CT ratio = (primary rated current)/(secondary rated current).

Setting of scheme switch [1REF] to [3REF]

[1REF] to [3REF] are set to "1I0", "2I0" or "3I0" when they introduce one, two or three line currents respectively.

Setting of scheme switch [REF_DEF]

The function of REF_DEF is set to “On/Off” by setting.

2.4 Overcurrent Protection

GRT100 provides definite time and inverse time overcurrent elements for both phase faults and earth faults, separately for each transformer winding. Three phase currents from each set of line CTs are used for the phase fault protection elements, while the earth fault protection is based on the neutral CT input.These elements can be used selectively depending on the requirements of the particular application, but the following points should be noted:

- In the case of large power transformers, overcurrent protection is usually employed only as back-up protection for terminal faults, and for uncleared LV system faults. In such cases, the overcurrent elements can be applied either on one or both sides of the transformer as required.
- Coverage of internal transformer faults is generally limited.
- It is common practice to apply IDMTL phase and earth fault overcurrent protection as back-up for the LV system. Current and time settings must be arranged to grade with downstream relays and fuses. The phase fault current setting must also be set to exceed the maximum overload current.
- High-set instantaneous overcurrent protection can be applied on the primary side to provide back-up protection for terminal faults. The current setting must be higher than the maximum through-fault current to ensure that the element does not operate for faults on the LV side.

One of the following IEC-standard-compliant inverse time characteristics or one long time inverse characteristic is available for the inverse current protection.

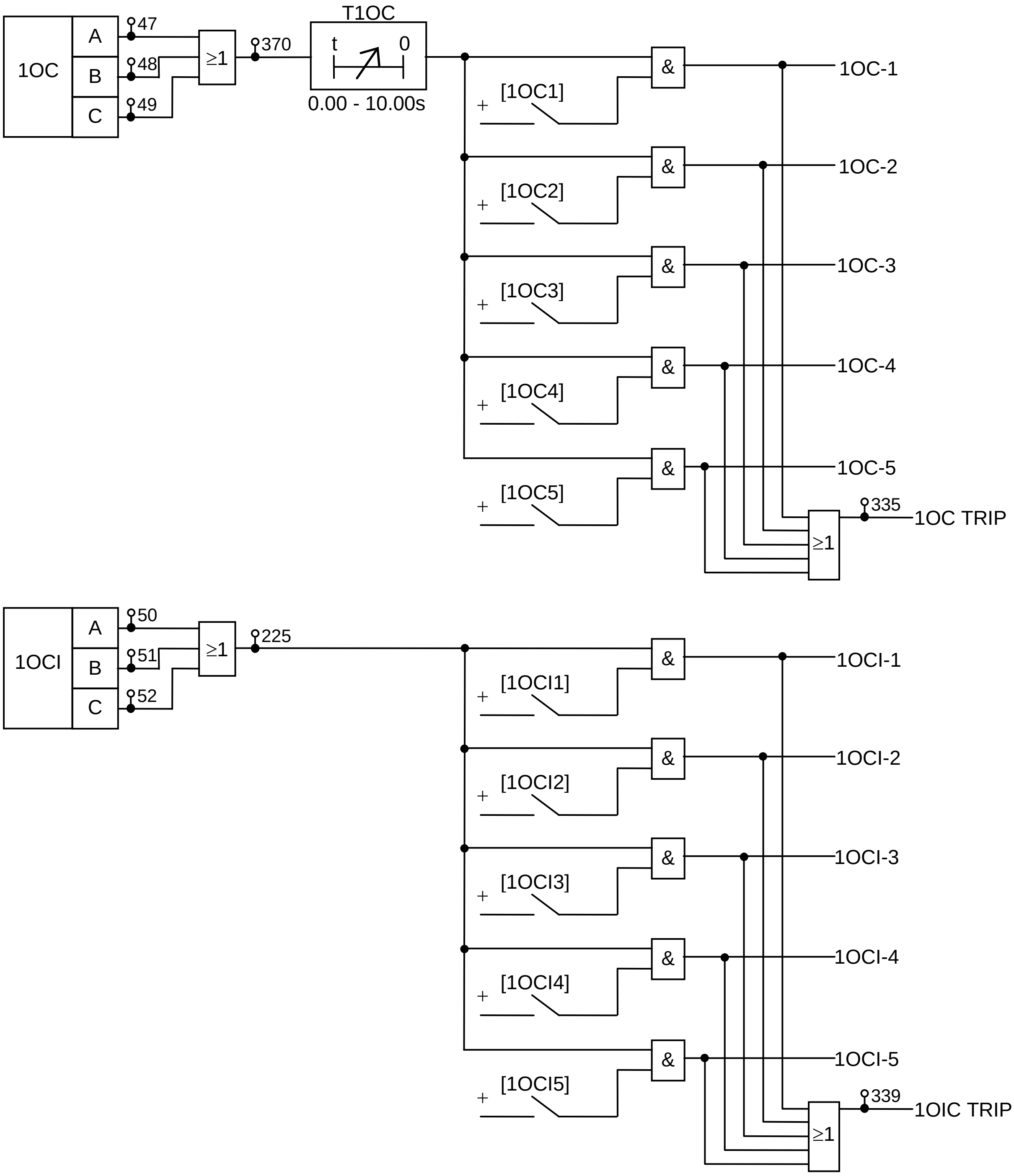
- standard inverse IEC 60255-3
- very inverse IEC 60255-3
- extremely inverse IEC 60255-3

Up to three definite time elements (1OC to 3OC) and inverse time elements (1OCI to 3OCI) input three phase currents from line CTs in the transformer windings.

Up to three definite time elements (1EF to 3EF) and inverse time elements (1EFI to 3EFI) input neutral currents from CTs in the neutral circuit.

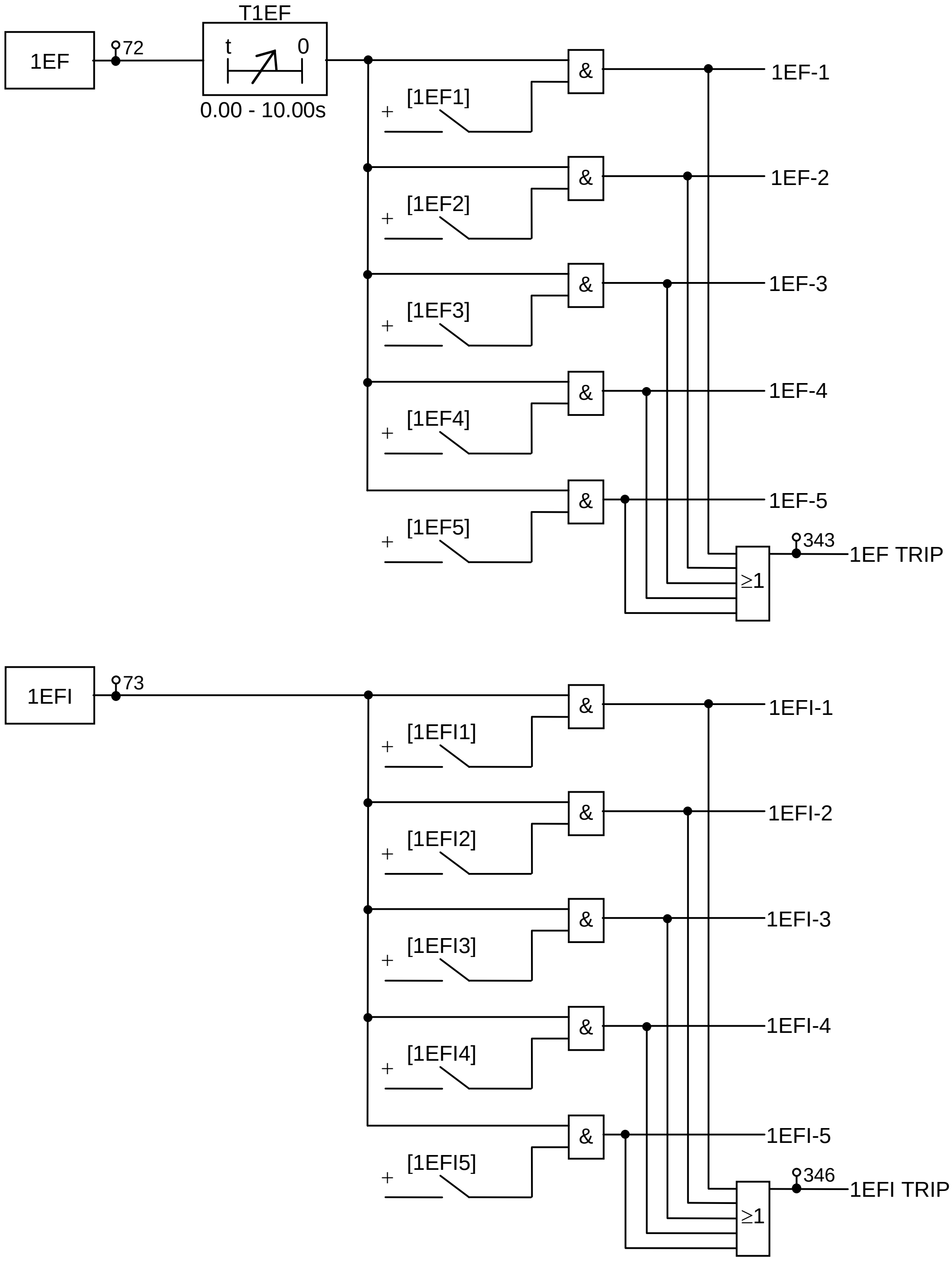
Figure 2.4.1 and Figure 2.4.2 show the scheme logic of overcurrent protection. Each element can perform time-delayed tripping of up to five breakers. The breaker tripping signals are blocked by the scheme switch settings.

The number of overcurrent elements applied depends on the relay models.



Note: 2OC and 3OC provide the same logic as 1OC. 2OCI and 3OCI provide the same logic as 1OCI. Models 203 and 204 are not provided with 1OC-4, 1OC-5, 2OC-4, 2OC-5, 3OC-4, 3OC-5, 1OCI-4, 1OCI-5, 2OCI-4, 2OCI-5, 3OCI-4 and 3OCI-5.

Figure 2.4.1 Scheme Logic of the Overcurrent Protection



Note: 2EF and 3EF provide the same logic as 1EF. 2EFI and 3EFI provide the same logic as 1EFI. Models 203 and 204 are not provided with 1EF-4, 1EF-5, 2EF-4, 2EF-5, 3EF-4, 3EF-5, 1EFI-4, 1EFI-5, 2EFI-4, 2EFI-5, 3EFI-4 and 3EFI-5.

Figure 2.4.2 Scheme Logic of the Overcurrent Protection for Earth Faults

Setting

The following shows the setting elements for the overcurrent protection and their setting ranges.

Element	Range	Step	Default	Remarks
1OC	0.10 – 20.0(*)	0.01	2.00	Definite time overcurrent (line)
2OC	0.10 – 20.0(*)	0.01	2.00	Definite time overcurrent (line)
3OC	0.10 – 20.0(*)	0.01	2.00	Definite time overcurrent (line)
T1OC	0.00 – 10.00s	0.01s	1.00s	Delayed tripping for 1OC
T2OC	0.00 – 10.00s	0.01s	1.00s	Delayed tripping for 2OC
T3OC	0.00 – 10.00s	0.01s	1.00s	Delayed tripping for 3OC
1OCI	0.10 – 5.00(*)	0.01	1.00	Inverse time overcurrent (line)
2OCI	0.10 – 5.00(*)	0.01	1.00	Inverse time overcurrent (line)
3OCI	0.10 – 5.00(*)	0.01	1.00	Inverse time overcurrent (line)
T1OCI	0.05 – 1.00	0.01	1.00	Time multiplier setting for 1OCI
T2OCI	0.05 – 1.00	0.01	1.00	Time multiplier setting for 2OCI
T3OCI	0.05 – 1.00	0.01	1.00	Time multiplier setting for 3OCI
1EF	0.10 – 20.00(*)	0.01	2.00	Definite time overcurrent (neutral)
2EF	0.10 – 20.00(*)	0.01	2.00	Definite time overcurrent (neutral)
3EF	0.10 – 20.00(*)	0.01	2.00	Definite time overcurrent (neutral)
T1EF	0.00 – 10.00s	0.01s	1.00s	Delayed tripping for 1EF
T2EF	0.00 – 10.00s	0.01s	1.00s	Delayed tripping for 2EF
T3EF	0.00 – 10.00s	0.01s	1.00s	Delayed tripping for 3EF
1EFI	0.10 – 5.00(*)	0.01	1.00	Inverse time overcurrent (neutral)
2EFI	0.10 – 5.00(*)	0.01	1.00	Inverse time overcurrent (neutral)
3EFI	0.10 – 5.00(*)	0.01	1.00	Inverse time overcurrent (neutral)
T1EFI	0.05 – 1.00	0.01	1.00	Time multiplier setting for 1EFI
T2EFI	0.05 – 1.00	0.01	1.00	Time multiplier setting for 2EFI
T3EFI	0.05 – 1.00	0.01	1.00	Time multiplier setting for 3EFI
Scheme switch				Inverse time characteristic selection of
M1OCI to M3OCI	Long-Std-Very-Ext		Std	OCI elements
M1EFI to M3EFI	Long-Std-Very-Ext		Std	EFI elements
Scheme switch	Off/On		(**)	Enable or disable tripping by
[1OC1] to [3OC5]				OC elements
[1OCI1] to [3OCI5]				OCI elements
[1EF1] to [3EF5]				EF elements
[1EFI1] to [3EFI5]				EFI elements

(*) : Multiplier of CT secondary rated current.
(**) : Default settings are dependent on the models. See Appendix H.

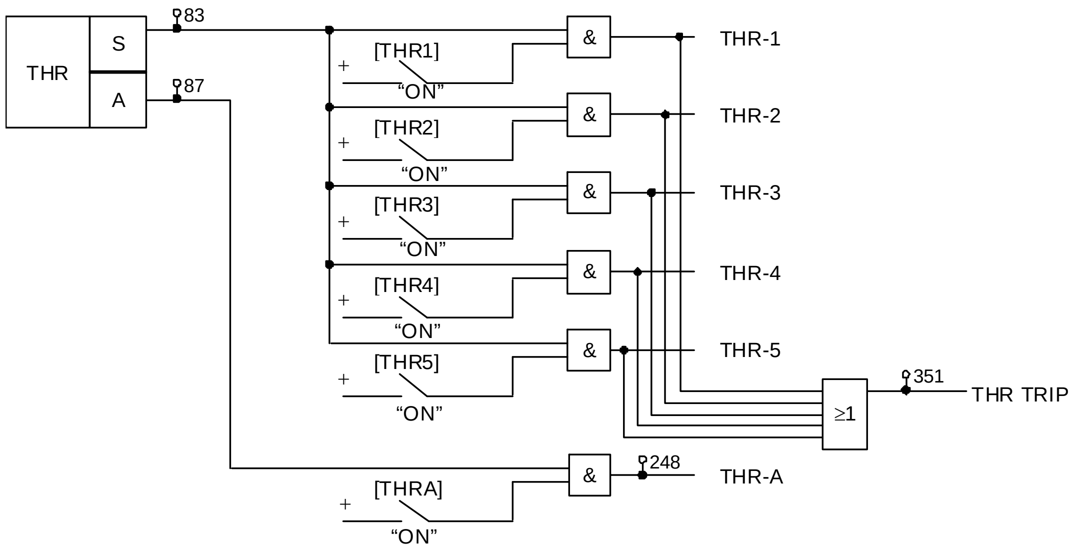
The overcurrent elements use the same three-phase line currents and neutral current as the differential protection and the restricted earth fault protection. When choosing settings, the following relationships between the overcurrent elements and the connected windings must be taken into account.

1OC, 1OCI :	Primary (high-voltage) winding
2OC, 2OCI :	Secondary (medium-voltage) winding
3OC, 3OCI :	Tertiary (low-voltage) winding
1EF, 1EFI :	1REF applied neutral circuit
2EF, 2EFI :	2REF applied neutral circuit
3EF, 3EFI :	3REF applied neutral circuit

2.5 Thermal Overload Protection

The thermal overload protection is applied to protect transformers from electrical thermal damage. A-phase current is used to detect the thermal overload of a transformer. The characteristics are exponential functions according to the IEC 60255-8 standard and take into account the I^2R losses due to the particular operational current and the simultaneous cooling due to the coolant. In this way the tripping time during an overload condition takes the pre-load into consideration. An alarm stage can be set to operate before reaching the tripping condition.

Figure 2.5.1 shows the scheme logic of the thermal overcurrent protection. THR tripping output can be given to up to five breakers. Any of the five breaker tripping signals THR-1 to THR-5 can be blocked by the scheme switch [THR1] to [THR5] settings. Alarming signal THR-A can be blocked by the scheme switch [THRA] setting.



Note: Models 203 and 204 are not provided with THR-4 and THR-5.

Figure 2.5.1 Scheme Logic of Thermal Overload Protection

Setting

The following shows the setting elements for the thermal overload protection and their setting ranges.

Element	Range	Step	Default	Remarks
τ	0.5 – 500.0min	0.1min	60.0min	Thermal time constant
k	0.10 – 4.00	0.01	1.30	Constant
IB	0.50 – 2.50(*1)	0.01	1.00	Basic current
Ip	0.00 – 1.00(*1)	0.01	0.00	Pre-specified load current
TA	0 – 10min	1min	10min	Time for alarm (before trip) (*3)
Scheme switch				Enable or disable
THR1 to THR5	Off/On		(*2)	Trip
THRA	Off/On		On	Alarm

(∗1): Multiplier of CT secondary rated current

(*2): Default settings are dependent on the models. See Appendix H.

(*3): Alarming time = THR trip time (operating time) – T_A (setting time)

Note: Ip 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, Ip should be set to zero, in which case the previous load current, Ip, is calculated internally by the thermal model, providing memory of conditions occurring before an overload.

2.6 Frequency Protection

GRT100 provides underfrequency or overfrequency protection and/or alarms for load shedding or for detecting such an overfrequency condition caused by disconnecting load from a particular generation location.

The frequency element FRQ comprises two frequency elements 81-1 and 81-2, the former is used for tripping and the latter for alarms.

Figure 2.6.1 shows the scheme logic of the frequency protection. The tripping element 81-1 outputs underfrequency and overfrequency trip signals L1 and H1. Either underfrequency or overfrequency protection is selected by setting the scheme switch [FRQ-UF1] to "ON" or "OFF".

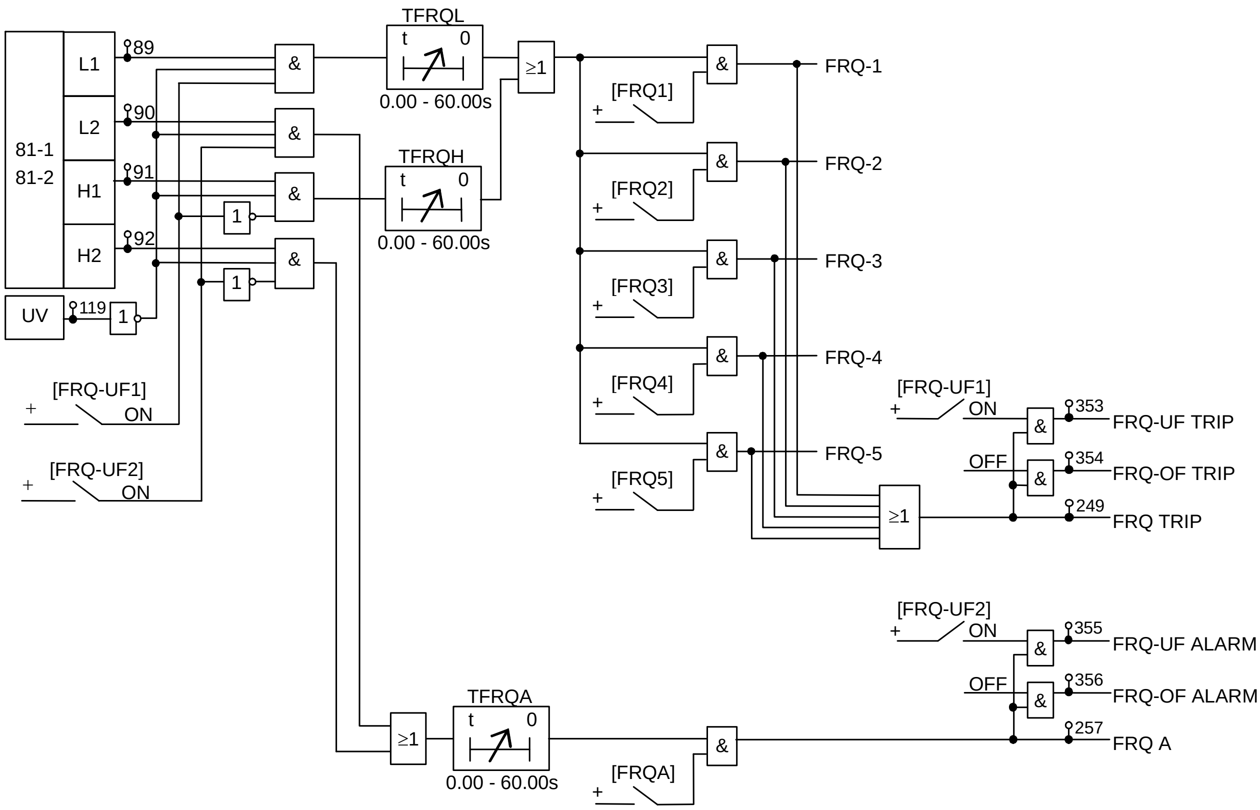
The alarm element 81-2 outputs underfrequency and overfrequency alarm signals L2 and H2. Either underfrequency or overfrequency alarms are selected by setting the scheme switch [FRQ-UF2] to "ON" or "OFF".

Frequency protection can perform time-delayed tripping of up to five breakers. Any of the breaker tripping signals FRQ-1 to FRQ-5 can be blocked by the scheme switch [FRQ1] to [FRQ5] settings.

Note: Models 203 and 204 are not provided with FRQ-4 and FRQ-5.

Alarm signal FRQ-A can be blocked by the scheme switch [FRQA] setting.

Frequency protection is blocked under the condition that the system voltage is lower than the setting of the undervoltage element UV.



Note: Models 203 and 204 are not provided with FRQ-4 and FRQ-5.

Figure 2.6.1 Scheme Logic of Frequency Protection

Setting

The following shows the setting elements for the frequency protection and their setting ranges.

Element	Range	Step	Default	Remarks
81-1 (L1, H1)	45.00 – 55.00Hz (54.00 – 66.00Hz	0.01Hz 0.01Hz	49.00Hz 59.00Hz) (*)	Trip
81-2 (L2, H2)	45.00 – 55.00Hz (54.00 – 66.00Hz	0.01Hz 0.01Hz	48.00Hz 58.00Hz)	Alarms
UV	40 – 100V	1V	40V	Undervoltage block
TFRQL	0.00 – 60.00s	0.01s	10.00s	Underfrequency trip time delay
TFRQH	0.00 – 60.00s	0.01s	10.00s	Overfrequency trip time delay
TFRQA	0.00 – 60.00s	0.01s	10.00s	Alarm time delay
Scheme switch				Enable or disable
[FRQ-UF1]	Off/On		On	Trip
[FRQ-UF2]	Off/On		On	Alarm
[FRQ1] to [FRQ5]	Off/On		(**)	Trip
[FRQA]	Off/On		On	Alarm

(*) : Frequency values shown in parentheses are for the case of 60Hz rating. Other frequency values are shown for the case of 50Hz rating.

(**): Default settings are dependent on the models. See Appendix H.

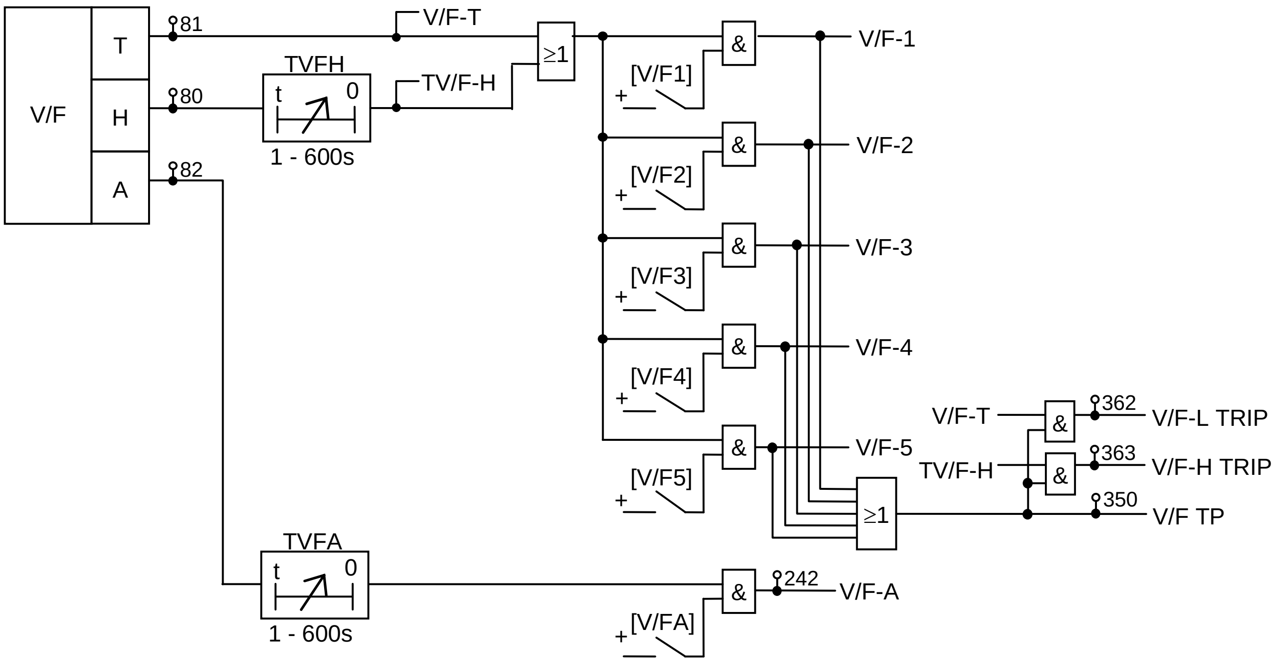
2.7 Overexcitation Protection

Overexcitation protection is applied to protect transformers from overvoltage and overfluxing conditions.

Any single phase-to-phase connected voltage is used to detect overexcitation. Trip and alarm characteristics, which are based on a measurement of the voltage/frequency ratio, are provided.

Figure 2.7.1 shows the scheme logic of overexcitation protection. Overexcitation element V/F responds to voltage/frequency and outputs three signals. Signal T has an inverse time characteristic. Signals H and A have high-set and low-set definite time characteristics respectively. Signal T and signal H with a delayed pick-up timer TVFH are used for tripping. Signal A is used for alarm with a delayed pick-up timer TVFA.

The V/F element has a reset feature with definite time reset. The reset time RT is set to match the cooling characteristic that is the time for the protected transformer to reach a normal temperature after releasing the overexitation condition.



Note: Models 203 and 204 are not provided with V/F-4 and V/F-5.

Figure 2.7.1 Scheme Logic of Overexcitation Protection

Overexcitation protection can trip up to five breakers. Any of the breaker tripping signals V/F-1 to V/F-5 can be blocked by the scheme switch [V/F1] to [V/F5] settings.

Note: Models 203 and 204 are not provided with V/F-4 and V/F-5.

Alarm signal V/F-A can be blocked by the scheme switch [V/FA] setting.

Setting

The following shows the setting elements for the overexcitation protection and their setting ranges.

Element	Range	Step	Default	Remarks
V	100.0 – 120.0V	0.1V	100.0V	Transformer rated voltage / VT ratio
A	1.03 – 1.30(*)	0.01	1.03	Alarm
L	1.05 – 1.30	0.01	1.05	Low level
H	1.10 – 1.40	0.01	1.40	High level
LT	1 – 600s	1s	600s	Operation time at low level (Inverse time curve)
HT	1 – 600s	1s	1s	Operation time at high level (Inverse time curve)
RT	60 – 3600s	1s	250s	Reset time after removing overexcitation condition
TVFH	1 – 600s	1s	10s	Operating time at high level setting (Definite time delay)
TVFA	1 – 600s	1s	10s	Alarm time (Definite time delay)
Scheme switch				
[V/F1] to [V/F5]	Off/On		(**)	Enable or disable tripping
[V/FA]	Off/On		On	Enable or disable alarm

(∗): Multiplier of (rated voltage) / (rated frequency)
(**): Refer to Appendix H for default setting.

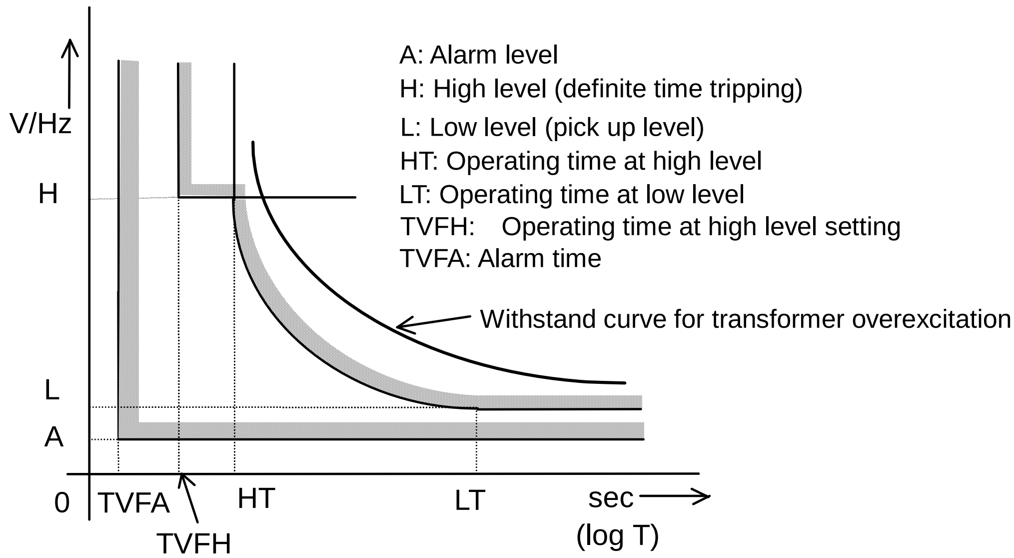


Figure 2.7.2 Setting Points

2.8 Trip by External Devices

Up to four binary signals EXT. MECHANICAL TRIP1 to EXT. MECHANICAL TRIP4 can be used for tripping external devices. Figure 2.8.1 shows the scheme logic for the signal EXT_MEC.TP1. The signal can trip up to five breakers. Any of the tripping signals EXT_MEC.TP1-1 to EXT_MEC.TP4-5 can be blocked by the scheme switches [M.T1-1] to [M.T1-5] setting.

Note: Models 203 and 204 are not provided with EXT_MEC.TP1-4 and EXT_MEC.TP1-5, and [M.T1-4] and [M.T1-5].

The other binary signals have the same scheme logic.

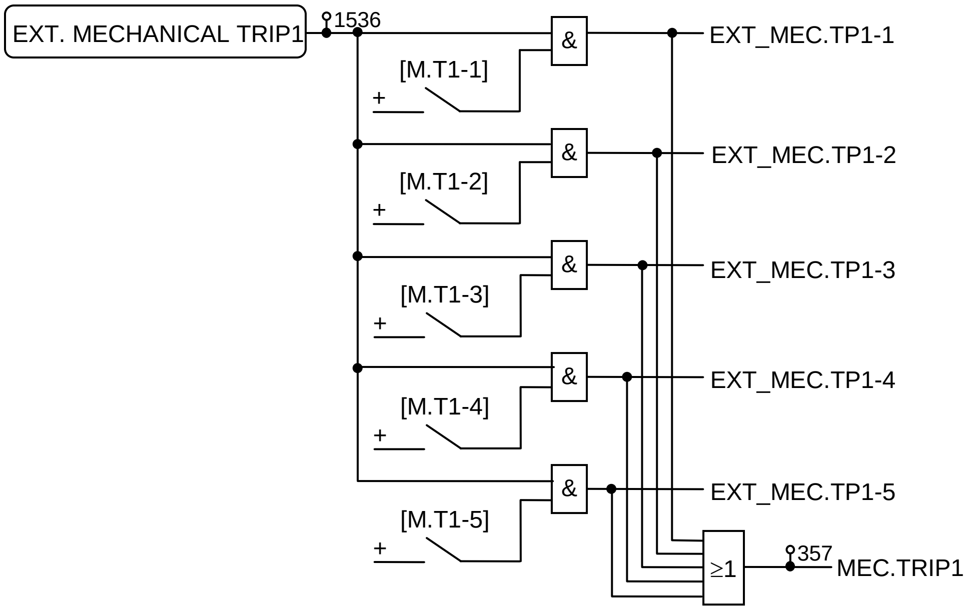


Figure 2.8.1 Scheme Logic of Trip by External Device

Setting

The following shows the setting elements for tripping by external devices and their setting ranges.

Element	Range	Step	Default	Remarks
Scheme switch				Enable or disable tripping
EXT_MEC.TP1-1 to -5	Off/On		(*)	
EXT_MEC.TP2-1 to -5				
EXT_MEC.TP3-1 to -5				
EXT_MEC.TP4-1 to -5				

(*): Default settings are dependent on the model. See Appendix H.

2.9 Tripping Output

Figure 2.9.1 shows the tripping logic. Each protection can output five tripping signals to enable tripping for five breakers. The tripping signals are set according to the number of breakers to be tripped and drive the heavy duty, high-speed tripping output relays TRIP-1 to TRIP-5.

Note: Models 203 and 204 are not provided with TRIP-4 and TRIP-5.

When the scheme switch [L/O] is set to “ON”, tripping signals can be locked and reset with the 〔RESET〕 key on the front panel. When the switch is set to “OFF”, they are reset automatically after clearing the fault.

The tripping output relays reset 200ms after the tripping signal disappears. When [L/O] is set to “OFF”, 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.

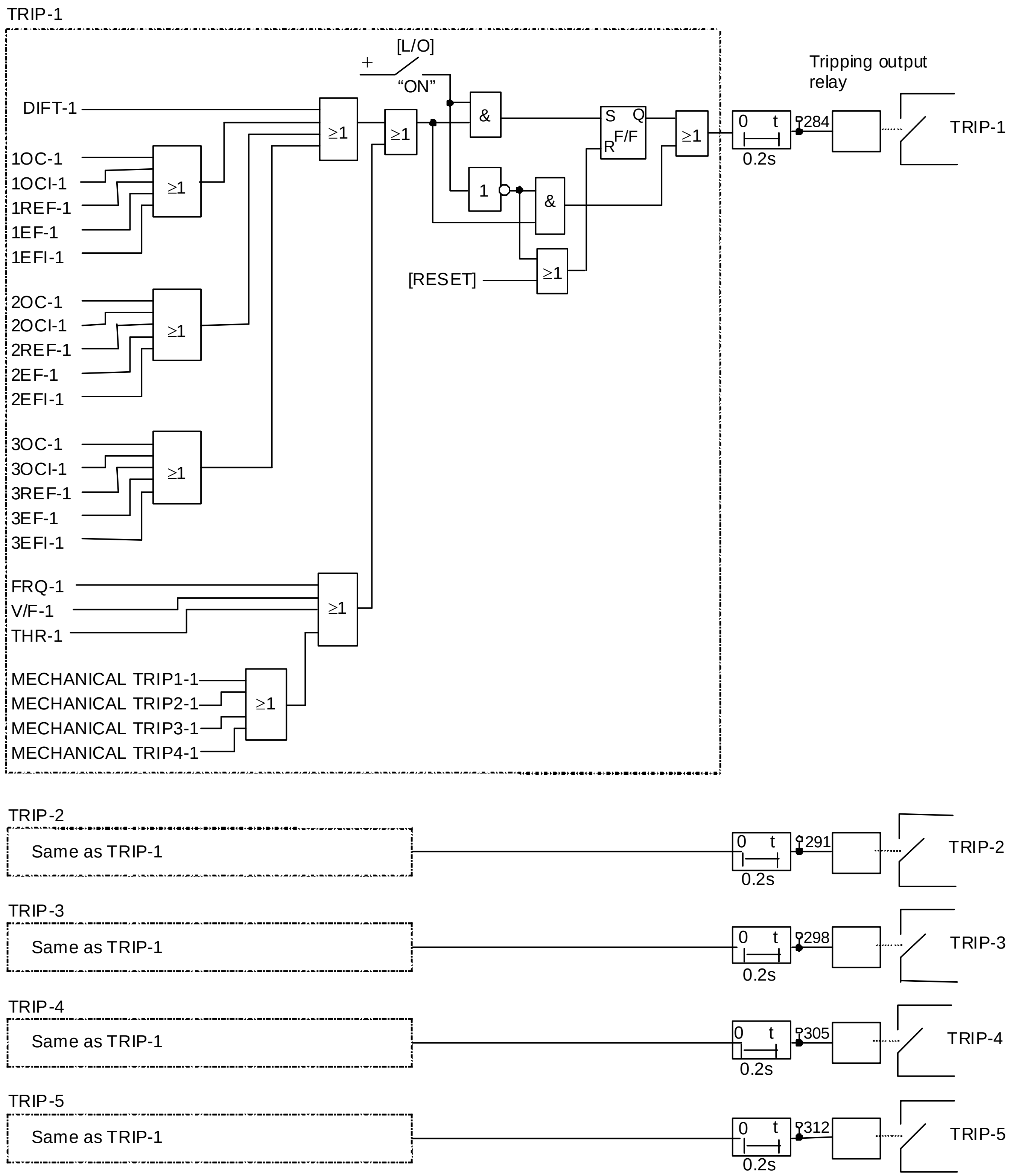


Figure 2.9.1 Tripping Logic

2.10 Characteristics of Measuring Elements

2.10.1 Percentage Current Differential Element DIF

The segregated-phase current differential element DIF has dual percentage restraining characteristics. Figure 2.10.1 shows the characteristics of DF1 and DF2 on the differential current (I_d) and restraining current (I_r) plane. I_d is a vector summation of phase current of all windings and I_r is a scalar summation of phase current of all windings.

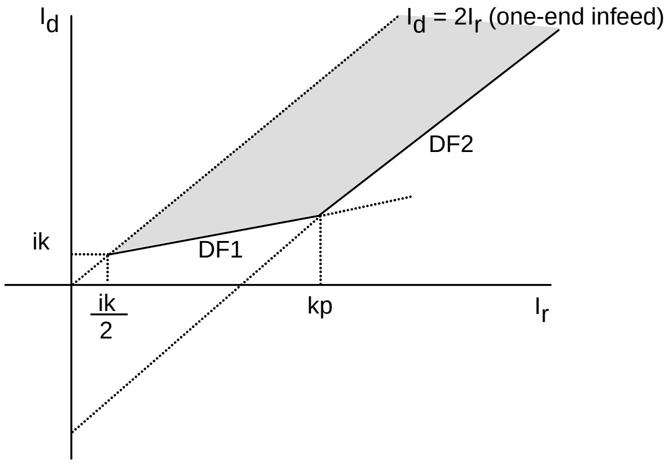


Figure 2.10.1 Current Differential Element

Characteristic DF1 is expressed by the following equation:

$I_d \geq p1 \cdot I_r + (1 - p1/2)ik$

where,

p1 : slope of DF1

ik : minimum operating current

Id and Ir are defined as follows for a three-winding transformer.

$I_d = | kct1 \cdot I_1 + kct2 \cdot I_2 + kct3 \cdot I_3 |$

$I_r = (kct1 \cdot |I_1| + kct2 \cdot |I_2| + kct3 \cdot |I_3|)/2$

where,

kct1 ,kct2 ,kct3 : CT ratio matching settings of primary, secondary and tertiary winding

I_1 ,I_2 ,I_3 : currents of primary, secondary and tertiary winding

This characteristic has weaker restraint in the small current region and ensures sensitivity to low level faults.

Characteristic DF2 is expressed by the following equation:

$I_d \geq p2 \cdot I_r + (p1 - p2)kp + (1 - p1/2)ik$

where,

p2 : slope of DF2

kp : break point of DF1 characteristic

This characteristic has stronger restraint in the large current region and ensures stability against CT saturation during through faults.

2.10.2 High-set Overcurrent Element HOC

High-set overcurrent element HOC is an instantaneous overcurrent characteristic, and is applied in the differential circuit. The characteristic is expressed by the following equation:

$I_d \geq kh$

Id is defined as follows for three-winding transformer.

$I_d = |\ kct1 \cdot I_1 + kct2 \cdot I_2 + kct3 \cdot I_3\ |$

where,

kct1, kct2, kct3: CT ratio matching settings of primary, secondary and tertiary winding

HOC is an un-restrained current differential element which can protect a transformer against damage due to a heavy internal fault, because it has a simple operation principle and high-speed operation. Note that HOC is not immune to transformer inrush currents and therefore cannot be applied with a sensitive setting.

2.10.3 Restricted Earth Fault Element REF

The restricted earth fault element REF is composed of REF_DIF and REF_DEF, as was shown in Figure 2.3.2.

The REF_DIF has dual percentage restraining characteristics. Figure 2.10.2 shows the characteristics on the differential current (Id) and restraining current (Ir) plane. Id is the differential current between the residual current of each winding and the neutral current and Ir is the restraining current which is the larger of the residual current and the neutral current.

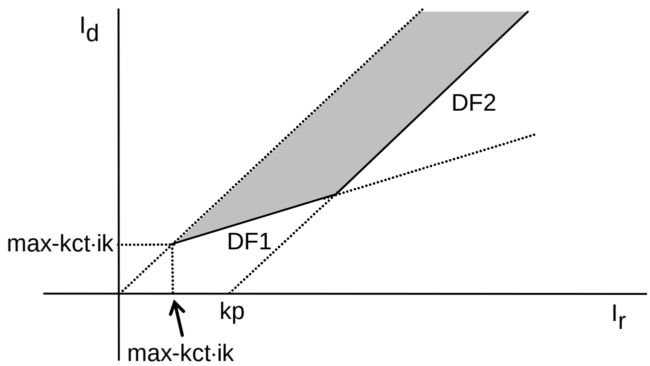


Figure 2.10.2 REF_DIF Characteristic

Characteristic DF1 is expressed by the following equation:

$I_d \geq p1 \cdot I_r + (1\text{-}p1) \cdot ik \cdot max\text{-}kct$

where,

p1 : slope of DF1 (fixed to 10%)

ik : minimum operating current

max-kct : CT ratio matching of line CT to neutral CT (when plural line CTs are applied, maximum kct is employed.)

For the 1REF element, I_d and I_r are calculated by the following equations when applied to a circuit with one neutral CT and three line CTs. (For the REF element application, see Appendix L.)

$I_d = |1kct1 \cdot I_{1o} + 1kct2 \cdot I_{2o} + 1kct3 \cdot I_{3o} + I_N|$

I_r = max.(1kct1·$|I_{1a}|$, 1kct1·$|I_{1b}|$, 1kct1·$|I_{1c}|$, 1kct2·$|I_{2a}|$, 1kct2·$|I_{2b}|$, 1kct2·$|I_{2c}|$,1kct3·$|I_{3a}|$, 1kct3·$|I_{3b}|$, 1kct3·$|I_{3c}|$, $|I_N|$)

where,

I_{1o} ,I_{2o} ,I_{3o} : residual current of primary, secondary and tertiary winding

I_{1a} ,I_{1b} ,I_{1c} ,I_{2a} ,I_{2b} ,I_{2c} ,I_{3a} ,I_{3b} ,I_{3c} : phase current of primary, secondary and tertiary winding

I_N : residual current of neutral circuit

1kct1, 1kct2, 1kct3: CT ratio matching of primary, secondary and tertiary line CT to neutral CT

Characteristic DF2 is expressed by the following equation:

$I_d \geq p2\,(I_r - kp)$

where

p2 : slope of DF2

kp : break point of DF1 characteristic

The characteristic of REF_DEF is composed of a directional characteristic and a non-directional characteristic as shown in Figure 2.10.3 (a) and (b). This characteristic is employed so that the REF is not blocked at one-end infeed current I_N.

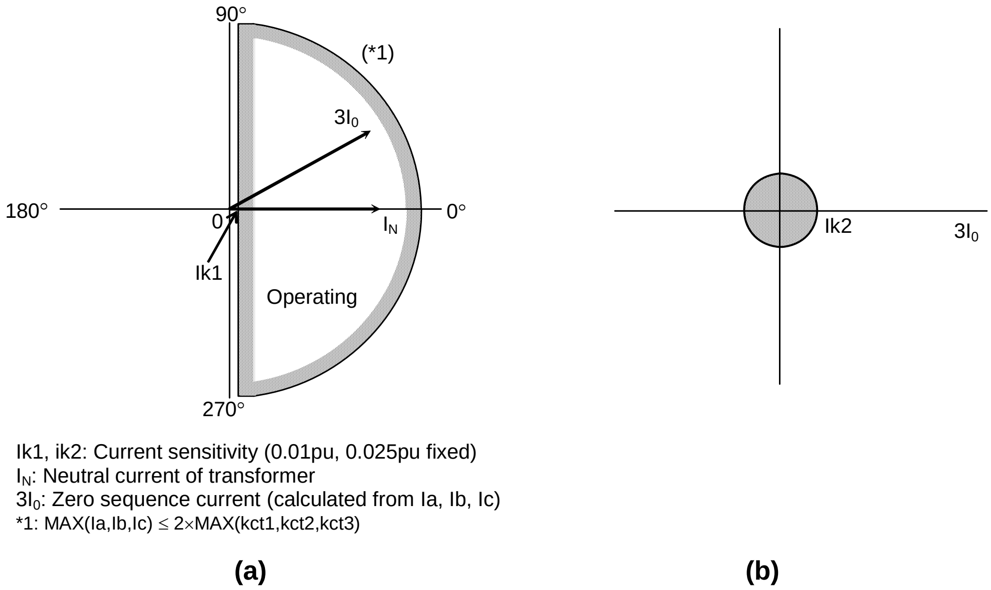
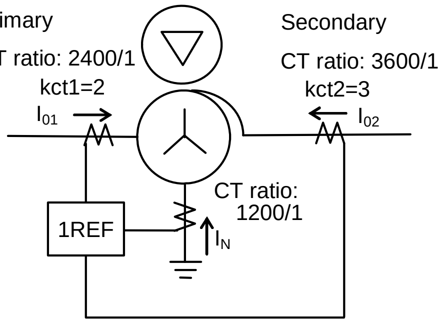


Figure 2.10.3 REF_DEF Characteristic

The REF_DEF detects an internal fault by checking the direction between transformer neutral current I_N and zero-sequence current $3I_0$ calculated from phase currents I_a, I_b and I_c. The REF_DEF is blocked when the maximum phase current is larger than 2 times of Max-kct as follows:

Max.(1kct1•I_{1a}, ….1kct3•I_{3c}) ≥ I_{BLK}=Max.(1kct1,1kct2,1kct3)×2

(Example)



max-kct = 3
Therefore, REF is blocked at
I_{BLK}=3×2.0=6A (CT secondary)
If the maximum of phase currents of both primary and secondary windings is 7200A (=6x1200A), the REF is blocked.
Reference current: 1200A
(Rated current of neutral CT)

2.10.4 Inverse Time Overcurrent Element OCI and EFI

The OCI and EFI elements have one long time inverse characteristic and three inverse time characteristics in conformity with IEC 60255-3 as shown in Figure 2.10.4. One of these characteristics can be selected.

These characteristics are expressed by the following equations and curves.

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

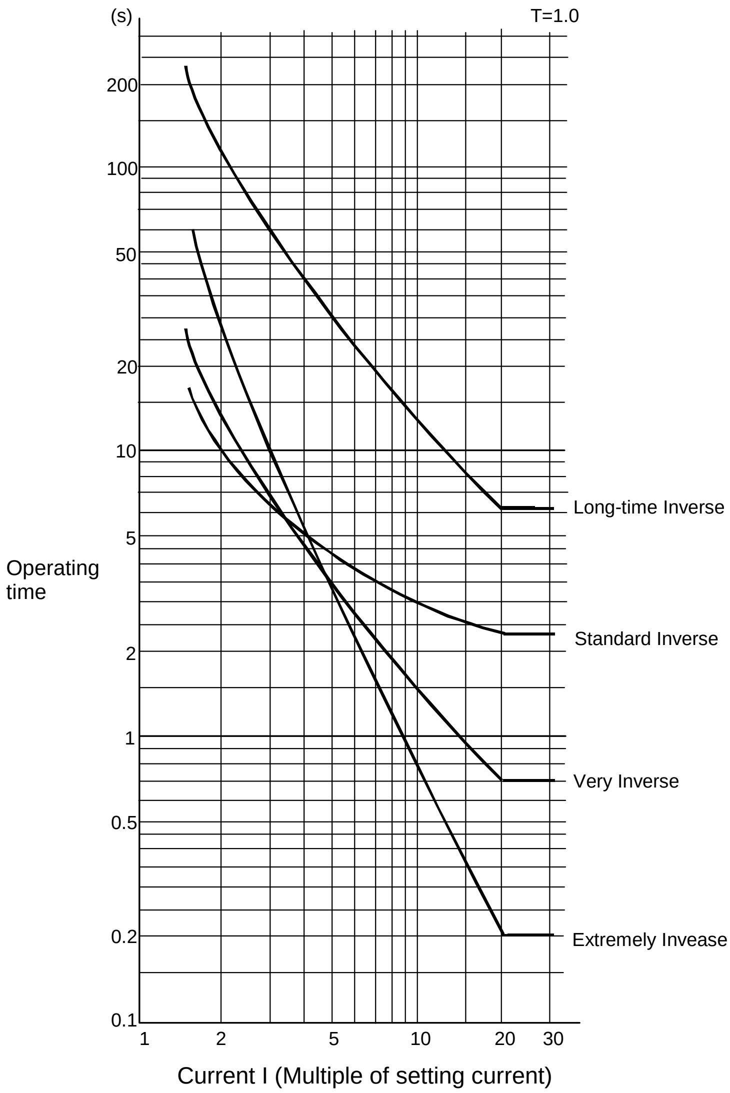


Figure 2.10.4 Characteristics of Inverse Time Overcurrent Element

2.10.5 Definite Time Overcurrent element OC and EF

The OC and EF elements measure the phase currents and the residual current respectively.

2.10.6 Thermal Overload Element THR

Thermal overload element THR has a characteristic based on thermal replica according to the IEC 60255-8 standard (see Appendix N), which evaluates the phase current (A-phase) of the CT secondary circuits. Figure 2.10.5 shows the characteristic of THR element. The element has trip and alarm stages.

Trip stage:

$$t = \tau \cdot Ln \frac{I^2 - Ip^2}{I^2 - (k \cdot I_B)^2}$$

Alarm stage:

$$t = \tau \cdot Ln \frac{(I^2 - Ip^2) \cdot (1 - T_A/\tau)}{I^2 - (k \cdot I_B)^2}$$

where

- t : operating time
- τ : thermal time constant
- I : load current
- $k \cdot I_B$: allowable overload current as specified in IEC 60255-8 (refer to Appendix N)
- I_B : basic current of transformer (rated current)
- k : constant (allowable overload current / I_B)
- Ip : prior load current before the overload occurs
- T_A : time for alarm

  (Alarming time = t (operating time) – T_A (setting time)
- *Ln* : natural logarithm

Figure 2.10.6 shows the thermal curve for a range of time constant settings in the cold state when the prior load current Ip is zero.

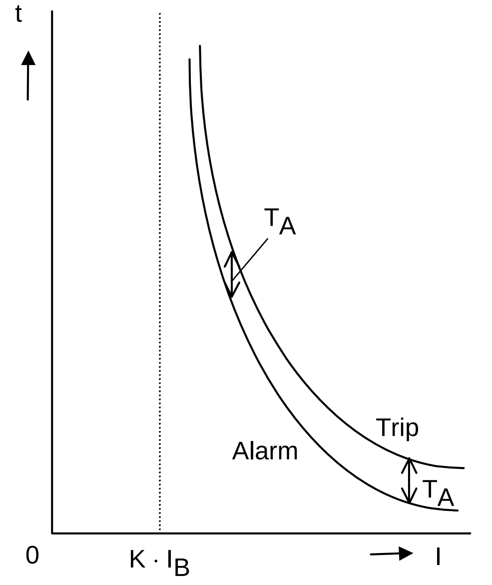


Figure 2.10.5 Characteristic of Thermal Overload Element

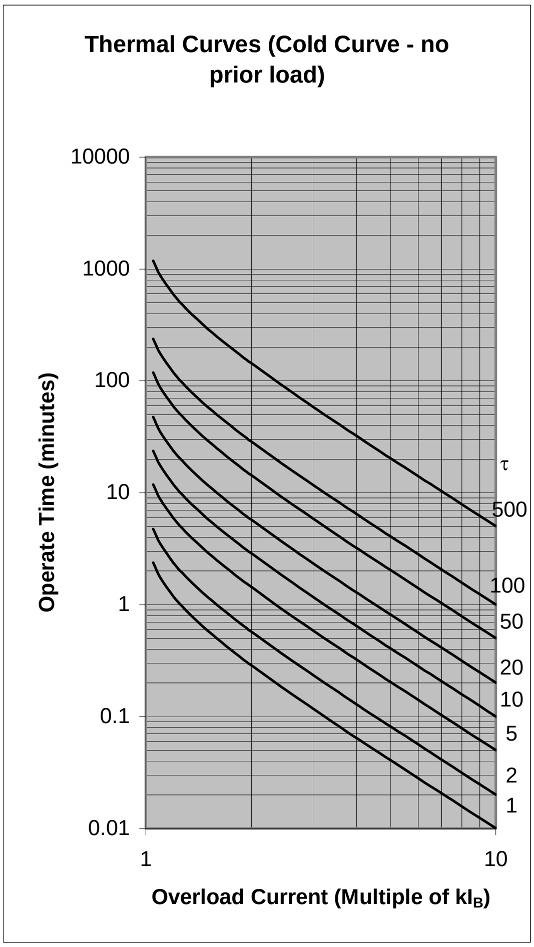


Figure 2.10.6 Thermal Curves

2.10.7 Frequency Element FRQ

GRT100 has two elements for trip or alarm. Each element operates either in overfrequency or underfrequency.

2.10.8 Overexcitation Element V/F

The characteristic is based on the ratio of voltage to frequency. The alarm is definite time delayed, while the tripping characteristic is either definite time or inverse time, as shown in Figure 2.10.7.

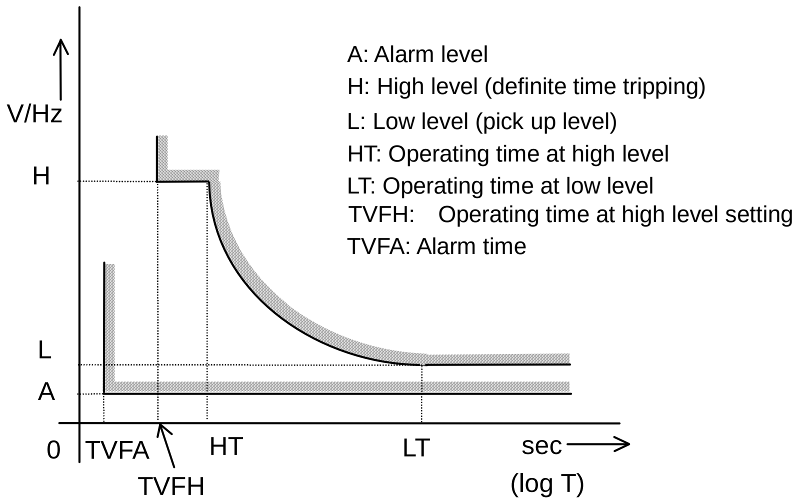


Figure 2.10.7 Characteristic of Overexcitation Element

The inverse time characteristic of V/F is expressed by the following equation.

$$t = \frac{K_2}{(V/F) - K_1}$$

where,

t : operating time

V : voltage (any phase-to-phase voltage)

F : frequency

V/F=(Vm/Fm) / (Vs/Fs)

(Vm: Input voltage, Fm: Input frequency, Vs: Setting of rated voltage, Fs: Rated frequency)

$$K_1 = \frac{(LT) \times L - (HT) \times H}{(LT) - (HT)}$$

$$K_2 = \frac{(LT) \times (HT) \times (H - L)}{(LT) - (HT)}$$

The V/F element has a reset feature with definite time reset (RT). When the V/F falls below the reset threshold, the integral state of the inverse time function is reset to the initial value after the RT time.

Example: V/F=(Vin/Fin)/(V/Fs)=(130/50)/(100/50)=1.3, in case of Vin: Input voltage (130V),
Fin: Input frequency (50Hz), V: Rated voltage (100V), Fs: Rated frequency (50Hz)

3. Technical Description

3.1 Hardware Description

3.1.1 Outline of Hardware Modules

The case outline of GRT100 is shown in Appendix F.

The hardware structures of the models are shown in Figure 3.1.1 and Figure 3.1.2. The front view shows the equipment without the human machine interface module.

The GRT100 consists of the following hardware modules. The human machine interface module is provided with the front panel.

