TOSHIBA

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INSTRUCTION MANUAL

TRANSFORMER PROTECTION RELAY

GRT100 - ***B

TOSHIBA CORPORATION

(Ver. 0.8)

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.

⚠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.

- **Battery**

Avoid placing the back side of the printed circuit board with a battery (SPM board) directly on top of a metal conductor or wrapping it with metal foil, as this may short-circuit the battery power supply. However, the board may be placed on an antistatic conductive mat.

- **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.

- **Disposal**

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

Contents

■ The data given in this manual are subject to change without notice. (Ver. 0.8)

1. Introduction

The GRT100 provides transformer protection for two- or three- winding power transformers connected to single, double or a one-and-a-half busbar system.

The GRT100 is member of the G-series numerical relays which are built on common hardware modules and featured with the following functions:

- Human interfaces on the relay front panel, and local and remote PCs
  4 × 40 character LCD and keypad
  RS232C and RS485 communication ports
- Meeting and recording of event, fault and disturbance
- IRIG-B time synchronization
- Automatic supervision
- User configurable binary output

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; 13 N/O programmable output contacts • Model 102; 23 N/O programmable output contacts
- Model 200 series; 3 three-phase current inputs, applied to two- and three-winding transformers • Model 201; 13 N/O programmable output contacts • Model 202; 23 N/O programmable output contacts

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

2.1 Application

The 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.

The 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

The GRT100 provides the stabilization for magnetizing inrush and overexcitation.

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

The relay can be integrated with a local PC or a remote PC through a communication port. A local PC can be connected via the RS232C port on the front panel of the relay. A remote PC can also be connected through the RS485 port on the rear panel of the relay.

2.2 Protection Scheme

GRT100 provides the following protection schemes with measuring elements in parentheses. Appendix A shows 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 number of measuring elements for the restricted earth fault protection and time-overcurrent protection is dependent on the relay models.

Figure 2.2.1 and 2.2.2 show the relationship between AC inputs and the measuring elements applied in each model.

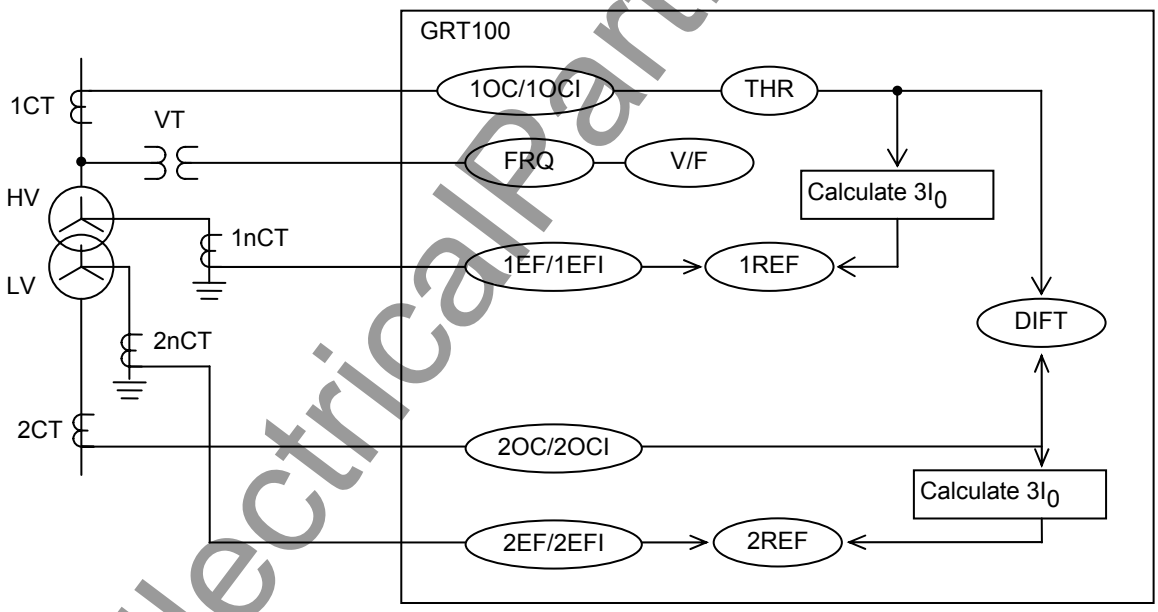


Figure 2.2.1 Measuring Elements of Model 100s