- Transformer module (VCT)
- Signal processing module (SPM)
- Binary input and output module #1 (IO1 or IO8)
- Binary input and output module #2 (IO2)
- Binary output module #3 (IO3)
- Human machine interface module (HMI)

Front view without front panel

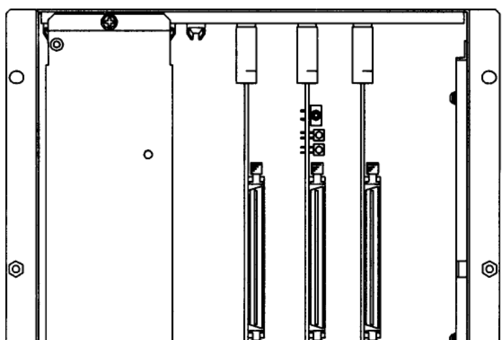


Figure 3.1.1 Hardware Structure (Model: 101, 201, 203)

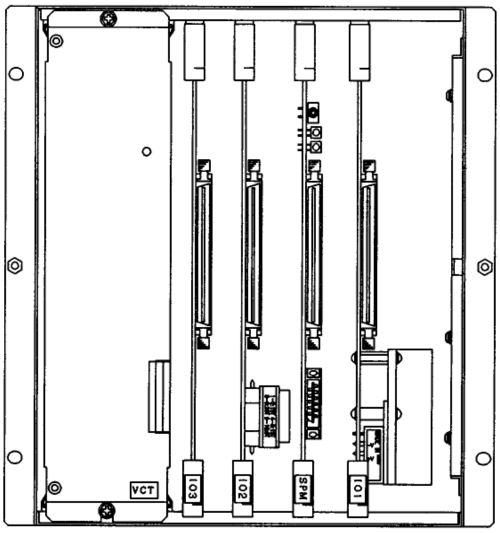


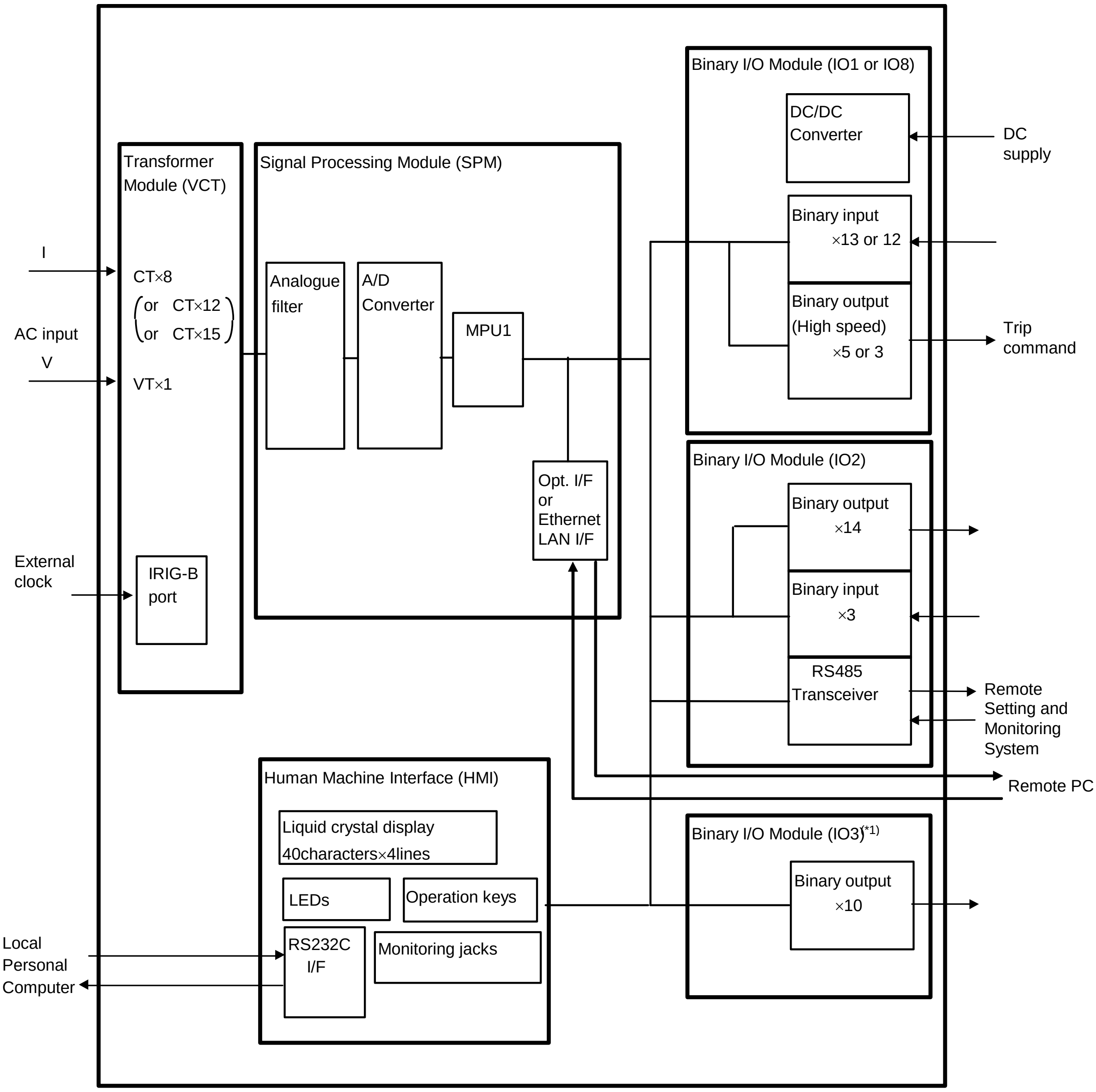
Figure 3.1.2 Hardware Structure (Model: 102, 202, 204)

The correspondence between each model and module used is as follows:

Module \ Models	101	102	201	202	203	204
VCT	×	×	×	×	×	×
SPM	×	×	×	×	×	×
IO1	×	×	×	×		
IO2	×	×	×	×	×	×
IO3		×		×		×
IO8					×	×
HMI	×	×	×	×	×	×

Note: The VCT and SPM modules are not interchangeable among different models.

The hardware block diagram of the GRT100 using these moduls is shown in Figure 3.1.3.



(*1) I03: required for Model 102, 202, 204

Figure 3.1.3 Hardware Block Diagram (Models 101, 102, 201, 202, 203 and 204)

3.1.2 Transformer Module

The transformer module (VCT module) provides isolation between the internal and external circuits through auxiliary transformers and transforms the magnitude of the 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) for each winding
- neutral current (I_N) for each winding
- phase-to-phase voltage

Figure 3.1.4 shows a block diagram of the transformer module. There are 8 to 12 auxiliary CTs and 1 auxiliary VT mounted in the transformer module depending on the relay model. (For the correspondence between the relay model and number of AC input signals, see Table 3.2.1.)

The transformer module is also provided with an IRIG-B port. This port collects the serial IRIG-B format data from an external clock for synchronization of 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.

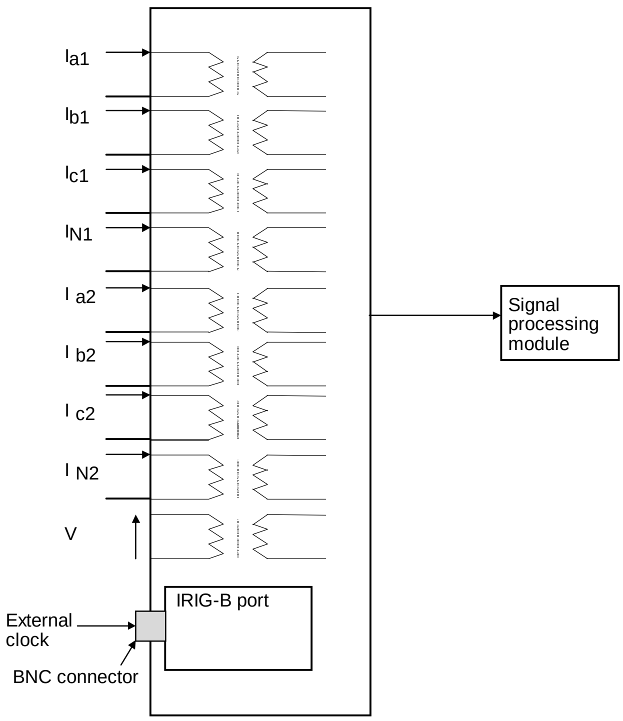


Figure 3.1.4 Transformer Module (e.g. models 101, 102)

3.1.3 Signal Processing 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 signal processing circuit consists of an analog filter, multiplexer, analog to digital (A/D) converter, main processing unit (MPU) and memories (RAM and ROM), and executes all kinds of processing including protection, measurement, recording and display.

The SPM contains a lithium-ion battery, which should be removed at the end-of-life of the product. The nominal backup time of a lithium-ion battery is one year after the shipment from the factory.

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 MPU carries out operations for the measuring elements and scheme logic operations for protection, recording, displaying and signal transmission control.

The SPM can be provided with Optical interface or Ethernet LAN interface for serial communication system.

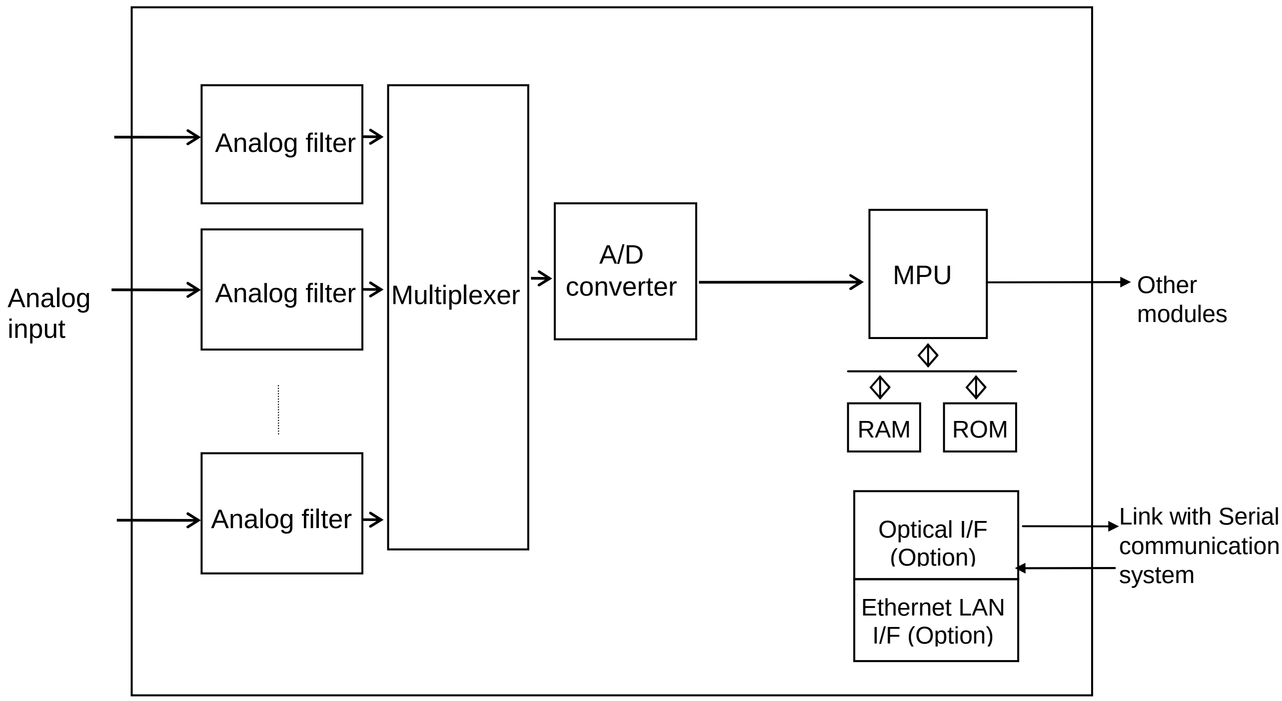


Figure 3.1.3.1 Signal Processing Module

3.1.4 Binary Input and Output Module

There are four types of binary input and output module (IO module): These modules are fitted according to the model (see Section 3.1.1).

3.1.4.1 IO1 and IO8 Module

IO1 and IO8 provide 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 (TP1 to 5) dedicated to the circuit breaker tripping command.

As shown in Figure 3.1.4.2, the IO8 module incorporates a DC/DC converter, 12 photo-coupler circuits (BI) for binary input signals and 3 auxiliary relays (TP) dedicated to the circuit breaker tripping command. The 12 binary inputs have dedicated positive and negative inputs suitable for double-pole switching.

The nominal 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 five or three tripping command auxiliary relays are the high-speed operation type and have one normally open output contact.

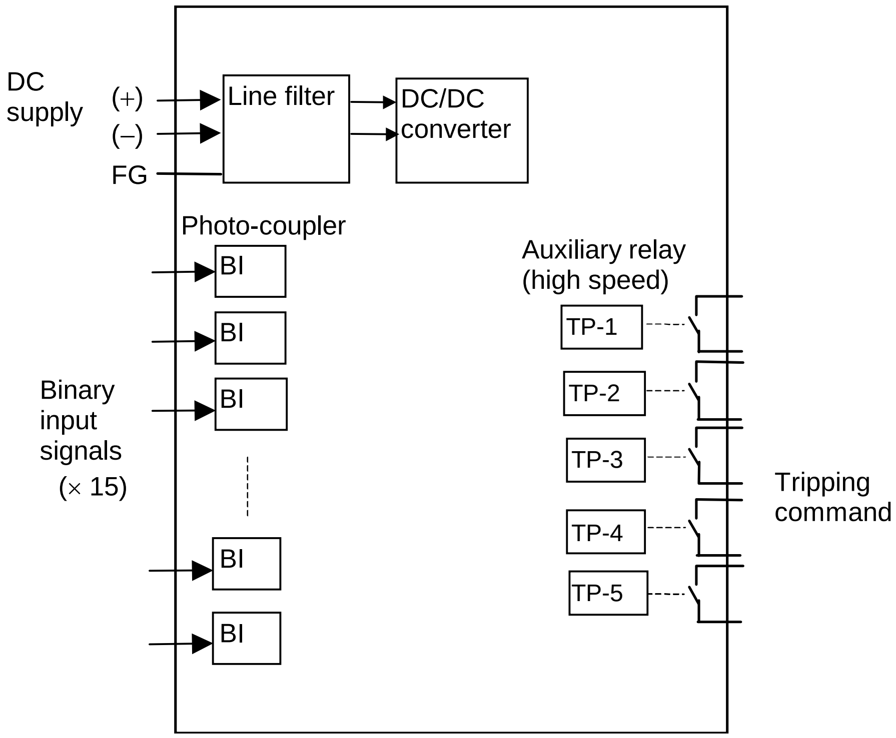


Figure 3.1.4.1 IO1 Module

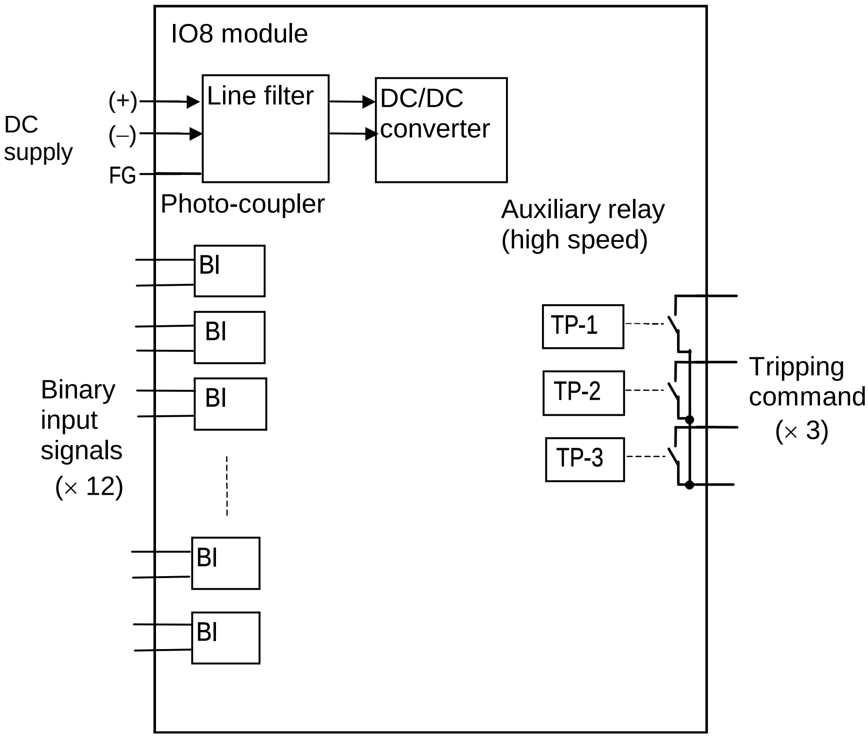


Figure 3.1.4.2 IO8 Module

3.1.4.2 IO2 Module

As shown in Figure 3.1.4.3, the IO2 module incorporates 3 photo-coupler circuits (BI14-BI16) for binary input signals, 14 auxiliary relays (BO1-BO13 and FAIL) for binary output signals and an RS-485 transceiver.

The auxiliary relay FAIL has one normally closed contact, and operates when a relay failure or abnormality in the DC circuit is detected. BO1 to BO13 each have one normally open contact. BO12 and BO13 are the high-speed operation type.

The RS-485 transceiver is used for the link with the relay setting and monitoring (RSM) system. The external signal is isolated from the relay internal signal.

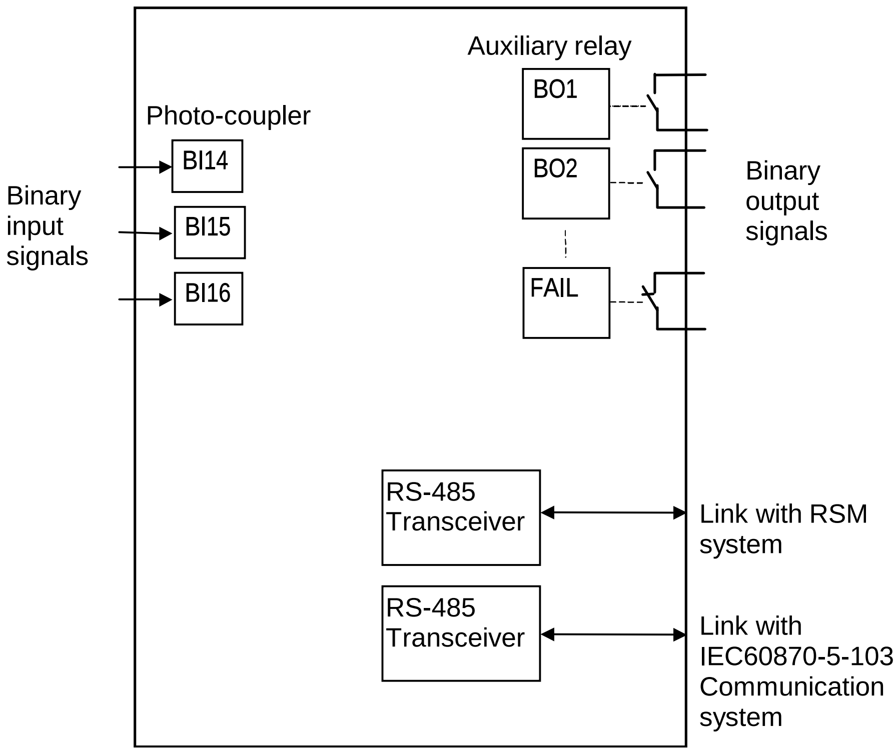


Figure 3.1.4.3 IO2 Module

3.1.4.3 IO3 Module

The IO3 module is used to increase the number of binary outputs.

The IO3 module incorporates 10 auxiliary relays (BO1-BO10) for binary outputs. All auxiliary relays each have one normally open contact.

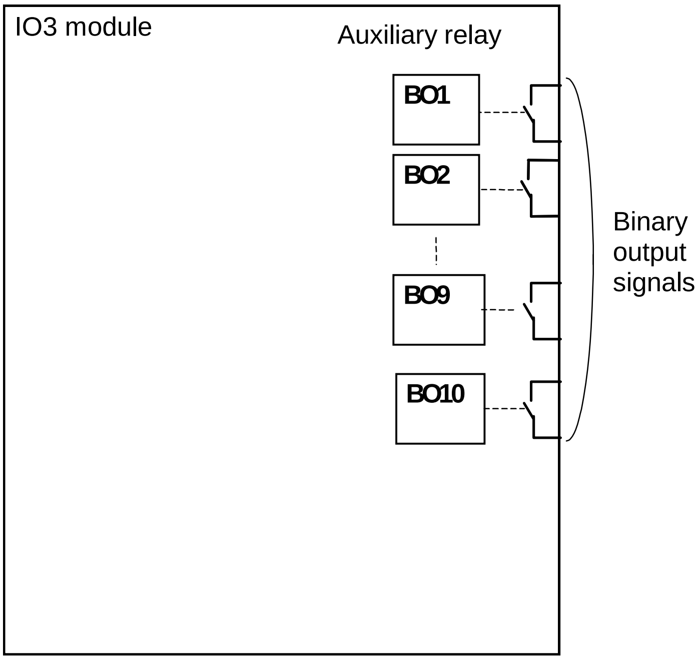


Figure 3.1.4.4 IO3 Module

3.1.5 Human Machine Interface (HMI) Module

The operator can access the GRT100 via the human machine interface (HMI) module. As shown in Figure 3.1.5, the HMI module has a liquid crystal display (LCD), light emitting diodes (LED), view and reset keys, operation keys, testing jacks and an RS-232C 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 relay is in service.
TRIP	Red	Lit when trip command is issued.
ALARM	Red	Lit when failure is detected.
TESTING	Red	Lit when disabling automatic monitoring function or resetting the time counting of THR and V/F elements by the scheme switches.
(LED1)	Red	
(LED2)	Red	
(LED3)	Red	
(LED4)	Red	

LED1 to LED4 are user-configurable.

Once it has started operating, the TRIP LED continues to operate even after the trip command disappears. Pressing the RESET key resets it. Other LEDs operate as long as a signal is present. The RESET key is ineffective for these LEDs.

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 transmitted to an oscilloscope via the monitoring jacks. (For the "Signal List" or "Variable Timer List", see Appendix B or C.)

The RS-232C connector is a 9-way D-type connector for serial RS-232C connection. This connector is used for connection with a local personal computer.

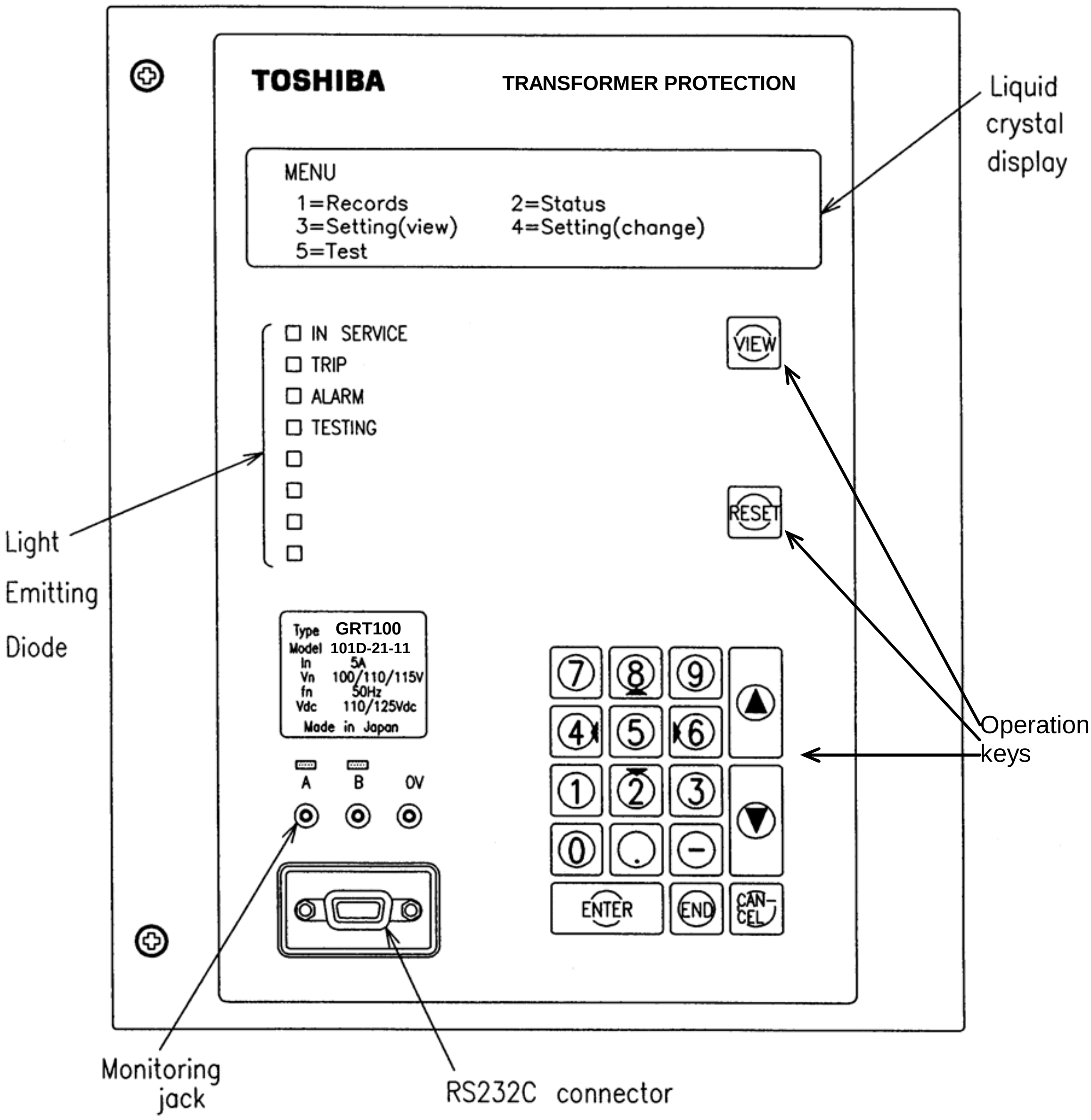


Figure 3.1.5 Front Panel

3.2 Input and Output Signals

3.2.1 Input Signals

AC input signals

Table 3.2.1 shows the AC input signals necessary for each of the GRT100 models and their respective input terminal numbers. See Appendix G for external connections.

Winding 1, 2 and 3 in the Table correspond to high-voltage or primary, medium-voltage or secondary, and low-voltage or tertiary winding respectively.

Table 3.2.1 AC Input Signals

Terminal No.	GRT100-101, 102	Terminal No.	GRT100-201, 202, 203, 204
TB1		TB1	
1-2	A phase current of winding 1	1-2	A phase current of winding 1
3-4	B phase current of winding 1	3-4	B phase current of winding 1
5-6	C phase current of winding 1	5-6	C phase current of winding 1
7-8	Neutral current of winding 1	7-8	Neutral current of winding 1
9-10	A phase current of winding 2	9-10	A phase current of winding 2
11-12	B phase current of winding 2	11-12	B phase current of winding 2
13-14	C phase current of winding 2	13-14	C phase current of winding 2
15-16	Neutral current of winding 2	15-16	Neutral current of winding 2
17-18	—	17-18	A phase current of winding 3
19-20	—	19-20	B phase current of winding 3
21-22	—	21-22	C phase current of winding 3
23-24	—	23-24	Neutral current of winding 3
25-26	—	25-26	—
27-28	Phase to phase voltage of winding 1	27-28	Phase to phase voltage of winding 1
30	(earth)	30	(earth)

Binary input signals

Table 3.2.2 shows the binary input signals necessary for the GRT100, their driving contact conditions and functions enabled. See Appendix G for external connections.

The binary input circuit of the GRT100 is provided with a logic level inversion function as shown in Figure 3.2.1. 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 contacts. Where the driving contact meets the contact conditions indicated in Table 3.2.2 then the BISW can be set to “N” (normal). If not, then “I” (inverted) should be selected.

The default setting of the BISW is "N" (normal) for all input signals.

Further, all binary input functions are programmable by PLC (Programmable Logic Circuit) function.

If a signal is not required, the function concerned is disabled.

The operating voltage of binary input signal is typical 74V DC at 110V/125V DC rating and 138V DC at 220/250V DC. The minimum operating voltage is 70V DC at 110/125V DC rating and 125V DC at 220/250V DC.

Table 3.2.2 Binary Input Signals

Signal Names	Driving Contact Condition / Function Enabled	BISW∗ (default)
External Mechanical trip (EXT_MEC.TP1)	Closed when external device operated. / Initiate trip command from operation of external device.	1
External Mechanical trip (EXT_MEC.TP2)	Closed when external device operated. / Initiate trip command from operation of external device.	2
External Mechanical trip (EXT_MEC.TP3)	Closed when external device operated. / Initiate trip command from operation of external device.	3
External Mechanical trip (EXT_MEC.TP4)	Closed when external device operated. / Initiate trip command from operation of external device.	4
Indication reset	Closed to reset TRIP LED indication. / Reset indication externally.	5
Protection block	Closed to block the protection. / Block the protection externally.	6
Signal for event record	Closed when external device operated. / Initiate event record with external signal.	14
Signal for event record	Closed when external device operated. / Initiate event record with external signal.	15
Signal for event record	Closed when external device operated. / Initiate event record with external signal.	16

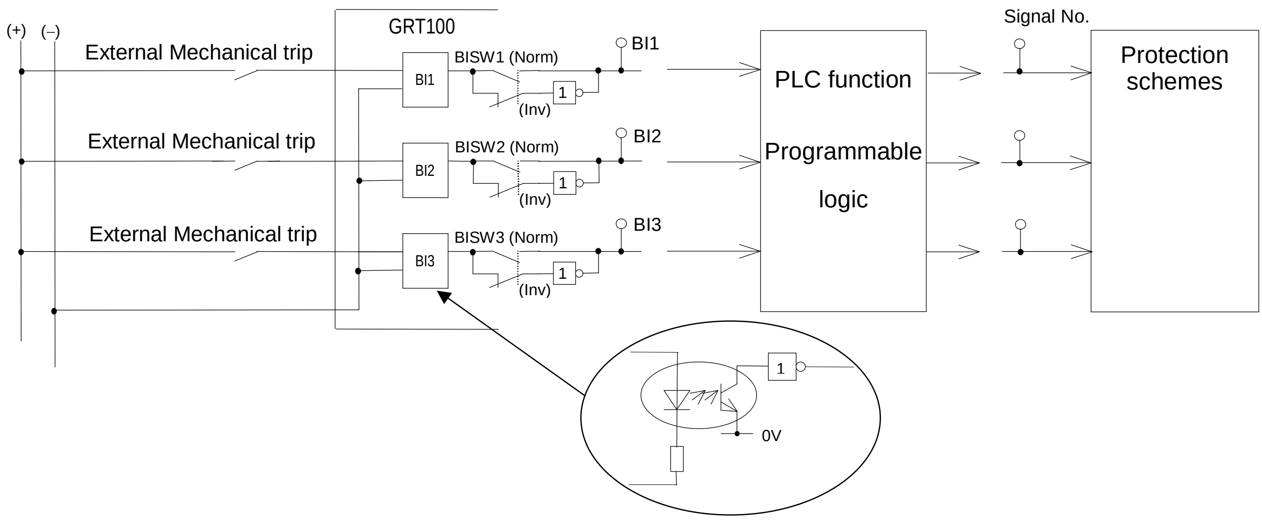


Figure 3.2.1 Logic Level Inversion

3.2.2 Binary Output Signals

The number of output binary signals and their output terminals vary depending on the relay model. See Appendix G for details. For all models, all outputs except the tripping command, signal for command protections 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. 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].

The relay failure contact closes when a relay defect or abnormality in the DC power supply circuit is detected.

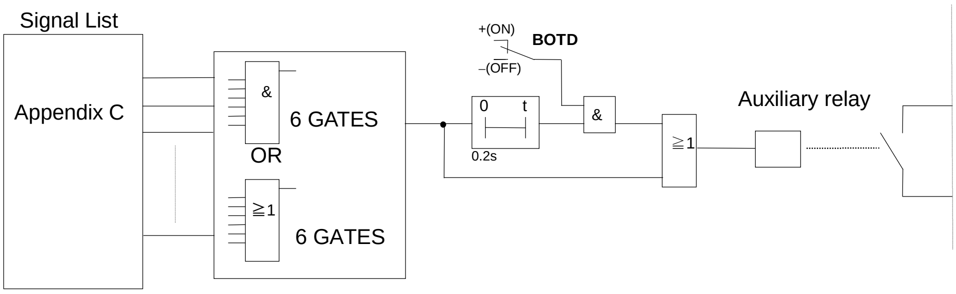


Figure 3.2.2 Configurable Output

3.2.3 PLC (Programmable Logic Controller) Function

GRT100 is provided with a PLC function allowing user-configurable sequence logics on binary signals. The sequence logics with timers, flip-flops, AND, OR, 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 editor tool. For PLC tool, refer to PLC tool instruction manual.

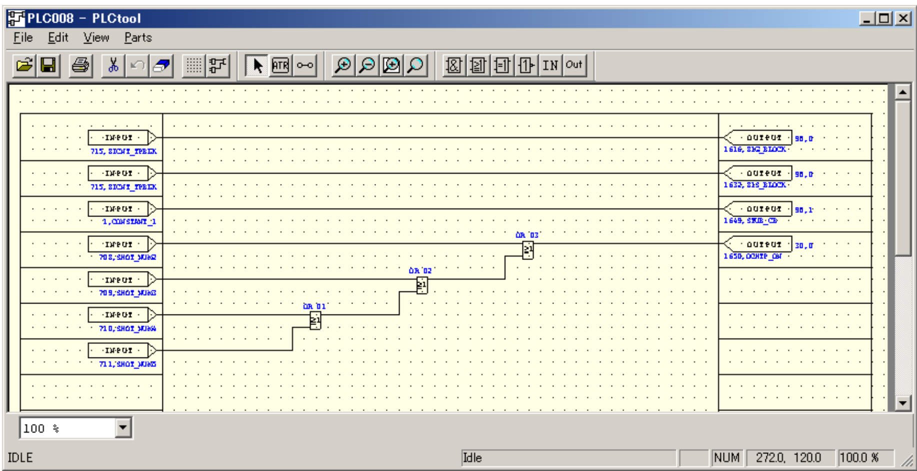


Figure 3.2.3 Sample Screen of PLC Tool

3.3 Automatic Supervision

3.3.1 Basic Concept of Supervision

Though the protection system is in a non-operating state under normal conditions, it is waiting for a power system fault to occur at any time and must operate for the fault without fail. Therefore, the automatic supervision function, which checks the health of the protection system during normal operation by itself, plays an important role. A numerical relay based on microprocessor technology is able to implement such as automatic supervision function. GRT100 implements an automatic supervision function based on the following concept:

- The supervising function should not affect protection performance.
- Perform supervision with no omissions wherever possible.
- When a failure occurs, it should be possible to easily identify the failure location.

Note: Automatic supervision function includes automatic monitor function and automatic test function. For the terminology, refer to IEC IEV 60448.

3.3.2 Relay Monitoring and Testing

The relay is supervised with the following items.

AC input imbalance monitoring

The AC current input is monitored such that the following equation is satisfied and the health of the AC input 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

A/D accuracy checking

An analogue reference voltage is transmitted to a prescribed channel in the analogue-to-digital (A/D) converter, and it is checked that the data after A/D conversion is within a prescribed range and that the A/D conversion characteristics are correct.

Memory monitoring

The memories are monitored as follows depending on the type of the memory and checked that the memory circuits are healthy:

- 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 discrepancy between the setting values stored in duplicate.

Watchdog Timer

A hardware timer which is cleared periodically by software is provided and it is checked that the software is running normally.

DC Supply monitoring

The secondary voltage level of the built-in DC/DC converter is monitored and checked that the DC voltage is within a prescribed range.

3.3.3 PLC Data and IEC61850 Mapping Data Monitoring

If there is a failure in PLC data and IEC61850 mapping data, the function may be stopped. Therefore, the PLC data and IEC61850 mapping data are monitored and an alarm of "PLC stop" or "MAP stop" is issued if any failure detected.

3.3.4 IEC61850 Communication Monitoring

The sending and receiving functions in the Ethernet LAN communication are monitored. The receiving function is executed by checking GOOSE message receiving status, and the sending function is executed by checking Ping response to the other party. If a failure is detected, an alarm of "GOOSE stop" or "Ping err" is issued.

These functions are disabled by setting the scheme switches [GSECHK] and [PINGCHK].

3.3.5 Failure Alarms

When a failure is detected by the automatic supervision, it is followed with LCD display, LEDs indication, external alarms and event recording. Table 3.3.1 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.

Those alarms are retained until the failure is recovered.

Those alarms can be disabled collectively by setting the scheme switch [AMF] to OFF. The setting is used to block unnecessary alarms during commissioning test or maintenance.

When the Watchdog Timer detects that the software fails to run normally, LCD display and event recording on the failure cannot be expected.

DC supply failure disables the LCD display and event recording on the failure as well.

For the discrimination of the two failures mentioned above, refer to Section 6.7.2.

Table 3.3.1 Supervision Items and Alarms

Supervision Item	LCD Message	LED "IN SERVICE"	LED "ALARM"	Ext. alarm	Event record Message
AC input imbalance monitoring	(1)	On/Off (2)	On	(4)	CT err Relay fail
A/D accuracy check	A/D err	Off	On	(4)	Relay fail
CPU, Memory monitoring	(1)				
Watchdog Timer	----	Off	On	(4)	----
DC supply monitoring	----	Off	(3)	(4)	Relay fail
PLC data or IEC61850 mapping data monitoring	PLC stop or MAP stop	on	on	(4)	Relay fail-A
GOOSE message check	GOOSE stop	on	on	(4)	Relay fail-A

Supervision Item	LCD Message	LED "IN SERVICE"	LED "ALARM"	Ext. alarm	Event record Message
Ping response check	Ping err	on	on	(4)	Relay fail-A

(1): Diverse messages are provided as expressed with "---fail" 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 set to "ALM & BLK" (refer to Section 3.3.4).
(3): Whether the LED is lit or not depends on the degree of the voltage drops.
(4): The binary output relay "FAIL" operates.

3.3.6 Trip Blocking

When a failure is detected by the following supervision items, the trip function is blocked as long as the failure exists and restored when the failure is removed.

- A/D accuracy check
- Memory monitoring
- Watchdog Timer
- DC supply monitoring

When a failure is detected by the AC input imbalance monitoring, the scheme switch [SVCNT] setting can be used to determine if both tripping is blocked and an alarm is initiated, or, if only an alarm is initiated.

3.3.7 Setting

The setting elements necessary for the automatic supervision and its setting range are shown in the table below.

Element	Range	Step	Default	Remarks
[SVCNT]	ALM&BLK / ALM		ALM&BLK	Alarming and/or blocking
[GSECHK]	OFF/ON		OFF	GOOSE check
[PINGCHK]	OFF/ON		OFF	Ping response check

3.4 Recording Function

GRT100 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 GRT100 or PLC command by user-setting (max. 8) and the following items are recorded for one fault:

Date and time of fault occurrence

Operating phase or fault phase

Tripping command

Tripping mode

Power system quantities

Up to the 8 most-recent faults can be 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 1ms using the relay internal clock.

To be precise, this is the time at which a tripping command has been initiated, and thus it is approximately 10 ms after the occurrence of the fault.

Operating phase or fault phase

The operating phase or fault phase can be selected to be displayed following tripping, depending on the requirements of user.

For details, see Section 2.3.1.

Tripping command

The tripping output relay(s) operated is shown in terms of its number (e.g. TP-1: 1, TP-2: 2 etc.).

Tripping mode

This shows the protection scheme that initiated the tripping command.

Power system quantities

The following power system quantities for pre-fault and post-fault are recorded.

- Magnitude and phase angle of phase current of each winding (I_{a1}, I_{b1}, I_{c1} up to I_{a3}, I_{b3}, I_{c3})
- Magnitude and phase angle of neutral current of each winding (I_{n1} up to I_{n3})
- Magnitude and phase angle of symmetrical component current of each winding (I_{11}, I_{21}, I_{01} up to I_{13}, I_{23}, I_{03})
- Magnitude and phase angle of phase-to-phase voltage (V)

- Magnitude of phase differential current (I_{da}, I_{db}, I_{dc})
- Magnitude of residual differential current for REF protection (I_{d01} up to I_{d03})
- Percentage of thermal capacity (THM%)

Phase angles above are expressed taking that of the voltage as a reference phase angle. If the voltage input is not provided, then the positive sequence current of the primary winding is used 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 a maximum of 128 recording items, and their status change mode. The event items can be assigned to a signal number in the signal list. The status change mode is set to "On" (only recording On transitions) or "On/Off"(recording both On and Off transitions) mode by setting. The "On/Off" mode events 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 an event cannot be set on LCD. It can set only by RSM100. Maximum 22 characters can be set and can be viewed on both of the LCD and RSM Setting(view) screen. But the LCD screen of event record displays only 11 characters. Therefore, it is recommended the maximum 11 characters are set.

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 1024 records can be stored. If an additional event occurs when 1024 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 starter elements operate or a tripping command is output, or PLC command by user-setting (max. 4: Signal No. 2632 to 2635) is output. The records include 13 analog signals (primary: I_{a1}, I_{b1}, I_{c1}, I_{n1}, secondary: I_{a2}, I_{b2}, I_{c2}, I_{n2}, tertiary: I_{a3}, I_{b3}, I_{c3}, I_{n3}, voltage: V), 32 binary signals and the dates and times at which recording started. Any binary signal in shown in Appendix B can be assigned by the binary signal setting of disturbance record. The default setting of binary signal is shown in Appendix H.

The name of binary signal can be set only by RSM100. Maximum 22 characters can be set and can be viewed on both of the LCD and RSM Setting(view) screen. But the waveform data analysis screen of disturbance record displays up to 11 characters of them. Therefore, it is recommended the maximum 11 characters are set.

The LCD display only shows the dates and times of the disturbance records stored. Details can be displayed on a PC. For how to obtain disturbance records on the PC, see the PC software instruction manual.

The post-fault recording time can be set between 0.1 and 3.0s and the default setting is 1.0s. The pre-fault recording time depends on the post recording time. The pre-fault recording time is fixed at 0.3s.

The number of records stored depends on the post-fault recording time. The approximate relationship between the post-fault recording time and the number of records stored is shown in Table 3.4.2.

Note: If the recording time setting is changed, all previously recorded data is deleted.

Table 3.4.2 Post Fault Recording Time and Number of Disturbance Records Stored

Model	Recording time / Frequency	0.1s	0.5s	1.0s	1.5s	2.0s	2.5s	3.0s
101,102	50Hz	40	34	20	15	11	9	8
	60Hz	40	28	17	12	9	8	6
201,202	50Hz	40	25	15	11	8	7	6
203,204	60Hz	40	21	13	9	7	6	5

Disturbance recording is initiated when overcurrent elements operate, a tripping signal is output, 2F or 5F element operates or external event signals are input. Three phase overcurrent elements 1OCP-S to 3OCP-S are applied to the line CTs and neutral overcurrent elements 1OCP-G to 3OCP-G to the neutral CTs.

The initiations are blocked by the scheme switches.

Settings

The elements necessary for starting disturbance recording and their setting ranges are shown in the table below.

Element	Range	Step	Default(**)	Remarks
1OCP-S	0.10 - 20.00(*)	0.01		Phase overcurrent element
2OCP-S	0.10 - 20.00(*)	0.01		
3OCP-S	0.10 - 20.00(*)	0.01		
1OCP-G	0.05 - 20.00(*)	0.01		Neutral overcurrent element
2OCP-G	0.05 - 20.00(*)	0.01		
3OCP-G	0.05 - 20.00(*)	0.01		
Scheme switch	ON/OFF			Initiating disturbance record
TRIP1 to TRIP5				by tripping
1OCPS to 3OCPS				by phase overcurrent element
1OCPG to 3OCPG				by neutral overcurrent element
2F				by 2F element
5F				by 5F element
EVENT1 to EVENT3				by external event

(*) : Multiplier of CT secondary rated current
(**): Default settings are dependent on the models. See Appendix H.

3.5 Metering Function

The GRT100 performs continuous measurement of the analogue input quantities. The measurement data shown below are displayed on the LCD of the relay front panel or on the local or remote PC.

- Magnitude and phase angle of phase current of each winding (I_{a1}, I_{b1}, I_{c1} up to I_{a3}, I_{b3}, I_{c3})
- Magnitude and phase angle of neutral current of each winding (I_{n1} up to I_{n3})
- Magnitude and phase angle of symmetrical component current of each winding (I_{11}, I_{21}, I_{01} up to I_{13}, I_{23}, I_{03})
- Magnitude and phase angle of phase-to-phase voltage (V)
- Magnitude of phase differential current (I_{da}, I_{db}, I_{dc})
- Magnitude of residual differential current for REF protection (I_{d01} up to I_{d03})
- Percentage of thermal capacity (THM%)
- Frequency

Phase angles above are expressed taking that of positive sequence voltage as a reference phase angle, where leading phase angles are expressed as positive values.

The above system quantities are displayed in values on the primary side or on the secondary side of the CT according to a setting. To display accurate values, it is necessary to set the CT ratio and VT ratio too. For the setting method, see "Setting the transformer parameters" in 4.2.6.7.

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), IEC103 communication via an RS485, optical fibre or Ethernet LAN etc.

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 3.1.13, the front panel is provided with a liquid crystal display (LCD), light emitting diodes (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 setting. 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 colours 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 disabling automatic monitoring function or resetting the time counting of THR and V/F elements by the scheme switches.
(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 configurable.

The TRIP LED lights up once the relay is operating and remains lit even after the trip command goes off. The TRIP LED can be turned off by pressing the RESET key. Other LEDs are lit as long as a signal is present and the RESET key is invalid while the signal is being maintained.

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 VIEW key displays digest screens such as "Metering", "Latest fault" and "Auto-supervision".

Pressing 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 transmitted 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.

4.1.2 Communication Ports

The following 3 individual interfaces are mounted as the communication ports:

- RS232C port
- Serial communication port (RS485 port, optional Fibre optic or Ethernet LAN etc.)
- IRIG-B port

(1) RS232C port

This connector is a standard 9-way D-type connector for serial port RS232C transmission and mounted on the front panel. By connecting with a personal computer using this connector, setting operation and display functions can be performed on the personal computer.

(2) Serial communication port

Two serial communication ports can be provided. In one port, 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 another port, it is connected to the substation automation system via Ethernet communication networks using IEC 61850 protocol.

Screw terminal for RS485, ST connector for fibre optic, or 100Base-TX (RJ-45 connector) or 100Base-FX (SC connector) for Ethernet LAN is provided on the back of the relay as shown in Figure 4.1.1.

(3) IRIG-B port

The IRIG-B port is mounted on the transformer module. This port 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 using a photocoupler. A BNC connector is used as the input connector.

This port is provided on the back of the relay and Figure 4.1.1 shows the location of this connector.

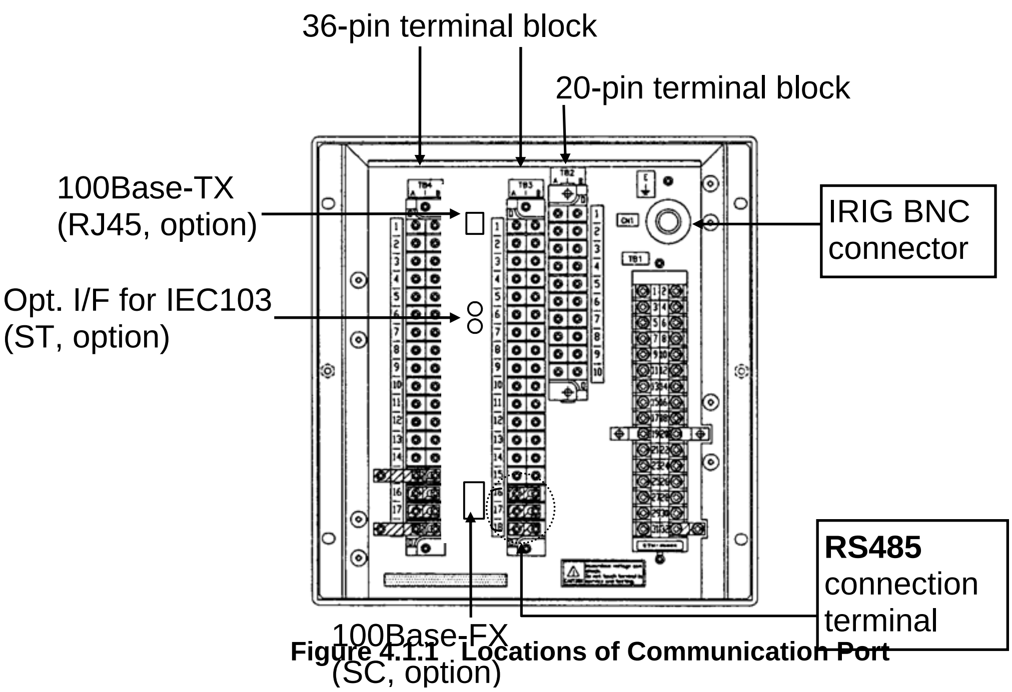


Figure 4.1.1 Locations of Communication Port

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.

4.2.1 LCD and LED Displays

Displays during normal operation

When the GRT100 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 which are "Metering", "Latest fault" and "Auto-supervision" screens 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              08/Dec/1997   22:56
Ia1 ***.*kA    Ia2 **.**kA   In1 **.**kA
Ib1 ***.*kA    Ib2 **.**kA   In2 **.**kA
Ic1 ***.*kA    Ic2 **.**kA
```

```
Metering2              08/Dec/1997   22:56
Ia3 ***.*kA                  In3 **.**kA
Ib3 ***.*kA                  V   ***.*kV
Ic3 ***.*kA                      **.*Hz
```

Note: I □1 for primary(high-voltage) winding current
I □2 for secondary(medium-voltage) winding current
I □3 for tertiary(low-voltage) winding current
Ia□, Ib□, Ic□ for phase current
In□ for neutral current

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   08/Dec/1997   22:56:**.***
Phase  BC            Trip   1-2-3-4-5
DIFT
```

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.

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 "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 screens 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 screen.
- Press the RESET key to turn off the LCD.

4.2.2 Relay Menu

Figure 4.2.1 shows the menu hierarchy in the GRT100. The main menu has five sub-menus, "Record", "Status", "Setting (view)", "Setting (change)", and "Test". For details of the menu hierarchy, see Appendix E.

- Menu
  - Record
    - Fault record
    - Event record
    - Disturbance record
  - Status
    - Metering
    - Binary input & output
    - Relay element
    - Time synchronization source
    - Clock adjustment
  - Setting (view)
    - Relay version
    - Description
    - Communication
    - Record
    - Status
    - Protection
    - Binary input
    - Binary output
    - LED
  - Setting (change)
    - Password
    - Description
    - Communication
    - Record
    - Status
    - Protection
    - Binary input
    - Binary output
    - LED
  - Test
    - Switch
    - Binary output
    - Timer
    - Logic circuit

Figure 4.2.1 Relay Menu

Record

In the "Record" menu, the fault records, event records and disturbance records are displayed or erased.

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 or IEC) and adjusts the clock.

Setting (view)

The "Setting (view)" menu displays the relay version, plant name and the current settings of relay address and RS232C baud rate in communication, record, status, protection, configurable binary inputs and outputs, and configurable LEDs.

Setting (change)

The "Setting (change)" menu is used to set or change the settings of password, plant name, relay address and RS232C baud rate in communication, record, status, protection, configurable binary inputs and 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 forcibly operate binary output relays, to measure variable timer time and to observe the binary signals in the logic circuit.

This menu also has password security protection.

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 1/7 displayed on the far right means that the screen has seven lines excluding the top line and that the cursor is on the first line.

To move the cursor downward or upward for setting or for viewing other lines not displayed on the window, use the ▼ and ▲ keys.

```
/6 VT & CT ratio                           1/ 7
1CT   (    1- 20000):    2000  _
2CT   (    1- 20000):    1000
3CT   (    1- 20000):     400
1nCT  (    1- 20000):     100
2nCT  (    1- 20000):     100
3nCT  (    1- 20000):     100
VT    (    1- 20000):     400
```

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 and disturbance records.

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
```

- 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/ 4
#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.

Date and Time
Fault phase
Tripping mode
CB tripped
Power system quantities

```
/4 Fault Record #1                                3/42
16/Oct/1997   18:13:57.031
Phase BC                  Trip   1-2-3-4-5
DIFT
Prefault values
Ia1  **.**kA   ***.*°   Ia2  **.**kA   ***.*°
Ib1  **.**kA   ***.*°   Ib2  **.**kA   ***.*°
Ic1  **.**kA   ***.*°   Ic2  **.**kA   ***.*°
I11  **.**kA   ***.*°   I12  **.**kA   ***.*°
I21  **.**kA   ***.*°   I22  **.**kA   ***.*°
I01  **.**kA   ***.*°   I02  **.**kA   ***.*°
In1  **.**kA   ***.*°   In2  **.**kA   ***.*°
Ia3  **.**kA   ***.*°
Ib3  **.**kA   ***.*°
Ic3  **.**kA   ***.*°
I13  **.**kA   ***.*°
I23  **.**kA   ***.*°
I03  **.**kA   ***.*°
In3  **.**kA   ***.*°
V    ***.*kV   ***.*°
Ida  ***.**pu            Id01  ***.**pu
Idb  ***.**pu            Id02  ***.**pu
Idc  ***.**pu            Id03  ***.**pu

Fault values
Ia1  **.**kA   ***.*°   Ia2  **.**kA   ***.*°
Ib1  **.**kA   ***.*°   Ib2  **.**kA   ***.*°
Ic1  **.**kA   ***.*°   Ic2  **.**kA   ***.*°
I11  **.**kA   ***.*°   I12  **.**kA   ***.*°
I21  **.**kA   ***.*°   I22  **.**kA   ***.*°
I01  **.**kA   ***.*°   I02  **.**kA   ***.*°
In1  **.**kA   ***.*°   In2  **.**kA   ***.*°
Ia3  **.**kA   ***.*°
Ib3  **.**kA   ***.*°
Ic3  **.**kA   ***.*°
I13  **.**kA   ***.*°
I23  **.**kA   ***.*°
I03  **.**kA   ***.*°
In3  **.**kA   ***.*°
V    ***.*kV   ***.*°
Ida  ***.**pu            Id01  ***.**pu
Idb  ***.**pu            Id02  ***.**pu
Idc  ***.**pu            Id03  ***.**pu
THM  ***.*%
```

Note: I □1 for primary(high-voltage) winding current
I □2 for secondary(medium-voltage) winding current
I □3 for tertiary(low-voltage) winding current
In□ for neutral current
I1□, I2□, I0□ for symmetrical component current
Ida, Idb, Idc for differential current
Ido1, Ido2, Ido3 for zero-phase differential current in 1REF, 2REF, 3REF

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 events 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=Display     2=Clear
```

- Select 1 (= Display) to display the events with date and time from the top in new-to-old sequence.

```
/3 Event record                           2/48
16/Oct/1998 23:18:04.294   Trip          Off
16/Oct/1998 23:18:03.913   Trip          On
12/Feb/1998 03:51:37.622   Rly.set change
```

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.

```
/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 the 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=Display      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.

4.2.4 Displaying the Status

From the sub-menu of "Status", the following statuses can be displayed on the LCD:

Metering data of the protected transformer

Status of binary inputs and outputs

Status of measuring elements output

Status of time synchronization source

The data are renewed 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.

```
/1 Status
1=Metering               2=Binary I/O
3=Relay element          4=Time sync source
5=Clock adjustment
```

- Select 1 (= Metering) to display the "Metering" screen.

```
/2 Metering    16/Oct/1997   18:13 3/20
Ia1  **.**kA  ***.*° Ia2  **.**kA  ***.*°
Ib1  **.**kA  ***.*° Ib2  **.**kA  ***.*°
Ic1  **.**kA  ***.*° Ic2  **.**kA  ***.*°
I11  **.**kA  ***.*° I12  **.**kA  ***.*°
I21  **.**kA  ***.*° I22  **.**kA  ***.*°
I01  **.**kA  ***.*° I02  **.**kA  ***.*°
In1  **.**kA  ***.*° In2  **.**kA  ***.*°
Ia3  **.**kA  ***.*°
Ib3  **.**kA  ***.*°
Ic3  **.**kA  ***.*°
I13  **.**kA  ***.*°
I23  **.**kA  ***.*°
I03  **.**kA  ***.*°
In3  **.**kA  ***.*°
V    ***.*kV  ***.*°
Ida  ***.**pu            Id01***.**pu
Idb  ***.**pu            Id02***.**pu
Idc  ***.**pu            Id03***.**pu
THM  ***.*%
Frequency                **.*Hz
```

Note: I □1 for primary(high-voltage) winding current
I □2 for secondary(medium-voltage) winding current
I □3 for tertiary(low-voltage) winding current
Ia□, Ib□, Ic□ for phase current
In□ for neutral current
I1□, I2□, I0□ for symmetrical component current
Ida, Idb, Idc for differential current
Ido1, Ido2, Ido3 for zero-phase differential current in 1REF, 2REF, 3REF

Metering data is expressed as primary values or secondary values depending on the setting. For setting, see Section 4.2.6.6.

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. (Binary inputs and outputs depend oh the relay model.)

```
/2 Binary input & output             3/ 5
Input (IO#1)         [000 000 000 000    ]
Input (IO#2)         [000                ]
Output(IO#1-trip)    [000 00             ]
Output(IO#2)         [000 000 000 000 00 ]
Output(IO#3)         [000 000 000 0      ]
```

The display format is shown below.

	[■	■	■	■	■	■	■	■	■	■	■	■	■	■	■]
Input (IO#1)	BI1	BI2	BI3	BI4	BI5	BI6	BI7	BI8	BI9	BI10	BI11	BI12	—	—	—
Input (IO#2)	BI14	BI15	BI16	—	—	—	—	—	—	—	—	—	—	—	—
Output (IO#1-trip)	TP-1	TP-2	TP-3	TP-4	TP-5	—	—	—	—	—	—	—	—	—	—
Output (IO#2)	BO1	BO2	BO3	BO4	BO5	BO6	BO7	BO8	BO9	BO10	BO11	BO12	FAIL	BO13	—
Output (IO#3)	BO1	BO2	BO3	BO4	BO5	BO6	BO7	BO8	BO9	BO10	—	—	—	—	—

Lines 1 and 2 show the binary input status. BI1 to BI16 corresponds 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. IO#1 and IO#2 in the table indicates the name of the module containing the binary input circuits.

Lines 3 to 5 show the binary output status. TP-1 to TP-5 of line 3 corresponding to the tripping command outputs. Models 203 and 204 are not provided with TP-4 and TP-5. FAIL of line 4 corresponds to the relay failure output. Other outputs expressed with BO1 to BO13 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".

IO#1 to IO#3 in the table indicate the names of the module containing the binary output relays.

To display all the lines, press the ▲ and ▼ keys.

4.2.4.3 Displaying the Status of Measuring Elements

To display the status of the 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.

```
/2 Relav element                          3/ 9
DIFT                [000 000 000 000     ]
REF                 [000                 ]
OC                  [000 000 000         ]
OCI                 [000 000 000         ]
EF                  [000                 ]
EFI                 [000                 ]
THR                 [00                  ]
V/F                 [000                 ]
FRQ                 [000 0               ]
```

The display format is as shown below.

	[■	■	■	■	■	■	■	■	■	■	■	■	■	■	■]
DIFT	A	B	C	A	B	C	A	B	C	A	B	C	—	—	—
		DIF			2f			5f			HOC				
REF	1	2	3	—	—	—	—	—	—	—	—	—	—	—	—
OC	A	B	C	A	B	C	A	B	C	—	—	—	—	—	—
		1OC			2OC			3OC							
OCI	A	B	C	A	B	C	A	B	C	—	—	—	—	—	—
		1OCI			2OCI			3OCI							
EF	1	2	3	—	—	—	—	—	—	—	—	—	—	—	—
EFI	1	2	3	—	—	—	—	—	—	—	—	—	—	—	—
THR	S	A	—	—	—	—	—	—	—	—	—	—	—	—	—
V/F	H	T	A	—	—	—	—	—	—	—	—	—	—	—	—
FRQ	L1	L2	H1	H2	—	—	—	—	—	—	—	—	—	—	—

Line 1 shows the operation status of current differential elements. Line 2 shows the status of restricted earth fault elements. Line 3 shows the status of overcurrent elements. Line 4 shows the status of time overcurrent elements. Line 5 shows the status of the overcurrent element for earth fault. Line 6 shows the status of time overcurrent elements for earth fault. Lines 7, 8 and 9 show the status of thermal overload element, overexcitation element and frequency element respectively.

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 inner clock of the GRT100 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 or SNTP server. 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      4/ 4
 IRIG: Inactive
 RSM:  Inactive
 IEC:  Inactive
*SNTP: Active (Server *)
```

The asterisk on the far left shows that the internal clock is synchronized with the marked source clock. If the marked source clock is inactive, the internal clock runs locally.

For details of 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 adjustment) 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 [SNTP] 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 is pressed, "Error: Incorrect date" is displayed on the top line and the adjustment is discarded. Adjust again.

4.2.5 Viewing the Settings

The sub-menu "Setting (view)" is used to view the settings made using the sub-menu "Setting (change)" except for the relay version.

The following items are displayed:

Relay version
Description
Address in the RSM, IEC60870-5-103 or IEC61850 communication
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 and the "Relay version" screen appears.

```
/2 Relay version                        3/ 8
Relay type:         **********************
Serial No.:         **********************
Main software:      **********************
IEC61850 eng.:      **********************
PLC data:           ************(********)
IEC103 data:        ************(********)
IEC61850 data:      ************(********)
GOOSE subscript:    ************(********)
```

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.

4.2.6 Changing the Settings

The "Setting (change)" sub-menu is used to make or change settings for the following items:

Password
Description
Address in the RSM, IEC60870-5-103 or IEC61850 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 selective number
- To enter numerical values
- To enter a text string

To enter a selected number

If a screen as shown below is displayed, perform 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/***
DIFTPMD   1=3POR  2=1P                          1 _
1REF      1=1I0   2=2I0   3=3I0                 1
2REF      1=1I0   2=2I0   3=3I0                 1
3REF      1=1I0   2=2I0   3=3I0                 1
REF_DEF   0=Off   1=On                          1
M1OCI     1=Long  2=Std  3=Very  4=Ext          1
M2OCI     1=Long  2=Std  3=Very  4=Ext          1
M3OCI     1=Long  2=Std  3=Very  4=Ext          1
M1EFI     1=Long  2=Std  3=Very  4=Ext          1
M2EFI     1=Long  2=Std  3=Very  4=Ext          1
M3EFI     1=Long  2=Std  3=Very  4=Ext          1
L/O       0=Off   1=On                          1
2F-LOCK   0=Off   1=On                          1
5F-LOCK   0=Off   1=On                          1
DIF1      0=Off   1=On                          1
DIF2      0=Off   1=On                          1
DIF3      0=Off   1=On                          1
  :                                             :
M.T4-1    0=Off   1=On                          1
M.T4-2    0=Off   1=On                          1
M.T4-3    0=Off   1=On                          1
  :                                             :
SVCNT     0=ALM&BLK  1=ALM                      1
CTSEN     0=Off   1=On                          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.

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, move the cursor to the correct line by pressing the ▲ and ▼ keys and enter the new number.

Note: If the CANCEL key is pressed after any 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 setting as follows.

The number to the right of "Current No.=" shows the current setting.

```
/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 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 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 VT & CT ratio                     1/7
1CT   (     1- 20000):   2000 _
2CT   (     1- 20000):   1000
3CT   (     1- 20000):    400
1nCT  (     1- 20000):    100
2nCT  (     1- 20000):    100
3nCT  (     1- 20000):    100
VT    (     1- 20000):    400
```

- 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 following.

- 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 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 the "Plant name" or "Description" screen.

To select a character, use keys 2, 4, 6 and 8 to move the blinking cursor down, left, right and up. "→" 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.

```
/3 Plant name [ _                    ]
ABCDEFGHIJKLMNOPQRSTUVWXYZ ()[]@_   ←→
abcdefghijklmnopqrstuvwxyz {}*/+-<=> ←→
0123456789 !"#$%&' :;,.^`           ←→
```

- 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 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.

```
/2 **************
Change settings?
        ENTER=Yes    CANCEL=No
```

- 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 re-entries. 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 and testing the relay, password protection can be set as follows;

- Press 4 (= Setting (change)) on the main "MENU" screen to display the "Setting (change)" screen.

```
/1 Setting(change)
1=Password  2=Description   3=RSM comm
4=Record    5=Status        6=Protection
7=Binary input  8=Binary output   9=LED
```

- Press 1 (= Password) to display the "Password" screen.

```
/2 Password
      Input new password   [_    ]
     Retype new password   [     ]
```

- Enter a 4-digit number within the brackets after "Input new password" and press the ENTER key.
- 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."

  Re-entry is then requested.

- Press 2 (= Test) on the "Password" screen to set the password for the test.

```
/2 Test
      Input new password   [_    ]
     Retype new password   [     ]
```

Set the password the same manner as that of the "Setting" above.

Password trap

After the password has been set, the password must be entered in order to enter the setting change and the test 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 GRT100 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.

```
/3 Description [  _                          ]
ABCDEFGHIJKLMNOPQRSTUVWXYZ  ()[]@           ←→
abcdefghijklmnopqrstuvwxyz  {}*/+-<=>       ←→
0123456789  !"#$%&' :;,.^`                  ←→
```

- Enter the text string.

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/ **
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  ⎬ For channel 1(port 1)
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  ⎭
SI1-1(      0-    254):     0  ⎫
SI1-2(      0-    254):     0  ⎬ For SNTP server 1
SI1-3(      0-    254):     0  ⎪
SI1-4(      0-    254):     0  ⎭
              :
SI4-1(      0-    254):     0  ⎫
SI4-2(      0-    254):     0  ⎬ For SNTP server 4
SI4-3(      0-    254):     0  ⎪
SI4-4(      0-    254):     0  ⎭
SMODE(      0-      1):     0
GOINT(      1-     60):    60      s
PG1-1(      0-    254):     0  ⎫
PG1-2(      0-    254):     0  ⎬ For channel 1(port 1)
PG1-3(      0-    254):     0  ⎪
PG1-4(      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).
  Enter IP address for IP1-1 to IP1-4, Subnet mask for SM1-1 to SM1-4, Default gateway for GW1-1 to GW1-4, and SNTP server address for SI1-1 to SI4-4. Four SNTP servers are available.
  Enter "0" or "1" on "SMODE" column to set the standard time synchronized mode for SNTP server. Using low accuracy level of time server, synchronized compensation to maintain synchronization accuracy may not be done automatically. Therefore enter "1", and synchronized compensation is done forcibly. The default setting is "0".
  Enter the time on "GOINT" to set the maximum GOOSE message publishing term if GOOSE message receive checked.
  Enter the IP address of the device for PG1-1 to PG1-4 if Ping response checked.

  IP address: $\underbrace{***}_{\text{IP1-1}}, \underbrace{***}_{\text{IP1-2}}, \underbrace{***}_{\text{IP1-3}}, \underbrace{***}_{\text{IP1-4}}$

  SM1-1 to SM1-4, GW1-1 to GW1-4, SI1-1 to SI4-4, PG1-1 to PG1-4: same as above.

- Press the ENTER key.

CAUTION: Do not overlap the number in a network.

- Press 2 (= Switch) on the "Communication" screen to select the protocol, transmission speed (baud rate) and test mode setting, etc., of the RSM or IEC60870-5-103 or IEC61850.

```
/3 Switch                                    1/  *
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
850BLK    1=Normal  2=Blocked                1
850AUT    0=Off  1= On                       1
TSTMOD    0=Off  1= On                       0
GSECHK    0=Off  1= On                       0
PINGCHK   0=Off  1= On                       0
```

- 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 RS-232C 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.

<850BLK>

Select 2 (=Blocked) to block the monitor direction in the IEC61850 communication.

<850AUT>

In the IEC61850 communication, GRT100 provides the access restriction which permits a client to access only if an authentication parameter matches with a valid parameter (password). Password is 4-digit number and shared with RSM100.

Select 1 (=On) to use the authentication function.

<TSTMOD>

Select 1 (=On) to set the test mode in the IEC61850 communication.

<GSECHK>

This function is to alarm if any one of GOOSE messages written in GOOSE subscribe file cannot be received.

Select 1 (=On) to execute GOOSE receive check in the IEC61850 communication.

<PINGCHK>

This function is to check the health of network by regularly sending Ping to IP address which is set on PG∗-∗.

Select 1 (=On) to execute Ping response check.

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
Phase mode    1=Operating 2=Fault        1 _
```

- Enter 1 or 2 and press the ENTER key.

  Enter 1 (= Operating) to display the operating phase.

  Enter 2 (= Fault) to display the fault phase.

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
EV5  (       0-   3071):     3071
EV6  (       0-   3071):     3071
EV7  (       0-   3071):     3071
EV8  (       0-   3071):     3071
EV9  (       0-   3071):     3071
EV10 (       0-   3071):     3071
                 :
                 :
                 :
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=Record 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):   1.0 _    s
1OCPS( 0.10-  20.00):   1.00       pu
2OCPS( 0.10-  20.00):   1.00       pu
1OCPG( 0.05-  20.00):   1.00       pu
2OCPG( 0.10-  20.00):   1.00       pu
```

- Enter the recording time and starter element settings.

To set starters, do the following:

- Press 2 (= Scheme switch) on the "Disturbance record" screen to display the "Scheme switch" screen.

```
/4 Scheme switch                  1/14
TRIP1   0=Off  1=On               1 -
TRIP2   0=Off  1=On               1
TRIP3   0=Off  1=On               1
  :       :      :                1
EVENT3  0=Off  1=On               1
```

- Enter 1 to use as a starter or enter 0 if not to use.
- 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                                        1/1
Display value 1=Primary 2=Secondary                1 _
```

- Enter the selected number and press the ENTER key. Repeat this for all items.

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(IEC) or SNTP. This is selected by setting as follows:

- Press 2 (= Time synchronization) to display the "Time synchronization" screen.

```
/3 Time synchronization
0=Off 1=IRIG 2=RSM 3=IEC 4=SNTP

  Current No.=0             Select No.=_
```

- Enter the selected number and press the ENTER key.

Note: When to select IRIG-B, RSM, IEC, or SNTP, 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 SNTP, the calendar clock runs locally.

Setting the time zone

When the calendar clock is synchronized with the IRIG-B time standard, it is possible to transform GMT to the local time.

- Press 3 (= Time zone) to display the "Time zone" screen.

```
/3 Time zone                                   1/2
GMT   (   -12-   +12):       +9 _        hrs
GMTm  (   -59-   +59):       +0          min
```

- Enter the difference between GMT and local time. Enter a numerical value to GMT (hrs) and GMTm (min), and press the ENTER key.

4.2.6.7 Protection

The GRT100 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 product GRT100 was shipped. For the default values, see Appendix D and H. To change the settings, do the following:

- 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=Transformer parameter
2=Trip
```

Settings are required for transformer parameter and protection functions.

Setting the transformer parameters

Enter the VT&CT ratio as follows:

- Press 1 (= Transformer parameter) on the "Protection" screen to display the "Transformer parameter" screen.

```
/5 Transformer parameter       (Group *)
1=VT & CT ratio
```

- Press 1 (VT&CT ratio) to display the "VT&CT ratio" screen.

```
/6 VT & CT ratio                          1/7
1CT   (     1- 20000):   2000 _
2CT   (     1- 20000):   1000
3CT   (     1- 20000):    400
1nCT  (     1- 20000):    100
2nCT  (     1- 20000):    100
3nCT  (     1- 20000):    100
VT    (     1- 20000):    400
```

- Enter the VT ratio and press the ENTER key.
- Enter the CT ratio and press the ENTER key.

CAUTION

Do not set the CT primary rated current. Set the **CT ratio**.

(CT ratio) = (CT primary rated current [A]) / (Relay rated current [A])

- Press the END key to return the display to the "Transformer parameter" screen.

Setting the protection function

To set the protection schemes, scheme switches and protection elements, do the following. Protection elements are measuring elements and timers.

Note: Depending on the selected protection scheme and scheme switch setting, some of the scheme switches and protection elements are not used and so need not be set. The protection function setting menu of the GRT100 does not display unnecessary setting items. Therefore, start by setting the protection scheme, then set the scheme switch, then 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.

- Press 2 (= Trip) on the "Protection" screen to display the "Trip" screen.

```
/5 Trip                               (Group *)
1=Phase matching
2=Scheme switch
3=Protection element
```

Setting the phase matching

- Press 1 (= Phase matching) to display the "Phase matching" screen.
- Select 1 (= Alpha) or 2 (= Beta) to set the phase matching method.

```
/6 Phase matching
1=Alpha   2=Beta

  Current No.= 2          Select No. = _
```

Note: If the "Alpha" is selected, the phase matching method corresponds to that of GRT100-xxxC model. If the "Beta", it corresponds to that of GRT100-xxxA and -xxxB models.

- Press the END key to return the display to the "Trip" screen.

Setting the scheme switch

- Press 2 (= Scheme switch) to display the "Scheme switch" screen.

```
/6 Scheme switch                          1/***
DIFTPMD   1=3POR 2=1P                        1 _
1REF      1=1I0  2=2I0   3=3I0               1
2REF      1=1I0  2=2I0   3=3I0               1
3REF      1=1I0  2=2I0   3=3I0               1
REF_DEF   0=Off  1=On                        1
M1OCI     1=Long 2=Std 3=Very 4=Ext          1
M2OCI     1=Long 2=Std 3=Very 4=Ext          1
M3OCI     1=Long 2=Std 3=Very 4=Ext          1
M1EFI     1=Long 2=Std 3=Very 4=Ext          1
M2EFI     1=Long 2=Std 3=Very 4=Ext          1
M3EFI     1=Long 2=Std 3=Very 4=Ext          1
L/O       0=Off  1=On                        1
2F-LOCK   0=Off  1=On                        1
5F-LOCK   0=Off  1=On                        1
DIF1      0=Off  1=On                        1
DIF2      0=Off  1=On                        1
DIF3      0=Off  1=On                        1
  :                                          :
M.T4-1    0=Off  1=On                        1
M.T4-2    0=Off  1=On                        1
M.T4-3    0=Off  1=On                        1
  :                                          :
SVCNT     0=ALM&BLK 1=ALM                    1
CTSEN     0=Off  1=On                        1
```

Note: The menu of DIFTPMD depends on the phase matching. The above screen is α-method (Alpha). In the case of β-method (Beta), DIFTPMD is 1=3POR, 2=2PAND, 3=1P. Refer to Section 2.2.1.
If the "On" is selected in the menu of REF_DEF, the REF characteristic corresponds to that of GRT100-xxxC model. If the "Off", it corresponds to that of GRT100-xxxA and -xxxB models.

- Enter the number corresponding to the switch status to be set and press the ENTER key for each switch.

  The setting of REF depends on the type of the transformer. The setting method is shown in Appendix L.

- After setting all switches, press the END key to return to the "Trip" screen.

Setting the protection elements

- Press 3 (= Protection element) on the "Trip" screen to display the "Protection element" screen.

```
/6 Protection element         (Group= *)
1=DIFT        2=REF          3=OC
4=THR         5=V/F          6=FRQ
```

<DIFT>

- Press 1 (= DIFT) to display the "DIFT" screen. The measuring elements used in the current differential protection are set using this screen.
- Enter the numerical value and press the ENTER key for each element.
- After setting all elements, press the END key to return to the "Protection element" menu.

/7 DIFT			1/15
ik	(0.10- 1.00):	0.10 _	pu
p1	(10- 100):	10	%
p2	(10- 200):	100	%
kp	(1.00- 20.00):	1.00	pu
kct1	(0.05- 50.00):	1.00	
kct2	(0.05- 50.00):	1.50	
kct3	(0.05- 50.00):	2.00	
yd_p	(1- 2):	1	
yd_s	(1- 2):	1	
vec_s	(1- 11):	0	
yd_t	(1- 2):	1	
vec_t	(1- 11):	0	
k2f	(10- 50):	10	%
k5f	(10- 100):	50	%
kh	(2.00- 20.00):	2.00	pu

<REF>

- Press 2 (= REF) to display the "REF" screen. The measuring elements and timers used in the restricted earth fault protection are set using this screen.
- Enter the numerical value and press the ENTER key for each element.
- After setting all elements, press the END key to return to the "Protection element" menu.

/7 REF			1/21
1ik	(0.05- 0.50):	0.05 _	pu
1kct1	(1.00- 50.00):	1.00	
1kct2	(1.00- 50.00):	1.00	
1kct3	(1.00- 50.00):	1.00	
1p2	(50- 100):	50	%
1kp	(0.50- 2.00):	1.00	pu
2ik	(0.05- 0.50):	0.50	pu
2kct1	(1.00- 50.00):	1.00	
2kct2	(1.00- 50.00):	1.00	
2kct3	(1.00- 50.00):	1.00	
2p2	(50- 100):	50	%
2kp	(0.50- 2.00):	1.00	pu
3ik	(0.05- 0.50):	0.50	pu
3kct1	(1.00- 50.00):	1.00	
3kct2	(1.00- 50.00):	1.00	
3kct3	(1.00- 50.00):	1.00	
3p2	(50- 100):	50	%
3kp	(0.50- 2.00):	1.00	pu
T1REF	(0.00- 10.00):	0.01	s
T2REF	(0.00- 10.00):	0.01	s
T3REF	(0.00- 10.00):	0.01	s

<OC>

- Press 3 (OC) to display the "OC" screen. The overcurrent elements and timers are set using this screen.

- Enter the numerical value and press the ENTER key for each element.
- After setting all elements, press the END key to return to the "Protection element" menu.

```
/7 OC                                            1/24
1OC     (  0.10-  20.00):   0.10 _          pu
2OC     (  0.10-  20.00):   0.10            pu
3OC     (  0.10-  20.00):   0.10            pu
T1OC    (  0.00-  10.00):   0.00             s
T2OC    (  0.00-  10.00):   0.00             s
T3OC    (  0.00-  10.00):   0.00             s
1OCI    (  0.10-   5.00):   0.10            pu
2OCI    (  0.10-   5.00):   0.10            pu
3OCI    (  0.10-   5.00):   0.10            pu
T1OCI   (  0.05-   1.00):   0.50
T2OCI   (  0.05-   1.00):   0.50
T3OCI   (  0.05-   1.00):   0.50
1EF     (  0.10-  20.00):   0.10            pu
2EF     (  0.10-  20.00):   0.10            pu
3EF     (  0.10-  20.00):   0.10            pu
T1EF    (  0.00-  10.00):   0.00             s
T2EF    (  0.00-  10.00):   0.00             s
T3EF    (  0.00-  10.00):   0.00             s
1EFI    (  0.10-   5.00):   0.10            pu
2EFI    (  0.10-   5.00):   0.10            pu
3EFI    (  0.10-   5.00):   0.10            pu
T1EFI   (  0.05-   1.00):   0.50
T2EFI   (  0.05-   1.00):   0.50
T3EFI   (  0.05-   1.00):   0.50
```

<THR>

- Press 4 (= THR) to display the "THR" screen. The measuring elements and the timer used in the thermal overload protection are set using this screen.
- Enter the numerical value and press the ENTER key for each element.
- After setting all elements, press the END key to return to the "Protection element" menu.

```
/7 THR                                        1/ 5
τ     (    0.5-  500.0):     0.5 _       min
k     (   0.10-   4.00):    0.10
IB    (   0.50-   2.50):    0.50         pu
Ip    (   0.00-   1.00):    0.50         pu
TA    (      0-     10):       0         min
```

<V/F>

- Press 5 (= V/F) to display the “V/F” screen. The measuring elements and timers used in the overexcitation protection are set using this screen.
- Enter the numerical value and press the ENTER key for each element.
- After setting all elements, press the END key to return to the “Protection element” menu.

```
/7 V/F                                   1/ 9
V     ( 100.0- 120.0):   100.0 _        V
A     (   1.03-   1.30):     1.10      pu
L     (   1.05-   1.30):     1.20      pu
H     (   1.10-   1.40):     1.30      pu
LT    (      1-    600):        1       s
HT    (      1-    600):        1       s
RT    (     60-   3600):       60       s
TVFH  (      1-    600):        1       s
TVFA  (      1-    600):        1       s
```

<FRQ>

- Press 6 (= FRQ) to display the “FRQ” screen. The measuring elements and timers used in the frequency protection are set using this screen.
- Enter the numerical value and press the ENTER key for each element.
- After setting all elements, press the END key to return to the “Protection element” menu.

```
/7 FRQ                                   1/ 6
81-1  ( 45.00- 55.00):   45.00 _       Hz
81-2  ( 45.00- 55.00):   45.00         Hz
UV    (     40-   100):      40         V
TFRQL(  0.00- 60.00):    0.00          s
TFRQH(  0.00- 60.00):    0.00          s
TFRQA(  0.00- 60.00):    0.00          s
```

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.

```
/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 conditions 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=Norm  2=Inv   1/15
BISW 1                                 1 _
BISW 2                                 1
BISW 3                                 1
BISW 4                                 1
BISW 5                                 1
  :                                    :
BISW14                                 1
BISW15                                 1
BISW16                                 1
```

- 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 GRT100 except the tripping command, and the relay failure signal are 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 seconds 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.

```
/2 Binary output
1=IO#2     2=IO#3
```

- Press the number corresponding to the selected output module to display the "Binary output" screen.

```
/3 Binary output                 (IO2)
Select BO          (  1- 13)

                     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 the logic gates #1 to #6 when assign signals.

Selecting the output relay

- Enter the output relay number and press the ENTER key to display the "Setting" screen.

```
/4 Setting             (BO1 of IO2)
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 and 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 drop-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.

```
/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 GRT100 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.

```
/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 and logic signal observation.

The password must be entered in order to enter the test screens because the "Test" menu has password security protection. (See Section 4.2.6.2.)

4.2.7.1 Setting the switches

The automatic monitor function (A.M.F.) can be disabled by setting the switch [A.M.F] to "OFF".

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: Set the switch [A.M.F] to "Off" before applying the test inputs, when the A.M.F is disabled.

The switch [Reset] is used to test the THR and V/F elements. When the switch [Reset] is set to "1", the time counting of inverse time characteristic can be forcibly reset.

While the switch [A.M.F] is set to "0" or [Reset] is set to "1", the red "TESTING" LED is lit for alarm purposes.

Caution: Be sure to restore these switches after the tests are completed.

Disabling automatic monitoring

- 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
```

- Press 1 (= Switch) to display the "Switch" screen.

```
/2 Switch                              1/ 3
A.M.F.   0=Off      1=On               1 _
Reset    0=Off      1=On               0
IECTST   0=Off      1=On               1
```

- Enter 0 for A.M.F to disable the A.M.F. and press the ENTER key.
- 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.

Resetting the time counting of THR and V/F elements

- Enter 1 for Reset to reset the time counting forcibly 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 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.

```
/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.
- 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 1 key to operate the output relays forcibly.
- Release the press of 1 key to reset the operation.

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" 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.

```
/2 Timer
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
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 the CANCEL key to test other timers. Repeat the above testing.

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.

4.3 Personal Computer Interface

The relay can be operated from a personal computer using an RS-232C 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

For the details, see the separate instruction manual "PC INTERFACE RSM100".

4.4 Communication Interface

The relay can be provided with the following communication interfaces:

- RSM100 (Relay Setting and Monitoring)
- IEC 60870-5-103
- IEC 61850

4.4.1 RSM (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 4.4.1.1 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 4.4.1.2 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.

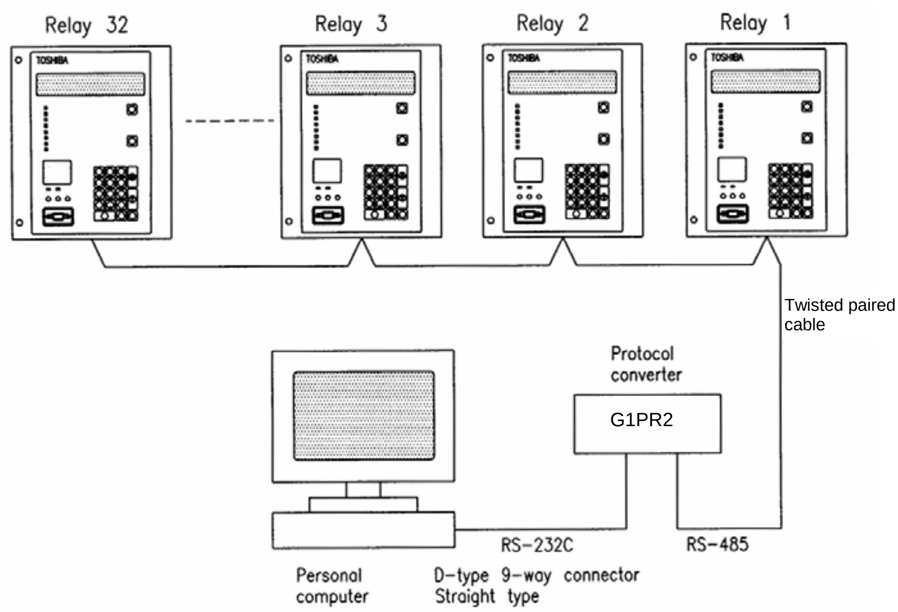


Figure 4.4.1.1 Relay Setting and Monitoring System (1)

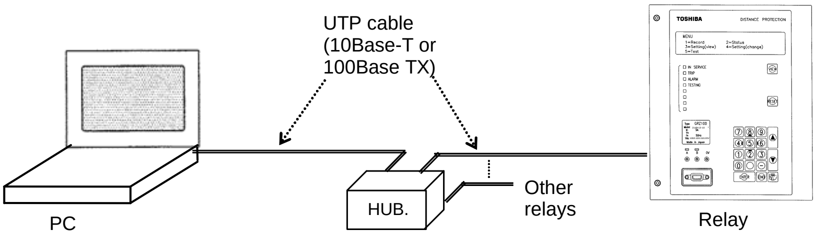


Figure 4.4.1.2 Relay Setting and Monitoring System (2)

4.4.2 IEC 60870-5-103 Interface

The relay can support the IEC60870-5-103 communication protocol. This protocol is mainly used when the relay communicates with substation automation 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, 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 N.

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.

4.4.3 IEC 61850 interface

The relay can also communicate with substation automation system via Ethernet communication networks using IEC 61850 protocols.

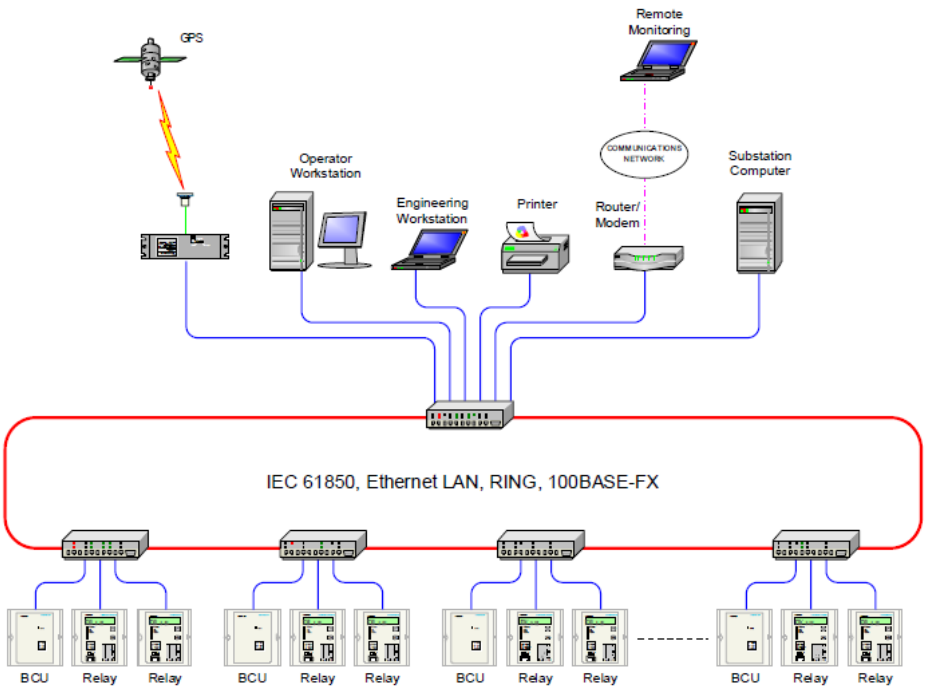


Figure 4.4.3.1 Substation Automation System using Ethernet-based IEC 61850 protocol

4.5 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 or IEC clock. This can be selected by setting.

If it is necessary to synchronize with the IRIG-B time standard 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 4.4.1.1, 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.

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 optional attachment kit required in rack-mounting. (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 GRT100 models are housed into type A case. Appendix F shows the case outline.

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 mounting 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.

Dimension of the attachment kit EP-101 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 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.

Note: In wire connections of terminal block for type A case, the following connections are recommended because a communication port is located between terminal blocks.

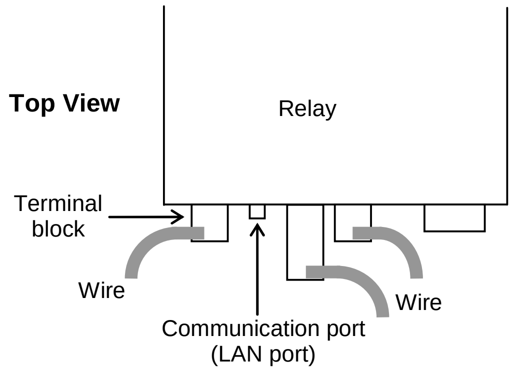


Figure 5.5.1 Example of Wire Connection

6. Commissioning and Maintenance

6.1 Outline of Commissioning Tests

The GRT100 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 function 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
Metering and recording

Conjunctive tests

The tests are performed after the relay is connected with the primary equipment and other external equipment.

The following tests are included in these tests:

On load test: phase sequence check and polarity check
Tripping circuit test

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.

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.

6.3 Preparations

Test equipment

The following test equipment is required for the commissioning tests.

1 Single-phase voltage source
2 Single-phase current sources
1 Variable-frequency source
1 Combined fundamental and 2nd-harmonic adjustable current supply
1 Combined fundamental and 5th-harmonic adjustable current supply
1 DC power supply
1 DC voltmeter
1 AC voltmeter
1 Phase angle meter
2 AC ammeters
1 Frequency meter
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 RS-232C 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".

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 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 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

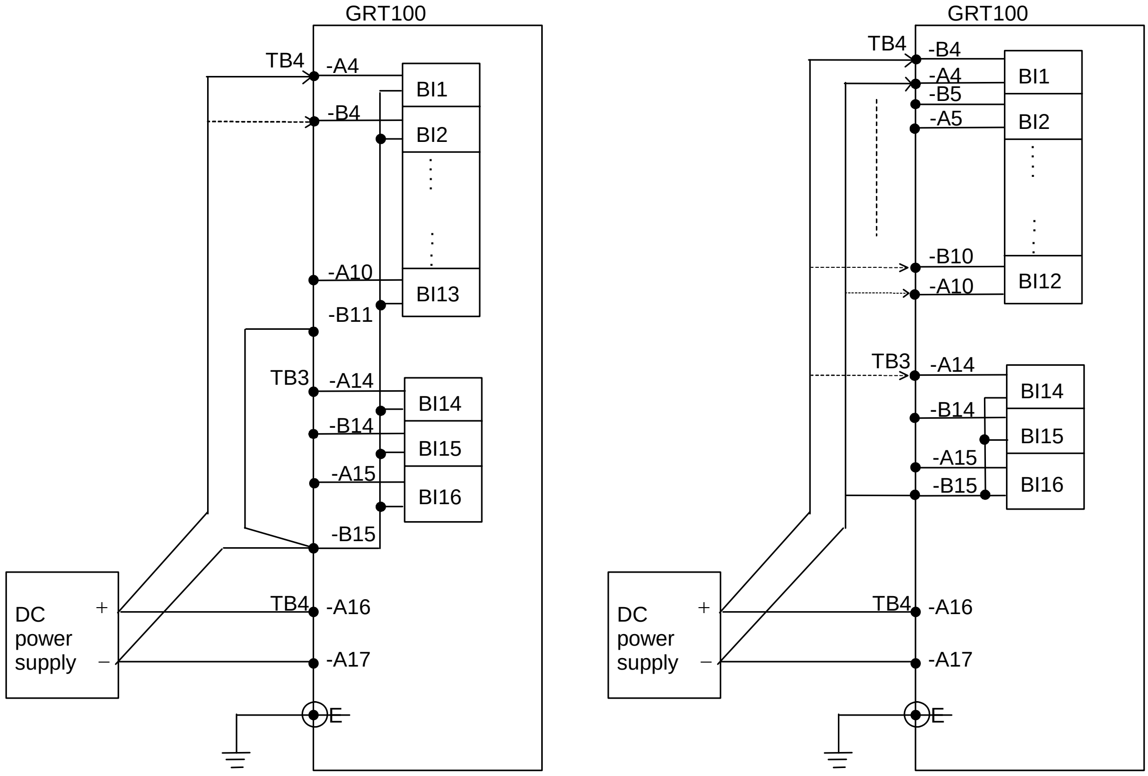
- Press the VIEW key when the LCD is off and check that the "Metering" screen is displayed on the LCD.
- Press the RESET key and check that the LCD turns off.

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.

6.4.2 Binary Input Circuit

The testing circuit is shown in Figure 6.4.1.



(a) For Model 101,102, 201, 202 (a) For Model 203, 204

Figure 6.4.1 Testing Binary Input Circuit

- Display the "Binary input & output" screen from the "Status" sub-menu.

```
/2 Binary input & output              3/ 5
Input (IO#1)        [000 000 000 000      ]
Input (IO#2)        [000                  ]
Output(IO#1-trip)   [000                  ]
Output(IO#2)        [000 000 000 000 00   ]
Output(IO#3)        [000 000 000 0        ]
```

- Apply the rated DC voltage to terminal A4, B4, ..., A6 of terminal block TB4, and A14, B14 and A15 of terminal block TB3.
  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.)

The user will be able to perform this test for one terminal to another or for all the terminals at once.

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.

```
/2 Binary output
1=IO#2      2=IO#3
```

- 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)  1/14
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.
- 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.

6.4.4 AC Input Circuits

This test can be performed by applying the checking 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 for Model 100 series is shown in Figure 6.4.2. A single-phase voltage source and two single-phase current sources are required. (Test Model 200 series by same testing method of Model 100 series.)

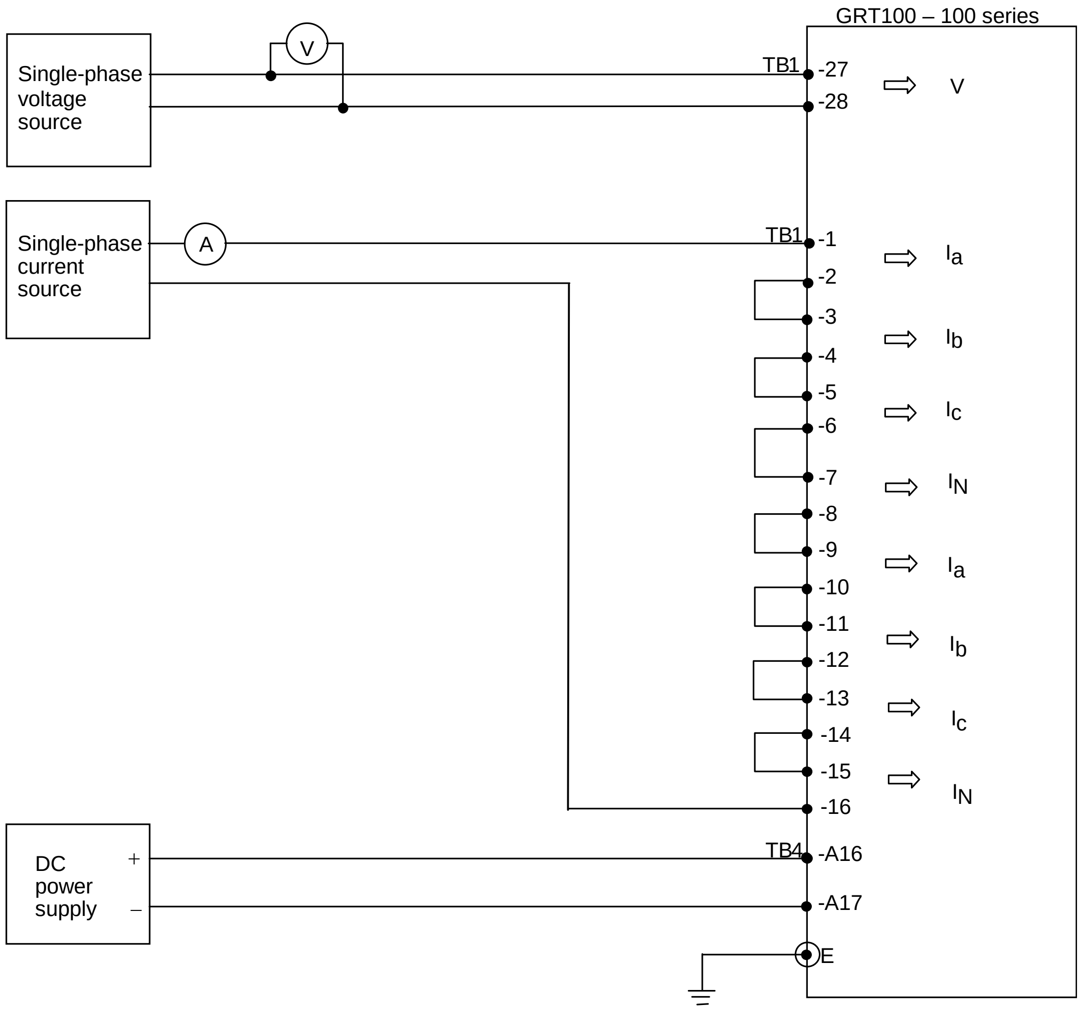


Figure 6.4.2 Testing AC Input Circuit (Model 100s)

- 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" setting 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 the rated AC voltages and currents and check that the displayed values are within ± 5% of the input values.

6.5 Function Test

6.5.1 Measuring Element

Measuring element characteristics are realized by the 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" and less than 0.1V for logic level "0".

CAUTION

- Use the testing 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 for a representative phase. A-phase element is selected hereafter.

6.5.1.1 Current differential element DIF

The current differential element is checked on the following items

- Operating current value
- Percentage restraining characteristic
- Operating time

Note: Set all the CT ratio matching settings (kct1 to kct3) to “1” and phase angle matching settings (d1 to d3) to “0” in the testing described in 6.5.1.1 to 6.5.1.4, because the operating value depends on the settings.

Operating current value

Minimum operating current value is checked by simulating a one-end infeed. Figure 6.5.1 shows a testing circuit simulating an infeed from a primary winding.

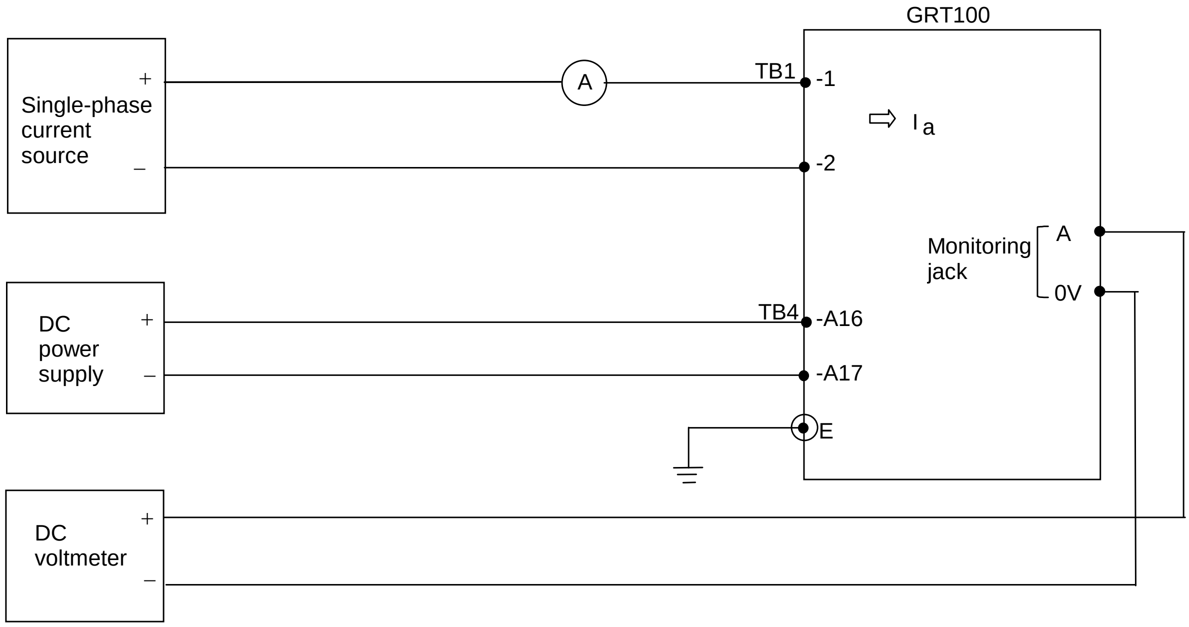


Figure 6.5.1 Operating Current Value Test Circuit (Model 100s, 200s)

The output signal numbers of the DIF elements are as follows:

Element	Signal number
DIF-A	44
DIF-B	45
DIF-C	46

- Press 4 (= Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number 44 to observe the DIF-A operation at monitoring jack A and press the ENTER key.
- Apply a test current to A-phase current terminals and change the magnitude of the current applied and measure the value at which the element DIF-A operates.
  Check that the measured value is within 7% of the theoretical operating value.
  Theoretical operating value = (CT secondary rated current) × (ik setting)

Percentage restraining characteristics

The percentage restraining characteristic is tested on the outflow current (I_{out}) and infeed current (I_{in}) plane as shown in Figure 6.5.2. The characteristic shown in Figure 6.5.2 is equivalent to the one on the differential current (Id) and restraining current (Ir) plane shown in Figure 2.11.1.

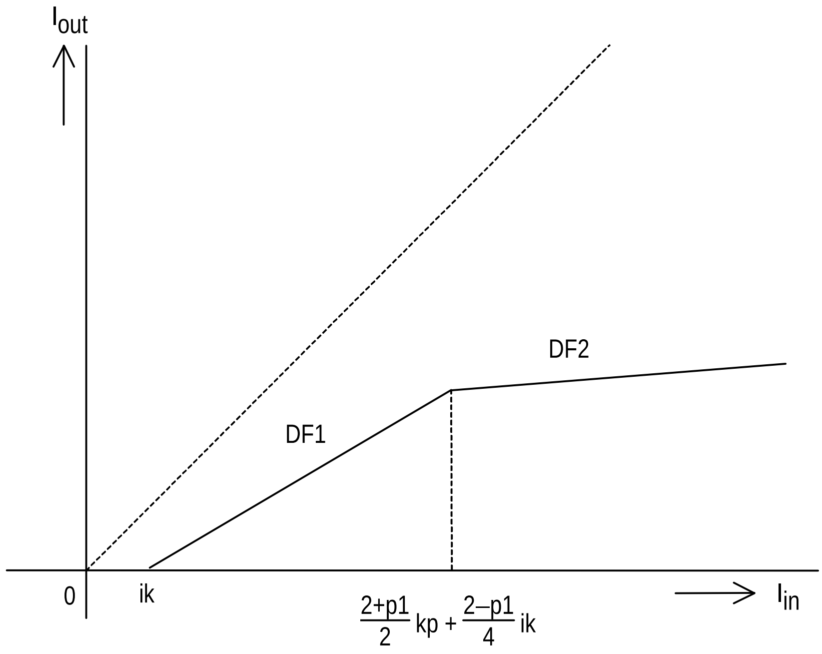


Figure 6.5.2 Current Differential Element (Iout - Iin Plane)

Figure 6.5.3 shows a testing circuit simulating an infeed from a primary winding and outflow from a secondary winding.

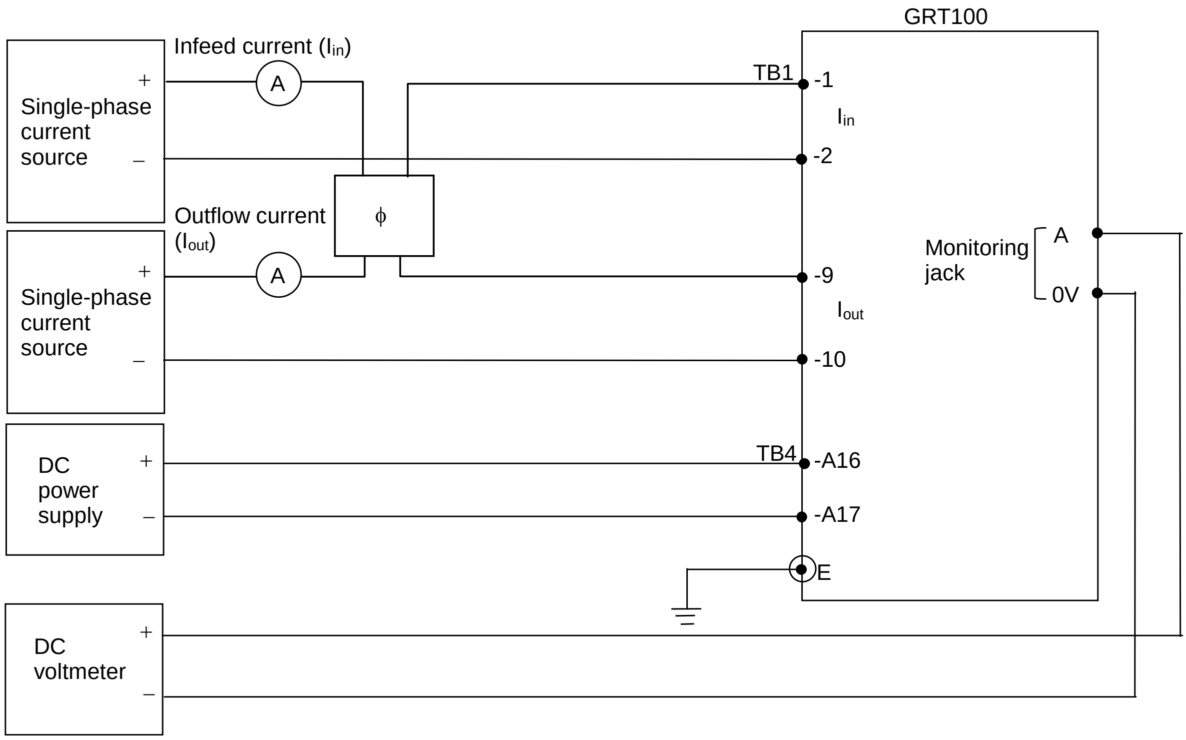


Figure 6.5.3 Percentage Restraining Characteristic Test of DIF (Model 100s, 200s)

- Press 4 (= Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number 44 to observe the DIF-A output at monitoring jack A and press the ENTER key.
- Apply an infeed current to terminal TB1-1 and -2.

  When the infeed current applied is larger than the setting of ik (pu) and smaller than $kp(2+p_1)/2 + ik(2-p_1)/4$ (pu), characteristic DF1 is checked.

  When the infeed current applied is larger than $kp(2+ p_1)/2 + ik(2- p_1)/4$ (pu), characteristic DF2 is checked.

  Note: When the default settings are applied, the critical infeed current which determines DF1 checking or DF2 checking is 1.56×(CT secondary rated current).

- Apply an outflow current of the same magnitude and counterphase with the infeed current to terminal TB1-9 and 10.
- Decrease the out flow current in magnitude and measure the values at which the element operates.
- Check that the measured values are within 7% of the theoretical values.

For characteristic DF1, the theoretical outflow current is given by the following equation:

$I_{out} = (2-p_1)(I_{in}-ik)/(2+p_1)$ (pu)

where, p_1 = slope setting of DF1

ik = minimum operating current setting

When the default settings are applied, $I_{out} = [(I_{in}-0.3) / 3]\times$ (CT secondary rated current).

For characteristic DF2, the theoretical outflow current is given by the following equation.

$I_{out} = [(2-p_2)I_{in} -(2-p_1)ik + 2(p_2- p_1)kp]/(2+ p_2)$ (pu)

where, p_2 = slope setting of DF2

kp = break point of DF1 and DF2

When the default settings are applied, $I_{out} = 0.43\times$ (CT secondary rated current).

Operating time

The testing circuit is shown in Figure 6.5.4.

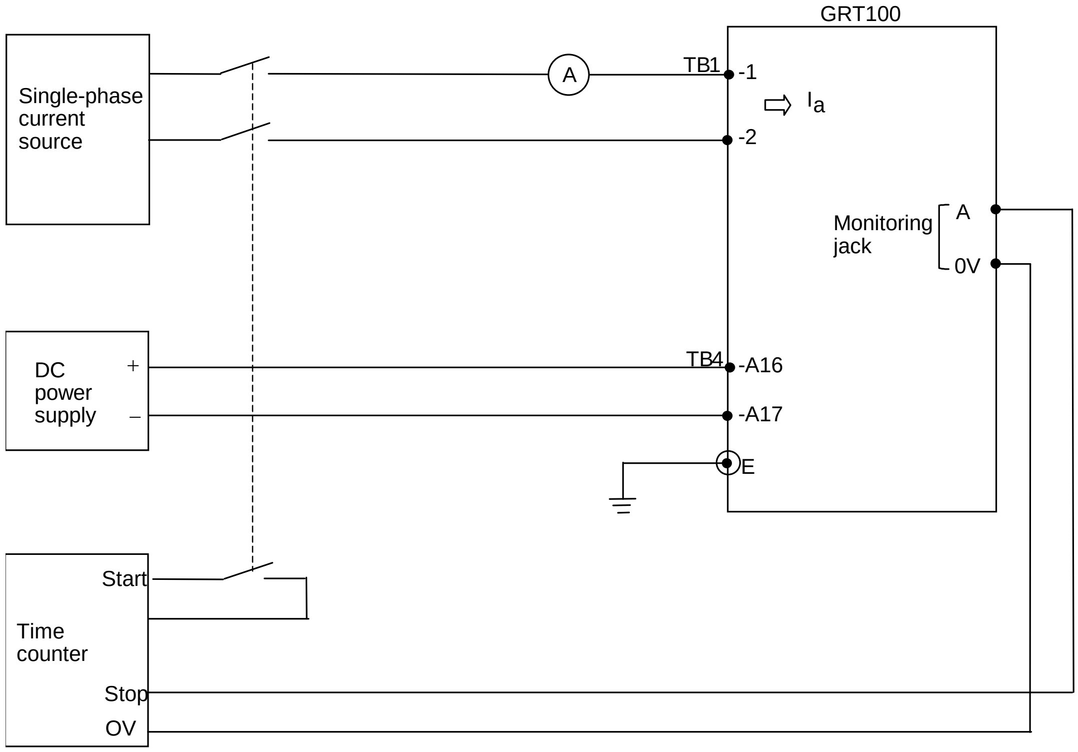


Figure 6.5.4 Operating Time Test (Model 100s, 200s)

- Set a test current to 3 times of DIF operating current (= CT secondary rated current × ik setting).
- Apply the test current and measure the operating time.
- Check that the operating time is 40 ms or less.

6.5.1.2 2F element

The testing circuit is shown in Figure 6.5.5.

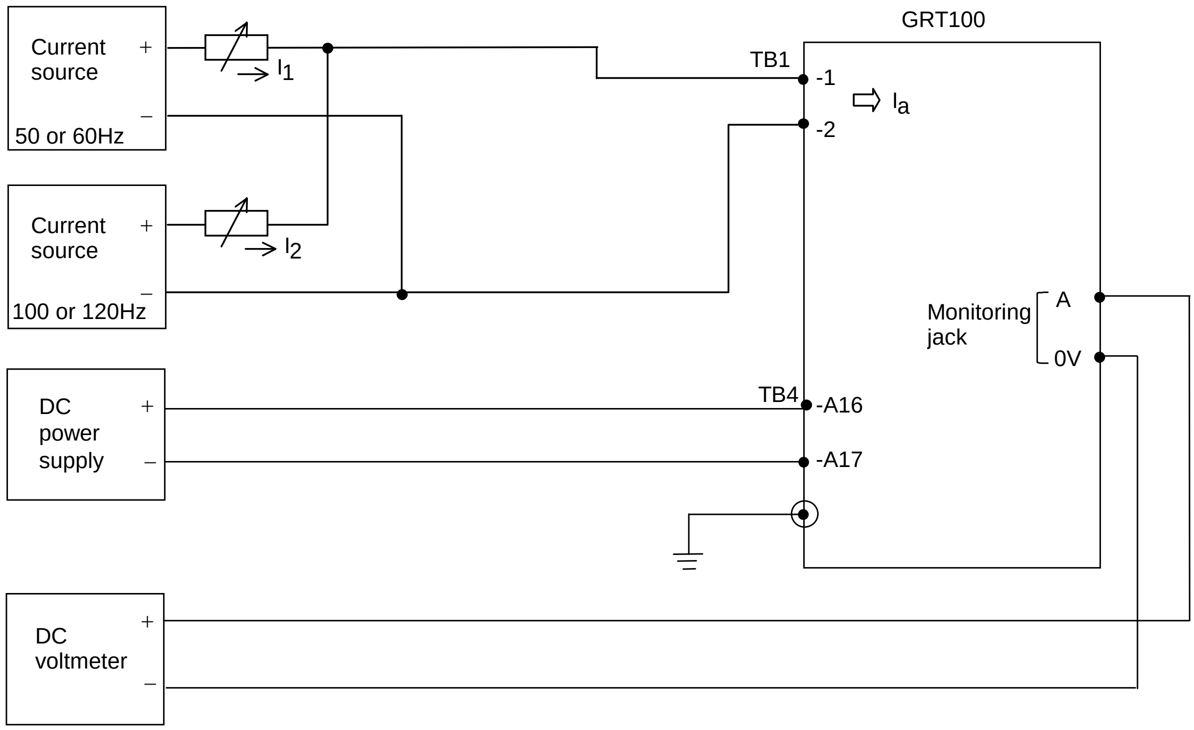


Figure 6.5.5 Testing 2F Element (Model 100s, 200s)

The output signal number of the 2F element is as follows:

Element	Signal number
2F	122

- Set the second harmonic restraint setting k2f to 15%(= default setting).
- Press 4 (= Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number to observe the 2F output at monitoring jack A and press the ENTER key.
- Set the fundamental frequency current I_1 to 3 times of ik setting. Change the magnitude of the second harmonic current I_2 and measure the value at which the element operates.
- Calculate the percentage of the second harmonic by I_2/I_1 when the element operates. Check that the percentage is within 7% of the k2f setting.

6.5.1.3 5F element

The testing circuit is shown in Figure 6.5.6.

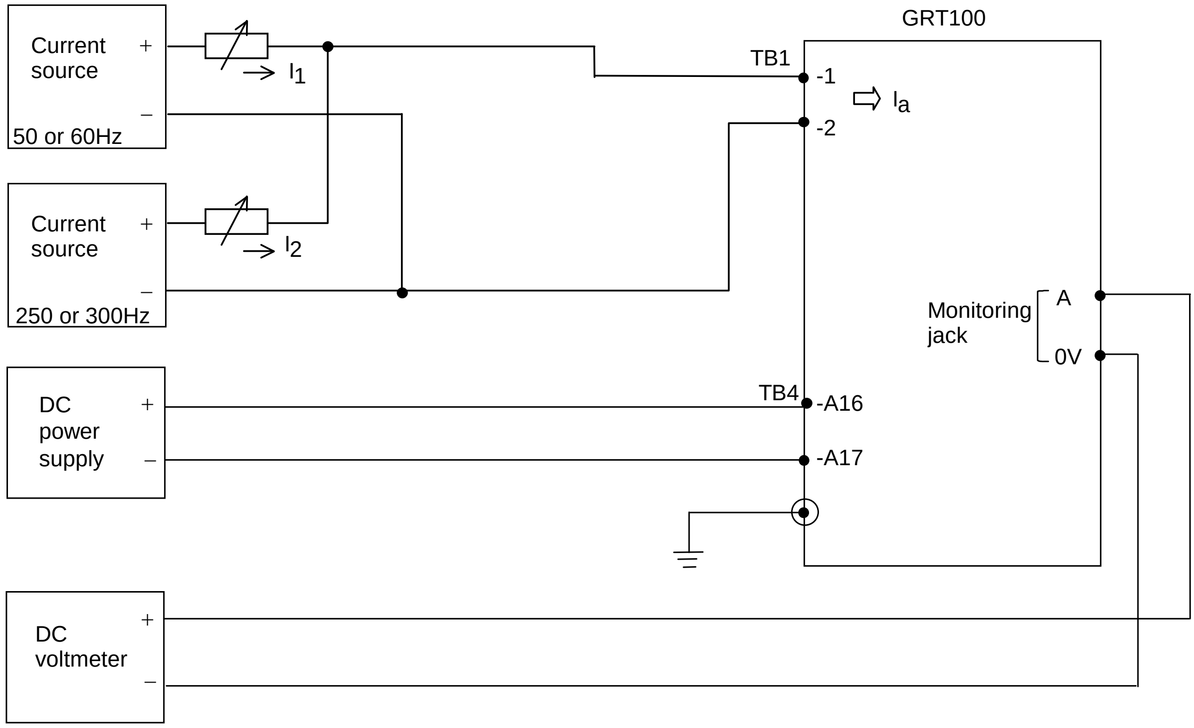


Figure 6.5.6 Testing 5F Element (Model 100s, 200s)

The output signal number of the 5F element is as follows:

Element	Signal number
5F	123

- Set the fifth harmonic restraint setting k5f to 30%.(= default setting)
- Press 4 (= Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number to observe the 5F output at monitoring jack A and press the ENTER key.
- Set the fundamental frequency current I_1 to 3 times of ik setting. Change the magnitude of the fifth harmonic current I_5 and measure the value at which the element operates.
- Calculate the percentage of the fifth harmonic by I_5/I_1 when the element operates. Check that the percentage is within 7% of the k5f setting.

6.5.1.4 High-set overcurrent element HOC

Operating current value

The testing circuit is shown in Figure 6.5.1.

The output signal numbers of the HOC elements are as follows:

Element	Signal number
HOC-A	41
HOC-B	42
HOC-C	43

- Press 4 (= Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number 41 to observe the HOC-A output at monitoring jack A and press the ENTER key.
- Apply a test current to A-phase current terminals 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 following value.

  Operating value = (CT secondary rated current) × (kh setting)

Operating time

The testing circuit is shown in Figure 6.5.4.

- Set a test current to 2 times of HOC operating current (= CT secondary rated current × kh setting)
- Apply the test current and measure the operating time.
- Check that the operating time is 25 ms or less.

6.5.1.5 Restricted earth fault element REF

The restricted earth fault element is checked on the following items.

- Operating current value
- Percentage restraining characteristic

Note: Set all the CT ratio matching settings (1kct1 - 1kct3 to 3kct1 - 3kct3) to "1", because the operating value depends on the settings.

Operation current value

The testing circuit is shown in Figure 6.5.7.

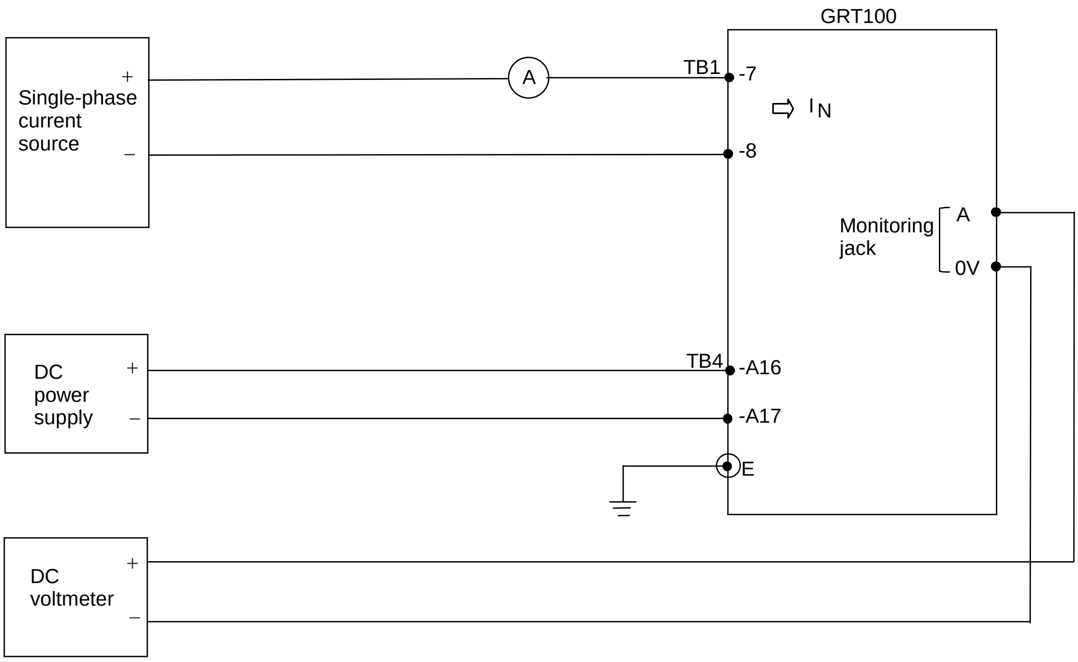


Figure 6.5.7 Operating Current Value Test of REF_DIF element (Model 100s, 200s)

The test current input terminal number and output signal number of the REF_DIF element is as follows:

Element	Input terminal number	Output signal number
1REF_DIF	TB1-7 and –8	29
2REF_DIF	TB1-15 and –16	30
3REF_DIF	TB1-23 and –24	31

- Press 4 (= Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter the signal number 29 to observe the 1REF_DIF output at monitoring jack A and press the ENTER key.
- Apply a test current to TB1-7 and -8 and change the magnitude of the current applied and measure the value at which the element operates.

Check that the measured value is within 15% of the theoretical operating value.
Theoretical operating value = (CT secondary rated current) × (1ik setting)

Percentage restraining characteristics

The percentage restraining characteristic is tested on the outflow current (I_{out}) and infeed current (I_{in}) plane as shown in Figure 6.5.8. The characteristic shown in Figure 6.5.8 is equivalent to the one on the differential current (Id) and restraining current (Ir) plane shown in Figure 2.11.2.

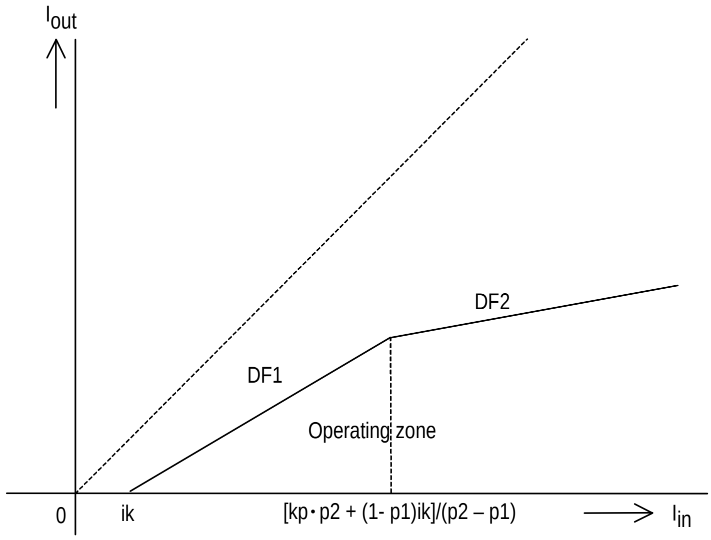


Figure 6.5.8 REF_DIF Element (I_{out} - I_{in} Plane)

Figure 6.5.9 shows a testing circuit simulating infeed from a neutral circuit and outflow from a primary winding.

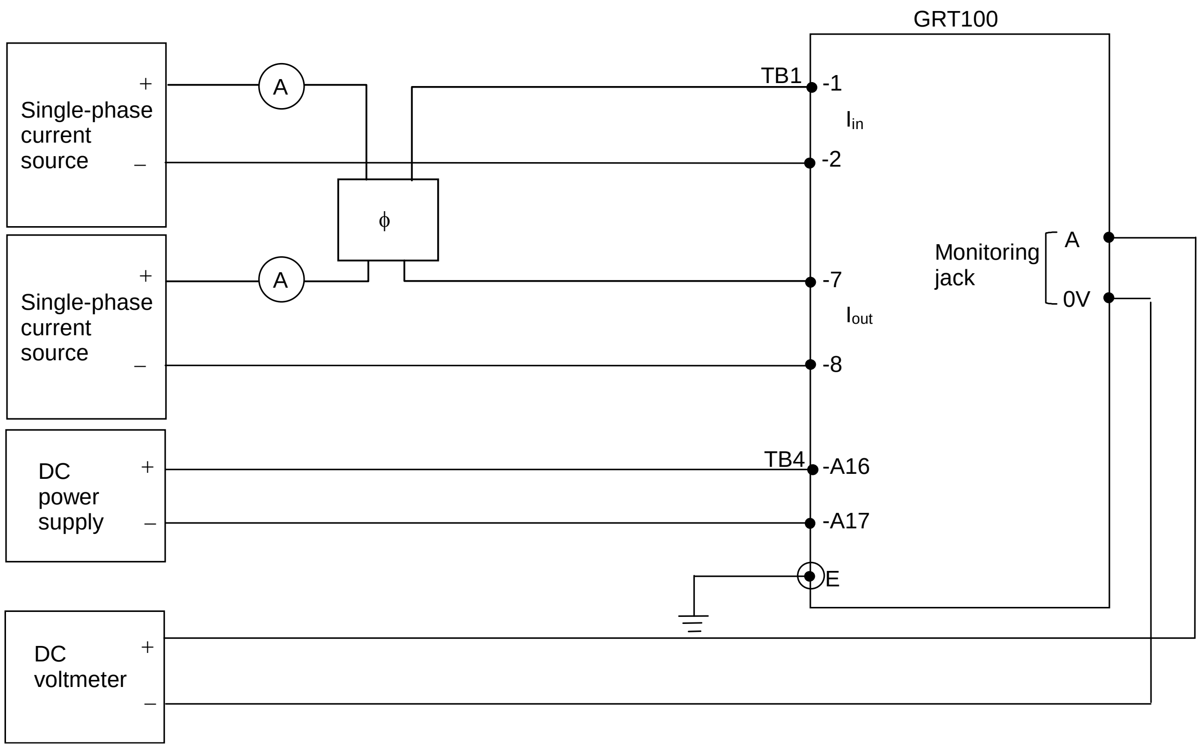


Figure 6.5.9 Testing Restricted Earth Fault Element (Model 100s, 200s)

- Enter a signal number 29 to observe the 1REF_DIF output at monitoring jack A and press the ENTER key.

- Apply an infeed current to terminal TB1-1 and -2.

  When the infeed current applied is larger than the setting of ik (pu) and smaller than [kp·p2 + (1–p1)ik]/(p2 – p1) (pu), characteristic DF1 is checked.

  When the infeed current applied is larger than [kp·p2 + (1–p1)ik]/(p2 – p1) (pu), characteristic DF2 is checked.

  Note: When the default settings are applied, the critical infeed current which determines DF1 checking or DF2 checking is 1.6×(CT secondary rated current).

- Apply an outflow current of the same magnitude and counterphase with the infeed current, to terminal TB1-7 and -8.
- Decrease the outflow current in magnitude and measure the values at which the element operates.
- Check that the measured values are within 15% of the theoretical values.

For characteristic DF1, the theoretical outflow current is given by the following equation.

$I_{out} = (1-p_1)(I_{in}-ik)$ (pu)

where,

p1 = slope setting of DF1 (= 0.1 fixed)

ik = minimum operating current setting

When the default settings are applied, $I_{out} = 0.9\times(I_{in} - 0.5)\times$ (CT secondary rated current). For characteristic DF2, the theoretical outflow current is given by the following equation

$I_{out} = (1-p_2)\, I_{in} + p_2 \times kp$ (pu)

where,

p_2 = slope setting of DF2

kp = restraining current section setting of DF2

When the default settings are applied, $I_{out} = 1.0\times$ (CT secondary rated current).

6.5.1.6 Definite time overcurrent elements OC, EF

The testing circuit is shown in Figure 6.5.10.

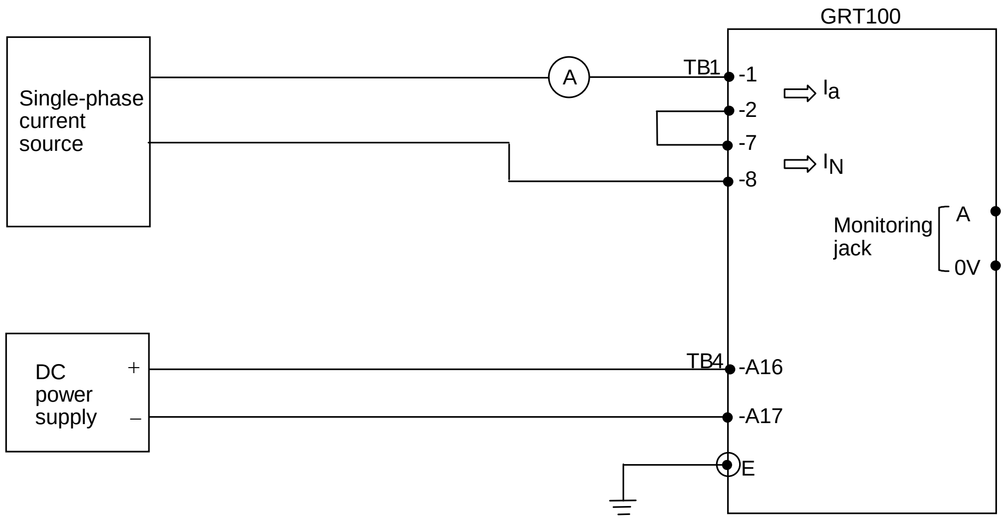


Figure 6.5.10 Testing OC and EF (Model 100s, 200s)

Element	Signal number
1OC, 2OC, 3OC	47, 53, 59
1EF, 2EF, 3EF	72, 75, 78

The testing procedure is as follows:

- Press 4 (= Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number to observe the OC or EF output at monitoring jack A and press the ENTER key.
- 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 ±5% of the theoretical operating value.

  Theoretical operating value = (CT secondary rated current) × (OC or EF setting)

6.5.1.7 Inverse time overcurrent elements OCI, EFI

The testing circuit is shown in Figure 6.5.11.

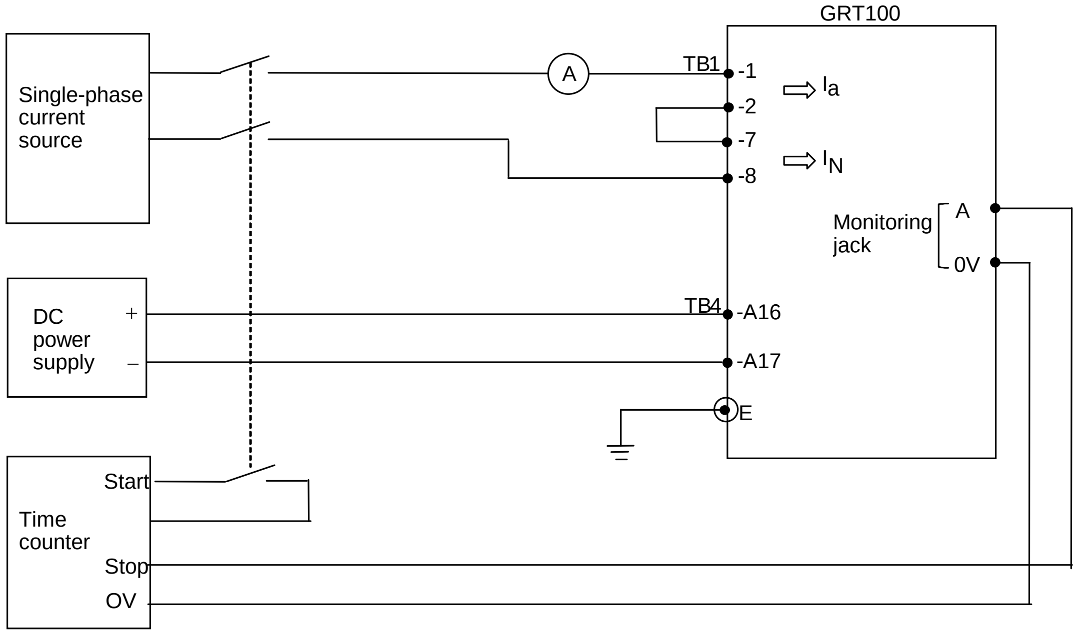


Figure 6.5.11 Testing OCI and EFI (Model 100s, 200s)

One of the four inverse time characteristics can be set, and the output signal numbers are as follows:

Element	Signal number
1OCI, 2OCI, 3OCI	50, 56, 62
1EFI, 2EFI, 3EFI	73, 76, 79

Fix the time characteristic to test by setting the OCI or EFI on the "OC" screen.

"Setting (change)" sub-menu → "Protection" screen → "Trip" screen → "Protection element" screen → "OC" screen

The testing procedure is as follows:

- Press 4 (= Logic circuit) on the "Test" sub-menu 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 × I_S to 20 × I_S, where I_S = (CT secondary rated current) × (OCI or EFI current setting).
- Calculate the theoretical operating time using the characteristic equations shown in Section 2.11.4. Check that the measured operating time is within the error mentioned below.

  Accuracy: Standard, Very and Long-time inverse: IEC 60255-3 class 5
  Extremely inverse: IEC 60255-3 class 7.5

6.5.1.8 Thermal overload element THR

The testing circuit is shown in Figure 6.5.12.

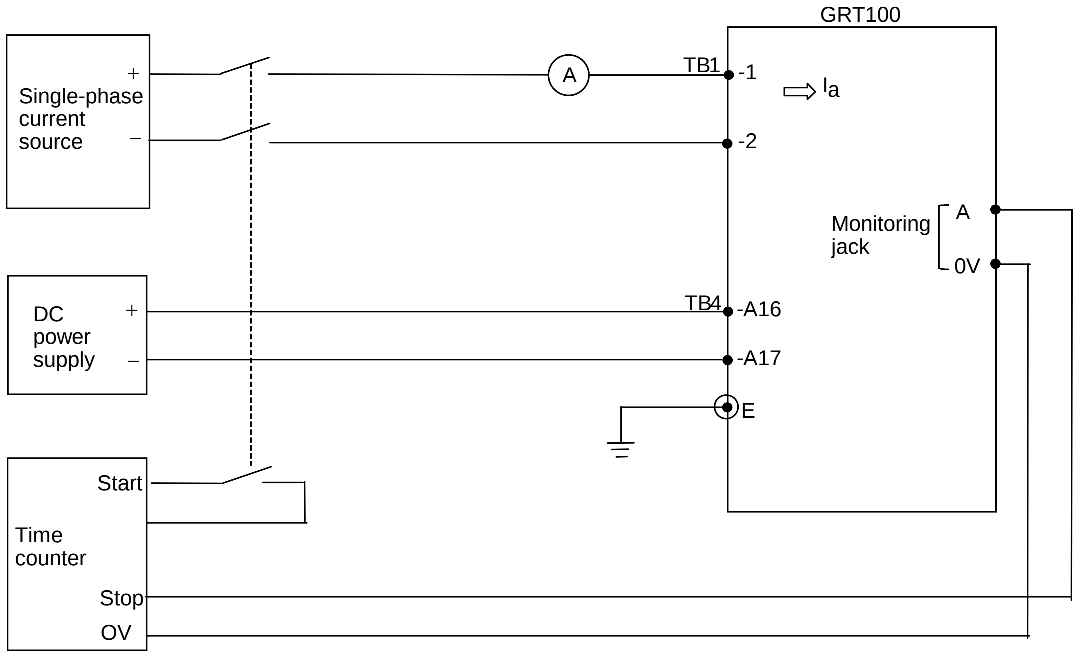


Figure 6.5.12 Testing THR (Model 100s, 200s)

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.
THR-S	83
THR-A	87

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 2.10.6. Check that the measured operating time is within 5%.

6.5.1.9 Frequency element FRQ

The frequency element is checked on the following items

- Operating frequency
- Undervoltage block

Operating frequency test

The testing circuit is shown in Figure 6.5.13.

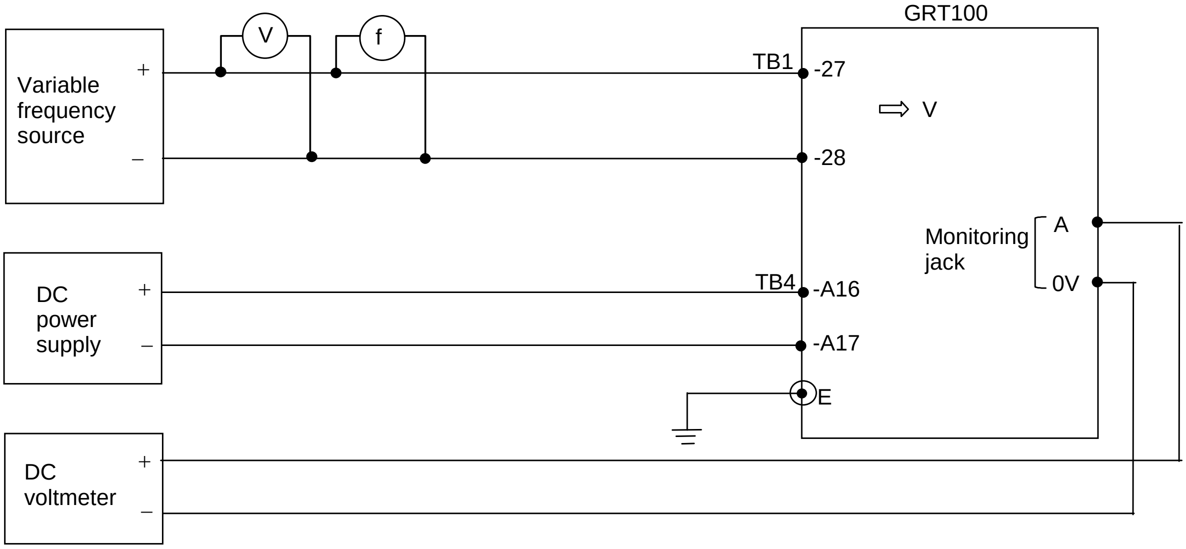


Figure 6.5.13 Testing Frequency Element (Model 100s, 200s)

The output signal numbers of the FRQ elements are as follows:

Element	Signal number	Remarks
81-1	89	Underfrequency tripping
	91	Overfrequency tripping
81-2	90	Underfrequency alarm
	92	Overfrequency alarm

- Press 4 (= Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number to observe the FRQ output at monitoring jack A and press the ENTER key.
- Apply rated voltage and change the magnitude of the frequency applied and measure the value at which the element operates. Check that the measured value is within ±0.03Hz of the setting.

Undervoltage block test

- Apply rated voltage and change the magnitude of frequency to operate the element.
- Keep the frequency that the element is operating, and change the magnitude of the voltage applied from the rated voltage to less than UV setting voltage. And then, check that the element resets.

6.5.1.10 Overexcitation element V/F

The overexcitation element is checked on the following items

- Operating value of definite time tripping and alarm characteristic
- Operating time of inverse time tripping characteristic

The output signal numbers of the V/F elements are as follows:

Element	Signal number	Remarks
V/F	80	Definite time tripping
	81	Inverse time tripping
	82	Definite time alarm

Operating value test for definite time tripping and alarm

The testing circuit is shown in Figure 6.5.14.

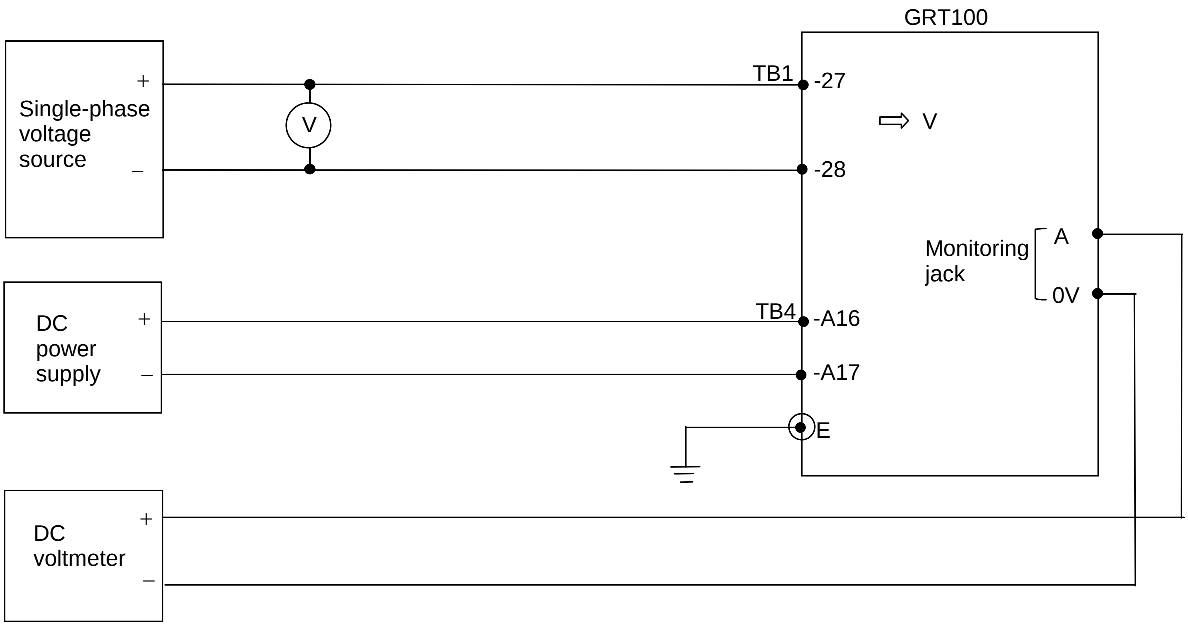


Figure 6.5.14 Operating Value Test of V/F (Model 100s, 200s)

- Set V (rated voltage setting) to 100V.
- Press 4 (= Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number 80 or 82 to observe the V/F output at monitoring jack A and press the ENTER key.
- Apply a test voltage at rated frequency and increase the magnitude of the voltage applied and measure the value at which an alarm signal or a trip signal is output. Check that the measured values are within 2% of (V setting) × (A setting) for an alarm signal and (V setting) × (H setting) for a trip signal.

Operating time characteristic test

The testing circuit is shown in Figure 6.5.15.

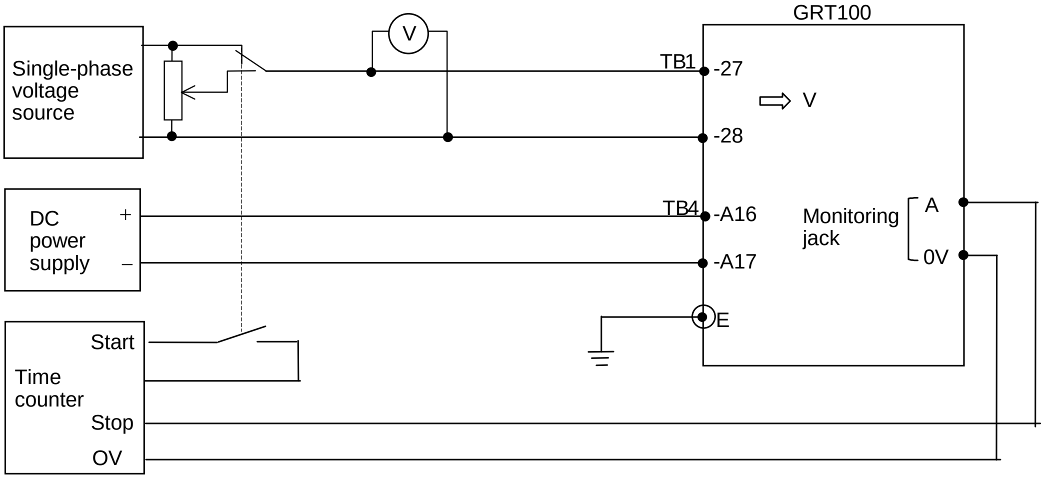


Figure 6.5.15 Operating Time Characteristic Test of V/F (Model 100s, 200s)

The testing procedure is as follows:

- Press 4 (= Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number 81 to observe the inverse time tripping output at monitoring jack A and press the ENTER key.

  Note: Set the swich [Reset] to “Off”→ “On”→ “Off” to initialize a time count. See Section 4.2.7.1.

- Apply a test voltage at rated frequency and measure the operating time. The magnitude of the test voltage should be between (V setting) × (L setting) and (V setting) × (H setting).
- Calculate the theoretical operating time using the characteristic equations shown in Section 2.11.8 where V is the test voltage. Check that the measured operating time is from +15% to –10% of the calculated value.

6.5.2 Timer Test

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 6.5.15. Jacks A and B are used to observe the input signal and output signal of the timer, respectively.

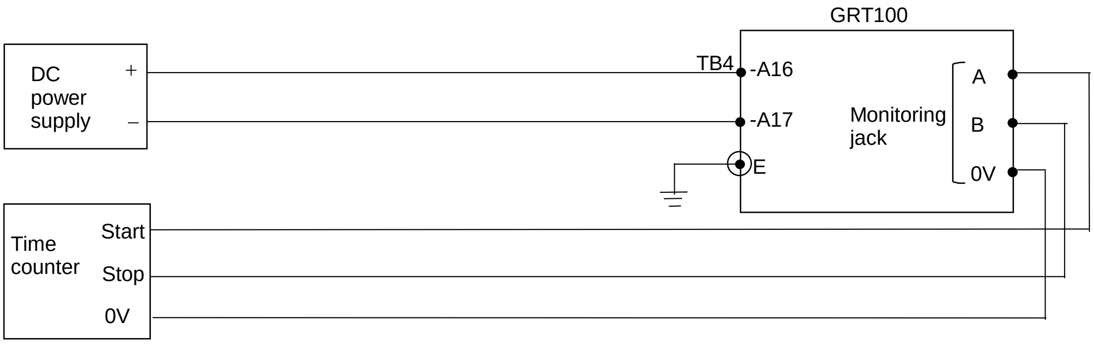


Figure 6.5.16 Testing Variable Timer (Model 100s, 200s)

- Press 3 (= Timer) on the "Test" sub-menu 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 start measuring the time. 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.

  Check that the measured time is within ± 10ms of the setting time.

  During the test, the following display appears on the LCD and the LEDs above the jacks are also lit if the input or output signal exists.

```
/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 the CANCEL key to test other timers. Repeat the above testing.

6.5.3 Protection Scheme

In the protection scheme tests, a dynamic test set is required to simulate power system pre-fault, fault and post-fault conditions.

Tripping is observed with the tripping command output relays TRIP-1 to -5.
Check that the indications and recordings are correct.

6.5.4 Metering and Recording

The metering function can be checked while testing the AC input circuit. See Section 6.4.4.

Fault recording can be checked while testing the protection schemes. Open the "Fault records" screen and check that the descriptions are correct for the applied fault.

Recording events are listed in Table 3.4.1. The top 8 events are external events and others are internal events. Event recording on the external events 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: 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 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.

6.6 Conjunctive Tests

6.6.1 On Load Test

With the relay connected to the line which is carrying a load current, it is possible to check the polarity of the voltage transformer and current transformer and the phase rotation with the metering displays on the LCD screen.

- Open the following "Metering" screen from the "Status" sub-menu.

```
/2 Metering    16/Oct/1997   18:13 3/20
Ia1 **.**kA ***.*° Ia2 **.**kA ***.*°
Ib1 **.**kA ***.*° Ib2 **.**kA ***.*°
Ic1 **.**kA ***.*° Ic2 **.**kA ***.*°
I11 **.**kA ***.*° I12 **.**kA ***.*°
I21 **.**kA ***.*° I22 **.**kA ***.*°
I01 **.**kA ***.*° I02 **.**kA ***.*°
In1 **.**kA ***.*° In2 **.**kA ***.*°
Ia3 **.**kA ***.*°
Ib3 **.**kA ***.*°
Ic3 **.**kA ***.*°
I13 **.**kA ***.*°
I23 **.**kA ***.*°
I03 **.**kA ***.*°
In3 **.**kA ***.*°
V   ***.*kV ***.*°
Ida ***.**pu            Id01***.**pu
Idb ***.**pu            Id02***.**pu
Idc ***.**pu            Id03***.**pu
THM ***.*%
Frequency            **.*Hz
```

Note: The magnitude of voltage and current 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 voltage input as the reference angle.

- Check that the phase rotation is correct.
- Verify the phase relation between voltage and current with a known load current direction.

6.6.2 Tripping Circuit Test

The tripping circuit including the circuit breaker is checked by forcibly operating the output relay and monitoring the breaker that is tripped. 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

- Set the breaker to be 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 IO1 module, then the LCD displays the screen shown below.

```
/3 BO           (0=Disable 1=Enable)   1/ 5
IO#1  TP-1                              1 _
IO#1  TP-2                              1
IO#1  TP-3                              1
IO#1  TP-4                              0
IO#1  TP-5                              0
```

TP-1 to 5 are output relays with one normally open contact. Models 203 and 204 are not provided with TP-4 and TP-5.

- Enter 1 for TP-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 operate the output relay TP-1 and check that the No. 1 breaker is tripped.
- Release pressing the 1 key to reset the operation.
- Repeat the above for other output relays TP-2 to TP-5.

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.

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 6.7.1.

This table shows the relationship between messages displayed on the LCD and the 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 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.

Table 6.7.1 LCD Message and Failure Location

Message	Failure location							
	VCT	SPM	IO1 or IO8	IO2	IO3	HMI	AC cable	LAN cable/ network	PLC, IEC61850 data
Checksum err		×							
ROM data err		×							
ROM-RAM err		×							
SRAM err		×							
CPU err		×							
Invalid err		×							
NMI err		×							
BU-RAM err		×							
EEPROM err		×							
A/D err		×							
Sampling err		×							
CT1 err	× (2)	× (2)					× (1)		
CT2 err	× (2)	× (2)					× (1)		
CT3 err	× (2)	× (2)					× (1)		
DIO err		× (2)	× (1)	× (1)	× (1)				
RSM err		× (1)	× (2)						
LCD err						×			
DC supply off			×						
RTC err		×							
PCI err		×							
LAN err		×							
GOOSE stop		× (2)						× (1)	
Ping err		× (2)						×(1)	
PLC stop									×
MAP stop									×
No-working of LCD		× (2)				× (1)			

The location marked with (1) has a higher probability than the location marked with (2).

If no message is shown on the LCD, this means that the failure location is either in the DC power supply circuit or in the microprocessors mounted on the SPM module. Then 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 so, replace the IO1 or IO8 module mounting the DC/DC converter and confirm that the "ALARM" LED is turned off.

In the latter case, replace the SPM module containing 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 module 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	G1PC2-□□□□
SPM	G1SP∗-□□□□
IO1	G1IO1-□□□□
IO2	G1IO2-□□□□
IO3	G1IO3-□□□□
IO8	G1IO8-□□□□
HMI	--

The software name is indicated on the memory device on the module with letters such as GSPTM1-***, 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 all of the settings including the data related to the PLC, IEC103 and IEC61850, etc. 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 (HMI) 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 (VCT) Module

CAUTION Before pulling out the transformer module, pull out all other modules. For the method of pulling out other module, see the section "Replacing other 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 by unscrewing the two binding screws located on the right side of the panel.
- 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 module 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.
- 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 by unscrewing the two binding screws located on the right side of the panel.
- 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.
- Pull out the module by pulling up or down the top and bottom levers.
- Insert the replacement module in the reverse procedure.
- After replacing the SPM module, input the user setting values again.

For failed module tracing and its replacement, see Appendix Q.

6.7.4 Resumption of Service

After replacing the failed module or repairing failed external circuits, take the following procedures for the relay to restore the 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.

- 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 60255-6 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.

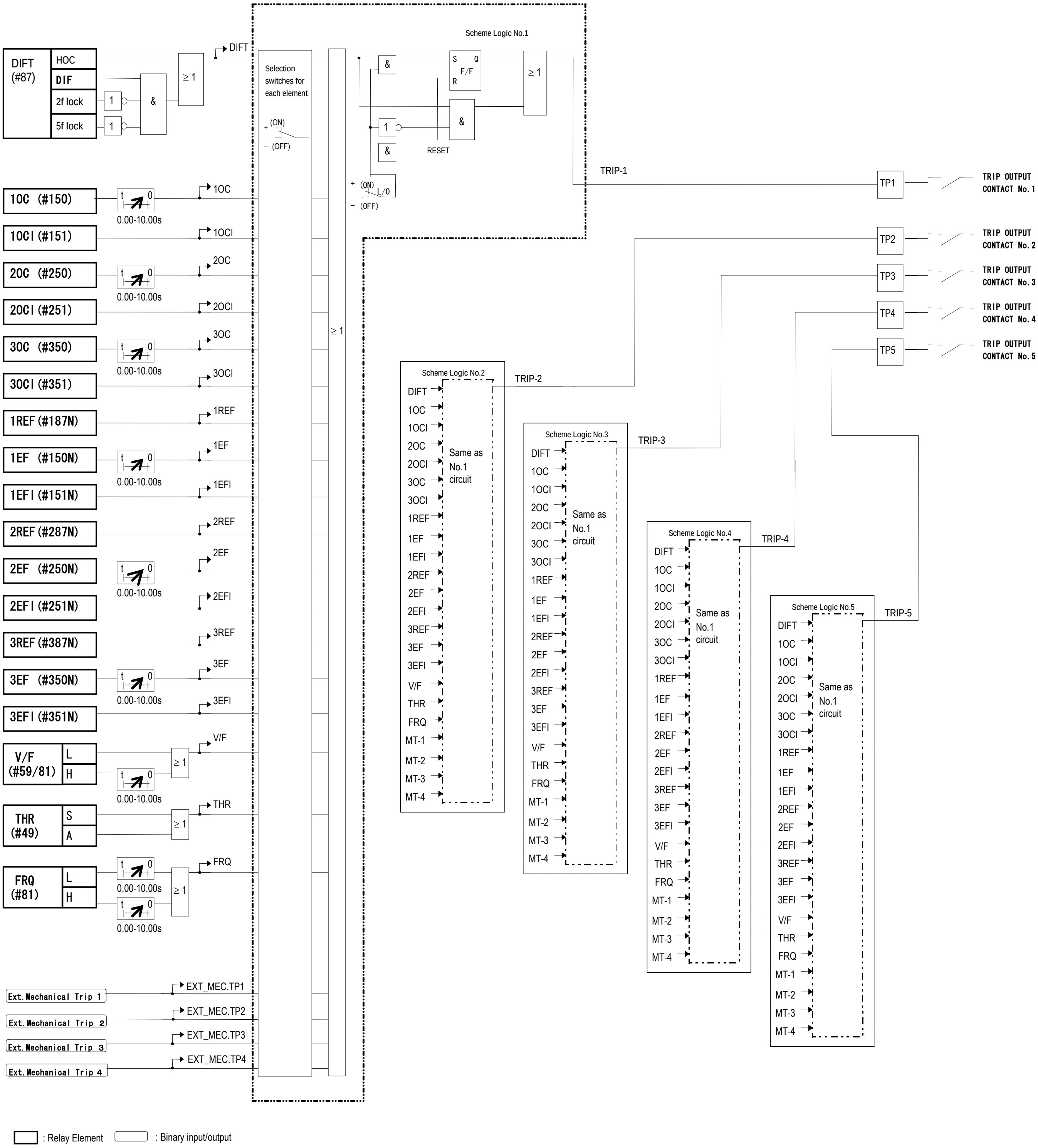
7. Putting Relay into Service

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 setting 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.
- 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.

Appendix A

Block Diagram



Note: Models 203 and 204 are not provided with TRIP-4 and TRIP-5.

Block Diagram of Transformer Differential Relay GRT100

Appendix B

Signal List

Signal list

No.	Signal Name	Contents
0	CONSTANT_0	constant 0
1	CONSTANT_1	constant 1
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38	DIF_NBLK-A	Differential element(2f/5f lock is not included)
39	DIF_NBLK-B	ditto
40	DIF_NBLK-C	ditto
41	DIFT_HOC-A	Differential relay
42	DIFT_HOC-B	ditto
43	DIFT_HOC-C	ditto
44	DIFT_DIF-A	ditto
45	DIFT_DIF-B	ditto
46	DIFT_DIF-C	ditto
47	1OC-A	OC relay
48	1OC-B	ditto
49	1OC-C	ditto
50	1OCI-A	Inverse time OC relay
51	1OCI-B	ditto
52	1OCI-C	ditto
53	2OC-A	OC relay
54	2OC-B	ditto
55	2OC-C	ditto
56	2OCI-A	Inverse time OC relay
57	2OCI-B	ditto
58	2OCI-C	ditto
59	3OC-A	OC relay
60	3OC-B	ditto
61	3OC-C	ditto
62	3OCI-A	Inverse time OC relay
63	3OCI-B	ditto
64	3OCI-C	ditto
65	4OC-A	OC relay
66	4OC-B	ditto
67	4OC-C	ditto
68	4OCI-A	Inverse time OC relay
69	4OCI-B	ditto
70	4OCI-C	ditto

Signal list

No.	Signal Name	Contents
71	1REF	Restricted earth fault relay
72	1EF	Earth fault relay
73	1EFI	Inverse time earth fault relay
74	2REF	Restricted earth fault relay
75	2EF	Earth fault relay
76	2EFI	Inverse time earth fault relay
77	3REF	Restricted earth fault relay
78	3EF	Earth fault relay
79	3EFI	Inverse time earth fault relay
80	V/F-H	Overexcitation relay
81	V/F-T	ditto
82	V/F-A	ditto
83	THR-S	Thermal overload relay
84		
85		
86		
87	THR-A	Thermal overload relay
88		
89	FRQ-L1	Frequency relay
90	FRQ-L2	ditto
91	FRQ-H1	ditto
92	FRQ-H2	ditto
93	CTF	CT failure detection
94	CTF_ALARM	CT failure alarm
95	2F-A	2nd harmonic inrush current detection
96	2F-B	ditto
97	2F-C	ditto
98	5F-A	fifth harmonic components detection
99	5F-B	ditto
100	5F-C	ditto
101	CT_SAT-A	CT saturation
102	CT_SAT-B	ditto
103	CT_SAT-C	ditto
104		
105		
106		
107		
108		
109		
110		
111		
112		
113		
114		
115		
116		
117		
118		
119	FRQBLK	UV block signal for FRQ
120		
121	DIF_TRIP	DIF relay trip
122	2F_LOCK	2F detect
123	5F_LOCK	5F detect
124	DIF-T1	DIF relay trip 1
125	DIF-T2	DIF relay trip 2
126	DIF-T3	DIF relay trip 3
127	DIF-T4	DIF relay trip 4
128	DIF-T5	DIF relay trip 5
129	T1OC	1OC relay timer
130	1OC-1	1OC relay trip 1
131	1OC-2	1OC relay trip 2
132	1OC-3	1OC relay trip 3
133	1OC-4	1OC relay trip 4
134	1OC-5	1OC relay trip 5
135	1OCI-1	1OCI relay trip 1
136	1OCI-2	1OCI relay trip 2
137	1OCI-3	1OCI relay trip 3
138	1OCI-4	1OCI relay trip 4
139	1OCI-5	1OCI relay trip 5
140	T2OC	2OC relay timer

Signal list

No.	Signal Name	Contents
141	2OC-1	2OC relay trip 1
142	2OC-2	2OC relay trip 2
143	2OC-3	2OC relay trip 3
144	2OC-4	2OC relay trip 4
145	2OC-5	2OC relay trip 5
146	2OCI-1	2OCI relay trip 1
147	2OCI-2	2OCI relay trip 2
148	2OCI-3	2OCI relay trip 3
149	2OCI-4	2OCI relay trip 4
150	2OCI-5	2OCI relay trip 5
151	T3OC	3OC relay timer
152	3OC-1	3OC relay trip 1
153	3OC-2	3OC relay trip 2
154	3OC-3	3OC relay trip 3
155	3OC-4	3OC relay trip 4
156	3OC-5	3OC relay trip 5
157	3OCI-1	3OCI relay trip 1
158	3OCI-2	3OCI relay trip 2
159	3OCI-3	3OCI relay trip 3
160	3OCI-4	3OCI relay trip 4
161	3OCI-5	3OCI relay trip 5
162	T4OC	4OC relay timer
163	4OC-1	4OC relay trip 1
164	4OC-2	4OC relay trip 2
165	4OC-3	4OC relay trip 3
166	4OC-4	4OC relay trip 4
167	4OC-5	4OC relay trip 5
168	4OCI-1	4OCI relay trip 1
169	4OCI-2	4OCI relay trip 2
170	4OCI-3	4OCI relay trip 3
171	4OCI-4	4OCI relay trip 4
172	4OCI-5	4OCI relay trip 5
173	T1REF	1REF relay timer
174	T1EF	1EF relay timer
175	1REF-1	1REF relay trip 1
176	1REF-2	1REF relay trip 2
177	1REF-3	1REF relay trip 3
178	1REF-4	1REF relay trip 4
179	1REF-5	1REF relay trip 5
180	1EF-1	1EF relay trip 1
181	1EF-2	1EF relay trip 2
182	1EF-3	1EF relay trip 3
183	1EF-4	1EF relay trip 4
184	1EF-5	1EF relay trip 5
185	1EFI-1	1EFI relay trip 1
186	1EFI-2	1EFI relay trip 2
187	1EFI-3	1EFI relay trip 3
188	1EFI-4	1EFI relay trip 4
189	1EFI-5	1EFI relay trip 5
190	T2REF	2REF relay timer
191	T2EF	2EF relay timer
192	2REF-1	2REF relay trip 1
193	2REF-2	2REF relay trip 2
194	2REF-3	2REF relay trip 3
195	2REF-4	2REF relay trip 4
196	2REF-5	2REF relay trip 5
197	2EF-1	2EF relay trip 1
198	2EF-2	2EF relay trip 2
199	2EF-3	2EF relay trip 3
200	2EF-4	2EF relay trip 4
201	2EF-5	2EF relay trip 5
202	2EFI-1	2EFI relay trip 1
203	2EFI-2	2EFI relay trip 2
204	2EFI-3	2EFI relay trip 3
205	2EFI-4	2EFI relay trip 4
206	2EFI-5	2EFI relay trip 5
207	T3REF	3REF relay timer
208	T3EF	3EF relay timer
209	3REF-1	3REF relay trip 1
210	3REF-2	3REF relay trip 2

Signal list

No.	Signal Name	Contents
211	3REF-3	3REF relay trip 3
212	3REF-4	3REF relay trip 4
213	3REF-5	3REF relay trip 5
214	3EF-1	3EF relay trip 1
215	3EF-2	3EF relay trip 2
216	3EF-3	3EF relay trip 3
217	3EF-4	3EF relay trip 4
218	3EF-5	3EF relay trip 5
219	3EFI-1	3EFI relay trip 1
220	3EFI-2	3EFI relay trip 2
221	3EFI-3	3EFI relay trip 3
222	3EFI-4	3EFI relay trip 4
223	3EFI-5	3EFI relay trip 5
224	DIF-T	DIFT relay trip
225	1OCI	1OCI relay trip
226	2OCI	2OCI relay trip
227	3OCI	3OCI relay trip
228	4OCI	4OCI relay trip
229	V/F_TRIP	V/F trip
230	FRQ	FRQ trip
231		
232		
233		
234		
235	TV/F-H	V/F-H relay timer
236	TV/F-A	V/F-A relay timer
237	V/F-1	V/F relay trip 1
238	V/F-2	V/F relay trip 2
239	V/F-3	V/F relay trip 3
240	V/F-4	V/F relay trip 4
241	V/F-5	V/F relay trip 5
242	V/F-ALARM	V/F relay alarm
243	THR-1	THR relay trip 1
244	THR-2	THR relay trip 2
245	THR-3	THR relay trip 3
246	THR-4	THR relay trip 4
247	THR-5	THR relay trip 5
248	THR-ALARM	THR relay alarm
249	TFRQ-L	FRQ-L relay timer
250	TFRQ-H	FRQ-H relay timer
251	TFRQ-A	FRQ-A relay timer
252	FRQ-1	FRQ relay trip 1
253	FRQ-2	FRQ relay trip 2
254	FRQ-3	FRQ relay trip 3
255	FRQ-4	FRQ relay trip 4
256	FRQ-5	FRQ relay trip 5
257	FRQ-A	FRQ relay alarm
258	MEC.TRIP1-1	Mechanical trip 1
259	MEC.TRIP1-2	ditto
260	MEC.TRIP1-3	ditto
261	MEC.TRIP1-4	ditto
262	MEC.TRIP1-5	ditto
263	MEC.TRIP2-1	Mechanical trip 2
264	MEC.TRIP2-2	ditto
265	MEC.TRIP2-3	ditto
266	MEC.TRIP2-4	ditto
267	MEC.TRIP2-5	ditto
268	MEC.TRIP3-1	Mechanical trip 3
269	MEC.TRIP3-2	ditto
270	MEC.TRIP3-3	ditto
271	MEC.TRIP3-4	ditto
272	MEC.TRIP3-5	ditto
273	MEC.TRIP4-1	Mechanical trip 4
274	MEC.TRIP4-2	ditto
275	MEC.TRIP4-3	ditto
276	MEC.TRIP4-4	ditto
277	MEC.TRIP4-5	ditto
278	WIND.1_TP-1	Element for trip 1
279	WIND.2_TP-1	ditto
280	WIND.3_TP-1	ditto

Signal list

No.	Signal Name	Contents
281	WIND.4_TP-1	ditto
282	MEC.TRIP-1	ditto
283	ELEMENT_OR-1	ditto
284	TRIP-1	Trip O/P-1
285	WIND.1_TP-2	Element for trip 2
286	WIND.2_TP-2	ditto
287	WIND.3_TP-2	ditto
288	WIND.4_TP-2	ditto
289	MEC.TRIP-2	ditto
290	ELEMENT_OR-2	ditto
291	TRIP-2	Trip O/P-2
292	WIND.1_TP-3	Element for trip 3
293	WIND.2_TP-3	ditto
294	WIND.3_TP-3	ditto
295	WIND.4_TP-3	ditto
296	MEC.TRIP-3	ditto
297	ELEMENT_OR-3	ditto
298	TRIP-3	Trip O/P-3
299	WIND.1_TP-4	Element for trip 4
300	WIND.2_TP-4	ditto
301	WIND.3_TP-4	ditto
302	WIND.4_TP-4	ditto
303	MEC.TRIP-4	ditto
304	ELEMENT_OR-4	ditto
305	TRIP-4	Trip O/P-4
306	WIND.1_TP-5	Element for trip 5
307	WIND.2_TP-5	ditto
308	WIND.3_TP-5	ditto
309	WIND.4_TP-5	ditto
310	MEC.TRIP-5	ditto
311	ELEMENT_OR-5	ditto
312	TRIP-5	Trip O/P-5
313	TRIP	Trip signal shot
314	TRIP-DETOR	Trip O/P OR
315	TP1	Trip command without off-delay timer
316	TP2	Trip command without off-delay timer
317	TP3	Trip command without off-delay timer
318	TP4	Trip command without off-delay timer
319	TP5	Trip command without off-delay timer
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327		
328		
329		
330	DIFT-DIF_TP	DIFT-DIF trip signal
331	DIFT-HOC_TP	DIFT-HOC trip signal
332	1REF_TRIP	1REF trip signal
333	2REF_TRIP	2REF trip signal
334	3REF_TRIP	3REF trip signal
335	1OC_TRIP	1OC trip signal
336	2OC_TRIP	2OC trip signal
337	3OC_TRIP	3OC trip signal
338	4OC_TRIP	4OC trip signal
339	1OCI_TRIP	1OCI trip signal
340	2OCI_TRIP	2OCI trip signal
341	3OCI_TRIP	3OCI trip signal
342	4OCI_TRIP	4OCI trip signal
343	1EF_TRIP	1EF trip signal
344	2EF_TRIP	2EF trip signal
345	3EF_TRIP	3EF trip signal
346	1EFI_TRIP	1EFI trip signal
347	2EFI_TRIP	2EFI trip signal
348	3EFI_TRIP	3EFI trip signal
349	FRQ_TRIP	FRQ trip signal
350	V/F_TP	V/F trip signal

Signal list

No.	Signal Name	Contents
351	THR_TRIP	Thermal trip signal
352	DIFT_TRIP	DIFT trip signal
353	FRQ-UF_TRIP	Under-FRQ trip signal
354	FRQ-OF_TRIP	Over-FRQ trip signal
355	FRQ-UF_ALARM	Under-FRQ alarm signal
356	FRQ-OF_ALARM	Over-FRQ alarm signal
357	MEC.TRIP1	Mechanical trip 1
358	MEC.TRIP2	Mechanical trip 2
359	MEC.TRIP3	Mechanical trip 3
360	MEC.TRIP4	Mechanical trip 4
361	MEC.TRIP	Mechanical trip
362	V/F-L_TRIP	V/F low level trip signal
363	V/F-H_TRIP	V/F high level trip signal
364		
365		
366		
367		
368		
369		
370	1OC	OC relay
371	2OC	ditto
372	3OC	ditto
373	4OC	ditto
374	DIFT_HOC	Differential relay
375		
376		
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Signal list

No.	Signal Name	Contents
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		
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Signal list

No.	Signal Name	Contents
1241	IEC_MDBLK	monitor direction blocked
1242	IEC_TESTMODE	IEC60870-5-103 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	A.M.F._OFF	SV BLOCK
1254		
1255		
1256		
1257		
1258	RELAY_FAIL-A	RELAY FAILURE (only alarm)
1259		
1260		
1261	TRIP-H	Trip signal hold
1262		
1263	CT1_ERR_UF	CT error(unfiltered)
1264	CT2_ERR_UF	ditto
1265	CT3_ERR_UF	ditto
1266	CT4_ERR_UF	ditto
1267	CT1_ERR	CT failure
1268	CT2_ERR	ditto
1269	CT3_ERR	ditto
1270	CT4_ERR	ditto
1271	CT_ERR	ditto
1272		
1273		
1274		
1275		
1276		
1277		
1278		
1279	GEN_PICKUP	General start/pick-up
1280	GEN_TRIP	General trip
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	BI16_COM_UF	Binary input signal BI16 (unfiltered)
1300		
1301		
1302		
1303		
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1305		
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Signal list

No.	Signal Name	Contents
1311		
1312		
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1327		
1328	GOOSE_IN_Q1	Goose Input Quality #1
1329	GOOSE_IN_Q2	Goose Input Quality #2
1330	GOOSE_IN_Q3	Goose Input Quality #3
1331	GOOSE_IN_Q4	Goose Input Quality #4
1332	GOOSE_IN_Q5	Goose Input Quality #5
1333	GOOSE_IN_Q6	Goose Input Quality #6
1334	GOOSE_IN_Q7	Goose Input Quality #7
1335	GOOSE_IN_Q8	Goose Input Quality #8
1336	GOOSE_IN_Q9	Goose Input Quality #9
1337	GOOSE_IN_Q10	Goose Input Quality #10
1338	GOOSE_IN_Q11	Goose Input Quality #11
1339	GOOSE_IN_Q12	Goose Input Quality #12
1340	GOOSE_IN_Q13	Goose Input Quality #13
1341	GOOSE_IN_Q14	Goose Input Quality #14
1342	GOOSE_IN_Q15	Goose Input Quality #15
1343	GOOSE_IN_Q16	Goose Input Quality #16
1344	GOOSE_IN_Q17	Goose Input Quality #17
1345	GOOSE_IN_Q18	Goose Input Quality #18
1346	GOOSE_IN_Q19	Goose Input Quality #19
1347	GOOSE_IN_Q20	Goose Input Quality #20
1348	GOOSE_IN_Q21	Goose Input Quality #21
1349	GOOSE_IN_Q22	Goose Input Quality #22
1350	GOOSE_IN_Q23	Goose Input Quality #23
1351	GOOSE_IN_Q24	Goose Input Quality #24
1352	GOOSE_IN_Q25	Goose Input Quality #25
1353	GOOSE_IN_Q26	Goose Input Quality #26
1354	GOOSE_IN_Q27	Goose Input Quality #27
1355	GOOSE_IN_Q28	Goose Input Quality #28
1356	GOOSE_IN_Q29	Goose Input Quality #29
1357	GOOSE_IN_Q30	Goose Input Quality #30
1358	GOOSE_IN_Q31	Goose Input Quality #31
1359	GOOSE_IN_Q32	Goose Input Quality #32
1360	GOOSE_IN_1	Goose Input #1
1361	GOOSE_IN_2	Goose Input #2
1362	GOOSE_IN_3	Goose Input #3
1363	GOOSE_IN_4	Goose Input #4
1364	GOOSE_IN_5	Goose Input #5
1365	GOOSE_IN_6	Goose Input #6
1366	GOOSE_IN_7	Goose Input #7
1367	GOOSE_IN_8	Goose Input #8
1368	GOOSE_IN_9	Goose Input #9
1369	GOOSE_IN_10	Goose Input #10
1370	GOOSE_IN_11	Goose Input #11
1371	GOOSE_IN_12	Goose Input #12
1372	GOOSE_IN_13	Goose Input #13
1373	GOOSE_IN_14	Goose Input #14
1374	GOOSE_IN_15	Goose Input #15
1375	GOOSE_IN_16	Goose Input #16
1376	GOOSE_IN_17	Goose Input #17
1377	GOOSE_IN_18	Goose Input #18
1378	GOOSE_IN_19	Goose Input #19
1379	GOOSE_IN_20	Goose Input #20
1380	GOOSE_IN_21	Goose Input #21

Signal list

No.	Signal Name	Contents
1381	GOOSE_IN_22	Goose Input #22
1382	GOOSE_IN_23	Goose Input #23
1383	GOOSE_IN_24	Goose Input #24
1384	GOOSE_IN_25	Goose Input #25
1385	GOOSE_IN_26	Goose Input #26
1386	GOOSE_IN_27	Goose Input #27
1387	GOOSE_IN_28	Goose Input #28
1388	GOOSE_IN_29	Goose Input #29
1389	GOOSE_IN_30	Goose Input #30
1390	GOOSE_IN_31	Goose Input #31
1391	GOOSE_IN_32	Goose Input #32
1392		
1393		
1394		
1395		
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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		
1409	LED_RESET	TRIP LED RESET
1410		
1411		
1412		
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		
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1432		
1433		
1434	F.Record_DONE	fault record sotred
1435	F.Record_CLR	Fault record clear
1436	E.Record_CLR	Event record clear
1437	D.Record_CLR	Disturbance record clear
1438	Data_Lost	Data clear by BU-RAM memory monitoring error
1439		
1440		
1441		
1442		
1443		
1444		
1445	PLC_data_CHG	PLC data change
1446	IEC103_data_CHG	IEC-103 data change
1447	IEC850_data_CHG	IEC-850 data change
1448	Sys.set_change	System setting change
1449	Rly.set_change	Relay setting change
1450	Grp.set_change	Group setting change

Signal list

No.	Signal Name	Contents
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	DC_supply_err	DC supply error
1466	RTC_err	RTC stopped
1467	PCI_err	PCI bus error
1468	GOOSE_stop	GOOSE stopped
1469	Ping_err	Ping no anwer
1470	PLC_err	PLC stopeed
1471	61850_err	61850 stopped
1472	SUM_err	Program ROM checksum error
1473	ROM_RAM_err	Rom - Ram mismatch error
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	CPU_err	Program error
1481	Invalid	Invalid error
1482	NMI	NMI
1483	Sampling_err	Sampling error
1484	DIO_err	DIO card connection error
1485	LAN_err	LAN error
1486	LCD_err	LCD panel connection error
1487	ROM_data_err	8M Romdata error
1488		
1489		
1490		
1491		
1492		
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Signal list

No.	Signal Name	Contents
1536	EXT_MEC.TP1	External mechanical trip commnad 1
1537	EXT_MEC.TP2	External mechanical trip commnad 2
1538	EXT_MEC.TP3	External mechanical trip commnad 3
1539	EXT_MEC.TP4	External mechanical trip commnad 4
1540	IND.RESET	Indication reset command
1541		
1542		
1543		
1544		
1545		
1546		
1547		
1548		
1549		
1550		
1551		
1552	EVENT1	External event command 1
1553	EVENT2	External event command 2
1554	EVENT3	External event command 3
1555		
1556		
1557		
1558		
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1560		
1561		
1562		
1563		
1564		
1565		
1566		
1567		
1568	PROT_BLOCK	Protection block command
1569	DIF_BLOCK	DIF trip block command
1570	1REF_BLOCK	1REF trip block command
1571	1OC_BLOCK	1OC trip block command
1572	1OCI_BLOCK	1OCI trip block command
1573	1EF_BLOCK	1EF trip block command
1574	1EFI_BLOCK	1EFI trip block command
1575	2REF_BLOCK	2REF trip block command
1576	2OC_BLOCK	2OC trip block command
1577	2OCI_BLOCK	2OCI trip block command
1578	2EF_BLOCK	2EF trip block command
1579	2EFI_BLOCK	2EFI trip block command
1580	3REF_BLOCK	3REF trip block command
1581	3OC_BLOCK	3OC trip block command
1582	3OCI_BLOCK	3OCI trip block command
1583	3EF_BLOCK	3EF trip block command
1584	3EFI_BLOCK	3EFI trip block command
1585	4OC_BLOCK	4OC trip block command
1586	4OCI_BLOCK	4OCI trip block command
1587	FRQ_BLOCK	FRQ trip block command
1588	FRQ-A_BLOCK	FRQ-A trip block command
1589	V/F_BLOCK	V/F trip block command
1590	V/F-A_BLOCK	V/F-A trip block command
1591	THR_BLOCK	THR trip block command
1592	THR-A_BLOCK	THR-A trip block command
1593	MEC.TP1_BLOCK	MEC.TP1 trip block command
1594	MEC.TP2_BLOCK	MEC.TP2 trip block command
1595	MEC.TP3_BLOCK	MEC.TP3 trip block command
1596	MEC.TP4_BLOCK	MEC.TP4 trip block command
1597		
1598		
1599		
1600	TP1_DELAY	Trip command off-delay timer setting
1601	TP2_DELAY	Trip command off-delay timer setting
1602	TP3_DELAY	Trip command off-delay timer setting
1603	TP4_DELAY	Trip command off-delay timer setting
1604	TP5_DELAY	Trip command off-delay timer setting
1605		

Signal list

No.	Signal Name	Contents
1606		
1607		
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1610		
1611		
1612		
1613		
1614		
1615		
1616	DIF-A_BLOCK	DIF-A trip blocking command
1617	DIF-B_BLOCK	DIF-B trip blocking command
1618	DIF-C_BLOCK	DIF-C trip blocking command
1619		
1620		
1621		
1622		
1623		
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Signal list

No.	Signal Name	Contents
1791		
1792	IO#1-TP1	Binary output signal of TP1
1793	IO#1-TP2	Binary output signal of TP2
1794	IO#1-TP3	Binary output signal of TP3
1795	IO#1-TP4	Binary output signal of TP4
1796	IO#1-TP5	Binary output signal of TP5
1797		
1798		
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1800		
1801		
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Signal list

No.	Signal Name	Contents
2621		
2622		
2623		
2624	F.RECORD1	Fault record stored command 1
2625	F.RECORD2	Fault record stored command 2
2626	F.RECORD3	Fault record stored command 3
2627	F.RECORD4	Fault record stored command 4
2628		
2629		
2630		
2631		
2632	D.RECORD1	Disturbance record stored command 1
2633	D.RECORD2	Disturbance record stored command 2
2634	D.RECORD3	Disturbance record stored command 3
2635	D.RECORD4	Disturbance record stored command 4
2636		
2637		
2638		
2639		
2640	SET.GROUP1	Active setting group changed commamd (Change to group1)
2641	SET.GROUP2	Active setting group changed commamd (Change to group2)
2642	SET.GROUP3	Active setting group changed commamd (Change to group3)
2643	SET.GROUP4	Active setting group changed commamd (Change to group4)
2644	SET.GROUP5	Active setting group changed commamd (Change to group5)
2645	SET.GROUP6	Active setting group changed commamd (Change to group6)
2646	SET.GROUP7	Active setting group changed commamd (Change to group7)
2647	SET.GROUP8	Active setting group changed commamd (Change to group8)
2648		
2649		
2650		
2651		
2652		
2653		
2654		
2655		
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		
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2681		
2682		
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2684		
2685		
2686	PROT_COM_RECV	Protection inactivate command received
2687		
2688	TPLED_RST_RCV	TRIP LED RESET command received
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2810		

Signal list

No.	Signal Name	Contents
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	

Signal list

No.	Signal Name	Contents
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	

Signal list

No.	Signal Name	Contents
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	

Signal list

No.	Signal Name	Contents
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	

Appendix C

Variable Timer List

Variable Timer List

Timer	Timer No.	Contents
T1OC	1	1OC TRIP TIMER
T2OC	2	2OC TRIP TIMER
T3OC	3	3OC TRIP TIMER
(T4OC)	4	(4OC TRIP TIMER)
T1REF	5	1REF TRIP TIMER
T1EF	6	1EF TRIP TIMER
T2REF	7	2REF TRIP TIMER
T2EF	8	2EF TRIP TIMER
T3REF	9	3REF TRIP TIMER
T3EF	10	3EF TRIP TIMER
TVFH	11	V/F-H TRIP TIMER
TVFA	12	V/F-A ALARM TIMER
TFRQL	13	FRQ-L TRIP TIMER
TFRQH	14	FRQ-H TRIP TIMER
TFRQA	15	FRQ-A ALARM TIMER

Appendix D

Binary Output Default Setting List

Binary Output Default Setting List

Relay Model	Module Name	BO No.	Signal Name	Contents	Setting		
					Signal No.	Logic (OR: 1, AND: 2)	Timer (OFF: 0, ON: 1)
GRT100 -101	IO2	BO1	TRIP-1	TRIP First	284	1	1
		BO2	TRIP-2	TRIP Second	291	1	1
		BO3	DIFT	DIFT relay operating	224	1	1
		BO4	1OC, 1OCI	1OC or 1OCI relay operating	129, 225	1	1
		BO5	2OC, 2OCI	2OC or 2OCI relay operating	140, 226	1	1
		BO6	1REF, 1EF, 1EFI	1REF, 1EF or 1EFI relay operating	173, 174, 73	1	1
		BO7	2REF, 2EF, 2EFI	2REF, 2EF or 2EFI relay operating	190, 191, 76	1	1
		BO8	FRQ	FRQ relay operating	230	1	1
		BO9	V/F	V/F-L, H relay operating	229	1	1
		BO10	V/F-A	V/F-A relay operating	242	1	1
		BO11	THR	THR-L, H relay operating	83	1	1
		BO12	THR-A	THR-A relay operating	248	1	1
		BO13	EXT_MEC.TP1, 2, 3, 4	External mechanical relay trip	1536, 1537, 1538, 1539	1	1
GRT100 -102	IO2	BO1	TRIP-1	TRIP First	284	1	1
		BO2	TRIP-2	TRIP Second	291	1	1
		BO3	DIFT	DIFT relay operating	224	1	1
		BO4	1OC, 1OCI	1OC or 1OCI relay operating	129, 225	1	1
		BO5	2OC, 2OCI	2OC or 2OCI relay operating	140, 226	1	1
		BO6	1REF	1REF relay operating	173	1	1
		BO7	2REF	2REF relay operating	190	1	1
		BO8	1EF, 1EFI	1EF or 1EFI relay operating	174, 73	1	1
		BO9	2EF, 2EFI	2EF or 2EFI relay operating	191, 76	1	1
		BO10	FRQ	FRQ relay operating	230	1	1
		BO11	V/F-T	V/F-T relay operating	81	1	1
		BO12	V/F-H	V/F-H relay operating	235	1	1
		BO13	V/F-A	V/F-A relay operating	242	1	1
	IO3	BO1	THR	THR-L, H relay operating	83	1	1
		BO2	THR-A	THR-A relay operating	248	1	1
		BO3	TRIP-1	TRIP First	284	1	1
		BO4	TRIP-2	TRIP Second	291	1	1
		BO5	TRIP-1	TRIP First	284	1	1
		BO6	TRIP-2	TRIP Second	291	1	1
		BO7	EXT_MEC. TP1	External mechanical relay trip 1	1536	1	1
		BO8	EXT_MEC. TP2	External mechanical relay trip 2	1537	1	1
		BO9	EXT_MEC. TP3	External mechanical relay trip 3	1538	1	1
		BO10	EXT_MEC. TP4	External mechanical relay trip 4	1539	1	1

Relay Model	Module Name	BO No.	Signal Name	Contents	Setting		
					Signal No.	Logic (OR: 1, AND: 2)	Timer (OFF: 0, ON: 1)
GRT100 -201	IO2	BO1	TRIP-1	TRIP First	284	1	1
		BO2	TRIP-2	TRIP Second	291	1	1
		BO3	TRIP-3	TRIP Third	298	1	1
		BO4	DIFT	DIFT relay operating	224	1	1
		BO5	1OC, 1OCI, 1REF, 1EF, 1EFI	1OC, 1OCI, 1REF, 1EF or 1EFI relay operating	129, 225, 173, 174, 73	1	1
		BO6	2OC, 2OCI, 2REF, 2EF, 2EFI	2OC, 2OCI, 2REF, 2EF or 2EFI relay operating	140, 226, 190, 191, 76	1	1
		BO7	3OC, 3OCI, 3REF, 3EF, 3EFI	3OC, 3OCI, 3REF, 3EF or 3EFI relay operating	151, 227, 207, 208, 79	1	1
		BO8	FRQ	FRQ relay operating	230	1	1
		BO9	V/F	V/F-L, H relay operating	229	1	1
		BO10	V/F-A	V/F-A relay operating	242	1	1
		BO11	THR	THR-L, H relay operating	83	1	1
		BO12	THR-A	THR-A relay operating	248	1	1
		BO13	EXT_MEC. TP1, 2, 3, 4	External mechanical relay trip	1536, 1537, 1538, 1539	1	1
GRT100 -202	IO2	BO1	TRIP-1	TRIP First	284	1	1
		BO2	TRIP-2	TRIP Second	291	1	1
		BO3	TRIP-3	TRIP Third	298	1	1
		BO4	DIFT	DIFT relay operating	224	1	1
		BO5	1OC, 1OCI	1OC or 1OCI relay operating	129, 225	1	1
		BO6	2OC, 2OCI	2OC or 2OCI relay operating	140, 226	1	1
		BO7	3OC, 3OCI	3OC or 3OCI relay operating	151, 227	1	1
		BO8	1REF	1REF relay operating	173	1	1
		BO9	2REF	2REF relay operating	190	1	1
		BO10	3REF	3REF relay operating	207	1	1
		BO11	1EF, 1EFI	1EF or 1EFI relay operating	174, 73	1	1
		BO12	2EF, 2EFI	2EF or 2EFI relay operating	191, 76	1	1
		BO13	3EF, 2EFI	3EF or 3EFI relay operating	208, 79	1	1
	IO3	BO1	FRQ	FRQ relay operating	230	1	1
		BO2	V/F-T	V/F-T relay operating	81	1	1
		BO3	V/F-H	V/F-H relay operating	235	1	1
		BO4	V/F-A	V/F-A relay operating	242	1	1
		BO5	THR	THR-L, H relay operating	83	1	1
		BO6	THR-A	THR-A relay operating	248	1	1
		BO7	EXT_MEC. TP1	External mechanical relay trip 1	1536	1	1
		BO8	EXT_MEC. TP2	External mechanical relay trip 2	1537	1	1
		BO9	EXT_MEC. TP3	External mechanical relay trip 3	1538	1	1
		BO10	EXT_MEC. TP4	External mechanical relay trip 4	1539	1	1

Relay Model	Module Name	BO No.	Signal Name	Contents	Setting		
					Signal No.	Logic (OR: 1, AND: 2)	Timer (OFF: 0, ON: 1)
GRT100 -203	IO2	BO1	TRIP-1	TRIP First	284	1	1
		BO2	TRIP-2	TRIP Second	291	1	1
		BO3	TRIP-3	TRIP Third	298	1	1
		BO4	DIFT	DIFT relay operating	224	1	1
		BO5	1OC, 1OCI, 1REF, 1EF, 1EFI	1OC, 1OCI, 1REF, 1EF or 1EFI relay operating	129, 225, 173, 174, 73	1	1
		BO6	2OC, 2OCI, 2REF, 2EF, 2EFI	2OC, 2OCI, 2REF, 2EF or 2EFI relay operating	140, 226, 190, 191, 76	1	1
		BO7	3OC, 3OCI, 3REF, 3EF, 3EFI	3OC, 3OCI, 3REF, 3EF or 3EFI relay operating	151, 227, 207, 208, 79	1	1
		BO8	FRQ	FRQ relay operating	230	1	1
		BO9	V/F	V/F-L, H relay operating	229	1	1
		BO10	V/F-A	V/F-A relay operating	242	1	1
		BO11	THR	THR-L, H relay operating	83	1	1
		BO12	THR-A	THR-A relay operating	248	1	1
		BO13	EXT_MEC. TP1, 2, 3, 4	External mechanical relay trip	1536, 1537, 1538, 1539	1	1
GRT100 -204	IO2	BO1	TRIP-1	TRIP First	284	1	1
		BO2	TRIP-2	TRIP Second	291	1	1
		BO3	TRIP-3	TRIP Third	298	1	1
		BO4	DIFT	DIFT relay operating	224	1	1
		BO5	1OC, 1OCI	1OC or 1OCI relay operating	129, 225	1	1
		BO6	2OC, 2OCI	2OC or 2OCI relay operating	140, 226	1	1
		BO7	3OC, 3OCI	3OC or 3OCI relay operating	151, 227	1	1
		BO8	1REF	1REF relay operating	173	1	1
		BO9	2REF	2REF relay operating	190	1	1
		BO10	3REF	3REF relay operating	207	1	1
		BO11	1EF, 1EFI	1EF or 1EFI relay operating	174, 73	1	1
		BO12	2EF, 2EFI	2EF or 2EFI relay operating	191, 76	1	1
		BO13	3EF, 2EFI	3EF or 3EFI relay operating	208, 79	1	1
	IO3	BO1	FRQ	FRQ relay operating	230	1	1
		BO2	V/F-T	V/F-T relay operating	81	1	1
		BO3	V/F-H	V/F-H relay operating	235	1	1
		BO4	V/F-A	V/F-A relay operating	242	1	1
		BO5	THR	THR-L, H relay operating	83	1	1
		BO6	THR-A	THR-A relay operating	248	1	1
		BO7	EXT_MEC. TP1	External mechanical relay trip 1	1536	1	1
		BO8	EXT_MEC. TP2	External mechanical relay trip 2	1537	1	1
		BO9	EXT_MEC. TP3	External mechanical relay trip 3	1538	1	1
		BO10	EXT_MEC. TP4	External mechanical relay trip 4	1539	1	1

Appendix E

Details of Relay Menu and LCD & Button Operation

```
   MENU
1=Record           2=Status
3=Setting(view)    4=Setting(change)
5=Test
```

```
/1 Record
1=Fault record       2=Event record
3=Disturbance record
```

```
/2 Fault record
1=Display        2=Clear
```

```
/3 Fault record                   2/8
#1  16/Oct/1998 23:18:03.913
#2  12/Feb/1998 03:51:37.622
#3  30/Jan/1997 15:06:11.835
```

```
/4 Fault record #2                3/33
16/Oct/1998 23:18:03.913
Phase  BC        Trip   ABC
DIFT
```

```
/2 Fault record
Clear all fault records?
      ENTER=Yes    CANCEL=No
```

```
/2 Event record
1=Display        2=Clear
```

```
/3 Event record                  2/48
16/Oct/1998 23:18:04.294 Trip      Off
16/Oct/1998 23:18:03.913 Trip       On
12/Feb/1998 03:51:37.622 Rly.set change
```

```
/2 Event record
Clear all event records?
      ENTER=Yes    CANCEL=No
```

```
/2 Disturbance record
1=Display        2=Clear
```

```
/3 Disturbance record            1/ 11
#1  16/Oct/1998 23:18:03.913
#2  12/Feb/1998 03:51:37.622
#3  30/Jan/1997 15:06:11.835
```

```
/2 Disturbance record
Clear all disturbance records?
      ENTER=Yes    CANCEL=No
```

```
/1 Status
1=Metering           2=Binary I/O
3=Relay element      4=Time sync source
5=Clock adjustment
```

```
/2 Metering    12/Feb/1998  22:56  3/13
Ia1 ***.*kA ***.*  Ia2  **.**kA  ***.*
Ib1 ***.*kA ***.*  Ib2  **.**kA  ***.*
Ic1 ***.*kA ***.*  Ic2  **.**kA  ***.*
```

```
/2 Binary input & output          3/ 5
Input (IO#1)      [000 000 000 000 000]
Input (IO#2)      [000                ]
Output(IO#1-trip)[000 00              ]
```

```
/2 Relay element                  3/ 9
DIFT             [000 000 000 000    ]
REF              [000                ]
OC               [000 000 000 00     ]
```

```
/2 Time synchronization source    3/ 4
*IRIG: Active
 RSM: Inactive
 IEC: Inactive
```

```
/2  12/Feb/1998  22:56:19 [local]  1/5
Minute (  0 -  59) :  56  _
Hour   (  0 -  23) :  22
Day    (  1 -  31) :  12
```

a-1

a-1

```
/1 Setting(view)
1=Version  2=Description 3=Comm.
4=Record   5=Status      6=Protection
7=Binary input  8=Binary output  9=LED
```

```
/2 Relay version                  3/ 8
Relay type:     ********************
Serial No.:     ********************
Main software:  ********************
```

```
/2 Description
Plant name:     ********************
Description:    ********************
```

```
/2 Communication
1=Address/Parameter
2=Switch
```

```
/3 Address/Parameter           3/***
HDLC (     1    )  IEC  (     1    )
SYADJ(     0 ms )  IP1-1(     0    )
IP1-2(     0    )  IP1-3(     0    )
```

```
/3 Switch                      3/***
PRTCL1   1=HDLC 2=1EC103           2
232C     1=9.6 2=19.2 3=38.4 4=57.6 4
IECBR    1=9.6 2=19.2              2
```

```
/2 Record
1=Fault record       2= Event record
2=Disturbance record
```

```
/3 Fault record                  1/1
Phase mode    1=Operating 2=Fault  1
```

```
/3 Event record
1=Signal no.
2=Event name
```

```
/4 Signal no.                   3/65
BITRN(   128    )   EV1  ( 3071    )
EV2  (     0    )   EV3  (    1    )
EV4  (     1    )   EV5  (    2    )
```

```
/4 Event name                  3/128
Event name1   [Event record name1 ]
Event name2   [                   ]
Event name3   [                   ]
```

```
/3 Disturbance record
1=Record time & starter
2=Scheme switch
3=Binary signal    4=Signal name
```

```
/4 Record time & starter        3/ 4
Time (   3.0 s    )  1OCPS(  0.10 pu )
2OCPS(  0.10 pu   )  3OCPS(  0.10 pu )
1OCPG(  0.10 pu   )  2OCPG(  0.10 pu )
```

```
/4 Scheme switch                1/16
TRIP1            0=Off   1=On    0
TRIP2            0=Off   1=On    0
TRIP3            0=Off   1=On    0
```

```
/4 Binary signal                3/16
SIG1 (   128    )   SIG2 ( 3071    )
SIG3 (     0    )   SIG4 (    1    )
SIG5 (     1    )   SIG6 (    2    )
```

```
/4 Signal name                  3/32
Signal name1   [Signal name1       ]
Signal name2   [                   ]
Signal name3   [                   ]
```

```
/2 Status
1=Metering
2=Time Synchronization
3=Time zone
```

```
/3 Metering                     1/ 1
Display value 1=Primary 2=Secondary 1
```

```
/3 Time synchronization
0=Off 1=IRIG 2=RSM 3=IEC 4=SNTP

  Current No.= 2
```

```
/3 Time zone                    1/ 1
GMT  (    * * hrs ) GMTm (    * * min )
```

a-1, b-1

a-1 b-1

```
/2 Protection        (Active group= *)
1=Group1  2=Group2  3=Group3  4=Group4
5=Group5  6=Group6  7=Group7  8=Group8
```

```
/3 Protection               (Group 1)
1=Transformer parameter
2=Trip
```

```
/4 Transformer parameter     (Group 1)
1= VT & CT ratio
```

```
/5 VT & CT ratio                  3/ 4
1CT  (   2000     )   2CT  (  1500   )
3CT  (   1500     )   1nCT (  1000   )
2nCT (    500     )   3nCT (  2000   )
```

```
/4 Trip                      (Group 1)
1=Phase matching
2=Scheme switch
3=Protection element
```

```
/5 Phase matching
1=Alpha  2=Beta

    Current No.=2        Select No. = _
```

```
/5 Scheme switch                  3/***
DIFTPMD 1=3POR 2=1P                   1
1REF     1=1IO  2=2IO  3=3IO          1
2REF     1=1IO  2=2IO  3=3IO          1
```

```
/5 Protection element        (Group 1)
1=DIFT       2=REF        3=OC
4=THR        5=V/F        6=FRQ
```

```
/6 DIFT                           3/ 7
ik   (  0.10 pu )  p1   (    10 %  )
p2   (    50 %  )  kp   (  1.00 pu )
kct1 (  0.50    )  kct2 (  0.50    )
```

```
/6 REF                            3/11
1ik  (  0.50 pu )  1kct1(  1.00    )
1kct2(  1.00    )  1kct3(  1.00    )
1p2  (    10 %  )  1kp  (  1.00pu  )
```

```
/6 OC                             3/12
1OC  (  0.10 pu )  2OC  (  0.10 pu )
3OC  (  0.10 pu )  T1OC ( 10.00 s  )
T2OC ( 10.00 s  )  T3OC ( 10.00 s  )
```

```
/6 THR                            3/ 3
τ    (   0.5 min)  k    (  0.10    )
IB   (  1.00 pu )  lp   (  0.10 pu )
TA   (     0 min)
```

```
/6 V/F                            3/ 5
V    ( 100.0 V  )  A    (  1.10 pu )
L    (  1.20 pu )  H    (  1.30 pu )
LT   (     1 s  )  HT   (     3 s  )
```

```
/6 FRQ                            3/ 3
81-1 ( 45.00 Hz )  81-2 ( 55.00 Hz )
UV   (    40 V  )  TFRQL(  1.00 s  )
TFRQH(  1.00 s  )  TFRQA(  1.00 s  )
```

```
/3 Protection               (Group 2)
1=Transformer parameter
2=Trip
```

```
/3 Protection               (Group 8)
1=Transformer parameter
2=Trip
```

```
/2 Binary input                   3/16
BISW 1  1=Norm  2=Inv              1
BISW 2  1=Norm  2=Inv              1
BISW 3  1=Norm  2=Inv              1
```

```
/2 Binary output
1=IO#2    2=IO#3
```

```
/3 Binary output          (IO#2) 3/13
BO1 (  1, 100,   0,   0,   0,   0)AND,
BO2 (  0,   0,   0,   0,   0,   0) OR,
BO3 (  1,   2,   3,   4,   5,   6) OR,
```

```
/3 Binary output          (IO#3) 3/10
BO1 (  1, 100,   0,   0,   0,   0)AND,
BO2 (  0,   0,   0,   0,   0,   0) OR,
BO3 (  1,   2,   3,   4,   5,   6) OR,
```

```
/2 LED                            3/ 4
LED1   (    1,  309,    0,    0) AND,I
LED2   (    0,    0,    0,    0)  OR,I
LED3   (   15,   16,   17,    0)  OR,L
```

a-1

a-1

: Password trap

```
Password
        Input password  [_  ]
```

: Confirmation trap

```
/2 *************
Change settings?
         ENTER=Yes  CANCEL=No
```

```
/1 Setting(change)
1=Password 2=Description  3=Comm.
4=Record   5=Status       6=Protection
7=Binary input  8=Binary output  9=LED
```

```
/2 Password
   Input new password    [ _ ]
  Retype new password    [   ]
```

```
/2 Description
1=Plant name  2=Description
```

```
/3 Plant name  [ _                  ]
ABCDEFGHIJKLMNOPQRSTUVWXYZ()[]@_← →
abcdefghijklmnopqrstuvwxyz{}*/+-<=>← →
0123456789!”#$%&’:;,.^         ← →
```

```
/3 Description  [ _                 ]
ABCDEFGHIJKLMNOPQRSTUVWXYZ()[]@_← →
abcdefghijklmnopqrstuvwxyz{}*/+-<=>← →
0123456789!”#$%&’:;,.^         ← →
```

```
/2 Communication
1=Address/Parameter
2=Switch
```

```
/3 Address/Parameter            1/***
HDLC (     1-    32):      1 _
IEC  (     0-   254):      2
SYADJ( -9999-  9999):      0   ms
```

```
/3 Switch                       1/***
PRTCL1  1=HDLC 2=1EC103            2 _
232C    1=9.6 2=19.2 3=38.4 4=57.6 4
IECBR   1=9.6 2=19.2               2
```

```
/2 Record
1=Fault record       2=Event record
2=Disturbance record
```

```
/3 Fault record                   1/1
Phase mode   1=Operating  2=Fault  1 _
```

```
/3 Event record                 1/129
BITRN(     0-   128):    128 _
EV1  (     0-  3071):      0
EV2  (     0-  3071):      1
```

```
/3 Disturbance record
1=Record time & starter
2=Scheme switch
3=Binary signal
```

```
/4 Record time & starter        1/ 7
Time (   0.1-   3.0):     2.0 _   s
1OCPS(  0.10- 20.00):    0.10     pu
2OCPS(  0.10- 20.00):    0.10     pu
```

```
/4 Scheme switch                1/16
TRIP1            0=Off   1=On    1 _
TRIP2            0=Off   1=On    1
TRIP3            0=Off   1=On    1
```

```
/4 Binary signal                1/32
SIG1 (     0-  3071):      1 _
SIG2 (     0-  3071):      2
SIG3 (     0-  3071):      3
```

```
/2 Status
1=Metering
2=Time Synchronization
3=Time zone
```

```
/3 Metering                      1/ 1
Display value 1=Primary 2=Secondary 1_
```

```
/3 Time synchronization
0=Off 1=IRIG 2=RSM 3=IEC 4=SNTP

  Current No.=0          Select No. = _
```

```
/3 Time zone                     1/ 2
GMT  (   -12-   +12):     +9  _   hrs
GMTm (   -59-   +59):     +0      min
```

a-1   b-2

a-1 b-2

```
/2 Protection
1=Change active group
2=Change setting
3=Copy group
```

```
/3Change active group(Active group= *)
1=Group1  2=Group2  3=Group3  4=Group4
5=Group5  6=Group6  7=Group7  8=Group8
  Current No.= *        Select No.= _
```

```
/3 Change setting (Active group= *)
1=Group1  2=Group2  3=Group3  4=Group4
5=Group5  6=Group6  7=Group7  8=Group8
```

```
/4 Protection               (Group 1)
1=Transformer parameter
2=Trip
```

```
/5 Transformer parameter     (Group 1)
1=VT & CT ratio
```

```
/6 VT & CT ratio                  1/ 7
1CT  (     1- 20000):    2000  _
2CT  (     1- 20000):    1000
3CT  (     1- 20000):     400
```

```
/5 Trip                      (Group 1)
1=Phase matching
2=Scheme switch
3=Protection element
```

```
/6 Phase matching
1=Alpha  2=Beta

    Current No.=2        Select No. = _
```

```
/6 Scheme switch                  1/***
DIFTPMD 1=3POR 2=1P                1 _
1REF    1=1IO  2=2IO  3=3IO        1
2REF    1=1IO  2=2IO  3=3IO        1
```

```
/6 Protection element       (Group= 1)
1=DIFT      2=REF       3=OC
4=THR       5=V/F       6=FRQ
```

```
/7 DIFT                           1/13
ik  (   0.10-  1.00):  0.10 _    pu
p1  (     10-   100):    10       %
p2  (     10-   200):   100       %
```

```
/7 REF                            1/21
1ik  (   0.05-  0.50):  0.05 _   pu
1kct1(   1.00- 50.00):  1.00
1kct2(   1.00- 50.00):  1.00
```

```
/7 OC                             1/24
1OC  (  0.10- 20.00):    0.10 _   pu
2OC  (  0.10- 20.00):    0.10     pu
3OC  (  0.10- 20.00):    0.10     pu
```

```
/7 THR                            1/ 5
τ    (    0.5- 500.0):    0.5  _   min
k    (   0.10-  4.00):   0.10
IB   (   0.50-  2.50):   0.50       pu
```

```
/7 V/F                            1/ 9
V    (  100.0- 120.0):  100.0_    V
A    (   1.03-  1.30):   1.10     pu
L    (   1.05-  1.30):   1.20     pu
```

```
/7 FRQ                            1/ 6
81-1  ( 45.00- 55.00):  45.00_    Hz
81-2  ( 45.00- 55.00):  45.00     Hz
UV    (    40-   100):     40     V
```

```
/4 Protection               (Group 2)
1=Transformer parameter
2=Trip
```

```
/4 Protection               (Group 8)
1=Transformer parameters
2=Trip
```

```
/3 Copy groupA to B  (Active group= 1)
A    (    1-    8):           _
B    (    1-    8):
```

a-1 b-2 c-1

a-1 b-2

```
/2 Binary input                        1/16
BISW 1  1=Norm  2=Inv                  1 _
BISW 2  1=Norm  2=Inv                  1
BISW 3  1=Norm  2=Inv                  1
```

```
/2 Binary output
1=IO#2    2=IO#3
```

```
/3 Binary output               (IO#2)
Select BO        (  1- 13)

                  Select No.= _
```

```
/4 Setting               (BO 1 of IO#2)
1=Logic gate type & delay timer
2=Input to logic gate
```

```
/5 Logic gate type & delay timer  1/ 2
Logic   1=OR  2=AND               1 _
BOTD    0=Off  1=On               1
```

```
/4 Setting               (BO 12 of IO#2)
1=Logic gate type & delay timer
2=Input to logic gate
```

```
/5 Input to logic gate          3/ 6
In #1 (     0 -   3071):     21  _
In #2 (     0 -   3071):      4
In #3 (     0 -   3071):     67
```

```
/3 Binary output               (IO#3)
Select BO          (  1- 10)

                     Select No.= _
```

```
/2 LED
Select LED          (  1-  4)

                     Select No.= _
```

```
/3 Setting              (LED*)
1=Logic gate type & reset
2=Input to logic gate
```

```
/4 Logic gate type & reset       1/ 2
Logic    1=OR 2=AND               1 _
Reset    0=Inst 1=Latch           1
```

```
/1 Test
1=Switch          2=Binary output
3=Timer           4=Logic circuit
```

```
/2 Switch                          1/ 3
A.M.F.   0=Off   1=On              1 _
Reset    0=Off   1=On              0
IECTST   0=Off   1=On              0
```

```
/4 Input to logic gate           1/ 4
In #1(      0-  3071):     21 _
In #2(      0-  3071):      4
In #3(      0-  3071):     67
```

```
/2 Binary output
1=IO#1  2=IO#2  3=IO#3
```

```
/3 BO       (0=Disable 1=Enable)  1/ 5
IO#1 TP-1:                         1 _
IO#1 TP-2:                         1
IO#1 TP-3:                         1
```

```
/3 BO
Keep pressing 1 to operate.

Press CANCEL to cancel.
```

```
/3 BO       (0=Disable 1=Enable)  1/ 10
IO#3  BO1:                         1 _
IO#3  BO2:                         1
IO#3  BO3:                         1
```

```
/2 Timer                          1/ 1
Timer(     1 -    100):      1 _
```

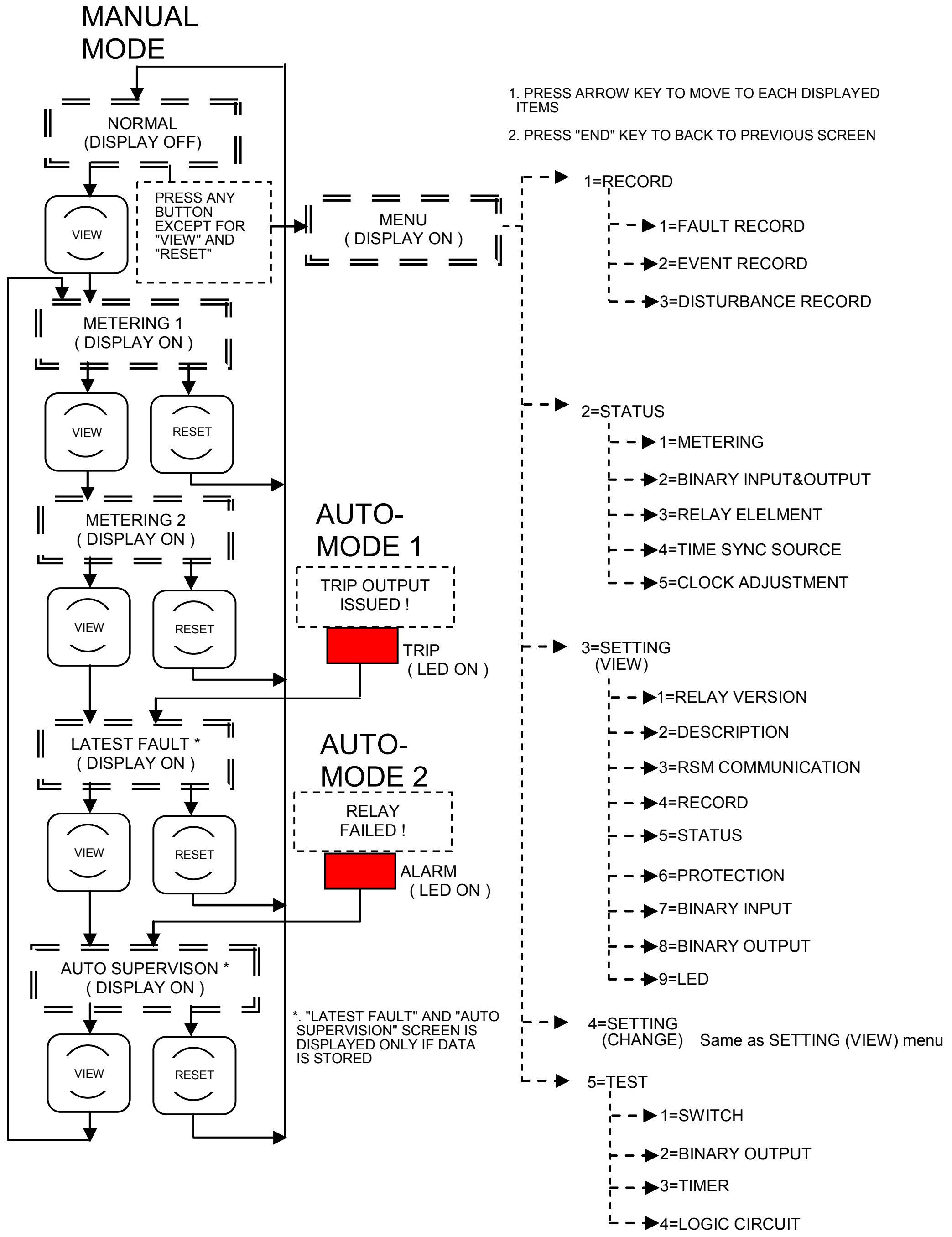
```
/2 Timer
Press ENTER to operate.

Press CANCEL to cancel.
```

```
/2 Timer
Operating . . .
Press END to reset.
Press CANCEL to cancel.
```

```
/2 Logic circuit                   1/ 2
TermA(     0 -   3071):       1  _
TermB(     0 -   3071):      48
```

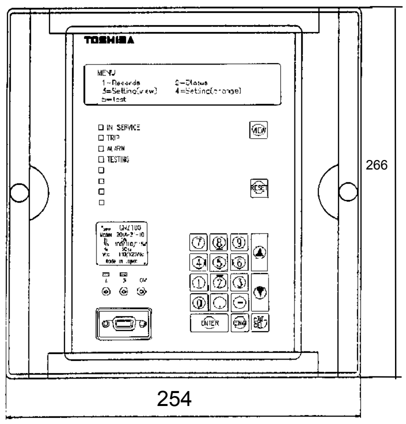
LCD AND BUTTON OPERATION INSTRUCTION



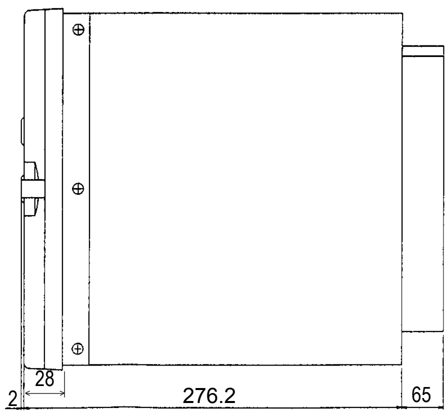
Appendix F

Case Outline

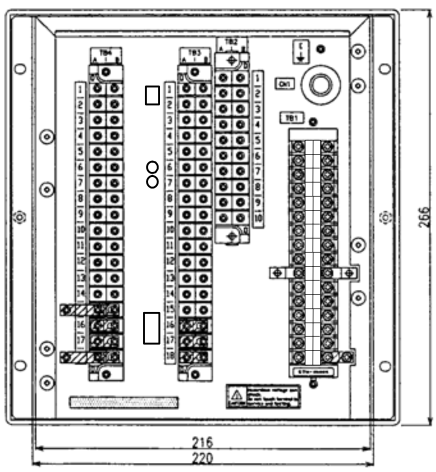
- Flush Mount Type
- Rack Mount Type



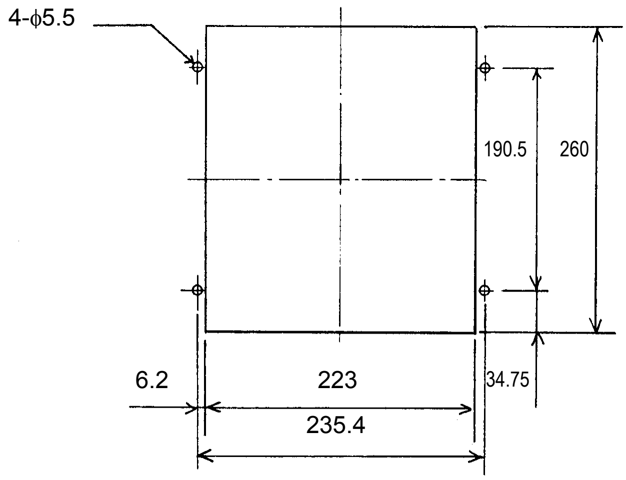
Front View



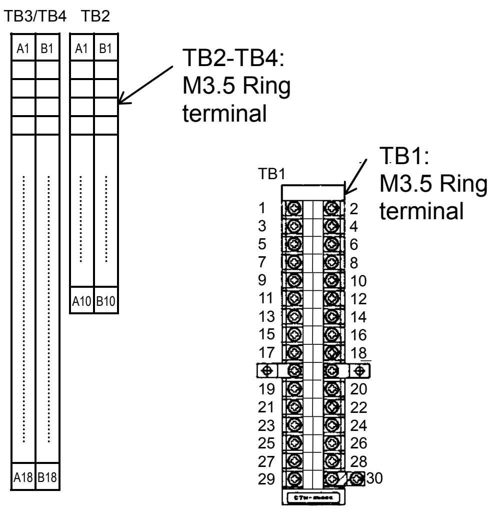
Side view



Rear view

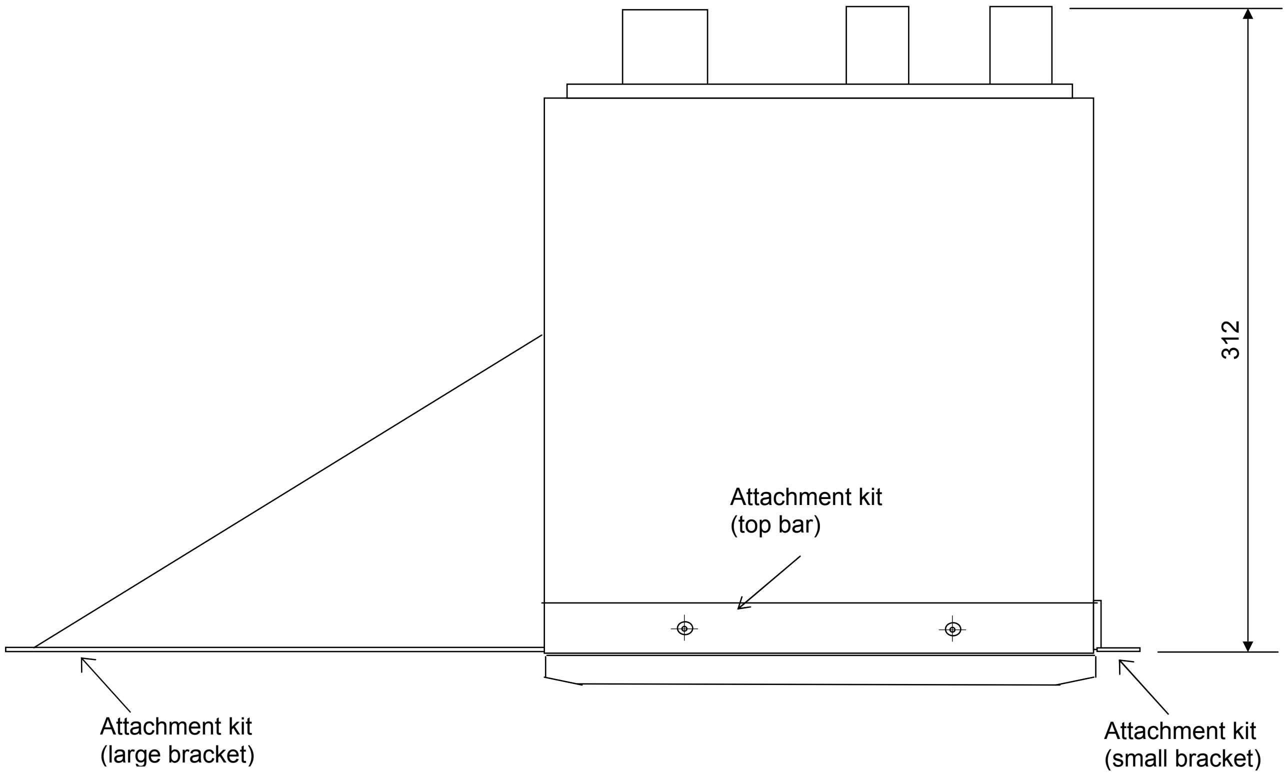


Panel cut-out

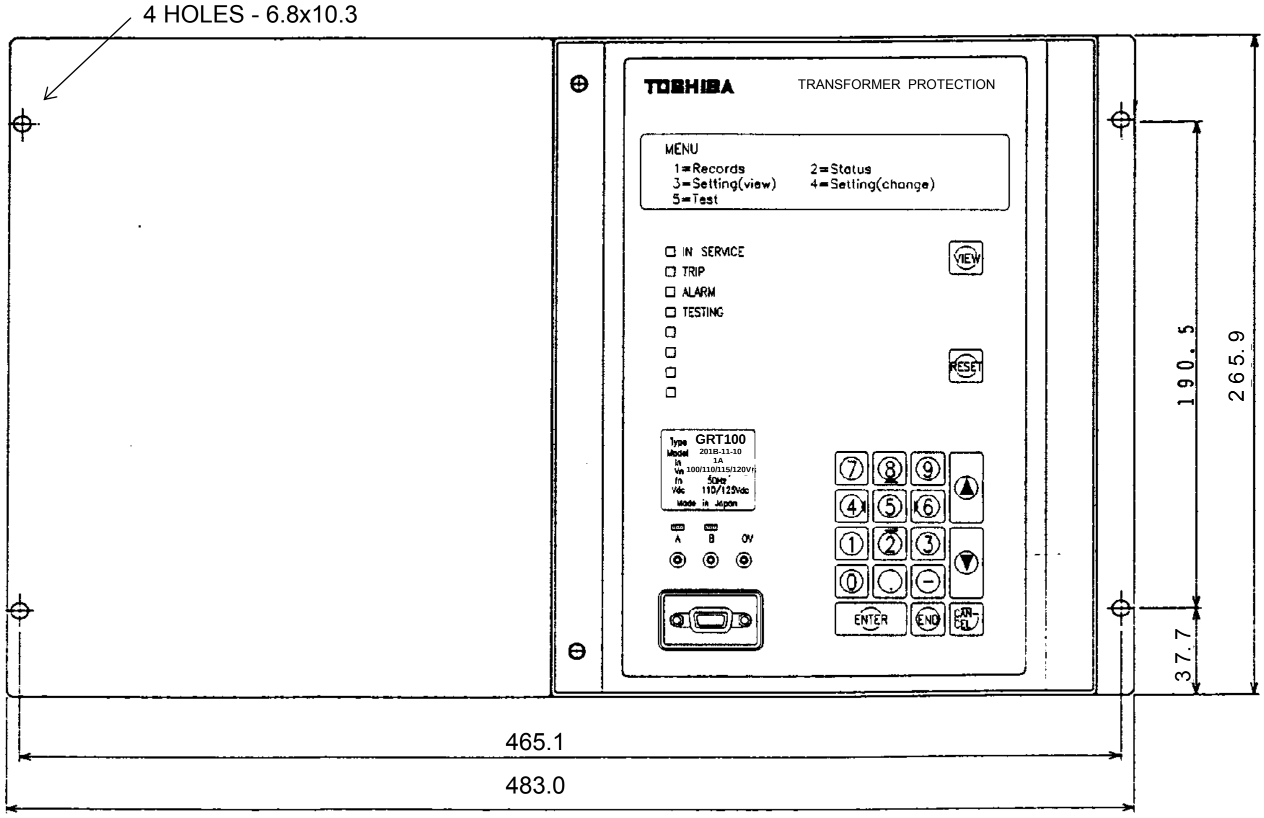


Terminal block

Case Outline : Flush Mount Type

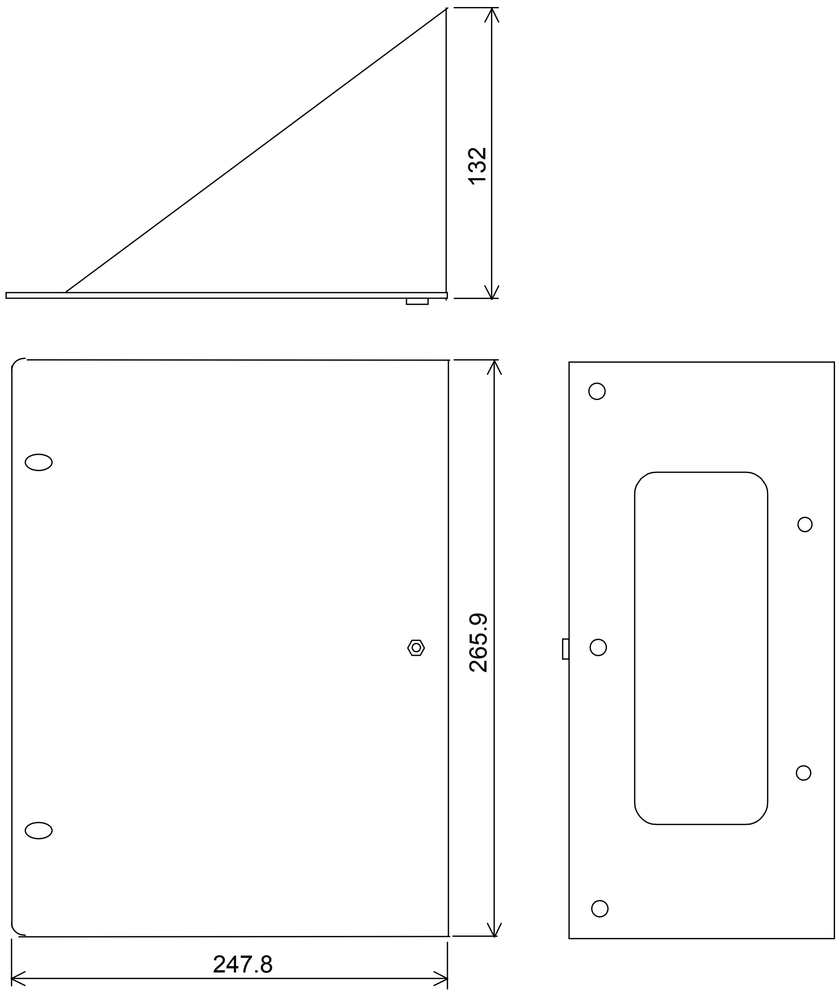


Top View

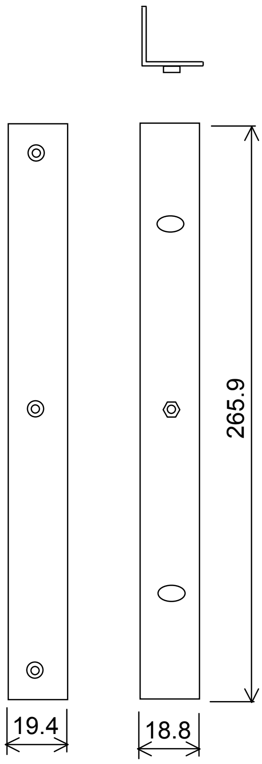


Front View

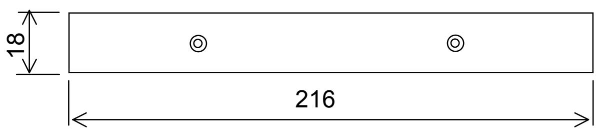
Case Outline: Rack Mount Type



(a) Large Bracket



(b) Small Bracket



(c) Bar for Top and Bottom of Relay

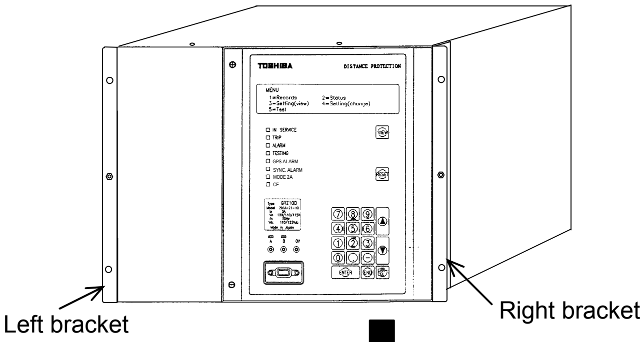
	Parts
(a)	1 Large bracket, 5 Round head screws with spring washers and washers (M4x10)
(b)	1 Small bracket, 3 Countersunk head screws (M4x6)
(c)	2 Bars, 4 Countersunk head screws (M3x8)

Dimensions of Attachment Kit EP-101

How to Mount Attachment Kit for Rack-Mounting

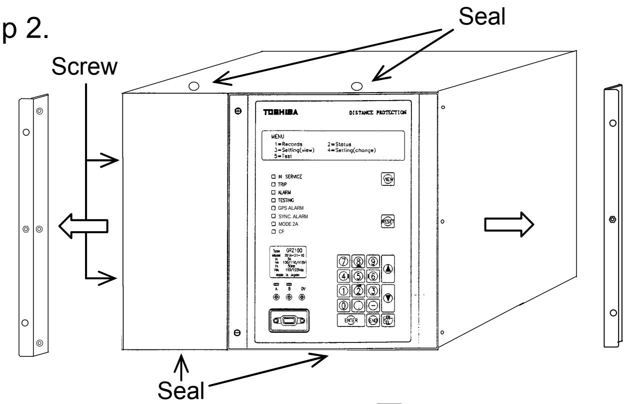
Caution: Be careful that the relay modules or terminal blocks, etc., are not damage while mounting.
Tighten screws to the specified torque according to the size of screw.

Step 1.



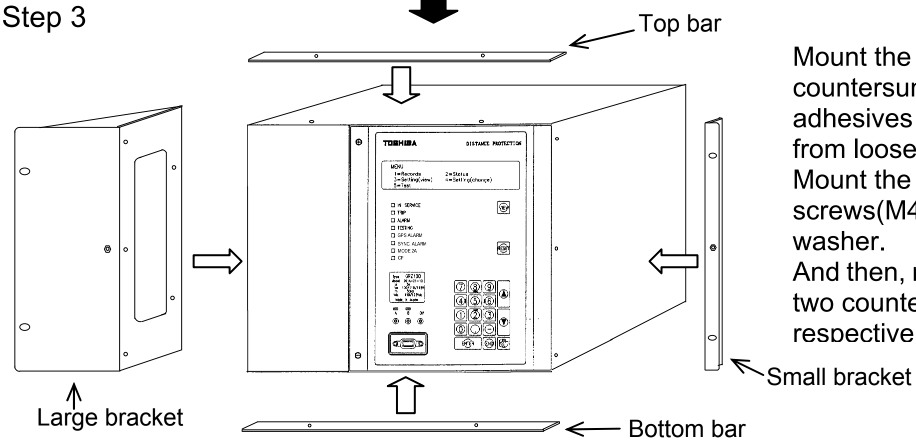
Remove case cover.

Step 2.



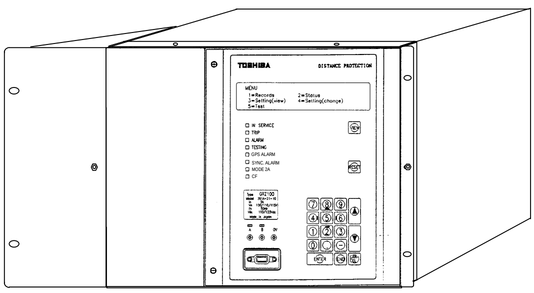
Remove the left and right brackets by unscrewing the three screws respectively, then remove two screws on left side of the relay.
And then, remove four seals on the top and bottom of the relay.

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 two countersunk head screws(M3x8) respectively.

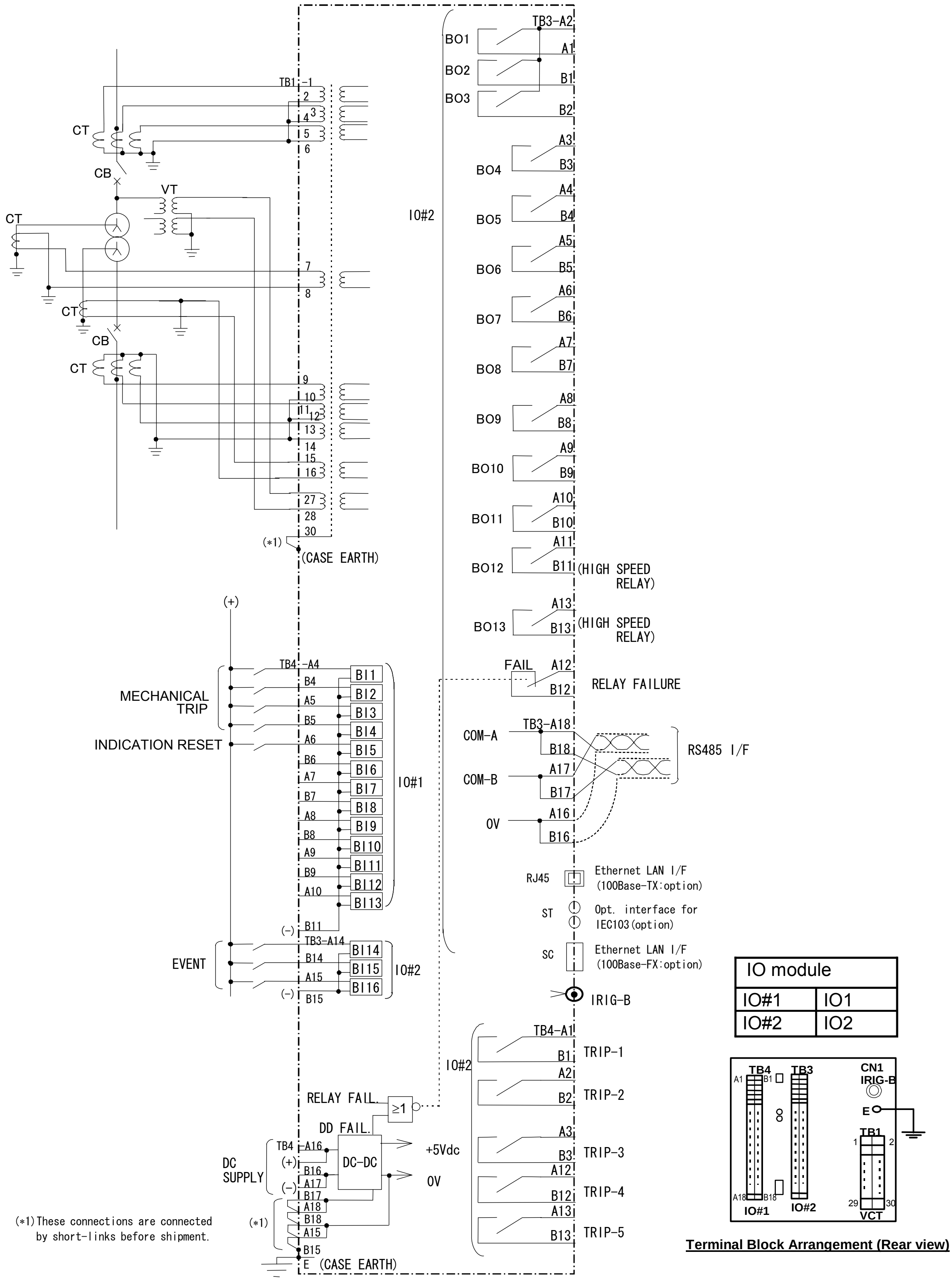
Step 4



Completed.

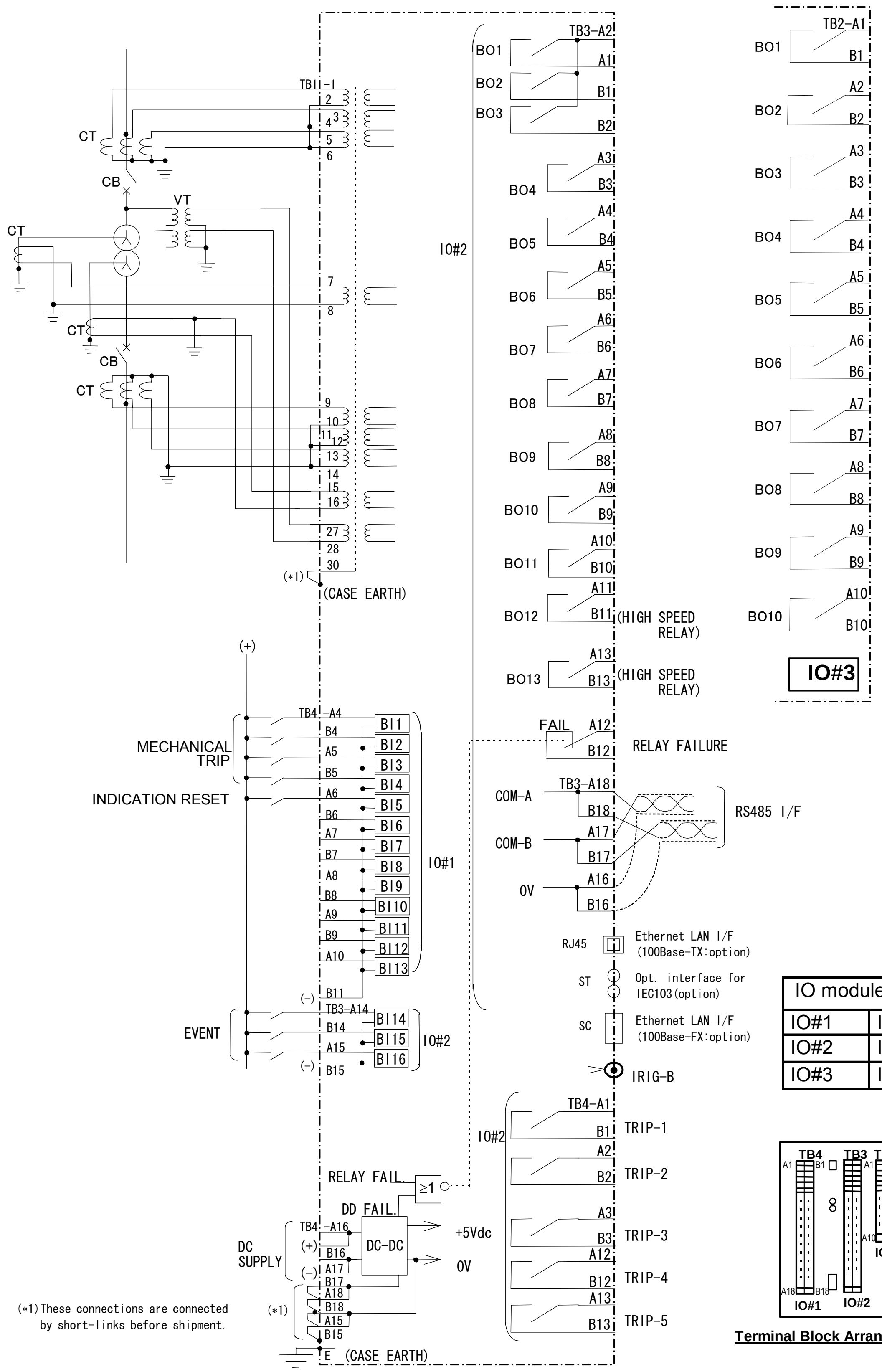
Appendix G

External Connections



IO module	
IO#1	IO1
IO#2	IO2

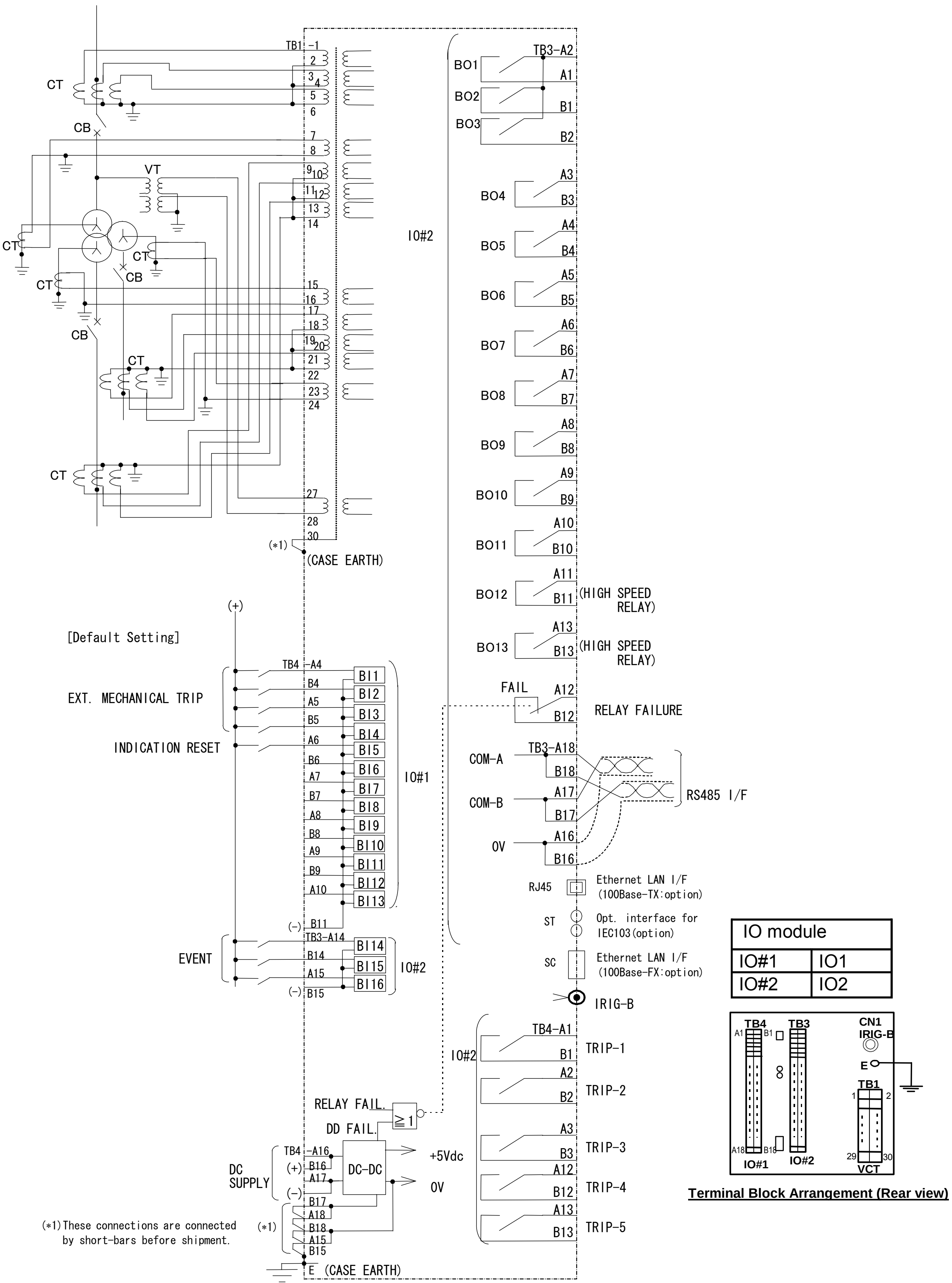
Typical External Connection of Model 101D



IO module	
IO#1	IO1
IO#2	IO2
IO#3	IO3

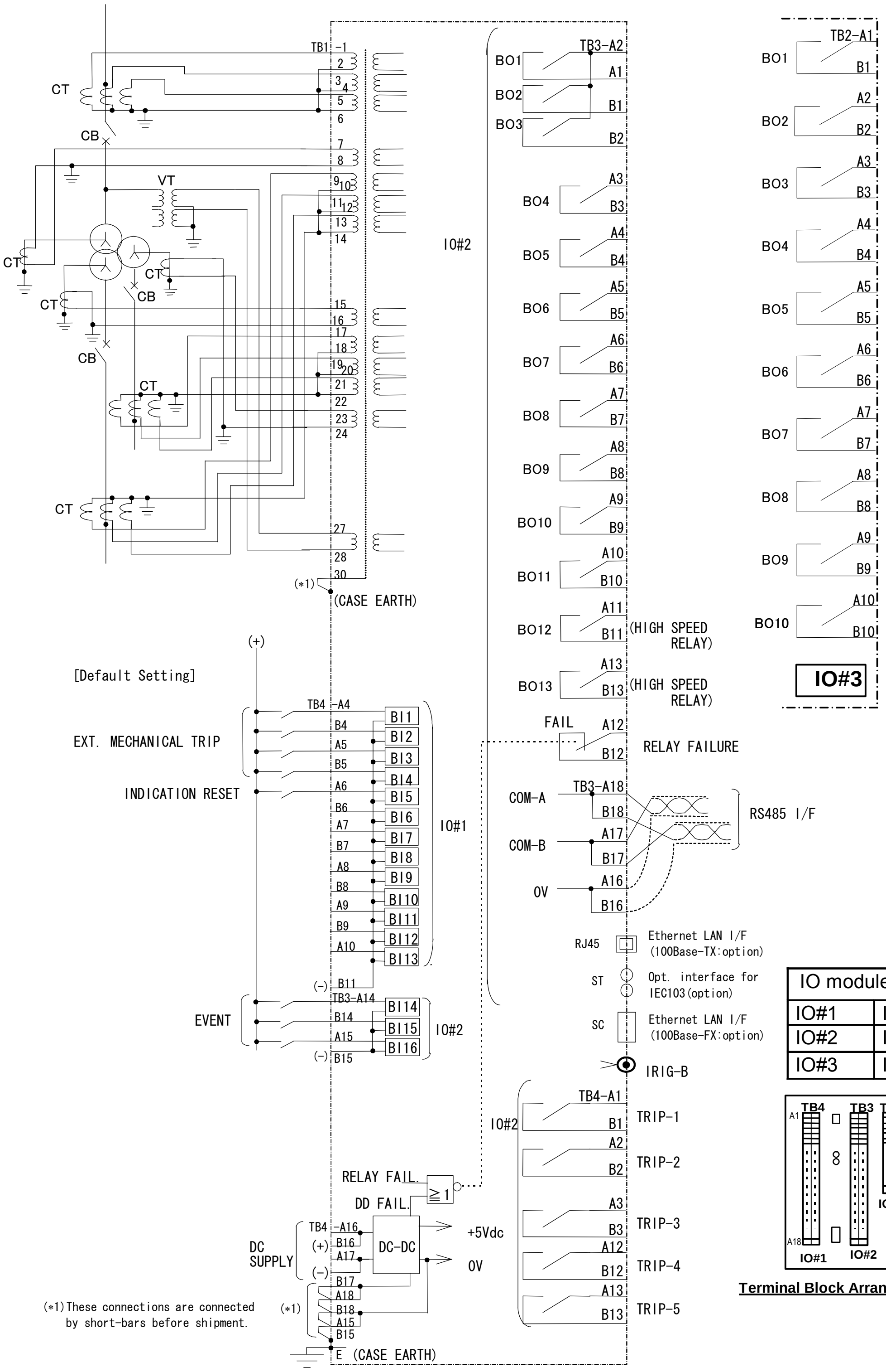
Terminal Block Arrangement (Rear view)

Typical External Connection of Model 102D

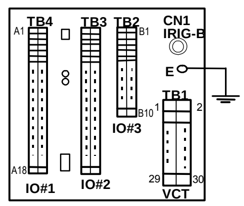


IO module	
IO#1	IO1
IO#2	IO2

Typical External Connection of Model 201D

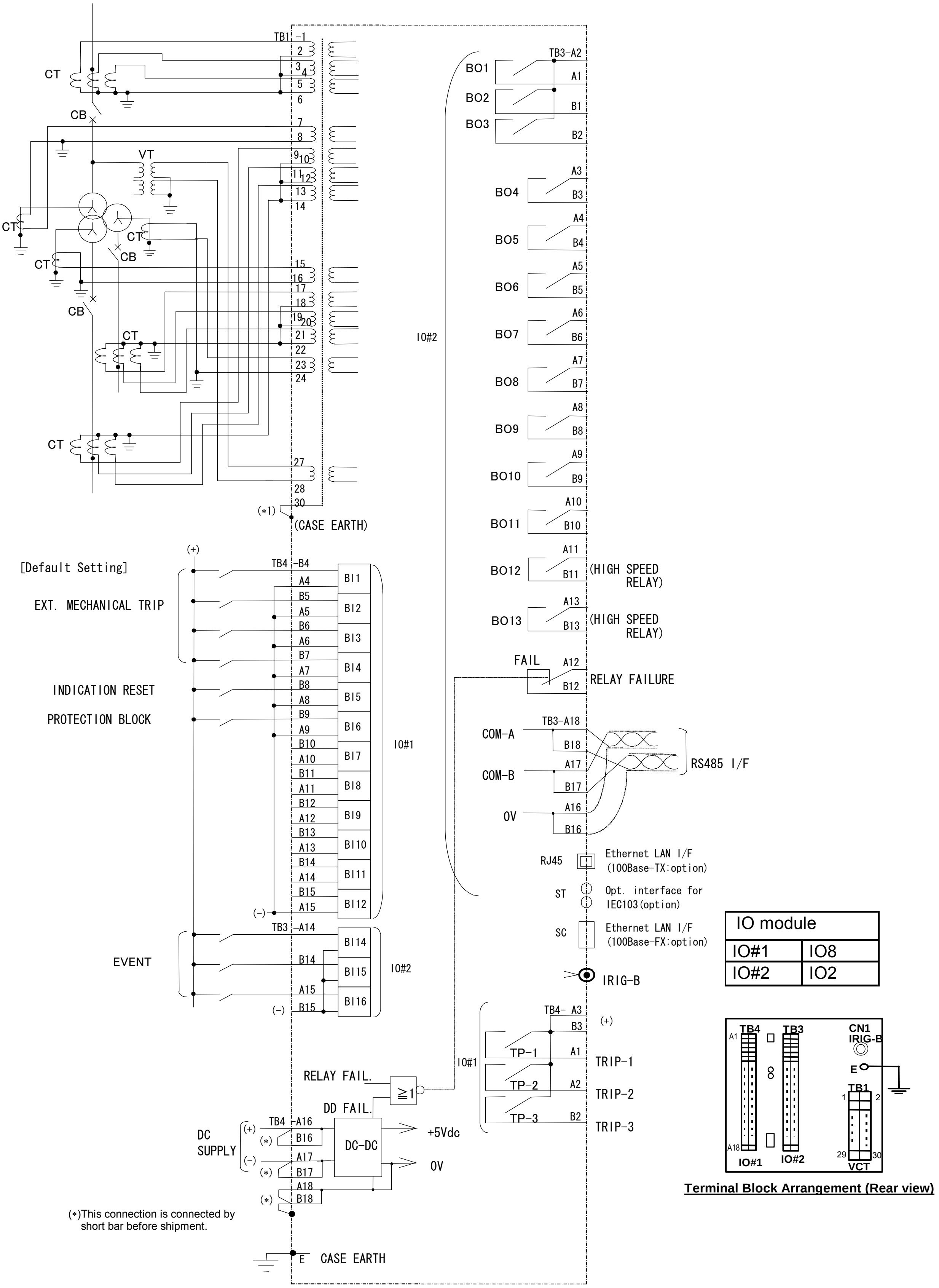


IO module	
IO#1	IO1
IO#2	IO2
IO#3	IO3



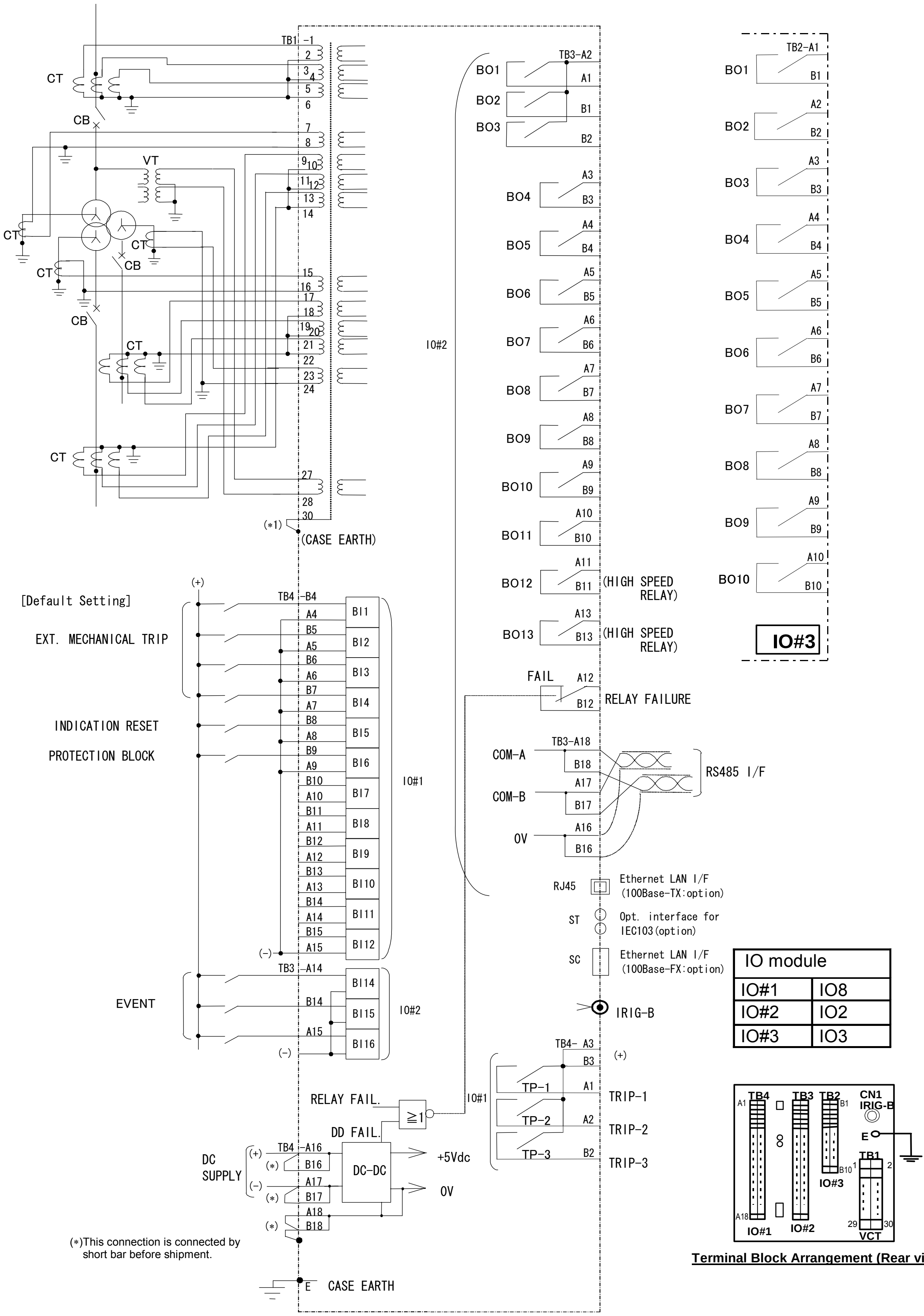
Terminal Block Arrangement (Rear view)

Typical External Connection of Model 202D



IO module	
IO#1	IO8
IO#2	IO2

Typical External Connection of Model 203D



IO module	
IO#1	IO8
IO#2	IO2
IO#3	IO3

Terminal Block Arrangement (Rear view)

Typical External Connection of Model 204D

Appendix H

Relay Setting Sheet

1. Relay Identification
2. Contacts Setting
3. Relay and Protection Scheme Setting Sheet

Relay Setting Sheets

1. Relay Identification

Date:

Relay type ____________________ Serial Number ____________________

Frequency ____________________ CT rating ____________________

VT rating ____________________ dc supply voltage ____________________

Password ____________________

Active setting group ____________________

2. 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 ____________________

3. Relay and Protection Scheme Setting Sheet

№	Name	Range 5A rating	Range 1A rating	Units	Contents	Default Setting of Relay Series(5A rating / 1A rating) World wide 2-Winding 101D	102D	World wide 3-Winding 201D	202D	ENA 3-Winding 203D	204D	User setting
1	Active group	1 - 8		–	Active setting group	1				1		
2	1CT	1 - 20000		–	CT ratio	2000				2000		
3	2CT	1 - 20000		–	ditto	2000				2000		
4	3CT	1 - 20000		–	ditto	--		2000		2000		
5	1nCT	1 - 20000		–	ditto	2000				2000		
6	2nCT	1 - 20000		–	ditto	400				400		
7	3nCT	1 - 20000		–	ditto	--		400		400		
8	VT	1 - 20000		–	VT ratio	400				400		
9	Phase matching	Alpha - Beta		–	Phase angle matching	Beta				Beta		
10	DIFTPMD	3POR - 2PAND - 1P		–	DIF trip mode	3POR				3POR		
		3POR - 1P				3POR				3POR		
11	1REF	1I0 - 2I0		–	Transformer type for REF	1I0		--		--		
		1I0 - 2I0 - 3I0				--		1I0		1I0		
12	2REF	1I0 - 2I0		–	ditto	1I0		--		--		
		1I0 - 2I0 - 3I0				--		1I0		1I0		
13	3REF	1I0 - 2I0 - 3I0		–	ditto	--		1I0		1I0		
14	REF_DEF	Off - On		–	Directional checking function of REF	Off				Off		
15	M1OCI	Long - Std - Very - Ext		–	OCI back-up trip	Std				Std		
16	M2OCI	Long - Std - Very - Ext		–	ditto	Std				Std		
17	M3OCI	Long - Std - Very - Ext		–	ditto	--		Std		Std		
18	M1EFI	Long - Std - Very - Ext		–	EFI back-up trip	Std				Std		
19	M2EFI	Long - Std - Very - Ext		–	ditto	Std				Std		
20	M3EFI	Long - Std - Very - Ext		–	ditto	--		Std		Std		
21	L/O	Off - On		–	Trip signal lock out	Off				Off		
22	2F-LOCK	Off - On		–	2F restraint	On				On		
23	5F-LOCK	Off - On		–	5F restraint	On				On		
24	DIF1	Off - On		–	Current differential trip	On				On		
25	DIF2	Off - On		–	ditto	On				On		
26	DIF3	Off - On		–	ditto	Off		On		On		
27	DIF4	Off - On		–	ditto	Off				--		
28	DIF5	Off - On		–	ditto	Off				--		
29	1REF1	Off - On		–	Restricted earth fault trip	On				On		
30	1REF2	Off - On		–	ditto	On				On		
31	1REF3	Off - On		–	ditto	On				On		
32	1REF4	Off - On		–	ditto	Off				--		
33	1REF5	Off - On		–	ditto	Off				--		
34	1OC1	Off - On		–	OC trip	On				On		
35	1OC2	Off - On		–	ditto	Off				Off		
36	1OC3	Off - On		–	ditto	Off				Off		
37	1OC4	Off - On		–	ditto	Off				--		
38	1OC5	Off - On		–	ditto	Off				--		
39	1OCI1	Off - On		–	OCI trip	On				On		
40	1OCI2	Off - On		–	ditto	Off				Off		
41	1OCI3	Off - On		–	ditto	Off				Off		
42	1OCI4	Off - On		–	ditto	Off				--		
43	1OCI5	Off - On		–	ditto	Off				--		
44	1EF1	Off - On		–	EF trip	On				On		
45	1EF2	Off - On		–	ditto	Off				Off		
46	1EF3	Off - On		–	ditto	Off				Off		
47	1EF4	Off - On		–	ditto	Off				--		
48	1EF5	Off - On		–	ditto	Off				--		
49	1EFI1	Off - On		–	EFI trip	On				On		
50	1EFI2	Off - On		–	ditto	Off				Off		
51	1EFI3	Off - On		–	ditto	Off				Off		
52	1EFI4	Off - On		–	ditto	Off				--		
53	1EFI5	Off - On		–	ditto	Off				--		
54	2REF1	Off - On		–	Restricted earth fault trip	On				On		
55	2REF2	Off - On		–	ditto	On				On		
56	2REF3	Off - On		–	ditto	On				On		
57	2REF4	Off - On		–	ditto	Off				--		
58	2REF5	Off - On		–	ditto	Off				--		
59	2OC1	Off - On		–	OC trip	Off				Off		
60	2OC2	Off - On		–	ditto	On				On		
61	2OC3	Off - On		–	ditto	Off				Off		
62	2OC4	Off - On		–	ditto	Off				--		
63	2OC5	Off - On		–	ditto	Off				--		
64	2OCI1	Off - On		–	OCI trip	Off				Off		
65	2OCI2	Off - On		–	ditto	On				On		
66	2OCI3	Off - On		–	ditto	Off				Off		
67	2OCI4	Off - On		–	ditto	Off				--		
68	2OCI5	Off - On		–	ditto	Off				--		
69	2EF1	Off - On		–	EF trip	Off				Off		
70	2EF2	Off - On		–	ditto	On				On		
71	2EF3	Off - On		–	ditto	Off				Off		
72	2EF4	Off - On		–	ditto	Off				--		
73	2EF5	Off - On		–	ditto	Off				--		

№	Name	Range		Units	Contents	Default Setting of Relay Series(5A rating / 1A rating)						User setting
						World wide				ENA		
						2-Winding		3-Winding		3-Winding		
		5A rating	1A rating			101D	102D	201D	202D	203D	204D	
74	2EFI1	Off - On		–	EFI trip	Off				Off		
75	2EFI2	Off - On		–	ditto	On				On		
76	2EFI3	Off - On		–	ditto	Off				Off		
77	2EFI4	Off - On		–	ditto	Off				--		
78	2EFI5	Off - On		–	ditto	Off				--		
79	3REF1	Off - On		–	Restricted earth fault trip	--		On		On		
80	3REF2	Off - On		–	ditto	--		On		On		
81	3REF3	Off - On		–	ditto	--		On		On		
82	3REF4	Off - On		–	ditto	--		Off		--		
83	3REF5	Off - On		–	ditto	--		Off		--		
84	3OC1	Off - On		–	OC trip	--		Off		Off		
85	3OC2	Off - On		–	ditto	--		Off		Off		
86	3OC3	Off - On		–	ditto	--		On		On		
87	3OC4	Off - On		–	ditto	--		Off		--		
88	3OC5	Off - On		–	ditto	--		Off		--		
89	3OCI1	Off - On		–	OCI trip	--		Off		Off		
90	3OCI2	Off - On		–	ditto	--		Off		Off		
91	3OCI3	Off - On		–	ditto	--		On		On		
92	3OCI4	Off - On		–	ditto	--		Off		--		
93	3OCI5	Off - On		–	ditto	--		Off		--		
94	3EF1	Off - On		–	EF trip	--		Off		Off		
95	3EF2	Off - On		–	ditto	--		Off		Off		
96	3EF3	Off - On		–	ditto	--		On		On		
97	3EF4	Off - On		–	ditto	--		Off		--		
98	3EF5	Off - On		–	ditto	--		Off		--		
99	3EFI1	Off - On		–	EFI trip	--		Off		Off		
100	3EFI2	Off - On		–	ditto	--		Off		Off		
101	3EFI3	Off - On		–	ditto	--		On		On		
102	3EFI4	Off - On		–	ditto	--		Off		--		
103	3EFI5	Off - On		–	ditto	--		Off		--		
104	FRQ-UF1	Off - On		–	FRQ trip	On				On		
105	FRQ-UF2	Off - On		–	ditto	On				On		
106	FRQ1	Off - On		–	ditto	On				On		
107	FRQ2	Off - On		–	ditto	On				On		
108	FRQ3	Off - On		–	ditto	Off		On		On		
109	FRQ4	Off - On		–	ditto	Off				--		
110	FRQ5	Off - On		–	ditto	Off				--		
111	FRQA	Off - On		–	ditto	On				On		
112	V/F1	Off - On		–	V/F trip	On				On		
113	V/F2	Off - On		–	ditto	On				On		
114	V/F3	Off - On		–	ditto	Off		On		On		
115	V/F4	Off - On		–	ditto	Off				--		
116	V/F5	Off - On		–	ditto	Off				--		
117	V/FA	Off - On		–	ditto	On				On		
118	THR1	Off - On		–	THR trip	On				On		
119	THR2	Off - On		–	ditto	On				On		
120	THR3	Off - On		–	ditto	Off		On		On		
121	THR4	Off - On		–	ditto	Off				--		
122	THR5	Off - On		–	ditto	Off				--		
123	THRA	Off - On		–	ditto	On				On		
124	M.T1-1	Off - On		–	Mechanical trip1	On				On		
125	M.T1-2	Off - On		–	ditto	On				On		
126	M.T1-3	Off - On		–	ditto	Off		On		On		
127	M.T1-4	Off - On		–	ditto	Off				--		
128	M.T1-5	Off - On		–	ditto	Off				--		
129	M.T2-1	Off - On		–	Mechanical trip2	On				On		
130	M.T2-2	Off - On		–	ditto	On				On		
131	M.T2-3	Off - On		–	ditto	Off		On		On		
132	M.T2-4	Off - On		–	ditto	Off				--		
133	M.T2-5	Off - On		–	ditto	Off				--		
134	M.T3-1	Off - On		–	Mechanical trip3	On				On		
135	M.T3-2	Off - On		–	ditto	On				On		
136	M.T3-3	Off - On		–	ditto	Off		On		On		
137	M.T3-4	Off - On		–	ditto	Off				--		
138	M.T3-5	Off - On		–	ditto	Off				--		
139	M.T4-1	Off - On		–	Mechanical trip4	On				On		
140	M.T4-2	Off - On		–	ditto	On				On		
141	M.T4-3	Off - On		–	ditto	Off		On		On		
142	M.T4-4	Off - On		–	ditto	Off				--		
143	M.T4-5	Off - On		–	ditto	Off				--		
144	SVCNT	ALM&BLK - ALM		–	Supervisor control	ALM&BLK				ALM&BLK		
145	CTSEN	Off - On		–	DIF output blocked by CT saturation	Off				Off		

№	Name		Range		Units	Contents	Default Setting of Relay Series(5A rating / 1A rating)						User setting
							World wide				ENA		
							2-Winding		3-Winding		3-Winding		
			5A rating	1A rating			101D	102D	201D	202D	203D	204D	
146	DIFT	ik	0.10 - 1.00		pu	Minimum operating current	0.30				0.30		
147		p1	10 - 100		%	% slope of small current region	100				100		
148		p2	10 - 200		%	% slope of large current region	200				200		
149		kp	1.00 - 20.00		pu	Break point of DIF characteristic	1.00				1.00		
150		kct1	0.05 - 50.00		—	CT ratio	1.00				1.00		
151		kct2	0.05 - 50.00		—	ditto	1.00				1.00		
152		kct3	0.05 - 50.00		—	ditto	--		1.00		1.00		
153		d1	0 - 11		—	Phase angle	0				0		
154		d2	0 - 11		—	ditto	0				0		
155		d3	0 - 11		—	ditto	0				0		
156		yd_p	1 - 2		—	Primary winding	2				2		
157		yd_s	1 - 2		—	Secondary winding	2				2		
158		vec_s	0 - 11		—	Phase angel(Secondary)	0				0		
159		yd_t	1 - 2		—	Tertiary winding	--		2		2		
160		vec_t	0 - 11		—	Phase angle(Tertiary)	--		0		0		
161		k2f	10 - 50		%	2f restraint	15				15		
162		k5f	10 - 100		%	5f restraint	30				30		
163		kh	2.00 - 20.00		pu	HOC operaing current	2.00				2.00		
164	REF	1ik	0.05 - 0.50		pu	Minimum sensitivity for 1REF	0.50				0.50		
165		1kct1	1.00 - 50.00		—	CT ratio for 1REF	1.00				1.00		
166		1kct2	1.00 - 50.00		—	ditto	1.00				1.00		
167		1kct3	1.00 - 50.00		—	ditto	--		1.00		1.00		
168		1p2	50 - 100		%	Percent slope for 1REF	100				100		
169		1kp	0.50 - 2.00		pu	DF2 sensitivity	1.00				1.00		
170		2ik	0.05 - 0.50		pu	Minimum sensitivity for 2REF	0.50				0.50		
171		2kct1	1.00 - 50.00		—	CT ratio for 2REF	1.00				1.00		
172		2kct2	1.00 - 50.00		—	ditto	1.00				1.00		
173		2kct3	1.00 - 50.00		—	ditto	--		1.00		1.00		
174		2p2	50 - 100		%	Percent slope for 2REF	100				100		
175		2kp	0.50 - 2.00		pu	DF2 sensitivity	1.00				1.00		
176		3ik	0.05 - 0.50		pu	Minimum sensitivity for 3REF	--		0.50		0.50		
177		3kct1	1.00 - 50.00		—	CT ratio for 3REF	--		1.00		1.00		
178		3kct2	1.00 - 50.00		—	ditto	--		1.00		1.00		
179		3kct3	1.00 - 50.00		—	ditto	--		1.00		1.00		
180		3p2	50 - 100		%	Percent slope for 3REF	--		100		100		
181		3kp	0.50 - 2.00		pu	DF2 sensitivity	--		1.00		1.00		
182		T1REF	0.00 - 10.00		s	1REF delay trip timer	0.00				0.00		
183		T2REF	0.00 - 10.00		s	2REF delay trip timer	0.00				0.00		
184		T3REF	0.00 - 10.00		s	3REF delay trip timer	--		0.00		0.00		
185	OC	1OC	0.10 - 20.00		pu	OC element	2.00				2.00		
186		2OC	0.10 - 20.00		pu	ditto	2.00				2.00		
187		3OC	0.10 - 20.00		pu	ditto	--		2.00		2.00		
188		T1OC	0.00 - 10.00		s	OC delay trip timer	1.00				1.00		
189		T2OC	0.00 - 10.00		s	ditto	1.00				1.00		
190		T3OC	0.00 - 10.00		s	ditto	--		1.00		1.00		
191		1OCI	0.10 - 5.00		pu	OCI element	1.00				1.00		
192		2OCI	0.10 - 5.00		pu	ditto	1.00				1.00		
193		3OCI	0.10 - 5.00		pu	ditto	--		1.00		1.00		
194		T1OCI	0.05 - 1.00		—	OCI delayed tripping timer	1.00				1.00		
195		T2OCI	0.05 - 1.00		—	ditto	1.00				1.00		
196		T3OCI	0.05 - 1.00		—	ditto	--		1.00		1.00		
197		1EF	0.10 - 20.00		pu	EF element	2.00				2.00		
198		2EF	0.10 - 20.00		pu	ditto	2.00				2.00		
199		3EF	0.10 - 20.00		pu	ditto	--		2.00		2.00		
200		T1EF	0.00 - 10.00		s	EF delay trip timer	1.00				1.00		
201		T2EF	0.00 - 10.00		s	ditto	1.00				1.00		
202		T3EF	0.00 - 10.00		s	ditto	--		1.00		1.00		
203		1EFI	0.10 - 5.00		pu	EFI element	1.00				1.00		
204		2EFI	0.10 - 5.00		pu	ditto	1.00				1.00		
205		3EFI	0.10 - 5.00		pu	dittp	--		1.00		1.00		
206		T1EFI	0.05 - 1.00		—	EFI delayed tripping timer	1.00				1.00		
207		T2EFI	0.05 - 1.00		—	ditto	1.00				1.00		
208		T3EFI	0.05 - 1.00		—	ditto	--		1.00		1.00		
209	THR	t	0.5 - 500.0		min	Time constant	60.0				60.0		
210		k	0.10 - 4.00		—	Constant	1.30				1.30		
211		IB	0.50 - 2.50		pu	Basic current	1.00				1.00		
212		Ip	0.00 - 1.00		pu	Pre-load current	0.00				0.00		
213		TA	0 - 10		min	Time for alarming	10				10		

№	Name		Range (5A rating / 1A rating)	Units	Contents	Default Setting of Relay Series(5A rating / 1A rating) World wide 2-Winding 101D, 102D / 3-Winding 201D, 202D	ENA 3-Winding 203D, 204D	User setting
214	V/F	V	100.0 - 120.0	V	Voltage	100.0	100.0	
215		A	1.03 - 1.30	pu	Alarm level	1.03	1.03	
216		L	1.05 - 1.30	pu	Low level	1.05	1.05	
217		H	1.10 - 1.40	pu	High level	1.40	1.40	
218		LT	1 - 600	s	Inverce time delay for high level	600	600	
219		HT	1 - 600	s	Inverce time delay fir low level	1	1	
220		RT	60 - 3600	s	Radiant heat time	250	250	
221		TVFH	1 - 600	s	Delay time for high level	10	10	
222		TVFA	1 - 600	s	Delay time for alarm level	10	10	
223	FRQ	81-1	45.00 - 55.00	Hz	Frequency-1 in 50Hz rating	49.00	49.00	
			54.00 - 66.00	Hz	Frequency-1 in 60Hz rating	59.00	59.00	
224		81-2	45.00 - 55.00	Hz	Frequency-2 in 50Hz rating	48.00	48.00	
			54.00 - 66.00	Hz	Frequency-2 in 60Hz rating	58.00	58.00	
225		UV	40 - 100	v	Voltage	40	40	
226		TFRQL	0.00 - 60.00	s	TRIP delay timer for low level	10.0	10.0	
227		TFRQH	0.00 - 60.00	s	TRIP delay timer for high level	10.0	10.0	
228		TFRQA	0.00 - 60.00	s	TRIP delay timer for alarm level	10.0	10.0	
229	BISW 1		Norm - Inv	–	Binary input	Norm	Norm	
230	BISW 2		Norm - Inv	–	ditto	Norm	Norm	
231	BISW 3		Norm - Inv	–	ditto	Norm	Norm	
232	BISW 4		Norm - Inv	–	ditto	Norm	Norm	
233	BISW 5		Norm - Inv	–	ditto	Norm	Norm	
234	BISW 6		Norm - Inv	–	ditto	Norm	Norm	
235	BISW 7		Norm - Inv	–	ditto	Norm	Norm	
236	BISW 8		Norm - Inv	–	ditto	Norm	Norm	
237	BISW 9		Norm - Inv	–	ditto	Norm	Norm	
238	BISW 10		Norm - Inv	–	ditto	Norm	Norm	
239	BISW 11		Norm - Inv	–	ditto	Norm	Norm	
240	BISW 12		Norm - Inv	–	ditto	Norm	Norm	
241	BISW 13		Norm - Inv	–	ditto	Norm	--	
242	BISW 14		Norm - Inv	–	ditto	Norm	Norm	
243	BISW 15		Norm - Inv	–	ditto	Norm	Norm	
244	BISW 16		Norm - Inv	–	ditto	Norm	Norm	
245	LED1	Logic	OR - AND	–	Configurable LEDs	OR	OR	
246		Reset	Inst - Latch	–		Inst	Inst	
247		In #1	0 - 3071	–		0	281	
248		In #2	0 - 3071	–		0	0	
249		In #3	0 - 3071	–		0	0	
250		In #4	0 - 3071	–		0	0	
251	LED2	Logic	OR - AND	–	Configurable LEDs	OR	OR	
252		Reset	Inst - Latch	–		Inst	Inst	
253		In #1	0 - 3071	–		0	291	
254		In #2	0 - 3071	–		0	0	
255		In #3	0 - 3071	–		0	0	
256		In #4	0 - 3071	–		0	0	
257	LED3	Logic	OR - AND	–	Configurable LEDs	OR	OR	
258		Reset	Inst - Latch	–		Inst	Inst	
259		In #1	0 - 3071	–		0	298	
260		In #2	0 - 3071	–		0	0	
261		In #3	0 - 3071	–		0	0	
262		In #4	0 - 3071	–		0	0	
263	LED4	Logic	OR - AND	–	Configurable LEDs	OR	OR	
264		Reset	Inst - Latch	–		Inst	Inst	
265		In #1	0 - 3071	–		0	0	
266		In #2	0 - 3071	–		0	0	
267		In #3	0 - 3071	–		0	0	
268		In #4	0 - 3071	–		0	0	
269	Plant name		Specified by user	–	Plant name	no-name	no-name	
270	Description		ditto	–	Memorandum for user	no-data	no-data	
271	HDLC		1 - 32	–	Relay ID No. for RSM	1	1	
272	IEC		0 - 254	–	Station address for IEC103	2	2	
273	SYADJ		-9999 - 9999	ms	Time sync. Compensation	0	0	
274	IP1-1		0 - 254	–	IP Address of CH#1	192	192	
275	IP1-2		0 - 254	–		168	168	
276	IP1-3		0 - 254	–		19	19	
277	IP1-4		0 - 254	–		172	172	
278	SM1-1		0 - 255	–	Subnet Mask of CH#1	255	255	
279	SM1-2		0 - 255	–		255	255	
280	SM1-3		0 - 255	–		255	255	
281	SM1-4		0 - 255	–	Subnet Mask of CH#1	0	0	
282	GW1-1		0 - 254	–	Gateway Address of CH#1	192	192	
283	GW1-2		0 - 254	–		168	168	
284	GW1-3		0 - 254	–		19	19	
285	GW1-4		0 - 254	–		1	1	

№	Name	Range		Units	Contents	Default Setting of Relay Series(5A rating / 1A rating)						User setting
						World wide				ENA		
						2-Winding		3-Winding		3-Winding		
		5A rating	1A rating			101D	102D	201D	202D	203D	204D	
286	IP2-1	0 - 254		—	IP Address of CH#2	192				192		
287	IP2-2	0 - 254		—		168				168		
288	IP2-3	0 - 254		—		19				19		
289	IP2-4	0 - 254		—		173				173		
290	SM2-1	0 - 255		—	Subnet Mask of CH#2	255				255		
291	SM2-2	0 - 255		—		255				255		
292	SM2-3	0 - 255		—		255				255		
293	SM2-4	0 - 255		—		0				0		
294	GW2-1	0 - 254		—	Gateway Address of CH#2	192				192		
295	GW2-2	0 - 254		—		168				168		
296	GW2-3	0 - 254		—		19				19		
297	GW2-4	0 - 254		—		1				1		
298	SI1-1	0 - 254		—	SNTP Server1 Address	0				0		
299	SI1-2	0 - 254		—		0				0		
300	SI1-3	0 - 254		—		0				0		
301	SI1-4	0 - 254		—		0				0		
302	SI2-1	0 - 254		—	SNTP Server2 Address	0				0		
303	SI2-2	0 - 254		—		0				0		
304	SI2-3	0 - 254		—		0				0		
305	SI2-4	0 - 254		—		0				0		
306	SI3-1	0 - 254		—	SNTP Server3 Address	0				0		
307	SI3-2	0 - 254		—		0				0		
308	SI3-3	0 - 254		—		0				0		
309	SI3-4	0 - 254		—		0				0		
310	SI4-1	0 - 254		—	SNTP Server4 Address	0				0		
311	SI4-2	0 - 254		—		0				0		
312	SI4-3	0 - 254		—		0				0		
313	SI4-4	0 - 254		—		0				0		
314	SMODE	0 - 1		—	SNTP operation mode (foecibly synchronising or not)	0				0		
315	GOINT	1 - 60		s	GOOSE message interval	60				60		
316	PG1-1	0 - 254		—	Ping check addrs port#1	0				0		
317	PG1-2	0 - 254		—		0				0		
318	PG1-3	0 - 254		—		0				0		
319	PG1-4	0 - 254		—		0				0		
320	PG2-1	0 - 254		—	Ping check addrs port#2	0				0		
321	PG2-2	0 - 254		—		0				0		
322	PG2-3	0 - 254		—		0				0		
323	PG2-4	0 - 254		—		0				0		
324	PRTCL1	HDLC - IEC103		—	CH#1 Communication protocol	HDLC				HDLC		
325	232C	9.6 - 19.2 - 38.4 - 57.6		—	RS-232C baud rate	9.6				9.6		
326	IECBR	9.6 - 19.2		—	IEC60870-5-103 baud rate	19.2				19.2		
327	IECBLK	Normal - Blocked		—	Monitor direction blocked	Normal				Normal		
328	850BLK	Normal - Blocked		—	IEC61850 Block	Normal				Normal		
329	850AUT	Off - On		—	IEC61850 Authorize	Off				Off		
330	TSTMOD	Off - On		—	IEC61850 Test mode	Off				Off		
331	GSECHK	Off - On		—	GOOSE receive check	Off				Off		
332	PINGCHK	Off - On		—	Ping check	Off				Off		
333	Phase mode	Operating - Fault		—	Phase indication of Fault recording	Operating				Operating		
334	BITRN	0 - 128		—	Number of bi-trigger (on/off) events	100				100		
335	Time	0.1 - 3.0		s	Disturbance record	1.0				1.0		
336	1OCPS	0.10 - 20.00		pu	OC element for disturbance recorder initiation	1.00				1.00		
337	2OCPS	0.10 - 20.00		pu		1.00				1.00		
338	3OCPS	0.10 - 20.00		pu		--		1.00		1.00		
339	1OCPG	0.05 - 20.00		pu		1.00				1.00		
340	2OCPG	0.05 - 20.00		pu		1.00				1.00		
341	3OCPG	0.05 - 20.00		pu		--		1.00		1.00		
342	TRIP1	Off - On		—	Disturbance trigger	On				On		
343	TRIP2	Off - On		—	ditto	On				On		
344	TRIP3	Off - On		—	ditto	Off		On		On		
345	TRIP4	Off - On		—	ditto	Off				--		
346	TRIP5	Off - On		—	ditto	Off				--		
347	1OCPS	Off - On		—	ditto	On				On		
348	2OCPS	Off - On		—	ditto	On				On		
349	3OCPS	Off - On		—	ditto	--		On		On		
350	1OCPG	Off - On		—	ditto	On				On		
351	2OCPG	Off - On		—	ditto	On				On		
352	3OCPG	Off - On		—	ditto	--		On		On		
353	2F	Off - On		—	ditto	On				On		
354	5F	Off - On		—	ditto	On				On		
355	EVENT1	Off - On		—	ditto	On				On		
356	EVENT2	Off - On		—	ditto	On				On		
357	EVENT3	Off - On		—	ditto	On				On		
358	Display value	Primary - Secondary		—	Metering	Primary				Primary		
359	Time sync	Off - IRIG - RSM - IEC - SNTP		—	Time	Off				Off		
360	GMT	-12 - +12		hrs	Time	0				0		
361	GMTm	-59 - +59		min	Time	0				0		

<table>
<tr><th colspan="8">Event record default setting</th><th colspan="6"></th></tr>
<tr><th rowspan="2">No.</th><th rowspan="2">Name</th><th rowspan="2">Range</th><th rowspan="2">Unit</th><th rowspan="2">Contents</th><th colspan="3">Default setting</th><th colspan="6">Model</th></tr>
<tr><th>Sig. NO.</th><th>Signal name</th><th>type</th><th>101D</th><th>102D</th><th>201D</th><th>201D</th><th>203D</th><th>204D</th></tr>
<tr><td>1</td><td>EV1</td><td>0 - 3071</td><td>—</td><td>Event record signal</td><td>1536</td><td>Mec.Trip1</td><td>On/Off</td><td colspan="6">✓</td></tr>
<tr><td>2</td><td>EV2</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>1537</td><td>Mec.Trip2</td><td>On/Off</td><td colspan="6">✓</td></tr>
<tr><td>3</td><td>EV3</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>1538</td><td>Mec.Trip3</td><td>On/Off</td><td colspan="6">✓</td></tr>
<tr><td>4</td><td>EV4</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>1539</td><td>Mec.Trip4</td><td>On/Off</td><td colspan="6">✓</td></tr>
<tr><td>5</td><td>EV5</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>314</td><td>Trip</td><td>On/Off</td><td colspan="6">✓</td></tr>
<tr><td>6</td><td>EV6</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>1540</td><td>Ind.reset</td><td>On/Off</td><td colspan="6">✓</td></tr>
<tr><td>7</td><td>EV7</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>1552</td><td>Event1</td><td>On/Off</td><td colspan="6">✓</td></tr>
<tr><td>8</td><td>EV8</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>1553</td><td>Event2</td><td>On/Off</td><td colspan="6">✓</td></tr>
<tr><td>9</td><td>EV9</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>1554</td><td>Event3</td><td>On/Off</td><td colspan="6">✓</td></tr>
<tr><td>10</td><td>EV10</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>1251</td><td>Relay fail</td><td>On/Off</td><td colspan="6">✓</td></tr>
<tr><td>11</td><td>EV11</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>1267</td><td>CT1 err</td><td>On/Off</td><td colspan="6">✓</td></tr>
<tr><td>12</td><td>EV12</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>1268</td><td>CT2 err</td><td>On/Off</td><td colspan="6">✓</td></tr>
<tr><td>13</td><td>EV13</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>1269</td><td>CT3 err</td><td>On/Off</td><td colspan="2">-</td><td colspan="4">✓</td></tr>
<tr><td>14</td><td>EV14</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>1270</td><td>CT4 err</td><td>On/Off</td><td colspan="6">-</td></tr>
<tr><td>15</td><td>EV15</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>16</td><td>EV16</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>17</td><td>EV17</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>18</td><td>EV18</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>19</td><td>EV19</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>20</td><td>EV20</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>21</td><td>EV21</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>22</td><td>EV22</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>23</td><td>EV23</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>24</td><td>EV24</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>25</td><td>EV25</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>26</td><td>EV26</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>27</td><td>EV27</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>28</td><td>EV28</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>29</td><td>EV29</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>30</td><td>EV30</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>31</td><td>EV31</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>32</td><td>EV32</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>33</td><td>EV33</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>34</td><td>EV34</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>35</td><td>EV35</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>36</td><td>EV36</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>37</td><td>EV37</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>38</td><td>EV38</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>39</td><td>EV39</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>40</td><td>EV40</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>41</td><td>EV41</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>42</td><td>EV42</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>43</td><td>EV43</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>44</td><td>EV44</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>45</td><td>EV45</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>46</td><td>EV46</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>47</td><td>EV47</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>48</td><td>EV48</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>49</td><td>EV49</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>1258</td><td>Relay fail-A</td><td>On/Off</td><td colspan="6">✓</td></tr>
<tr><td>50</td><td>EV50</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>1438</td><td>Data lost</td><td>On/Off</td><td colspan="6">✓</td></tr>
<tr><td>51</td><td>EV51</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>52</td><td>EV52</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>53</td><td>EV53</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>54</td><td>EV54</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>55</td><td>EV55</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>56</td><td>EV56</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>57</td><td>EV57</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>58</td><td>EV58</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>59</td><td>EV59</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>60</td><td>EV60</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>61</td><td>EV61</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>62</td><td>EV62</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>63</td><td>EV63</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
<tr><td>64</td><td>EV64</td><td>0 - 3071</td><td>—</td><td>ditto</td><td>0</td><td></td><td>On/Off</td><td colspan="6"></td></tr>
</table>

Event record default setting													
No.	Name	Range	Unit	Contents	Default setting			Model					
					Sig. NO.	Signal name	type	101D	102D	201D	201D	203D	204D
65	EV65	0 - 3071	–	ditto	0		On/Off						
66	EV66	0 - 3071	–	ditto	0		On/Off						
67	EV67	0 - 3071	–	ditto	0		On/Off						
68	EV68	0 - 3071	–	ditto	0		On/Off						
69	EV69	0 - 3071	–	ditto	0		On/Off						
70	EV70	0 - 3071	–	ditto	0		On/Off						
71	EV71	0 - 3071	–	ditto	0		On/Off						
72	EV72	0 - 3071	–	ditto	0		On/Off						
73	EV73	0 - 3071	–	ditto	0		On/Off						
74	EV74	0 - 3071	–	ditto	0		On/Off						
75	EV75	0 - 3071	–	ditto	0		On/Off						
76	EV76	0 - 3071	–	ditto	0		On/Off						
77	EV77	0 - 3071	–	ditto	0		On/Off						
78	EV78	0 - 3071	–	ditto	0		On/Off						
79	EV79	0 - 3071	–	ditto	0		On/Off						
80	EV80	0 - 3071	–	ditto	0		On/Off						
81	EV81	0 - 3071	–	ditto	0		On/Off						
82	EV82	0 - 3071	–	ditto	0		On/Off						
83	EV83	0 - 3071	–	ditto	0		On/Off						
84	EV84	0 - 3071	–	ditto	0		On/Off						
85	EV85	0 - 3071	–	ditto	0		On/Off						
86	EV86	0 - 3071	–	ditto	0		On/Off						
87	EV87	0 - 3071	–	ditto	0		On/Off						
88	EV88	0 - 3071	–	ditto	0		On/Off						
89	EV89	0 - 3071	–	ditto	0		On/Off						
90	EV90	0 - 3071	–	ditto	0		On/Off						
91	EV91	0 - 3071	–	ditto	0		On/Off						
92	EV92	0 - 3071	–	ditto	0		On/Off						
93	EV93	0 - 3071	–	ditto	0		On/Off						
94	EV94	0 - 3071	–	ditto	0		On/Off						
95	EV95	0 - 3071	–	ditto	0		On/Off						
96	EV96	0 - 3071	–	ditto	0		On/Off						
97	EV97	0 - 3071	–	ditto	0		On/Off						
98	EV98	0 - 3071	–	ditto	0		On/Off						
99	EV99	0 - 3071	–	ditto	0		On/Off						
100	EV100	0 - 3071	–	ditto	0		On/Off						
101	EV101	0 - 3071	–	ditto	1243	SET.GROUP1	On	✓					
102	EV102	0 - 3071	–	ditto	1244	SET.GROUP2	On	✓					
103	EV103	0 - 3071	–	ditto	1245	SET.GROUP3	On	✓					
104	EV104	0 - 3071	–	ditto	1246	SET.GROUP4	On	✓					
105	EV105	0 - 3071	–	ditto	1247	SET.GROUP5	On	✓					
106	EV106	0 - 3071	–	ditto	1248	SET.GROUP6	On	✓					
107	EV107	0 - 3071	–	ditto	1249	SET.GROUP7	On	✓					
108	EV108	0 - 3071	–	ditto	1250	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	0		On						
113	EV113	0 - 3071	–	ditto	0		On						
114	EV114	0 - 3071	–	ditto	0		On						
115	EV115	0 - 3071	–	ditto	0		On						
116	EV116	0 - 3071	–	ditto	0		On						
117	EV117	0 - 3071	–	ditto	0		On						
118	EV118	0 - 3071	–	ditto	0		On						
119	EV119	0 - 3071	–	ditto	1445	PLC data CHG	On	✓					
120	EV120	0 - 3071	–	ditto	0		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		On						
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		On						
127	EV127	0 - 3071	–	ditto	0		On						
128	EV128	0 - 3071	–	ditto	0		On						

Disturbance record default setting

No.	Name	Range	Unit	Contents	Default setting		Model		
					Signal No.	Signal name	101D 102D	201D 202D	203D 204D
1	SIG1	0 - 3071	–	disturbance record triger	284	TRIP-1	✓	✓	✓
2	SIG2	0 - 3071	–	ditto	291	TRIP-2	✓	✓	✓
3	SIG3	0 - 3071	–	ditto	298	TRIP-3	✓	✓	✓
4	SIG4	0 - 3071	–	ditto	305	TRIP-4	✓	✓	✓
5	SIG5	0 - 3071	–	ditto	312	TRIP-5	✓	✓	✓
6	SIG6	0 - 3071	–	ditto	330	DIFT	✓	✓	✓
7	SIG7	0 - 3071	–	ditto	331	HOC	✓	✓	✓
8	SIG8	0 - 3071	–	ditto	122	2F	✓	✓	✓
9	SIG9	0 - 3071	–	ditto	123	5F	✓	✓	✓
10	SIG10	0 - 3071	–	ditto	332	1REF	✓	✓	✓
11	SIG11	0 - 3071	–	ditto	333	2REF	✓	✓	✓
12	SIG12	0 - 3071	–	ditto	334	3REF	--	✓	✓
13	SIG13	0 - 3071	–	ditto	335	1OC	✓	✓	✓
14	SIG14	0 - 3071	–	ditto	336	2OC	✓	✓	✓
15	SIG15	0 - 3071	–	ditto	337	3OC	--	✓	✓
16	SIG16	0 - 3071	–	ditto	338	4OC	--	--	--
17	SIG17	0 - 3071	–	ditto	339	1OCI	✓	✓	✓
18	SIG18	0 - 3071	–	ditto	340	2OCI	✓	✓	✓
19	SIG19	0 - 3071	–	ditto	341	3OCI	--	✓	✓
20	SIG20	0 - 3071	–	ditto	342	4OCI	--	--	--
21	SIG21	0 - 3071	–	ditto	343	1EF	✓	✓	✓
22	SIG22	0 - 3071	–	ditto	344	2EF	✓	✓	✓
23	SIG23	0 - 3071	–	ditto	345	3EF	--	✓	✓
24	SIG24	0 - 3071	–	ditto	346	1EFI	✓	✓	✓
25	SIG25	0 - 3071	–	ditto	347	2EFI	✓	✓	✓
26	SIG26	0 - 3071	–	ditto	348	3EFI	--	✓	✓
27	SIG27	0 - 3071	–	ditto	349	FRQ	✓	✓	✓
28	SIG28	0 - 3071	–	ditto	350	V/F	✓	✓	✓
29	SIG29	0 - 3071	–	ditto	351	THR	✓	✓	✓
30	SIG30	0 - 3071	–	ditto	361	Mec.tirp	✓	✓	✓
31	SIG31	0 - 3071	–	ditto	0				
32	SIG32	0 - 3071	–	ditto	0				

PLC default setting

Output		Timing				Logic expression	Delay Time / Flip Flop							
		Cycle				Model 100s / Model 200s	Flip Flop			Timer				
№	Signal	30	90	User	Turn	Filename: PGRT100DA000	Norm	Back Up	Release Signal	Off Delay	On Delay	One Shot	Time Value	None
1536	EXT_MEC.TP1	X				[513]BI1_COMMAND								X
1537	EXT_MEC.TP2	X				[514]BI2_COMMAND								X
1538	EXT_MEC.TP3	X				[515]BI3_COMMAND								X
1539	EXT_MEC.TP4	X				[516]BI4_COMMAND								X
1540	IND.RESET	X				[517]BI5_COMMAND								X
1541														
1542														
1543														
1544														
1545														
1546														
1547														
1548														
1549														
1550														
1551														
1552	EVENT1	X				[526]BI14_COMMAND								X
1553	EVENT2	X				[527]BI15_COMMAND								X
1554	EVENT3	X				[528]BI16_COMMAND								X
1555														
1556														
1557														
1558														
1559														
1560														
1561														
1562														
1563														
1564														
1565														
1566														
1567														
1568	PROT_BLOCK					[518]BI6_COMMAND								X
1569	DIF_BLOCK													
1570	1REF_BLOCK													
1571	1OC_BLOCK													
1572	1OCI_BLOCK													
1573	1EF_BLOCK													
1574	1EFI_BLOCK													
1575	2REF_BLOCK													
1576	2OC_BLOCK													
1577	2OCI_BLOCK													
1578	2EF_BLOCK													
1579	2EFI_BLOCK													
1580	3REF_BLOCK													
1581	3OC_BLOCK													
1582	3OCI_BLOCK													
1583	3EF_BLOCK													
1584	3EFI_BLOCK													
1585	4OC_BLOCK													
1586	4OCI_BLOCK													
1587	FRQ_BLOCK													
1588	FRQ-A_BLOCK													
1589	V/F_BLOCK													
1590	V/F-A_BLOCK													
1591	THR_BLOCK													
1592	THR-A_BLOCK													
1593	MEC.TP1_BLOCK													
1594	MEC.TP2_BLOCK													
1595	MEC.TP3_BLOCK													
1596	MEC.TP4_BLOCK													
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Output		Timing				Logic expression		Delay Time / Flip Flop								
		Cycle				Model 100s	Model 200s	Flip Flop			Timer					
№	Signal	30	90	User	Turn	Filename: PGRT100DA000		Norm	Back Up	Release Signal	Off Delay	On Delay	One Shot	Time Value		None
1600	TP1_DELAY	X				[315]TP1					X			200	ms	
1601	TP2_DELAY	X				[316]TP2					X			200	ms	
1602	TP3_DELAY	X				[317]TP3					X			200	ms	
1603	TP4_DELAY	X				[318]TP4					X			200	ms	
1604	TP5_DELAY	X				[319]TP5					X			200	ms	
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Output		Timing				Logic expression		Delay Time / Flip Flop								
№	Signal	Cycle			Turn	Model 100s	Model 200s	Flip Flop			Timer					None
		30	90	User		Filename: PGRT100DA000		Norm	Back Up	Release Signal	Off Delay	On Delay	One Shot	Time Value		
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№	Signal	30	90	User		Filename: PGRT100DA000		Norm	Back Up	Release Signal	Off Delay	On Delay	One Shot	Time Value	
1792	IO#1-TP1	X				[284]TRIP-1									X
1793	IO#1-TP2	X				[291]TRIP-2									X
1794	IO#1-TP3	X				[298]TRIP-3									X
1795	IO#1-TP4	X				[305]TRIP-4									X
1796	IO#1-TP5	X				[312]TRIP-5									X
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№	Signal	30	90	User		Filename: PGRT100DA000		Norm	Back Up	Release Signal	Off Delay	On Delay	One Shot	Time Value		
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		Cycle				Model 100s	Model 200s	Flip Flop			Timer					
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		30	90	User		Filename: PGRT100DA000		Norm	Back Up	Release Signal	Off Delay	On Delay	One Shot	Time Value		
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																
2671																
2672																
2673																
2674																
2675																
2676																
2677																

Output		Timing				Logic expression		Delay Time / Flip Flop								
		Cycle			Turn	Model 100s	Model 200s	Flip Flop			Timer					None
№	Signal	30	90	User		Filename: PGRT100DA000		Norm	Back Up	Release Signal	Off Delay	On Delay	One Shot	Time Value		
2678																
2679																
2680																
2681																
2682																
2683																
2684																
2685																
2686	PROT_COM_RECV															
2687																
2688	TPLED_RST_RCV															
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																
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2721																
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2729																
2730																
2731																
2732																
2733																
2734																
2735																
2736																
2737																
2738																
2739																
2740																
2741																

Output		Timing				Logic expression		Delay Time / Flip Flop								
№	Signal	Cycle			Turn	Model 100s	Model 200s	Flip Flop			Timer					None
		30	90	User		Filename: PGRT100DA000		Norm	Back Up	Release Signal	Off Delay	On Delay	One Shot	Time Value		
2742																
2743																
2744																
2745																
2746																
2747																
2748																
2749																
2750																
2751																
2752																
2753																
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2757																
2758																
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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																
2811																
2812																
2813																
2814																
2815																

Output		Timing				Logic expression		Delay Time / Flip Flop								
№	Signal	Cycle			Turn	Model 100s	Model 200s	Flip Flop			Timer					None
		30	90	User		Filename: PGRT100DA000		Norm	Back Up	Release Signal	Off Delay	On Delay	One Shot	Time Value		
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															

Output		Timing				Logic expression		Delay Time / Flip Flop								
		Cycle			Turn	Model 100s	Model 200s	Flip Flop			Timer					None
№	Signal	30	90	User		Filename: PGRT100DA000		Norm	Back Up	Release Signal	Off Delay	On Delay	One Shot	Time Value		
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															

Output		Timing				Logic expression		Delay Time / Flip Flop							
		Cycle				Model 100s	Model 200s	Flip Flop			Timer				
№	Signal	30	90	User	Turn	Filename: PGRT100DA000		Norm	Back Up	Release Signal	Off Delay	On Delay	One Shot	Time Value	None
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														
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														

Output		Timing				Logic expression		Delay Time / Flip Flop							
		Cycle				Model 100s	Model 200s	Flip Flop			Timer				
№	Signal	30	90	User	Turn	Filename: PGRT100DA000		Norm	Back Up	Release Signal	Off Delay	On Delay	One Shot	Time Value	None
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														
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														

Appendix I

Commissioning Test Sheet (sample)

1. Relay identification
2. Preliminary check
3. Hardware test
   - 3.1 User interface check
   - 3.2 Binary input/Binary output circuit check
   - 3.3 AC input circuit check
4. Function test
   - 4.1 Percentage current differential element DIF test
   - 4.2 2F-lock element check
   - 4.3 5F-lock element check
   - 4.4 High-set overcurrent element HOC test
   - 4.5 Restricted earth fault element REF test
   - 4.6 Overcurrent element test
   - 4.7 Thermal overload element THR test
   - 4.8 Frequency element FRQ test
   - 4.9 Overexcitation element V/F test
5. Protection scheme test
6. Metering and recording check
7. Conjunctive test

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 check ☐

4. Function test

4.1 Percentage current differential element DIF test

(1) Minimum operating value test

Tap setting	Measured current

(2) Percentage restraining characteristic test

Tap setting	I_1	Measured current (I_2)
	$\times I_k$	
	$\times I_k$	

(3) Operating time test

Tap setting	Test current	Measured time

4.2 2F-lock element check

4.3 5F-lock element check

4.4 High-set overcurrent element HOC test

(1) Minimum operating value test

Tap setting	Measured current

(2) Operating time test

Tap setting	Test current	Measured time

4.5 Restricted earth fault element REF test

Tap setting	I_a	Measured current (I_n)
	$\times I_k$	
	$\times I_k$	

4.6 Overcurrent element test

(1) OC element

Element	Tap setting	Measured current
OC		

(2) EF element

Element	Tap setting	Measured current
EF		

(3) OCI element

Element	Test current	Measured operating time
OCI	$2 \times I_S$	
	$20 \times I_S$	

I_S: Setting value

(4) EFI element

Element	Test current	Measured operating time
EFI	$2 \times I_S$	
	$20 \times I_S$	

4.7 Thermal overload element THR test

Element	Test current	Measured operating time
THR		

4.8 Frequency element FRQ test

(1) Frequency

Element	Setting	Measured frequency
FRQ-L1		
FRQ-L2		
FRQ-H1		
FRQ-H2		

(2) Undervoltage block

Setting	Measured voltage

4.9 Overexcitation element V/F test

(1) Operating value test

Element	Setting	Measured voltage
V/F		

(2) Operating time test

Test voltage	Measured operating time

5. Protection scheme test

Scheme	Results

6. Metering and recording check

☐

7. Conjunctive test

Scheme	Results
On load Tripping circuit	

Appendix J

Return Repair Form

RETURN / REPAIR FORM

Please fill in this form and return it to Toshiba Corporation with the GRT100 to be repaired.

TOSHIBA CORPORATION Fuchu Complex
1, Toshiba-cho, Fuchu-shi, Tokyo, Japan
For: Power Systems Protection & Control Department
Quality Assurance Section

Type:___GRT100_____ Model:_______________
(Example: Type:____GRT100_____ Model:__101D- 10-A0__)

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.

   So please inform us the information concerned in the incident with Floppy Disk, or filling up the Fault Record sheet and Relay Setting sheet attached.

Fault Record

Date/Month/Year Time / / : : .

(Example: 04/ Nov./ 1997 15:09:58.442)

Faulty phase:

Prefault values (CT ratio: kA/: A, VT ratio: kV/: 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_{11}:	kA or A∠	°	I_{12}:	kA or A∠	°
I_{21}:	kA or A∠	°	I_{22}:	kA or A∠	°
I_{01}:	kA or A∠	°	I_{02}:	kA or A∠	°
I_{n1}:	kA or A∠	°	I_{n2}:	kA or A∠	°
I_{a3}:	kA or A∠	°			
I_{b3}:	kA or A∠	°			
I_{c3}:	kA or A∠	°			
I_{13}:	kA or A∠	°			
I_{23}:	kA or A∠	°			
I_{03}:	kA or A∠	°			
I_{n3}:	kA or A∠	°			
V:	kV or V∠	°			
I_{da}:	kA or A		I_{d01}:	kA or A	
I_{db}:	kA or A		I_{d02}:	kA or A	
I_{dc}:	kA or A		I_{d03}:	kA or A	

Fault values (CT ratio: kA/: A, VT ratio: kV/: 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_{11}:	kA or A∠	°	I_{12}:	kA or A∠	°
I_{21}:	kA or A∠	°	I_{22}:	kA or A∠	°
I_{01}:	kA or A∠	°	I_{02}:	kA or A∠	°
I_{n1}:	kA or A∠	°	I_{n2}:	kA or A∠	°
I_{a3}:	kA or A∠	°			
I_{b3}:	kA or A∠	°			
I_{c3}:	kA or A∠	°			
I_{13}:	kA or A∠	°			
I_{23}:	kA or A∠	°			
I_{03}:	kA or A∠	°			
I_{n3}:	kA or A∠	°			
V:	kV or V∠	°			
I_{da}:	kA or A		I_{d01}:	kA or A	
I_{db}:	kA or A		I_{d02}:	kA or A	
I_{dc}:	kA or A		I_{d03}:	kA or A	

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/ 1998)

6. Please write any comments on the GRT100, including the document.

Customer

Name: ________________________________

Company Name: ________________________________

Address: ________________________________

Telephone No.: ________________________________

Facsimile No.: ________________________________

Signature: ________________________________

Appendix K

Technical Data

TECHNICAL DATA

Ratings	
AC current	1A or 5A
AC voltage	100V, 110V, 115V, 120V
Frequency	50Hz or 60Hz
DC power supply	110Vdc/125Vdc (Operative range: 88 to 150Vdc) 220Vdc/250Vdc (Operative range: 176 to 300Vdc) 48Vdc/54Vdc/60Vdc (Operative range: 38.4 to 72Vdc) 24Vdc/30Vdc (Operative range: 19.2 to 36Vdc)
AC ripple on DC supply IEC 60255-11	maximum 12%
DC supply interruption IEC 60255-11	
Permissive duration of DC supply voltage interruption to maintain normal operation	maximum 50ms at 110Vdc
Restart time	less than 10s
Binary input circuit DC voltage	110Vdc/125Vdc (Operative range: 88 to 150Vdc) 220Vdc/250Vdc (Operative range: 176 to 300Vdc) 48Vdc/54Vdc/60Vdc (Operative range: 38.4 to 72Vdc) 24Vdc/30Vdc (Operative range: 19.2 to 36Vdc)
Overload rating	
AC current input	4 times rated continuous
	100 times rated for 1s
AC voltage input	2 times rated continuous
	2.5 times rated for 1s
Burden	
AC current circuit	0.3VA per phase (at rated 5A) 0.4VA at zero sequence circuit (at rated 5A)
	0.1VA per phase (at rated 1A) 0.3VA at zero sequence circuit (at rated 1A)
AC voltage circuit	0.1VA (at rated voltage)
DC power supply	less than 15W (quiescent)
	less than 25W(operation)
Binary input circuit	0.5W/input at 110Vdc
Current differential protection	
Minimum operate current (ik)	0.10 to 1.00pu in 0.01pu steps
Slope 1 (p1)	10 to 100% in 1% steps
Slope 2 (p2)	10 to 200% in 1% steps
kp	1.00 to 10.00pu in 0.01pu steps
Vector group compensation	0 to 330° in 30° steps
CT ratio correction (Winding 1 to 3) (kct1 – kct3)	0.05 to 50.00 in 0.01 steps
Inrush setting (2nd harmonic ratio) (k2f)	10 to 50% in 1% steps
Overexcitation setting (5th harmonic ratio) (k5f)	10 to 100% in 1% steps
Operating time	typical 35ms
High-set differential overcurrent protection	
Overcurrent (kh)	2.00 to 20.00pu in 0.01pu steps
Operating time	typical 20ms

Restricted earth fault element	
Minimum operating current	0.05 to 0.50pu in 0.01pu steps
Slope 1 (p1)	10 %
Slope 2 (p2)	50 to 100% in 1% steps
kp	0.50 to 2.00pu in 0.01pu steps
CT ratio correction (kct)	1.00 to 50.00 in 0.01 steps
Operating time	typical 35ms
Time-overcurrent protection	
High-set overcurrent element	
Pick up level (OC, EF)	0.10 to 20.00pu in 0.10pu steps
Delay time (TOC, TEF)	0.00 to 10.00s in 0.01s steps
Operating time	typical 30ms (without delay time)
Inverse time overcurrent element	
Pick up level (OCI, EFI)	0.10 to 5.00pu in 0.01pu steps
Time multiplier (TOCI, TEFI)	0.05 to 1.00 in 0.01 steps
Characteristic	Three IEC standard 60255-3 (Standard inverse, Very inverse, Extremely inverse), or Long-time inverse *Refer to Appendix P.
Thermal overload protection	
Thermal time constant (τ)	0.5 to 500.0min in 0.1min steps
Constant (k)	0.10 to 4.00 in 0.01 steps
Basic current (IB)	0.50 t0 2.50pu in 0.01pu steps
Special load current before overload (Ip)	0.00 to 1.00pu in 0.01 steps
Time for alarming (TA)	0 to 10min in 1min steps
Frequency protection	
Overfrequency	50.00 to 55.00Hz in 0.01Hz steps (50Hz relay)
	60.00 to 66.00Hz in 0.01Hz steps (60Hz relay)
Underfrequency	45.00 to 50.00Hz in 0.01Hz steps (50Hz relay)
	54.00 to 60.00Hz in 0.01Hz steps (60Hz relay)
Delay time	0.00 to 60.00s in 0.01s steps
Start time	less than 100ms
Undervoltage blocking	40 to 100V in 1V steps
Overexitation protection	
Pickup voltage	100.0 to 120.0V in 0.1V steps
Alarm level (A)	1.03 to 1.30pu in 0.01pu steps
High level (H)	1.10 to 1.40pu in 0.01pu steps
Low level (L)	1.05 to 1.30pu in 0.01pu steps
LT (Definite time)	1 to 600s in 1s steps
HT (Definite time)	1 to 600s in 1s steps
TVFH (Definite time)	1 to 600s in 1s steps
TVFA (Definite time)	1 to 600s in 1s steps
Start time	less than 130ms
RT (Definite time)	60 to 3600s in 1s steps

Accuracy	
Current differential element: pick-up	±5%
reset	±5%
Time-overcurrent protection: pick-up	±5%
Inverse time overcurrent characteristics:	
Standard inverse, Very and long-time inverse	IEC60255-3 class 5
Extremely inverse	IEC60255-3 class 7.5
Thermal overload protection: pick-up	±10%
Frequency protection: pick-up	±0.03Hz
Overexitation protection	±2% of pick-up voltage (frequency range ±2%)
Disturbance record initiation	
Overcurrent element	0.10 to 20.00pu in 0.01pu steps
Earth fault	0.05 to 20.00pu in 0.01pu steps
Pre-fault time	0.3s (fixed)
Post-fault time	0.1 to 3.0s in 0.1s steps
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-subminiature 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:	100BASE-TX: RJ-45 connector 100BASE-FX: SC 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 Typical 138Vdc(min. 125Vdc) for 220V/250Vdc rating Typical 31Vdc(min. 28Vdc) for 48V/54V/60Vdc rating Typical 16Vdc(min.15Vdc) for 24V/30Vdc rating

Contact ratings	
Trip contacts	
Make and carry	5A continuously, 30A, 290Vdc for 0.5s (L/R=10ms)
Break	0.15A, 290Vdc (L/R=40ms)
Auxiliary contacts	
Make and carry	4A continuously, 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	12kg
Case color	2.5Y7.5/1(approximation to Munsell value)
Installation	Flush mounting or rack mounting

CT requirement

The GRT100 does not require the use of dedicated CTs nor the use of CTs with an identical ratio. The GRT100 can share the CTs with other protections and the different ratios are adjusted by setting.

The general CT requirements are set for the through-fault stability which comes up when any CTs saturate under very large through-fault currents. To ensure correct operation of the GRT100 for such through-fault currents, the factor Ks of each CT is required to satisfy the following conditions:

$Ks \geqq 1$ when $Tc \leqq 150ms$

or

$Ks \geqq 5$ when $Tc \leqq 200ms$

where,

Ks = ratio of CT knee point voltage to CT secondary probable voltage under the maximum through-fault current

$= Vk / \{(R_{CT} + R_L + R_B + R_O)(I_F max / CT\ ratio)\}$

Tc = d.c. time constant of primary circuit

Vk = knee point voltage of CT

R_{CT} = resistance of CT secondary winding

R_L = loop resistance of cable between CT and relay

R_B = ohmic load of GRT100 (i.e. 0.1 ohm for 1A rating and 0.012 ohm for 5A rating)

R_O = ohmic load of other series-connected relays (if any)

$I_F max$ = maximum through-fault current

For example, if the following parameters are given:

Vk = 800 V, CT ratio = 1,200/1, R_{CT} = 5.0 ohm, R_L = 3.0 ohm, R_B = 0.1 ohm,

R_O = 0 ohm (i.e. no series-connected relays) and $I_F max$ = 40kA

then the factor Ks is calculated as:

$Ks = 800/\{(5.0 + 3.0 + 0.1) \times (40{,}000/1{,}200)\}$

$= 800/270$

$= 3.0$

This shows that the GRT100 operates correctly for all the faults under the condition that the d.c. time constant of the primary circuit is less than 200ms.

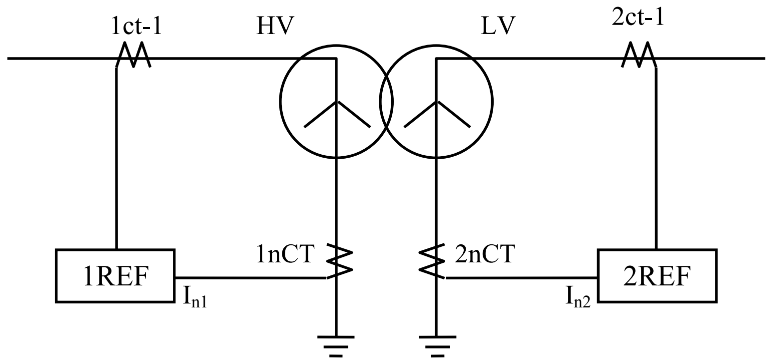
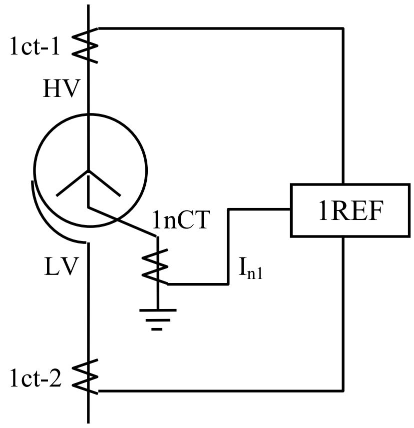
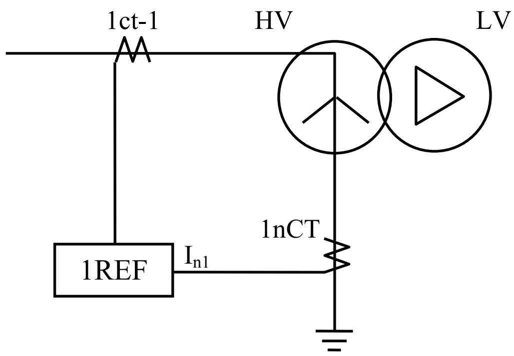
ENVIRONMENTAL PERFORMANCE CLAIMS

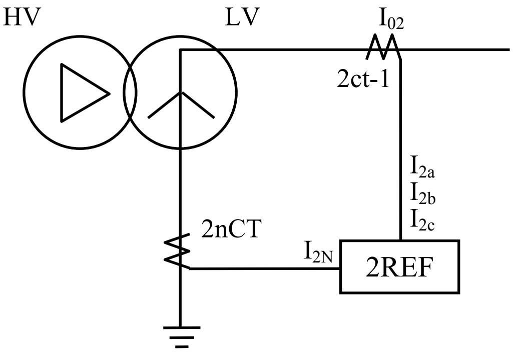
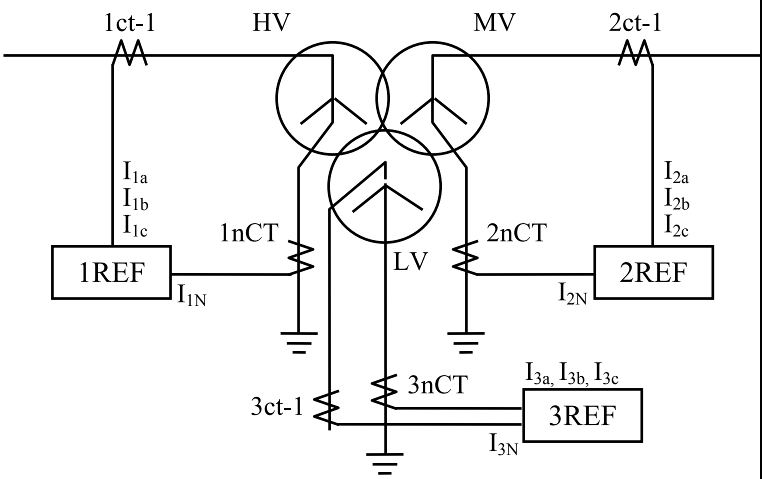
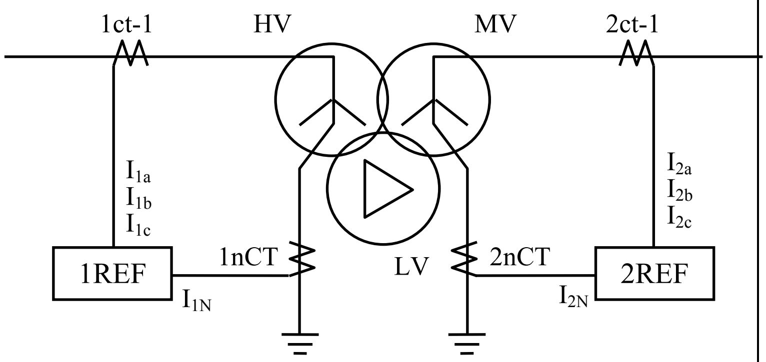
Test	Standards	Details
Atmospheric Environment		
Temperature	IEC60068-2-1/2	Operating range: -10°C to +55°C. Storage / Transit: -25°C to +70°C.
Humidity	IEC60068-2-78	56 days at 40°C and 93% relative humidity.
Enclosure Protection	IEC60529	IP51 (Rear: IP20)
Mechanical Environment		
Vibration	IEC60255-21-1	Response - Class 1 Endurance - Class 1
Shock and Bump	IEC60255-21-2	Shock Response Class 1 Shock Withstand Class 1 Bump Class 1
Seismic	IEC60255-21-3	Class 1
Electrical Environment		
Dielectric Withstand	IEC60255-5	2kVrms for 1 minute between all terminals and earth. 2kVrms for 1 minute between independent circuits. 1kVrms for 1 minute across normally open contacts.
High Voltage Impulse	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. 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: HV ports: 2kV/1kV (peak) PSU and I/O ports: 2kV/1kV (peak) 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. 150V 50Hz for 10s applied to ports in differential mode. Not applicable to AC inputs.
Conducted and Radiated Emissions	IEC60255-25, EN55022 Class A, IEC61000-6-4 / EN61000-6-4	Conducted emissions: 0.15 to 0.50MHz: <79dB (peak) or <66dB (mean) 0.50 to 30MHz: <73dB (peak) or <60dB (mean) Radiated emissions (at 30m): 30 to 230MHz: <30dB 230 to 1000MHz: <37dB

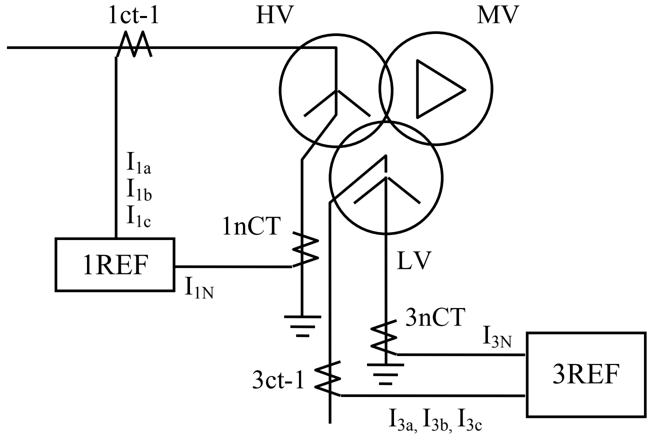
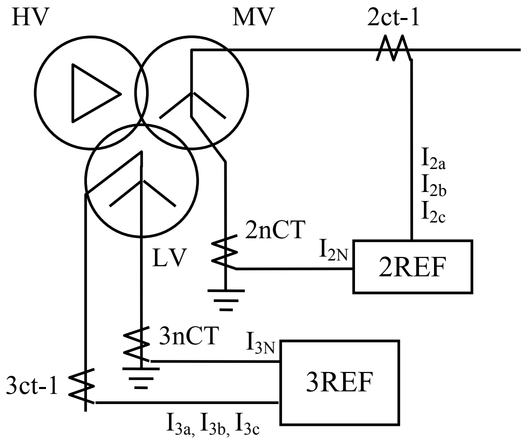
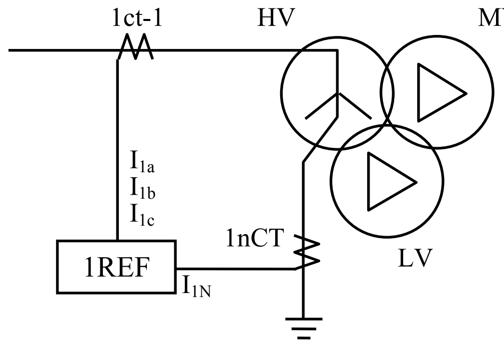
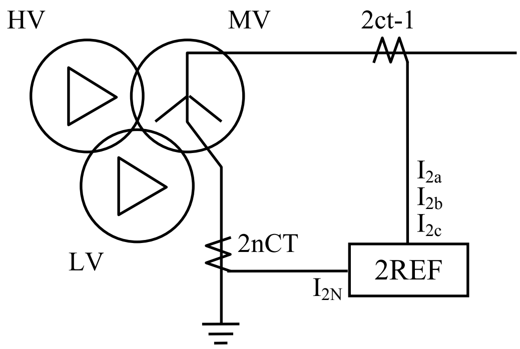
Test	Standards	Details
European Commission Directives		
	89/336/EEC	Compliance with the European Commission Electromagnetic Compatibility Directive is demonstrated according to EN 61000-6-2 and EN 61000-6-4.
	73/23/EEC	Compliance with the European Commission Low Voltage Directive is demonstrated according to EN 50178 and EN 60255-5.

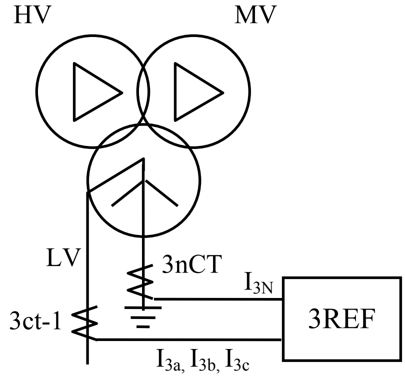
Appendix L

Setting of REF Element

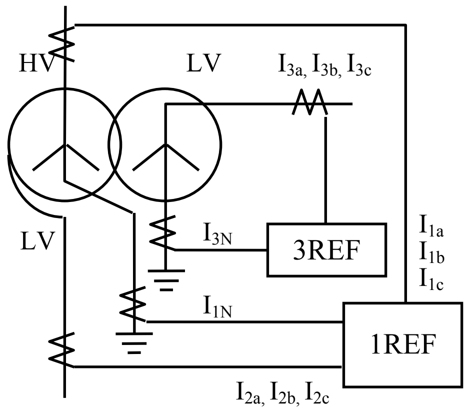
Type of transformer	Scheme switch setting
	[1REF] = 1I0 [2REF] = 1I0
	[1REF] = 2I0 2REF1 = OFF 2REF2 = OFF 2REF3 = OFF 2REF4 = OFF 2REF5 = OFF 3REF1 = OFF 3REF2 = OFF 3REF3 = OFF 3REF4 = OFF 3REF5 = OFF
	1REF = 1I0

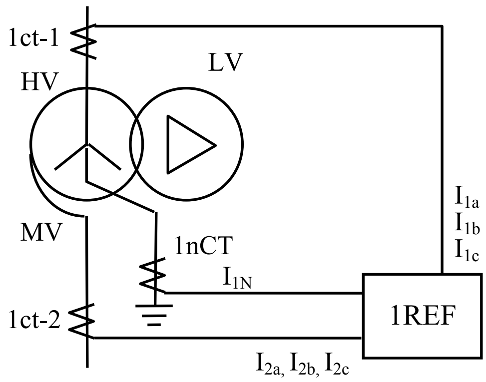
Type of transformer	Scheme switch setting
	2REF = 1I0 1REF1 to 5 = OFF 3REF1 to 5 = OFF
	1REF = 1I0 2REF = 1I0 3REF = 1I0
	1REF = 1I0 2REF = 1I0 3REF1 to 5 = OFF

Type of transformer	Scheme switch setting
	1REF = 1I0 3REF = 1I0 2REF1 to 5 = OFF
	2REF = 1I0 3REF = 1I0 1REF1 to 5 = OFF
	1REF = 1I0 2REF1 to 5 = OFF 3REF1 to 5 = OFF
	2REF = 1I0 1REF1 to 5 = OFF 3REF1 to 5 = OFF

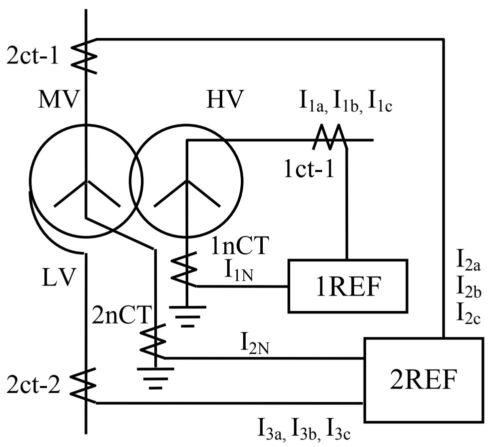
<table>
<tr><th>Type of transformer</th><th>Scheme switch setting</th></tr>
<tr><td>
</td><td>3REF = 1I0

1REF1 to 5 = OFF

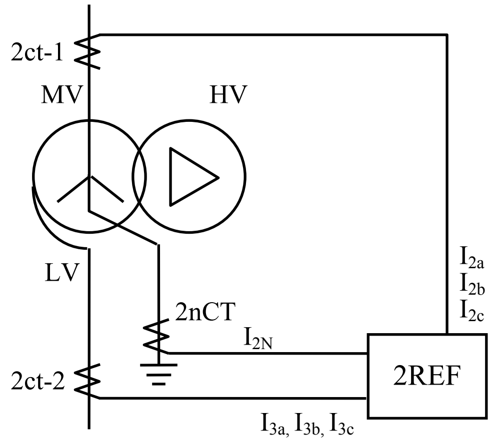
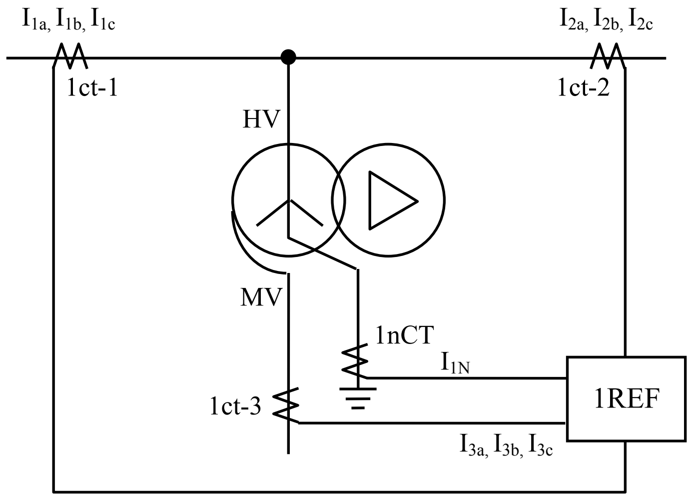
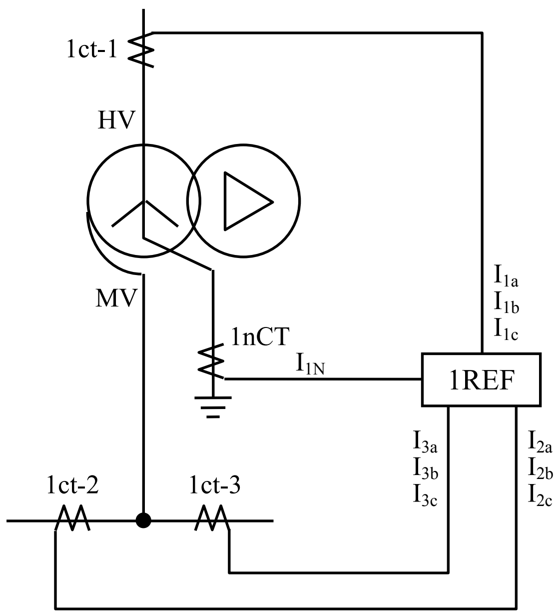
3REF1 to 5 = OFF</td></tr>
<tr><td>
</td><td>1REF = 2I0
3REF = 1I0

2REF1 to 5 = OFF</td></tr>
<tr><td>
</td><td>1REF = 2I0

2REF1 to 5 = OFF

3REF1 to 5 = OFF</td></tr>
<tr><td>
</td><td>1REF = 1I0
2REF = 2I0

3REF1 to 5 = OFF</td></tr>
</table>

Type of transformer	Scheme switch setting
	2REF = 2I0 1REF1 to 5 = OFF 3REF1 to 5 = OFF
	1REF = 3I0 2REF1 to 5 = OFF 3REF1 to 5 = OFF
	1REF = 3I0 2REF1 to 5 = OFF 3REF1 to 5 = OFF

Appendix M

Symbols Used in Scheme Logic

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

Signal names

Marked with [box] : Measuring element output signal

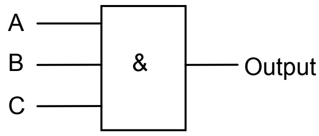
Marked with (rounded box) : Binary signal input from or output to the external equipment

Marked with [ ] : Scheme switch

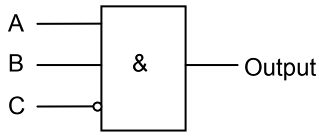
Marked with " " : Scheme switch position

Unmarked : Internal scheme logic signal

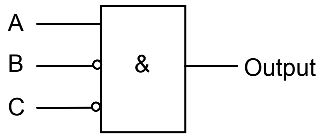
AND gates



A	B	C	Output
1	1	1	1
Other cases			0

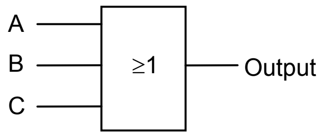


A	B	C	Output
1	1	0	1
Other cases			0

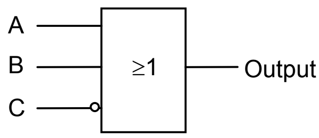


A	B	C	Output
1	0	0	1
Other cases			0

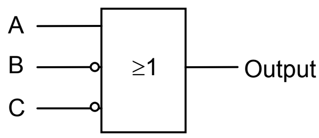
OR gates



A	B	C	Output
0	0	0	0
Other cases			1

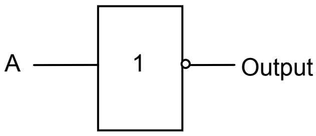


A	B	C	Output
0	0	1	0
Other cases			1



A	B	C	Output
0	1	1	0
Other cases			1

Signal inversion

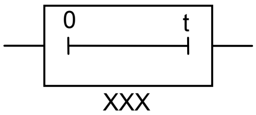


A	Output
0	1
1	0

Timer

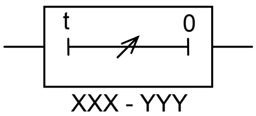
Delaye pick-up timer with fixed setting

XXX: Set time



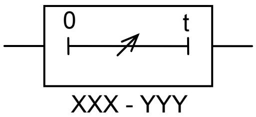
Delayed drop-off timer with fixed setting

XXX: Set time



Delaye pick-up timer with variable setting

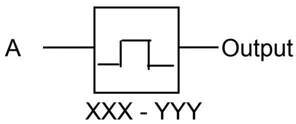
XXX - YYY: Setting range

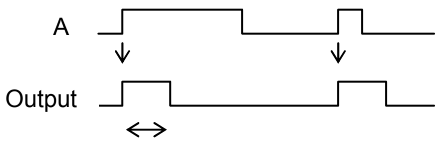


Delayed drop-off timer with variable setting

XXX - YYY: Setting range

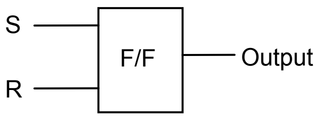
One-shot timer





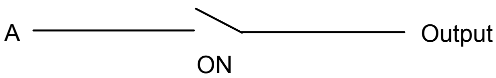
XXX - YYY: Setting range

Flip-flop

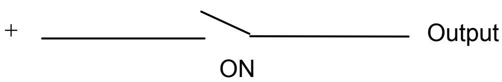


S	R	Output
0	0	No change
1	0	1
0	1	0
1	1	0

Scheme switch



A	Switch	Output
1	ON	1
Other cases		0



Switch	Output
ON	1
OFF	0

Appendix N

Implementation of Thermal Model to IEC60255-8

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:

θ = thermal state of the system as a percentage of allowable thermal capacity,

I = applied load current,

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

τ = thermal time constant of the system.

The thermal state θ 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 θ = 100%.

If current I is applied to a cold system, then θ will rise exponentially from 0% to ($I^2/I_{AOL}^2 \times 100\%$), with time constant τ, as in Figure N-1. If θ = 100%, then the allowable thermal capacity of the system has been reached.

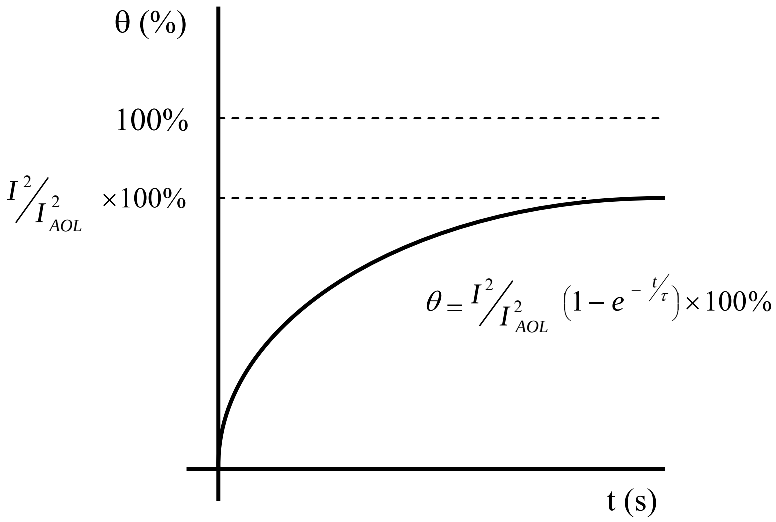


Figure N-1

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.

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 N-2 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.

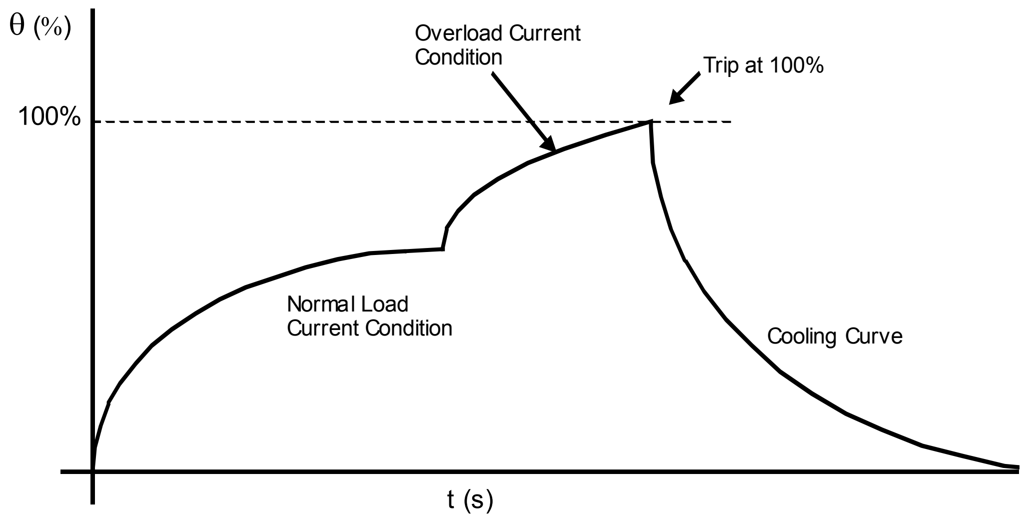


Figure N-2 (1) Thermal Curve without Prior Load Current

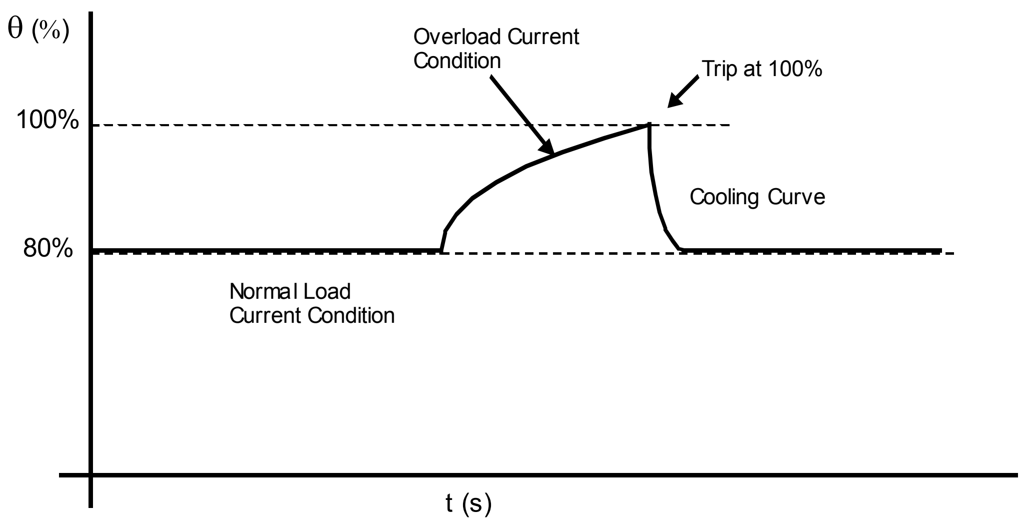


Figure N-2 (2) Thermal curve with Prior Load Current (θ=80%)

Appendix O

IEC60870-5-103: Interoperability and Troubleshooting

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.

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

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.6F2S0812.)

- 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’. 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.

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	176	--	--	--
3	Reset CU	Reset CU ACK	--	5	4	176	--	--	--
4	Start/Restart	Relay start/restart	--	5	5	176	--	--	--
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.	Not supported						
17	Teleprotection active	If protection using telecommunication is available, this item is set to active. If not, set to inactive.	Not supported						
18	Protection active	If the protection is available, this item is set to active. If not, set to inactive.	GI	1	1, 7, 9, 12, 20, 21	176	1413	1	2
19	LED reset	Reset of latched LEDs	--	1	1, 7, 11, 12, 20, 21	176	1409	--	2
20	Monitor direction blocked	Block the 103 transmission from a relay to control system. IECBLK: "Blocked" settimg.	GI	1	9, 11	176	1241	1	2
21	Test mode	Transmission of testmode situation froma relay to control system. IECTST "ON" setting.	GI	1	9, 11	176	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, 7, 9, 11, 12, 20, 21	176	1243	1	2
24	Characteristic2	Setting group 2 active	GI	1	1, 7, 9, 11, 12, 20, 21	176	1244	1	2
25	Characteristic3	Setting group 3 active	GI	1	1, 7, 9, 11, 12, 20, 21	176	1245	1	2
26	Characteristic4	Setting group 4 active	GI	1	1, 7, 9, 11, 12, 20, 21	176	1246	1	2
27	Auxiliary input1		No						
28	Auxiliary input2		No						
29	Auxiliary input3		No						
30	Auxiliary input4		No						
Supervision Indications									
32	Measurand supervision I	Zero sequence current supervision	GI	1	1, 7, 9	176	1271	1	2
33	Measurand supervision V	Zero sequence voltage supervision	Not supported						
35	Phase sequence supervision	Negative sequence voltage supevision	Not supported						
36	Trip circuit supervision	Output circuit supervision	Not supported						
37	I>>backup operation		Not supported						
38	VT fuse failure	VT failure	Not supported						
39	Teleprotection disturbed	CF(Communication system Fail) supervision	Not supported						
46	Group warning	Only alarming	GI	1	1, 7, 9	176	1258	1	2
47	Group alarm	Trip blocking and alarming	GI	1	1, 7, 9	176	1252	1	2
Earth Fault Indications									
48	Earth Fault L1	A phase earth fault	No						
49	Earth Fault L2	B phase earth fault	No						
50	Earth Fault L3	C phase earth fault	No						
51	Earth Fault Fwd	Earth fault forward	Not supported						
52	Earth Fault Rev	Earth fault reverse	Not supported						

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						
65	Start/pick-up L2	B phase, A-B phase or B-C phase element pick-up	No						
66	Start/pick-up L3	C phase, B-C phase or C-A phase element pick-up	No						
67	Start/pick-up N	Earth fault element pick-up	No						
68	General trip	Any trip	--	2	1, 7	176	1280	--	2
69	Trip L1	A phase, A-B phase or C-A phase trip	No						
70	Trip L2	B phase, A-B phase or B-C phase trip	No						
71	Trip L3	C phase, B-C phase or C-A phase trip	No						
72	Trip I>>(back-up)	Back up trip	Not supported						
73	Fault location X In ohms	Fault location (prim. [ohm] / second. [ohm] / km selectable by IECFL)	Not supported						
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	Not supported						
79	Zone2	Zone 2 trip	Not supported						
80	Zone3	Zone 3 trip	Not supported						
81	Zone4	Zone 4 trip	Not supported						
82	Zone5	Zone 5 trip	Not supported						
83	Zone6	Zone 6 trip	Not supported						
84	General Start/Pick-up	Any elements pick-up	No						
85	Breaker Failure	CBF trip or CBF retrip	Not supported						
86	Trip measuring system L1		No						
87	Trip measuring system L2		No						
88	Trip measuring system L3		No						
89	Trip measuring system E		No						
90	Trip I>	Inverse time OC trip	No						
91	Trip I>>	Definite time OC trip	No						
92	Trip IN>	Inverse time earth fault OC trip	No						
93	Trip IN>>	Definite time earth fault OC trip	No						
Autoreclose indications									
128	CB 'ON' by Autoreclose	CB close command output	Not supported						
129	CB 'ON' by long-time Autoreclose		Not supported						
130	Autoreclose Blocked	Autoreclose block	Not supported						

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	Ib1, Vab measurand <meaurand I>	--	3.2	2, 7	176	2
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	Ia1, Ib1, Ic1, f measurand <meaurand II>	--	9	2, 7	176	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	Tb1	Offset	Data type	Limit		Co eff
					Lower	Upper	
145	Ib1	1	28	short	0	4096	1.706666
	Vab	1	12	short	0	4096	3.413333
148	Ia1	1	24	short	0	4096	1.706666
	Ia2	1	28	short	0	4096	1.706666
	Ia3	1	32	short	0	4096	1.706666
	f	2	28	short	0	4096	0.0000833

INF	Description	Contents	IEC103 Configurator Default setting			
			COM	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		Not supported			
17	Teleprotection on/off		Not supported			
18	Protection on/off	(*1)	ON/OFF	20	20	176
19	LED reset	Reset indication of latched LEDs.	ON	20	20	176
23	Activate characteristic 1	Setting Group 1	ON	20	20	176
24	Activate characteristic 2	Setting Group 2	ON	20	20	176
25	Activate characteristic 3	Setting Group 3	ON	20	20	176
26	Activate characteristic 4	Setting Group 4	ON	20	20	176
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
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

	Description	Contents	GRT100 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	No	
	Voltage L2-E	Vb	No	
	Voltage L3-E	Vc	No	
	Active power P	P	No	
	Reactive power Q	Q	No	
	Frequency f	f	Configurable	
	Voltage L1 - L2	Vab	Configurable	

Details of Common settings in IEC103 configurator

- Setting file's remark: GRT100_1.00
- Remote operation valid time [ms]: 4000
- Local operation valid time [ms]: 4000
- Measurand period [s]: 2
- Function type of System functions: 176
- Signal No. of Test mode: 1242
- Signal No. for Real time and Fault number: 1279

[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)

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:

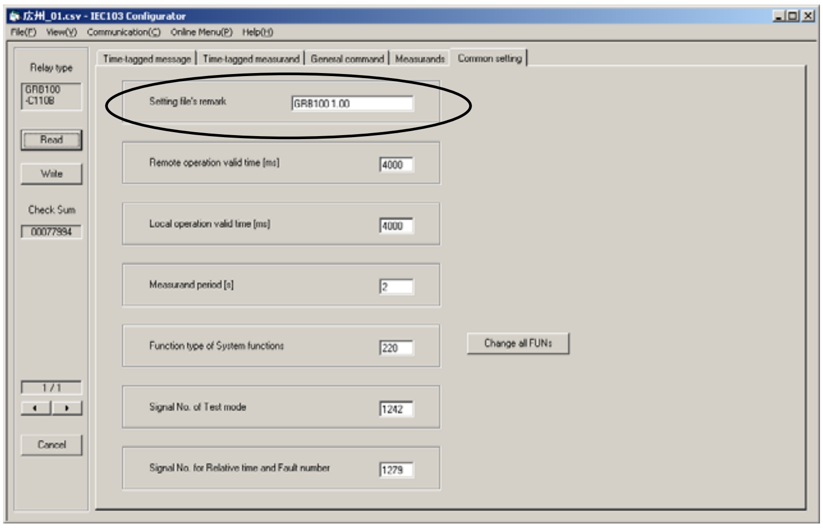
First draft: ******_01.csv

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.

Troubleshooting

No.	Phenomena	Supposed causes	Check / Confirmation	
			Object	Procedure
1	Communication trouble （IEC103 communication is not available.）	Address setting is incorrect.	BCU RY	Match address setting between BCU and relay. Avoid duplication of address with other relay.
		Transmission baud rate setting is incorrect.	BCU RY	Match transmission baud rate setting between BCU and relay.
		Start bit, stop bit and parity settings of data that BCU transmits to relay is incorrect.	BCU	Go over the following settings by BCU. Relay setting is fixed as following settings. - Start bit: 1bit - Stop bit: 1bit - Parity setting: even
		RS485 or optical cable interconnection is incorrect.	Cable	- Check the connection port. - Check the interconnection of RS485 A/B/COM - Check the send and received interconnection of optical cable.
		The setting of converter is incorrect. (RS485/optic conversion is executed with the transmission channel, etc.)	Converter	In the event of using G1IF2, change the DIPSW setting in reference to INSTRUCTION MANUAL (6F2S0794).
		The relationship between logical “0/1” of the signal and Sig.on/off is incorrect. (In the event of using optical cable)	BCU	Check the following; Logical0 : Sig.on Logical1:Sig.off
		Terminal resistor is not offered. (Especially when RS485 cable is long.)	cable	Impose terminal resistor (150[ohms]) to both ends of RS 485 cable.
		Relay cannot receive the requirement frame from BCU. (The timing coordination of sending and receiving switch control is irregular in half-duplex communication.)	BCU	Check to secure the margin more than 15ms between receiving the reply frame from the relay and transmitting the next requirement frame on BCU.
		The requirement frame from BCU and the reply frame from relay contend. (The sending and receiving timing coordination is irregular in half-duplex communication.)	BCU	Check to set the time-out of reply frame from the relay. Time-out setting: more than 100ms (acceptable value of response time 50ms plus margin)

2	HMI does not display IEC103 event on the SAS side.	The relevant event sending condition is not valid.	RY	Change the event sending condition (signal number) of 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 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

Appendix P

IEC61850: MICS & PICS

MICS: IEC61850 Model Implementation Conformance Statement

The GRT100 relay supports IEC 61850 logical nodes and common data classes as indicated in the following tables.

Logical nodes in IEC 61850-7-4

Logical Nodes	GRT100
L: System Logical Nodes	
LPHD	Yes
Common Logical Node	Yes
LLN0	Yes
P: Logical Nodes for Protection functions	
PDIF	Yes
PDIR	---
PDIS	---
PDOP	---
PDUP	---
PFRC	---
PHAR	Yes
PHIZ	---
PIOC	---
PMRI	---
PMSS	---
POPE	---
PPAM	---
PSCH	---
PSDE	---
PTEF	---
PTOC	Yes
PTOF	Yes
PTOV	---
PTRC	Yes
PTTR	Yes
PTUC	---
PTUV	---
PUPF	---
PTUF	Yes
PVOC	---
PVPH	Yes
PZSU	---
R: Logical Nodes for protection related functions	
RDRE	---
RADR	---
RBDR	---
RDRS	---
RBRF	---
RDIR	---
RFLO	---
RPSB	---
RREC	---
RSYN	---
C: Logical Nodes for Control	
CALH	---
CCGR	---
CILO	---
CPOW	---
CSWI	---
G: Logical Nodes for Generic references	
GAPC	Yes

GGIO	Yes
Nodes	GRT100
GSAL	---
I: Logical Nodes for Interfacing and archiving	
IARC	---
IHMI	---
ITCI	---
ITMI	---
A: Logical Nodes for Automatic control	
ANCR	---
ARCO	---
ATCC	---
AVCO	---
M: Logical Nodes for Metering and measurement	
MDIF	---
MHAI	---
MHAN	---
MMTR	---
MMXN	Yes
MMXU	Yes
MSQI	Yes
MSTA	---
S: Logical Nodes for Sensors and monitoring	
SARC	---
SIMG	---
SIML	---
SPDC	---
X: Logical Nodes for Switchgear	
XCBR	---
XSWI	---
T: Logical Nodes for Instrument transformers	
TCTR	---
TVTR	---
Y: Logical Nodes for Power transformers	
YEFN	---
YLTC	---
YPSH	---
YPTR	---
Z: Logical Nodes for Further power system equipment	
ZAXN	---
ZBAT	---
ZCAB	---
ZCAP	---
ZCON	---
ZGEN	---
ZGIL	---
ZLIN	---
ZMOT	---
ZREA	---
ZRRC	---
ZSAR	---
ZTCF	---
ZTCR	---

Common data classes in IEC61850-7-3

Common data classes	GRT100
Status information	
SPS	Yes
DPS	---
INS	Yes
ACT	Yes
ACD	Yes
SEC	---
BCR	---
Measured information	
MV	Yes
CMV	Yes
SAV	---
WYE	Yes
DEL	---
SEQ	Yes
HMV	---
HWYE	---
HDEL	---
Controllable status information	
SPC	Yes
DPC	---
INC	Yes
BSC	---
ISC	---
Controllable analogue information	
APC	---
Status settings	
SPG	---
ING	Yes
Analogue settings	
ASG	Yes
CURVE	---
Description information	
DPL	Yes
LPL	Yes
CSD	---

LPHD class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
PhyName	DPL	Physical device name plate		M	Y
PhyHealth	INS	Physical device health		M	Y
OutOv	SPS	Output communications buffer overflow		O	N
Proxy	SPS	Indicates if this LN is a proxy		M	Y
InOv	SPS	Input communications buffer overflow		O	N
NumPwrUp	INS	Number of Power ups		O	N
WrmStr	INS	Number of Warm Starts		O	N
WacTrg	INS	Number of watchdog device resets detected		O	N
PwrUp	SPS	Power Up detected		O	N
PwrDn	SPS	Power Down detected		O	N
PwrSupAlm	SPS	External power supply alarm		O	N
RsStat	SPC	Reset device statistics	T	O	N

Common Logical Node class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Mandatory Logical Node Information (Shall be inherited by ALL LN but LPHD)					
Mod	INC	Mode		M	Y
Beh	INS	Behaviour		M	Y
Health	INS	Health		M	Y
NamPlt	LPL	Name plate		M	Y
Optional Logical Node Information					
Loc	SPS	Local operation		O	N
EEHealth	INS	External equipment health		O	N
EEName	DPL	External equipment name plate		O	N
OpCntRs	INC	Operation counter resetable		O	N
OpCnt	INS	Operation counter		O	N
OpTmh	INS	Operation time		O	N
Data Sets (see IEC 61850-7-2)					
Inherited and pecialized from Logical Node class (see IEC 61850-7-2)					
Control Blocks (see IEC 61850-7-2)					
Inherited and pecialized from Logical Node class (see IEC 61850-7-2)					
Services (see IEC 61850-7-2)					
Inherited and pecialized from Logical Node class (see IEC 61850-7-2)					

LLNO class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
Loc	SPS	Local operation for complete logical device		O	Y
OpTmh	INS	Operation time		O	N
Controls					
Diag	SPC	Run Diagnostics		O	Y
LEDRs	SPC	LED reset	T	O	Y

PDIF class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resetable operation counter		O	N
Status Information					
Str	ACD	Start		M	Y
Op	ACT	Operate	T	M	Y
TmAst	CSD	Active curve charactristic		O	N
Measured Values					
DifAClc	WYE	Differential Current		O	Y
RstA	WYE	Restraint Current		O	N
Settings					
LinCapac	ASG	Line capacitance (for load currents)		O	N
LoSet	ING	Low operate value, percentage of the nominal current		O	N
HiSet	ING	High operate value, percentage of the nominal current		O	N
MinOpTmms	ING	Minimum Operate Time		O	N
MaxOpTmms	ING	Maximum Operate Time		O	N
RstMod	ING	Restraint Mode		O	N
RsDlTmms	ING	Reset Delay Time		O	N
TmACrv	CURVE	Operating Curve Type		O	N

PHAR class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resetable operation counter		O	N
Status Information					
Str	ACD	Start		M	Y
Settings					
HarRst	ING	Number of harmonic restrained		O	N
PhStr	ASG	Start Value		O	Y
PhStop	ASG	Stop Value		O	N
OpDlTmms	ING	Operate Delay Time		O	N
RsDlTmms	ING	Reset Delay Time		O	N

PTOC class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resetable operation counter		O	N
Status Information					
Str	ACD	Start		M	Y
Op	ACT	Operate	T	M	Y
TmASt	CSD	Active curve characteristic		O	N
Settings					
TmACrv	CURVE	Operating Curve Type		O	N
StrVal	ASG	Start Value		O	Y
TmMult	ASG	Time Dial Multiplier		O	N
MinOpTmms	ING	Minimum Operate Time		O	N
MaxOpTmms	ING	Maximum Operate Time		O	N
OpDlTmms	ING	Operate Delay Time		O	Y
TypRsCrv	ING	Type of Reset Curve		O	N
RsDlTmms	ING	Reset Delay Time		O	N
DirMod	ING	Directional Mode		O	N

PTOF class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resetable operation counter		O	N
Status Information					
Str	ACD	Start		M	Y
Op	ACT	Operate	T	M	Y
BlkV	SPS	Blocked because of voltage		O	Y
Settings					
StrVal	ASG	Start Value (frequency)		O	Y
BlkVal	ASG	Voltage Block Value		O	Y
OpDlTmms	ING	Operate Delay Time		O	Y
RsDlTmms	ING	Reset Delay Time		O	N

PTRC class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resetable operation counter		O	N
Status Information					
Tr	ACT	Trip		C	Y
Op	ACT	Operate (combination of subscribed Op from protection functions)		C	N
Str	ACD	Sum of all starts of all connected Logical Nodes		O	N
Settings					
TrMod	ING	Trip Mode		O	N
TrPlsTmms	ING	Trip Pulse Time		O	N

Condition C: At least one of the two status information (Tr, Op) shall be used.

PTTR class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resetable operation counter		O	N
Measured Values					
Amp	MV	Current for thermal load model		O	N
Tmp	MV	Temperature for thermal load		O	N
TmpRl	MV	Relation between temperature and max. temperature		O	N
LodRsvAlm	MV	Load reserve to alarm		O	N
LodRsvTr	MV	Load reserve to trip		O	N
AgeRat	MV	Ageing rate		O	N
Status Information					
Str	ACD	Start		O	Y
Op	ACT	Operate	T	M	Y
AlmThm	ACT	Thermal Alarm		O	Y
TmTmpSt	CSD	Active curve characteristic		O	N
TmASt	CSD	Active curve characteristic		O	N
Settings					
TmTmpCrv	CURVE	Characteristic Curve for temperature measurement		O	N
TmACrv	CURVE	Characteristic Curve for current measurement /Thermal model		O	N
TmpMax	ASG	Maximum allowed temperature		O	N
StrVal	ASG	Start Value		O	Y
OpDlTmms	ING	Operate Delay Time		O	N
MinOpTmms	ING	Minimum Operate Time		O	N
MaxOpTmms	ING	Maximum Operate Time		O	N
RsDlTmms	ING	Reset Delay Time		O	N
ConsTms	ING	Time constant of the thermal model		O	N
AlmVal	ASG	Alarm Value		O	N

PTUF class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resetable operation counter		O	N
Status Information					
Str	ACD	Start		M	Y
Op	ACT	Operate	T	M	Y
BlkV	SPS	Blocked because of voltage		O	Y
Settings					
StrVal	ASG	Start Value (frequency)		O	Y
BlkVal	ASG	Voltage Block Value		O	Y
OpDlTmms	ING	Operate Delay Time		O	Y
RsDlTmms	ING	Reset Delay Time		O	N

PVPH class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
OpCntRs	INC	Resetable operation counter		O	N
Status Information					
Str	ACD	Start		M	Y
Op	ACT	Operate	T	M	Y
VHzSt	CSD	Active curve characteristic		O	N
Settings					
VHzCrv	CURVE	Operating Curve Type		O	N
StrVal	ASG	Volts per hertz Start Value		O	Y
OpDlTmms	ING	Operate Delay Time		O	Y
TypRsCrv	ING	Type of Reset Curve		O	N
RsDlTmms	ING	Reset Delay Time		O	N
TmMult	ASG	Time Dial Multiplier		O	N
MinOpTmms	ING	Minimum Operate Time		O	N
MaxOpTmms	ING	Maximum Operate Time		O	N

GAPC class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
Loc	SPS	Local operation		O	N
OpCntRs	INC	Resetable operation counter		O	N
Controls					
SPCSO	SPC	Single point controllable status output		O	N
DPCSO	DPC	Double point controllable status output		O	N
ISCSO	INC	Integer status controllable status output		O	N
Status Information					
Auto	SPS	Automatic operation		O	N
Str	ACD	Start		M	Y
Op	ACT	Operate	T	M	Y
Setting					
StrVal	ASG	Start Value		O	N

GGIO class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
EEHealth	INS	External equipment health (external sensor)		O	N
EEName	DPL	External equipment name plate		O	N
Loc	SPS	Local operation		O	N
OpCntRs	INC	Resetable operation counter		O	N
Measured values					
AnIn	MV	Analogue input		O	N
Controls					
SPCSO	SPC	Single point controllable status output		O	N
DPCSO	DPC	Double point controllable status output		O	N
ISCSO	INC	Integer status controllable status output		O	N
Status Information					
IntIn	INS	Integer status input		O	N
Alm	SPS	General single alarm		O	N
Ind01	SPS	General indication (binary input)		O	Y
Ind02	SPS	General indication (binary input)		O	Y
Ind03	SPS	General indication (binary input)		O	Y
Ind04	SPS	General indication (binary input)		O	Y
Ind05	SPS	General indication (binary input)		O	Y
Ind06	SPS	General indication (binary input)		O	Y
Ind07	SPS	General indication (binary input)		O	Y
Ind08	SPS	General indication (binary input)		O	Y
Ind09	SPS	General indication (binary input)		O	Y
Ind10	SPS	General indication (binary input)		O	Y
Ind11	SPS	General indication (binary input)		O	Y
Ind12	SPS	General indication (binary input)		O	Y
Ind13	SPS	General indication (binary input)		O	Y
Ind14	SPS	General indication (binary input)		O	Y
Ind15	SPS	General indication (binary input)		O	Y
Ind16	SPS	General indication (binary input)		O	Y
Ind17	SPS	General indication (binary input)		O	Y
Ind18	SPS	General indication (binary input)		O	Y
Ind19	SPS	General indication (binary input)		O	Y
Ind20	SPS	General indication (binary input)		O	Y
Ind21	SPS	General indication (binary input)		O	Y
Ind22	SPS	General indication (binary input)		O	Y
Ind23	SPS	General indication (binary input)		O	Y
Ind24	SPS	General indication (binary input)		O	Y
Ind25	SPS	General indication (binary input)		O	Y
Ind26	SPS	General indication (binary input)		O	Y

MMXN class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
EEHealth	INS	External equipment health (external sensor)		O	N
EEName	DPL	External equipment name plate		O	N
Measured values					
Amp	MV	Current I (rms) not allocated to a phase		O	N
Vol	MV	Voltage V (rms) not allocated to a phase		O	Y
Watt	MV	Power (P) not allocated to a phase		O	N
VolAmpr	MV	Reactive Power (Q) not allocated to a phase		O	N
VolAmp	MV	Apparent Power (S) not allocated to a phase		O	N
PwrFact	MV	Power Factor not allocated to a phase		O	N
Imp	CMV	Impedance		O	N
Hz	MV	Frequency		O	Y

MMXU class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
EEHealth	INS	External equipment health (external sensor)		O	N
Measured values					
TotW	MV	Total Active Power (Total P)		O	N
TotVAr	MV	Total Reactive Power (Total Q)		O	N
TotVA	MV	Total Apparent Power (Total S)		O	N
TotPF	MV	Average Power factor (Total PF)		O	N
Hz	MV	Frequency		O	N
PPV	DEL	Phase to phase voltages (VL1VL2, …)		O	N
PhV	WYE	Phase to ground voltages (VL1ER, …)		O	N
A	WYE	Phase currents (IL1, IL2, IL3)		O	Y
W	WYE	Phase active power (P)		O	N
VAr	WYE	Phase reactive power (Q)		O	N
VA	WYE	Phase apparent power (S)		O	N
PF	WYE	Phase power factor		O	N
Z	WYE	Phase Impedance		O	N

MSQI class					
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**	**GRT100**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)			
Data					
Common Logical Node Information					
		LN shall inherit all Mandatory Data from Common Logical Node Class		M	
EEHealth	INS	External equipment health (external sensor)		O	N
EEName	DPL	External equipment name plate		O	N
Measured values					
SeqA	SEQ	Positive, Negative and Zero Sequence Current		C	Y
SeqV	SEQ	Positive, Negative and Zero Sequence Voltage		C	N
DQ0Seq	SEQ	DQ0 Sequence		O	N
ImbA	WYE	Imbalance current		O	N
ImbNgA	MV	Imbalance negative sequence current		O	N
ImbNgV	MV	Imbalance negative sequence voltage		O	N
ImbPPV	DEL	Imbalance phase-phase voltage		O	N
ImbV	WYE	Imbalance voltage		O	N
ImbZroA	MV	Imbalance zero sequence current		O	N
ImbZroV	MV	Imbalance zero sequence voltage		O	N
MaxImbA	MV	Maximum imbalance current		O	N
MaxImbPPV	MV	Maximum imbalance phase-phase voltage		O	N
MaxImbV	MV	Maximum imbalance voltage		O	N

Condition C: At least one of either data shall be used.

SPS class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRT100**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
status						
stVal	BOOLEAN	ST	dchg	TRUE | FALSE	M	Y
q	Quality	ST	qchg		M	Y
t	TimeStamp	ST			M	Y
substitution						
subEna	BOOLEAN	SV			PICS_SUBST	N
subVal	BOOLEAN	SV		TRUE | FALSE	PICS_SUBST	N
subQ	Quality	SV			PICS_SUBST	N
subID	VISIBLE STRING64	SV			PICS_SUBST	N
configuration, description and extension						
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 13						

INS class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRT100**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
status						
stVal	INT32	ST	dchg		M	Y(*1)
q	Quality	ST	qchg		M	Y
t	TimeStamp	ST			M	Y
Substitution						
subEna	BOOLEAN	SV			PICS_SUBST	N
subVal	INT32	SV			PICS_SUBST	N
subQ	Quality	SV			PICS_SUBST	N
subID	VISIBLE STRING64	SV			PICS_SUBST	N
configuration, description and extension						
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 13						

(*1): "ENUM" type is also used.

ACT class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRT100**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
status						
general	BOOLEAN	ST	dchg		M	Y
phsA	BOOLEAN	ST	dchg		O	N
phsB	BOOLEAN	ST	dchg		O	N
phsC	BOOLEAN	ST	dchg		O	N
neut	BOOLEAN	ST	dchg		O	N
q	Quality	ST	qchg		M	Y
t	TimeStamp	ST			M	Y
configuration, description and extension						
operTm	TimeStamp	CF			O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 13						

ACD class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRT100**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
status						
general	BOOLEAN	ST	dchg		M	Y
dirGeneral	ENUMERATED	ST	dchg	unknown | forward | backward | both	M	Y
phsA	BOOLEAN	ST	dchg		GC_2 (1)	N
dirPhsA	ENUMERATED	ST	dchg	unknown | forward | backward	GC_2 (1)	N
phsB	BOOLEAN	ST	dchg		GC_2 (2)	N
dirPhsB	ENUMERATED	ST	dchg	unknown | forward | backward	GC_2 (2)	N
phsC	BOOLEAN	ST	dchg		GC_2 (3)	N
dirPhsC	ENUMERATED	ST	dchg	unknown | forward | backward	GC_2 (3)	N
neut	BOOLEAN	ST	dchg		GC_2 (4)	N
dirNeut	ENUMERATED	ST	dchg	unknown | forward | backward	GC_2 (4)	N
q	Quality	ST	qchg		M	Y
t	TimeStamp	ST			M	Y
configuration, description and extension						
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 13						

MV class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRT100**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
				measured values		
instMag	AnalogueValue	MX			O	N
mag	AnalogueValue	MX	dchg		M	Y
range	ENUMERATED	MX	dchg	normal | high | low | high-high | low-low |…	O	N
q	Quality	MX	qchg		M	Y
t	TimeStamp	MX			M	Y
				substitution		
subEna	BOOLEAN	SV			PICS_SUBST	N
subVal	AnalogueValue	SV			PICS_SUBST	N
subQ	Quality	SV			PICS_SUBST	N
subID	VISIBLE STRING64	SV			PICS_SUBST	N
				configuration, description and extension		
units	Unit	CF		see Annex A	O	Y
db	INT32U	CF		0 … 100 000	O	N
zeroDb	INT32U	CF		0 … 100 000	O	N
sVC	ScaledValueConfig	CF			AC_SCAV	N
rangeC	RangeConfig	CF			GC_CON	N
smpRate	INT32U	CF			O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 21						

CMV class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRT100**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
measured values						
instCVal	Vector	MX			O	N
cVal	Vector	MX	dchg		M	Y
range	ENUMERATED	MX	dchg	normal | high | low | high-high | low-low |…	O	N
q	Quality	MX	qchg		M	Y
t	TimeStamp	MX			M	Y
substitution						
subEna	BOOLEAN	SV			PICS_SUBST	N
subVal	Vector	SV			PICS_SUBST	N
subQ	Quality	SV			PICS_SUBST	N
subID	VISIBLE STRING64	SV			PICS_SUBST	N
configuration, description and extension						
units	Unit	CF		see Annex A	O	Y
db	INT32U	CF		0 … 100 000	O	N
zeroDb	INT32U	CF		0 … 100 000	O	N
rangeC	RangeConfig	CF			GC_CON	N
magSVC	ScaledValueConfig	CF			AC_SCAV	N
angSVC	ScaledValueConfig	CF			AC_SCAV	N
angRef	ENUMERATED	CF		V | A | other …	O	N
smpRate	INT32U	CF			O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 21						

WYE class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRT100**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
Data						
phsA	CMV				GC_1	Y
phsB	CMV				GC_1	Y
phsC	CMV				GC_1	Y
neut	CMV				GC_1	Y
net	CMV				GC_1	N
res	CMV				GC_1	N
DataAttribute						
configuration, description and extension						
angRef	ENUMERATED	CF		Va | Vb | Vc | Aa | Ab | Ac | Vab | Vbc | Vca | Vother | Aother	O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 21						

SEQ class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRT100**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
Data						
c1	CMV				M	Y
c2	CMV				M	Y
c3	CMV				M	Y
DataAttribute						
measured attributes						
seqT	ENUMERATED	MX		pos-neg-zero | dir-quad-zero	M	Y
configuration, description and extension						
phsRef	ENUMERATED	CF		A | B | C | …	O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 21						

SPC class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRT100**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
control and status						
ctlVal	BOOLEAN	CO		off (FALSE) | on (TRUE)	AC_CO_M	N
operTm	TimeStamp	CO			AC_CO_O	N
origin	Originator	CO, ST			AC_CO_O	Y
ctlNum	INT8U_RO	CO, ST		0..255	AC_CO_O	N
SBO	VISIBLE STRING65	CO			AC_CO_SBO_N_M	N
SBOw	SBOW	CO			AC_CO_SBOW_E_M	N
Oper	Oper	CO			AC_CO_M	Y
Cancel	Cancel	CO			AC_CO_SBO_N_M and AC_CO_SBOW_E_M and AC_CO_TA_E_M	N
stVal	BOOLEAN	ST	dchg	FALSE | TRUE	AC_ST	Y
q	Quality	ST	qchg		AC_ST	Y
t	TimeStamp	ST			AC_ST	Y
stSeld	BOOLEAN	ST	dchg		AC_CO_O	N
substitution						
subEna	BOOLEAN	SV			PICS_SUBST	N
subVal	BOOLEAN	SV		FALSE | TRUE	PICS_SUBST	N
subQ	Quality	SV			PICS_SUBST	N
subID	VISIBLE STRING64	SV			PICS_SUBST	N
configuration, description and extension						
pulseConfig	PulseConfig	CF			AC_CO_O	N
CtlModel	CtlModels	CF			M	Y
sboTimeout	INT32U	CF			AC_CO_O	N
sboClass	SboClasses	CF			AC_CO_O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 31						

INC class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRT100**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
			control and status			
ctlVal	INT32	CO			AC_CO_M	Y(*2)
operTm	TimeStamp	CO			AC_CO_O	N
origin	Originator	CO, ST			AC_CO_O	N
ctlNum	INT8U	CO, ST		0..255	AC_CO_O	N
SBO	VISIBLE STRING65	CO			AC_CO_SBO_N_M	N
SBOw	SBOW	CO			AC_CO_SBOW_E_M	N
Oper	Oper	CO			AC_CO _M	N
Cancel	Cancel	CO			AC_CO_SBO_N_M and AC_CO_SBOW_E_M and AC_CO_TA_E_M	N
stVal	INT32	ST	dchg		M	Y
Q	Quality	ST	qchg		M	Y
T	TimeStamp	ST			M	Y
stSeld	BOOLEAN	ST	dchg		AC_CO_O	N
			substitution			
subEna	BOOLEAN	SV			PICS_SUBST	N
subVal	INT32	SV		FALSE | TRUE	PICS_SUBST	N
subQ	Quality	SV			PICS_SUBST	N
subID	VISIBLE STRING64	SV			PICS_SUBST	N
			configuration, description and extension			
CtlModel	CtlModels	CF			M	Y
sboTimeout	INT32U	CF			AC_CO_O	N
sboClass	SboClasses	CF			AC_CO_O	N
minVal	INT32	CF			O	N
maxVal	INT32	CF			O	N
stepSize	INT32U	CF		1 … (maxVal – minVal)	O	N
D	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 31						

(*2): "ENUM" type is used.

ING class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRT100**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
setting						
setVal	INT32	SP			AC_NSG_M	Y(*3)
setVal	INT32	SG, SE			AC_SG_M	N
configuration, description and extension						
minVal	INT32	CF			O	N
maxVal	INT32	CF			O	N
stepSize	INT32U	CF		1 … (maxVal – minVal)	O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 39						

(*3): "ENUM" type is also used.

ASG class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRT100**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
setting						
setMag	AnalogueValue	SP			AC_NSG_M	Y
setMag	AnalogueValue	SG, SE			AC_SG_M	N
configuration, description and extension						
units	Unit	CF		see Annex A	O	Y
sVC	ScaledValueConfig	CF			AC_SCAV	Y
minVal	AnalogueValue	CF			O	N
maxVal	AnalogueValue	CF			O	N
stepSize	AnalogueValue	CF		1 … (maxVal – minVal)	O	N
d	VISIBLE STRING255	DC		Text	O	N
dU	UNICODE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 42						

DPL class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRT100**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
				configuration, description and extension		
vendor	VISIBLE STRING255	DC			M	Y
hwRev	VISIBLE STRING255	DC			O	N
swRev	VISIBLE STRING255	DC			O	Y
serNum	VISIBLE STRING255	DC			O	N
model	VISIBLE STRING255	DC			O	Y
location	VISIBLE STRING255	DC			O	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 45						

LPL class						
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**	**GRT100**
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
				configuration, description and extension		
vendor	VISIBLE STRING255	DC			M	Y
swRev	VISIBLE STRING255	DC			M	Y
d	VISIBLE STRING255	DC			M	Y
dU	UNICODE STRING255	DC			O	N
configRev	VISIBLE STRING255	DC			AC_LN0_M	Y
ldNs	VISIBLE STRING255	EX		shall be included in **LLN0** only; for example "IEC 61850-7-4:2003"	AC_LN0_EX	N
lnNs	VISIBLE STRING255	EX			AC_DLD_M	N
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M	N
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M	N
dataNs	VISIBLE STRING255	EX			AC_DLN_M	N
Services						
As defined in Table 45						

PICS: IEC61850 ASCI Conformance Statement

		Client/ subscriber	Server/ publisher	GRT100	Remarks
Client-server roles					
B11	Server side (of TWO-PARTY-APPLICATION-ASSOCIATION)	-	c1	Y	
B12	Client side of (TWO-PARTY-APPLICATION-ASSOCIATION)	c1	-	-	
SCSMs supported					
B21	SCSM: IEC61850-8-1 used			Y	
B22	SCSM: IEC61850-9-1 used			N	
B23	SCSM: IEC61850-9-2 used			N	
B24	SCSM: other			-	
Generic substation event model (GSE)					
B31	Publisher side	-	O	Y	
B32	Subscriber side	O	-	Y	
Transmission of sampled value model (SVC)					
B41	Publisher side	-	O	N	
B42	Subscriber side	O	-	N	
If Server side (B11) supported					
M1	Logical device	c2	c2	Y	
M2	Logical node	c3	c3	Y	
M3	Data	c4	c4	Y	
M4	Data set	c5	c5	Y	
M5	Substitution	O	O	N	
M6	Setting group control	O	O	Y	
	Reporting				
M7	Buffered report control	O	O	Y	
M7-1	sequence-number			Y	
M7-2	report-time-stamp			Y	
M7-3	reason-for-inclusion			Y	
M7-4	data-set-name			Y	
M7-5	data-reference			Y	
M7-6	buffer-overflow			Y	
M7-7	entryID			Y	
M7-8	BufTm			Y	
M7-9	IntgPd			Y	
M7-10	GI			Y	
	Unbuffered report control	O	O	Y	
M8-1	sequence-number			Y	
M8-2	report-time-stamp			Y	
M8-3	reason-for-inclusion			Y	
M8-4	data-set-name			Y	
M8-5	data-reference			Y	
M8-6	BufTm			Y	
M8-7	IntgPd			Y	
M8-8	GI			Y	
	Logging	O	O	N	
M9	Log control	O	O	N	
M9-1	IntgPd			N	
M10	Log	O	O	N	
M11	Control	M	M	Y	
If GSE (B31/B32) is supported					
	GOOSE	O	O	Y	
~~M12-1~~	~~entryID~~				

~~M12-2~~	~~DataRefInc~~				
M13	GSSE	O	O	N	
If SVC (B41/B42) is supported					
M14	Multicast SVC	O	O	N	
M15	Unicast SVC	O	O	N	
M16	Time	M	M	Y	
M17	File Transfer	O	O	Y	
Server					
S1	ServerDirectory		M	Y	
Application association					
S2	Associate	M	M	Y	
S3	Abort	M	M	Y	
S4	Release	M	M	Y	
Logical device					
S5	LogicalDeviceDirectory	M	M	Y	
Logical node					
S6	LogicalNodeDirectory	M	M	Y	
S7	GetAllDataValues	O	M	Y	
Data					
S8	GetDataValues	M	M	Y	
S9	SetDataValues	O	O	N	
S10	GetDataDirectory	O	M	Y	
S11	GetDataDefinition	O	M	Y	
Data set					
S12	GetDataSetValues	O	M	Y	
S13	SetDataSetValues	O	O	N	
S14	CreateDataSet	O	O	N	
S15	DeleteDataSet	O	O	N	
S16	GetDataSetDirectory	O	O	Y	
Substitution					
S17	SetDataValues	M	M	N	
Setting group control					
S18	SelectActiveSG	O	O	Y	
S19	SelectEditSG	O	O	N	
S20	SetSGValues	O	O	N	
S21	ConfirmEditSGValues	O	O	N	
S22	GetSGValues	O	O	N	
S23	GetSGCBValues	O	O	Y	
Reporting					
Buffered report control block (BRCB)					
S24	Report	c6	c6	Y	
S24-1	data-change (dchg)			Y	
S24-2	quality-change (qchg)			Y	
S24-3	data-update (dupd)			N	
S25	GetBRCBValues	c6	c6	Y	
S26	SetBRCBValues	c6	c6	Y	
Unbuffered report control block (BRCB)					
S27	Report	c6	c6	Y	
S27-1	data-change (dchg)			Y	
S27-2	quality-change (qchg)			Y	
S27-3	data-update (dupd)			N	
S28	GetURCBValues	c6	c6	Y	
S29	SetURCBValues	c6	c6	Y	
Logging					
Log control block					
S30	GetLCBValues	M	M	N	

S31	SetLCBValues	O	M	N	
Log					
S32	QueryLogByTime	c7	M	N	
S33	QueryLogAfter	c7	M	N	
S34	GetLogStatusValues	M	M	N	
Generic substation event model (GSE)					
GOOSE-CONTROL-BLOCK					
S35	SendGOOSEMessage	c8	c8	Y	
S36	GetGoReference	O	c9	N	
S37	GetGOOSEElementNumber	O	c9	N	
S38	GetGoCBValues	O	O	Y	
S39	SetGoCBValues	O	O	Y	
GSSE-CONTROL-BLOCK					
S40	SendGSSEMessage	c8	c8	N	
S41	GetGsReference	O	c9	N	
S42	GetGSSEElementNumber	O	c9	N	
S43	GetGsCBValues	O	O	N	
S44	SetGsCBValues	O	O	N	
Transmission of sampled value model (SVC)					
Multicast SVC					
S45	SendMSVMessage	c10	c10	N	
S46	GetMSVCBValues	O	O	N	
S47	SetMSVCBValues	O	O	N	
Unicast SVC					
S48	SendUSVMessage	c10	c10	N	
S49	GetUSVCBValues	O	O	N	
S50	SetUSVCBValues	O	O	N	
Control					
S51	Select	M	O	N	
S52	SelectWithValue	M	O	N	
S53	Cancel	O	O	N	
S54	Operate	M	M	Y	
S55	CommandTermination	M	O	Y	
S56	TimeActivatedOperate	O	O	N	
File Transfer					
S57	GetFile	O	M	Y	
S58	SetFile	O	O	N	
S59	DeleteFile	O	O	N	
S60	GetFileAttributeValues	O	O	Y	
Time					
T1	Time resolution of internal clock			1ms	
T2	Time accuracy of internal clock			1ms	T1
T3	Supported TimeStamp resolution			1ms	

M – Mandatory
O – Optional
c1 – shall be ‘M’ if support for LOGICAL-DEVICE model has been declared.
c2 – shall be ‘M’ if support for LOGICAL-NODE model has been declared.
c3 – shall be ‘M’ if support for DATA model has been declared.
c4 – shall be ‘M’ if support for DATA-SET, Substitution, Report, Log Control, or Time model has been declared.
c5 – shall be ‘M’ if support for Report, GSE, or SV models has been declared.
c6 – shall declare support for at least one (BRCB or URCB)
c7 – shall declare support for at least one (QueryLogByTime or QueryLogAfter).
c8 – shall declare support for at least one (SendGOOSEMessage or SendGSSEMessage)
c9 – shall declare support if TWO-PARTY association is available.

c10 – shall declare support for at least one (SendMSVMessage or SendUSVMessage).

PICS for A-Profile support

A-Profile shortcut	Profile Description	Client		Server		GRT100	Remarks
		F/S		F/S			
A1	Client/server A-Profile	c1		c1		Y	
A2	GOOSE/GSE management A-Profile	c2		c2		Y	
A3	GSSE A-Profile	c3		c3		N	
A4	TimeSync A-Profile	c4		c4		Y	

c1 Shall be 'm' if support for any service specified in Table 2 are declared within the ACSI basic conformance statement.
c2 Shall be 'm' if support for any service specified in Table 6 are declared within the ACSI basic conformance statement.
c3 Shall be 'm' if support for any service specified in Table 9 are declared within the ACSI basic conformance statement.
c4 Support for at least one other A-Profile shall be declared (e.g. in A1-A3) in order to claim conformance to IEC 61850-8-1.

PICS for T-Profile support

A-Profile shortcut	Profile Description	Client		Server		GRT100	Remarks
		F/S		F/S			
T1	TCP/IP T-Profile	c1		c1		Y	
T2	OSI T-Profile	c2		c2		N	
T3	GOOSE/GSE T-Profile	c3		c3		Y	
T4	GSSE T-Profile	c4		c4		N	
T5	TimeSync T-Profile	o		o		Y	

c1 Shall be 'm' if support for A1 is declared. Otherwise, shall be 'i'.
c2 Shall be 'o' if support for A1 is declared. Otherwise, shall be 'i'.
c3 Shall be 'm' if support for A2 is declared. Otherwise, shall be 'i.
c4 Shall be 'm' if support for A3 is declared. Otherwise, shall be 'i.

MMS InitiateRequest general parameters

InitiateRequest	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
InitiateRequest							
localDetailCalling	m	m		m	m		Y
proposedMaxServOutstandingCalling	m	m	1 or greater	m	m	1 or greater	Y
proposedMaxServOustandingCalled	m	m	1 or greater	m	m	1 or greater	Y
initRequestDetail	m	m		m	m		Y
InitiateRequestDetail							
proposedVersionNumber	m	m	shall be 2.1	m	m	shall be 2.1	Y
proposedParameterCBB	m	m		m	m		Y
servicesSupportedCalling	m	m		m	m		Y
additionalSupportedCalling	c1	x		c1	x		N
additionalCbbSupportedCalling	c1	x		c1	x		N
privilegeClassIdentityCalling	c1	x		c1	x		N
c1 Conditional upon Parameter CBB CSPI							

MMS InitiateResponse general parameters

InitiateRequest	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
InitiateResponse							
localDetailCalled	m	m		m	m		Y
negotiatedMaxServOutstandingCalling	m	m	1 or greater	m	m	1 or greater	Y
negotiatedMaxServOustandingCalled	m	m	1 or greater	m	m	1 or greater	Y
initResponseDetail	m	m		m	m		Y
InitiateResponseDetail							
negotiatedVersionNumber	m	m	shall be 2.1	m	m	shall be 2.1	Y
negotiatedParameterCBB	m	m		m	m		Y
servicesSupportedCalled	m	m		m	m		Y
additionalSupportedCalled	c1	x		c1	x		N
additionalCbbSupportedCalled	c1	x		c1	x		N
privilegeClassIdentityCalled	c1	x		c1	x		N
c1 Conditional upon Parameter CBB CSPI							

MMS service supported conformance table

MMS service supported CBB	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
status	o	o		o	m		Y
getNameList	o	o		o	c1		Y
identify	o	o		m	m		Y
rename	o	o		o	o		N
read	o	o		o	c2		Y
write	o	o		o	c3		Y
getVariableAccessAttributes	o	o		o	c4		Y
defineNamedVariable	o	o		o	o		N
defineScatteredAccess	o	i		o	i		N
getScatteredAccessAttributes	o	i		o	i		N
deleteVariableAccess	o	o		o	o		N
defineNamedVariableList	o	o		o	o		N
getNamedVariableListAttributes	o	o		o	c5		Y
deleteNamedVariableList	o	o		o	c6		N
defineNamedType	o	i		o	i		N
getNamedTypeAttributes	o	i		o	i		N
deleteNamedType	o	i		o	i		N
input	o	i		o	i		N
output	o	i		o	i		N
takeControl	o	i		o	i		N
relinquishControl	o	i		o	i		N
defineSemaphore	o	i		o	i		N
deleteSemaphore	o	i		o	i		N
reportPoolSemaphoreStatus	o	i		o	i		N
reportSemaphoreStatus	o	i		o	i		N
initiateDownloadSequence	o	i		o	i		N
downloadSegment	o	i		o	i		N
terminateDownloadSequence	o	i		o	i		N
initiateUploadSequence	o	i		o	i		N
uploadSegment	o	i		o	i		N
terminateUploadSequence	o	i		o	i		N
requestDomainDownload	o	i		o	i		N
requestDomainUpload	o	i		o	i		N
loadDomainContent	o	i		o	i		N
storeDomainContent	o	i		o	i		N
deleteDomain	o	i		o	i		N
getDomainAttributes	o	o		o	c14		Y
createProgramInvocation	o	i		o	i		N

MMS service supported CBB	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
deleteProgramInvocation	o	i		o	i		N
start	o	i		o	i		N
stop	o	i		o	i		N
resume	o	i		o	i		N
reset	o	i		o	i		N
kill	o	i		o	i		N
getProgramInvocationAttributes	o	i		o	i		N
obtainFile	o	c9		o	c9		N
defineEventCondition	o	i		o	i		N
deleteEventCondition	o	i		o	i		N
getEventConditionAttributes	o	i		o	i		N
reportEventConditionStatus	o	i		o	i		N
alterEventConditionMonitoring	o	i		o	i		N
triggerEvent	o	i		o	i		N
defineEventAction	o	i		o	i		N
deleteEventAction	o	i		o	i		N
alterEventEnrollment	o	i		o	i		N
reportEventEnrollmentStatus	o	i		o	i		N
getEventEnrollmentAttributes	o	i		o	i		N
acknowledgeEventNotification	o	i		o	i		N
getAlarmSummary	o	i		o	i		N
getAlarmEnrollmentSummary	o	i		o	i		N
readJournal	o	c13		o	c13		N
writeJournal	o	o		o	o		N
initializeJournal	o	o		o	c12		N
reportJournalStatus	o	i		o	i		N
createJournal	o	i		o	i		N
deleteJournal	o	i		o	i		N
fileOpen	o	c8		o	c8		Y
fileRead	o	c8		o	c8		Y
fileClose	o	c8		o	c8		Y
fileRename	o	i		o	i		N
fileDelete	o	c9		o	c9		N
fileDirectory	o	c11		o	c11		Y
unsolicitedStatus	o	i		o	i		N
informationReport	o	c7		o	c7		Y
eventNotification	o	i		o	i		N
attachToEventCondition	o	i		o	i		N
attachToSemaphore	o	i		o	i		N
conclude	m	m		m	m		N
cancel	o	o		o	m		N
getDataExchangeAttributes	o	c10		o	c10		N
exchangeData	o	c10		o	c10		N

MMS service supported CBB	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
defineAccessControlList	o	c10		o	c10		N
getAccessControlListAttributes	o	c10		o	c10		N
reportAccessControlledObjects	o	c10		o	c10		N
deleteAccessControlList	o	c10		o	c10		N
alterAccessControl	o	c10		o	c10		N
reconfigureProgramInvocation	o	c10		o	c10		N

c1 Shall be ‘m’ if logical device or logical node model support is declared in ACSI basic conformance statement.
c2 Shall be ‘m’ if logical node model support is declared in ACSI basic conformance statement or if support for the MMS write service is declared.
c3 Shall be ‘m’ if ACSI support for SetDataValues service is declared or implied.
c4 Shall be ‘m’ if logical node model support is declared in ACSI basic conformance statement.
c5 Shall be ‘m’ if data set support is declared in the ACSI basic conformance statement.
c6 Shall be ‘m’ if support for defineNamedVariableList is declared.
c7 Shall be 'm' if support for ACSI Report or ACSI command termination is declared.
c8 Shall be 'm' if support for ACSI GetFile is declared.
c9 Shall be 'm' if support for ACSI SetFile is declared.
c10 Shall not be present since MMS minor version is declared to be 1.
c11 Shall be 'm' if support for ACSI GetFileAttributeValues is declared.
c12 Shall be 'm' if support for the ACSI log model is declared.
c13 Shall be 'm' if support for the ACSI QueryLogByTime or QueryLogAfter is declared.
c14 Shall be 'm' if support for the ACSI logical device model is declared.

MMS Parameter CBB

MMS parameter CBB	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
STR1	o	o		o	c1		Y
STR2	o	o		o	o		N
NEST	1	1 or greater		1	c2		Y(10)
VNAM	o	o		o	c1		Y
VADR	o	o		o	o		N
VALT	o	o		o	c1		Y
bit	x	x		x	x		N
TPY	o	o		o	o		N
VLIS	o	c1		o	c3		Y
bit	x	x		x	x		N
bit	x	x		x	x		N
CEI	o	i		o	i		N
ACO	o	c4		o	c4		N
SEM	o	c4		o	c4		N
CSR	o	c4		o	c4		N
CSNC	o	c4		o	c4		N
CSPLC	o	c4		o	c4		N
CSPI	o	c4		o	c4		N

c1 Shall be ‘m’ if ACSI logical node model support declared.
c2 Shall be five(5) or greater if ACSI logical node model support is declared.
c3 Shall be ‘m’ if ACSI data set, reporting, GOOSE, or logging model support is declared.
c4 Shall not be present. Receiving implementations shall assume not supported.

GetNameList conformance statement

GetNameList	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
Request							
ObjectClass	m	m		m	m		Y
ObjectScope	m	m		m	m		Y
DomainName	o	o		m	m		Y
ContinueAfter	o	m		m	m		Y
Response+							
List Of Identifier	m	m		m	m		Y
MoreFollows	m	m		m	m		Y
Response-							
Error Type	m	m		m	m		Y
NOTE Object class 'vmd' (formerly VMDSpecific in MMS V1.0) shall not appear. If a request contains this ObjectClass, an MMS Reject shall be issued.							

AlternateAccessSelection conformance statement

Not applicable.

VariableAccessSpecification conformance statement

VariableAccessSpecification	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
listOfVariable	**o**	**o**		**o**	**c1**		**Y**
variableSpecification	**o**	**o**		**o**	**c1**		**Y**
alternateAccess	**o**	**o**		**o**	**c1**		**Y**
variableListName	**o**	**o**		**o**	**c2**		**Y**
c1 Shall be 'm' if ACSI support for Logical Node Model is declared. c2 Shall be 'm' if ACSI support for ACSI DataSets, reporting, or logging is declared.							

VariableSpecification conformance statement

VariableSpecification	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
name	**o**	**o**		**o**	**m**		**Y**
address	**o**	**o**		**o**	**i**		**N**
variableDescription	**o**	**o**		**o**	**i**		**N**
scatteredAccessDescription	**o**	**x**		**o**	**x**		**N**
invalidated	**o**	**x**		**o**	**x**		**N**

Read conformance statement

Read	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
Request							
specificationWithResult	o	o		o	m		Y
variableAccessSpecification	m	m		m	m		Y
Response							
variableAccessSpecification	o	o		o	m		Y
listOfAccessResult	m	m		m	m		Y

Write conformance statement

Write	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
Request							
variableAccessSpecification	m	m		m	m		Y
listOfData	m	m		m	m		Y
Response							
failure	m	m		m	m		Y
success	m	m		m	m		Y

InformationReport conformance statement

InformationReport	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
Request							
variableAccessSpecification	m	m		m	m		Y
listOfAccessResult	m	m		m	m		Y

GetVariableAccessAttributes conformance statement

GetVariableAccessAttributes	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
Request							
name	o	o		m	m		Y
address	o	o		m	x		N
Response							
mmsDeletable	m	m		m	m		Y
address	o	x		o	x		N
typeSpecification	m	m		m	m		Y

DefineNamedVariableList conformance statement

Not applicable.

GetNamedVariableListAttributes conformance statement

GetNamedVariableListAttributes	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
Request							
ObjectName	m	m		m	m		Y
Response							
mmsDeletable	m	m		m	m		Y
listOfVariable	m	m		m	m		Y
variableSpecification	m	m		m	m		Y
alternateAccess	o	m		o	i		N

DeleteNamedVariableList conformance statement

Not applicable.

ReadJournal conformance statement

Not applicable.

JournalEntry conformance statement

Not applicable.

InitializeJournal conformance statement

Not applicable.

FileDirectory conformance statement

FileDirectory	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
Request							
filespecification	**o**	**o**		**m**	**m**		**Y**
continueAfter	**o**	**o**		**m**	**m**		**Y**
Response+							
listOfDirectoryEntry	**m**	**m**		**m**	**m**		**Y**
MoreFollows	**m**	**m**		**m**	**m**		**Y**

FileOpen conformance statement

FileOpen	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
Request							
filename	**m**	**m**		**m**	**m**		**Y**
initialPosition	**o**	**o**		**m**	**m**		**Y**
Response+							
frsmID	**m**	**m**		**m**	**m**		**Y**
fileAttributes	**m**	**m**		**m**	**m**		**Y**

FileRead conformance statement

FileRead	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
Request							
frsmID	**m**	**m**		**m**	**m**		**Y**
Response+							
fileData	**m**	**m**		**m**	**m**		**Y**
MoreFollows	**m**	**m**		**m**	**m**		**Y**

FileClose conformance statement

FileClose	Client-CR			Server-CR			GRT100
	Base	F/S	Value/range	Base	F/S	Value/range	
Request							
frsmID	**m**	**m**		**m**	**m**		**Y**
Response+	**m**	**m**		**m**	**m**		**Y**

GOOSE conformance statement

	Subscriber	Publisher	Value/comment	GRT100
GOOSE Services	c1	c1		Y
SendGOOSEMessage	m	m		Y
GetGoReference	o	c3		N
GetGOOSEElementNumber	o	c4		N
GetGoCBValues	o	o		Y
SetGoCBValues	o	o		Y
GSENotSupported	c2	c5		N
GOOSE Control Block (GoCB)	o	o		Y

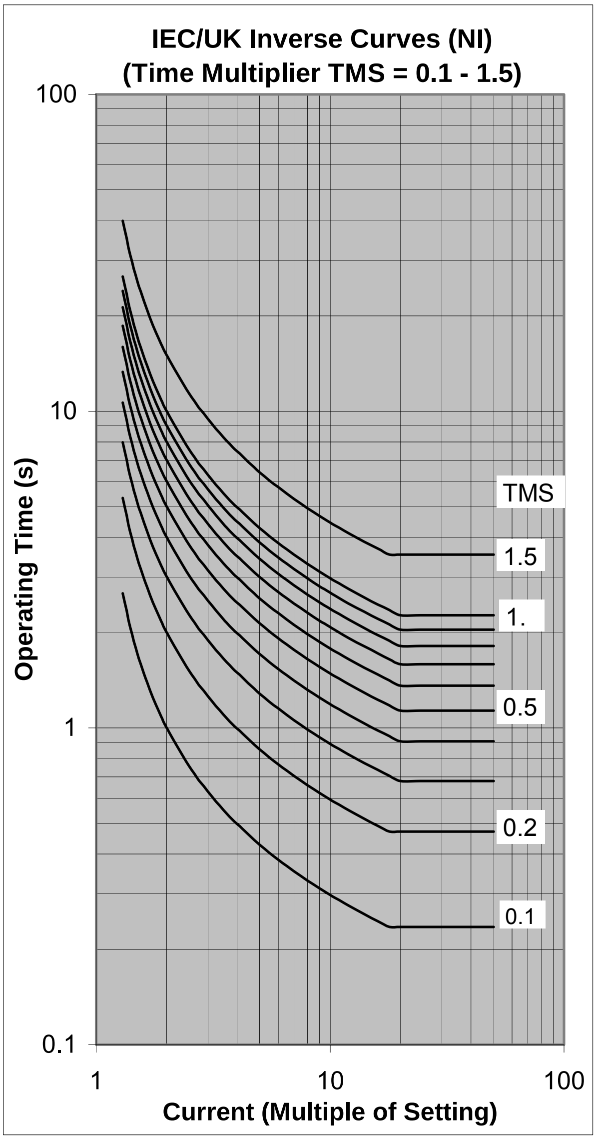
c1 Shall be 'm' if support is declared within ACSI basic conformance statement.
c2 Shall be 'm' if ACSI basic conformance support for either GetGoReference or GetGOOSEElementNumber is declared.
c3 Shall be 'm' if support for ACSI basic conformance of GetGoReference is declared.
c4 Shall be 'm' if support for ACSI basic conformance of GetGOOSEElementNumber.
c5 Shall be 'm' if no support for ACSI basic conformance of GetGOOSEElementNumber is declared.

GSSE conformance statement

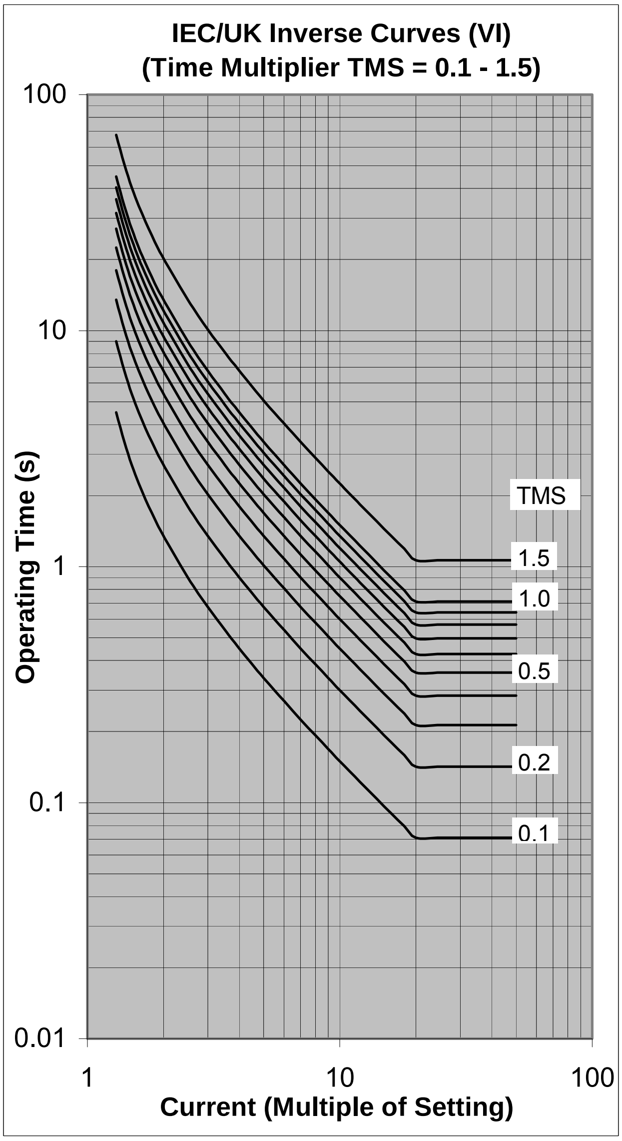
Not applicable.

Appendix Q

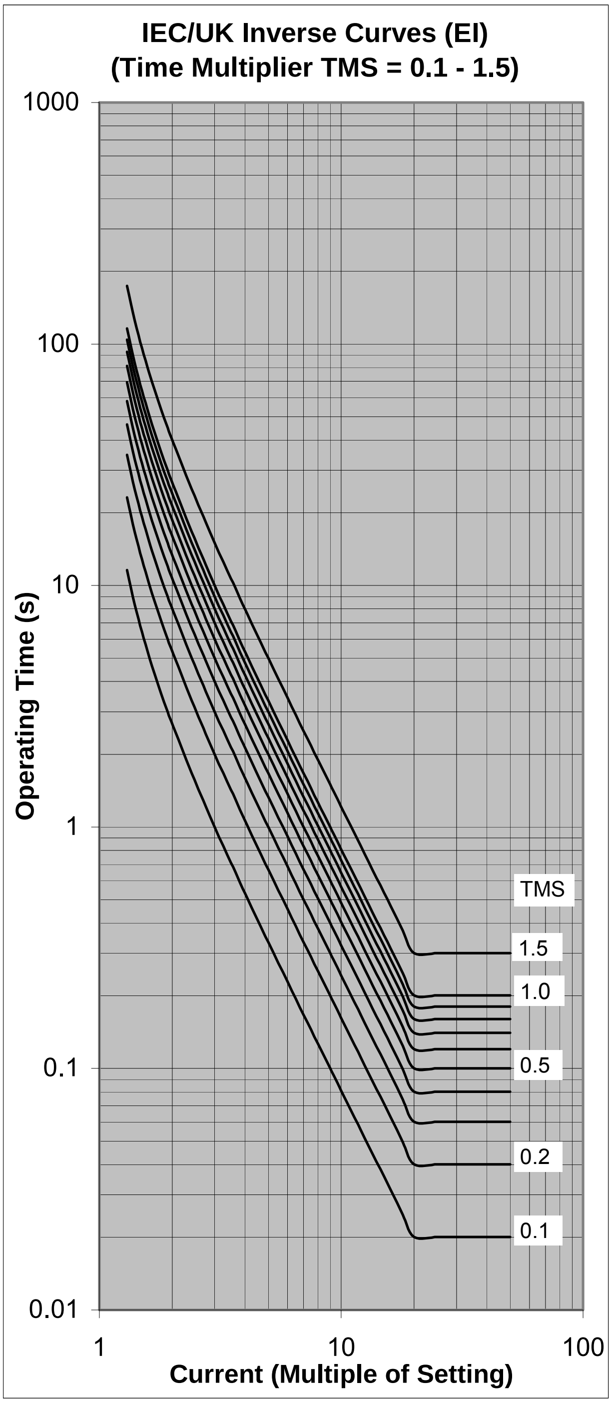
Inverse Time Characteristics



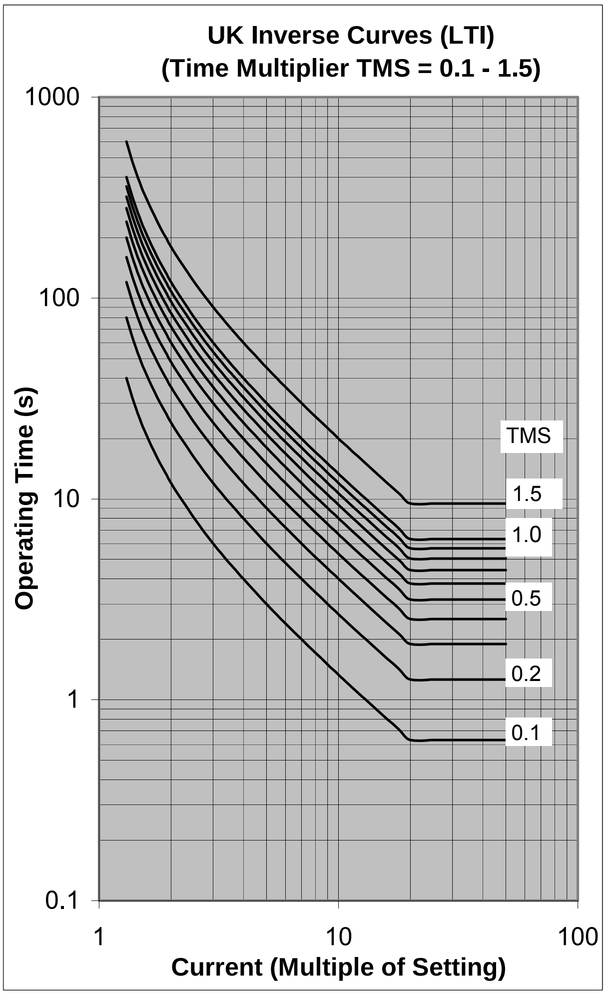
Normal Inverse



Very Inverse



Extremely Inverse



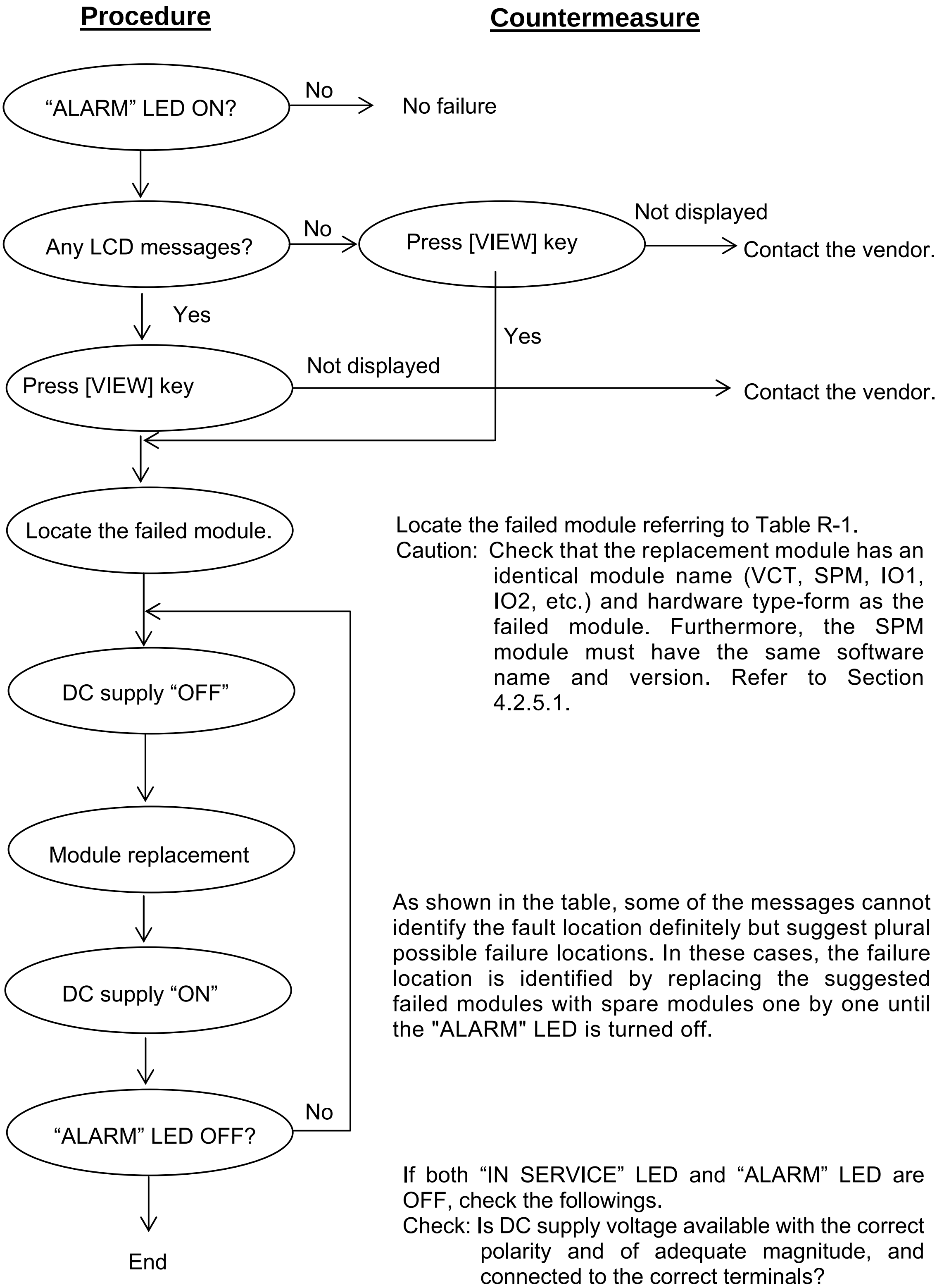
Long Time Inverse

Appendix R

Failed Module Tracing and Replacement

1. Failed module tracing and its replacement

If the "ALARM" LED is ON, the following procedure is recommended. If not repaired, contact the vendor.



Locate the failed module referring to Table R-1.
Caution: Check that the replacement module has an identical module name (VCT, SPM, IO1, IO2, etc.) and hardware type-form as the failed module. Furthermore, the SPM module must have the same software name and version. Refer to Section 4.2.5.1.

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 until the "ALARM" LED is turned off.

If both "IN SERVICE" LED and "ALARM" LED are OFF, check the followings.
Check: Is DC supply voltage available with the correct polarity and of adequate magnitude, and connected to the correct terminals?

Table R-1 LCD Message and Failure Location

Message	Failure location								
	VCT	SPM	IO1 or IO8	IO2	IO3	HMI	AC cable	LAN cable/ network	PLC, IEC61850 data
Checksum err		×							
ROM data err		×							
ROM-RAM err		×							
SRAM err		×							
CPU err		×							
Invalid err		×							
NMI err		×							
BU-RAM err		×							
EEPROM err		×							
A/D err		×							
Sampling err		×							
CT1 err	× (2)	× (2)					× (1)		
CT2 err	× (2)	× (2)					× (1)		
CT3 err	× (2)	× (2)					× (1)		
DIO err		× (2)	× (1)	× (1)	× (1)				
RSM err		× (1)	× (2)						
LCD err						×			
DC supply off			×						
RTC err		×							
PCI err		×							
LAN err		×							
GOOSE stop		× (2)						× (1)	
Ping err		× (2)						×(1)	
PLC stop									×
MAP stop									×
No-working of LCD		× (2)				× (1)			

Note: This table shows the relationship between messages displayed on the LCD and the estimated failure location. Locations marked with (1) have a higher probability than locations marked with (2).

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 data related the PLC, IEC103 and IEC61850, etc. are restored the original settings.

The initial replacement procedure is as follows:

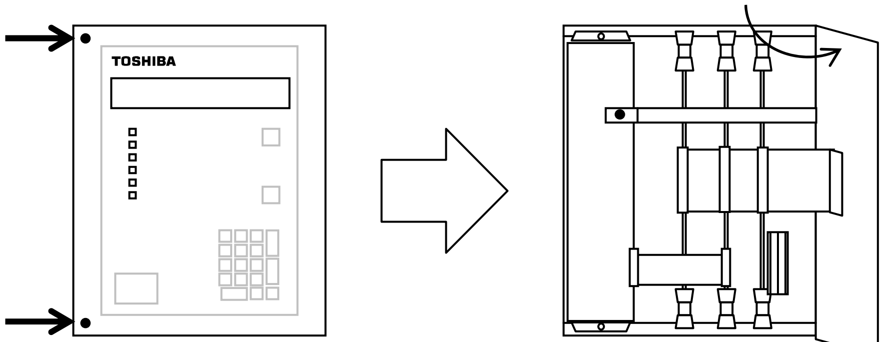
1). Switch off the DC power supply.

⚠ 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.

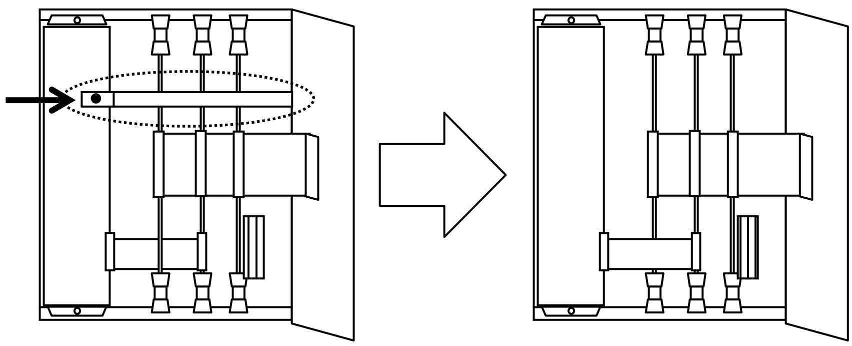
Open the front panel of the relay by unscrewing the binding screw located on the left side of the front panel.



Case size : 1/2"inchs

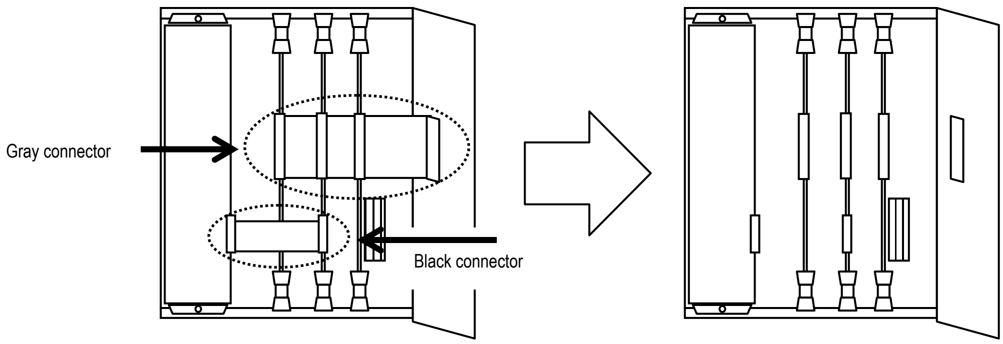
4). Detach the holding bar.

Detach the module holding bar by unscrewing the binding screw located on the left side of the bar.



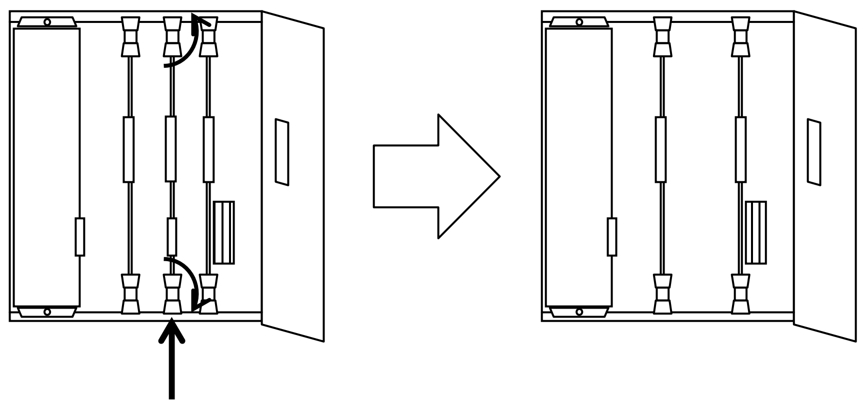
5). Unplug the cables.

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).



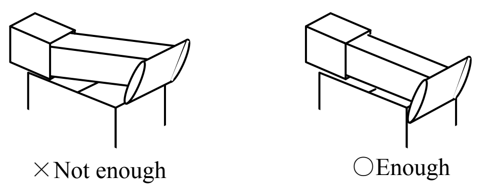
7). Insert the replacement module.

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)



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.

Appendix S

Ordering

Ordering

GRT100 [ ] D [ ][ ] - [ ][ ] - [ ]

Model 100 series

Type:	
Transformer protection Relay	GRT100
Model:	
-Model 100 series: 2 three-phase current inputs for 2-winding transformer	
- 16 BIs, 13 BOs, 5 trip BOs	101
- 16 BIs, 23 BOs, 5 trip BOs	102
CT Rating:	
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
Mix, 50Hz, 110V/125Vdc	J
Mix, 60Hz, 110V/125Vdc	K
Mix, 50Hz, 220V/250Vdc	L
Mix, 60Hz, 220V/250Vdc	M
Mix, 50Hz, 48V/54V/60Vdc	N
Mix, 60Hz, 48V/54V/60Vdc	P
Mix, 50Hz, 24V/30Vdc	Q
Mix, 60Hz, 24V/30Vdc	R
CT Rating-2:	
Single CT Rating	0
Mix, Primary:1A, Secondary: 5A	1
Mix, Primary:5A, Secondary: 1A	2
Communications:	
RS485 + 100BASE-TX	A
RS485 + 100BASE-FX	B
Fibre optic + 100BASE-FX	E
Miscellaneous:	
None	0
LED label:	
Standard	None
Option: User configurable LED label	J

Note: Please inform us which is ordered panel surface mount type or 19-inch rack mount type.
In 19 inch rack mount type, please order optional attachment kit.
- for relay case Type-A attachment kit: EP101

GRT100 – [ ] D – [ ][ ] – [ ][ ] – [ ]

Model 200 series

Type:	
Transformer protection Relay	GRT100
Model:	
-Model 200 series: 3 three-phase current inputs for 3-winding transformer	
- 16 BIs, 13 BOs, 5 trip BOs	201
- 16 BIs, 23 BOs, 5 trip BOs	202
- 15 BIs (12-independent), 13 BOs, 3 trip BOs	203
- 15 BIs (12-independent), 23 BOs, 3 trip BOs	204
CT Rating:	
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
Mix, 50Hz, 110V/125Vdc	J
Mix, 60Hz, 110V/125Vdc	K
Mix, 50Hz, 220V/250Vdc	L
Mix, 60Hz, 220V/250Vdc	M
Mix, 50Hz, 48V/54V/60Vdc	N
Mix, 60Hz, 48V/54V/60Vdc	P
Mix, 50Hz, 24V/30Vdc	Q
Mix, 60Hz, 24V/30Vdc	R
CT Rating-2:	
Single CT Rating	0
Mix, Primary:1A, Secondary:5A, Tertiary:5A	1
Mix, Primary:5A, Secondary:1A, Tertiary:5A	2
Mix, Primary:1A, Secondary:1A, Tertiary:5A	3
Communications:	
RS485 + 100BASE-TX	A
RS485 + 100BASE-FX	B
Fibre optic + 100BASE-FX	E
Miscellaneous:	
None	0
LED label:	
Standard	None
Option: User configurable LED label	J

Note: Please inform us which is ordered panel surface mount type or 19-inch rack mount type.
In 19 inch rack mount type, please order optional attachment kit.
- for relay case Type-A attachment kit: EP101

Version-up Records

Version No.	Date	Revised Section	Contents
0.0	Sep. 12, 2007	--	First issue
1.0	Apr. 14, 2008	2.2.2 3.1.3 4.2.6.4, 4.2.6.6 4.4.2	Modified the description and Figure 2.2.2.1. Modified the description. Modified the description. Modified the description.
2.0	Jul. 31, 2009	Precaution 4.2.2,4.2.6.2,4.2.7 Appendixes	Modified the description of 'Disposal'. Modified the description.(Add explanation of password for test screen.) Modified Appendix E and S.
3.0	Oct. 16, 2009	2.2.5 2.3 2.5 2.9 2.10.6 3.1.3 Appendix	Modified the description and Table numbers. Modified Figure 2.3.3. (Add " ON" under the scheme switch) Modified the description and Figure 2.5.1. (Add " ON" under the scheme switch) Modified Figure 2.9.1. (Add " ON" under the scheme switch) Modified the description Modified the description Modified Appendix N.
4.0	Dec. 11, 2009	2.2.1	Modified Table 2.2.1.1 and Figure 2.2.1.4.

TOSHIBA CORPORATION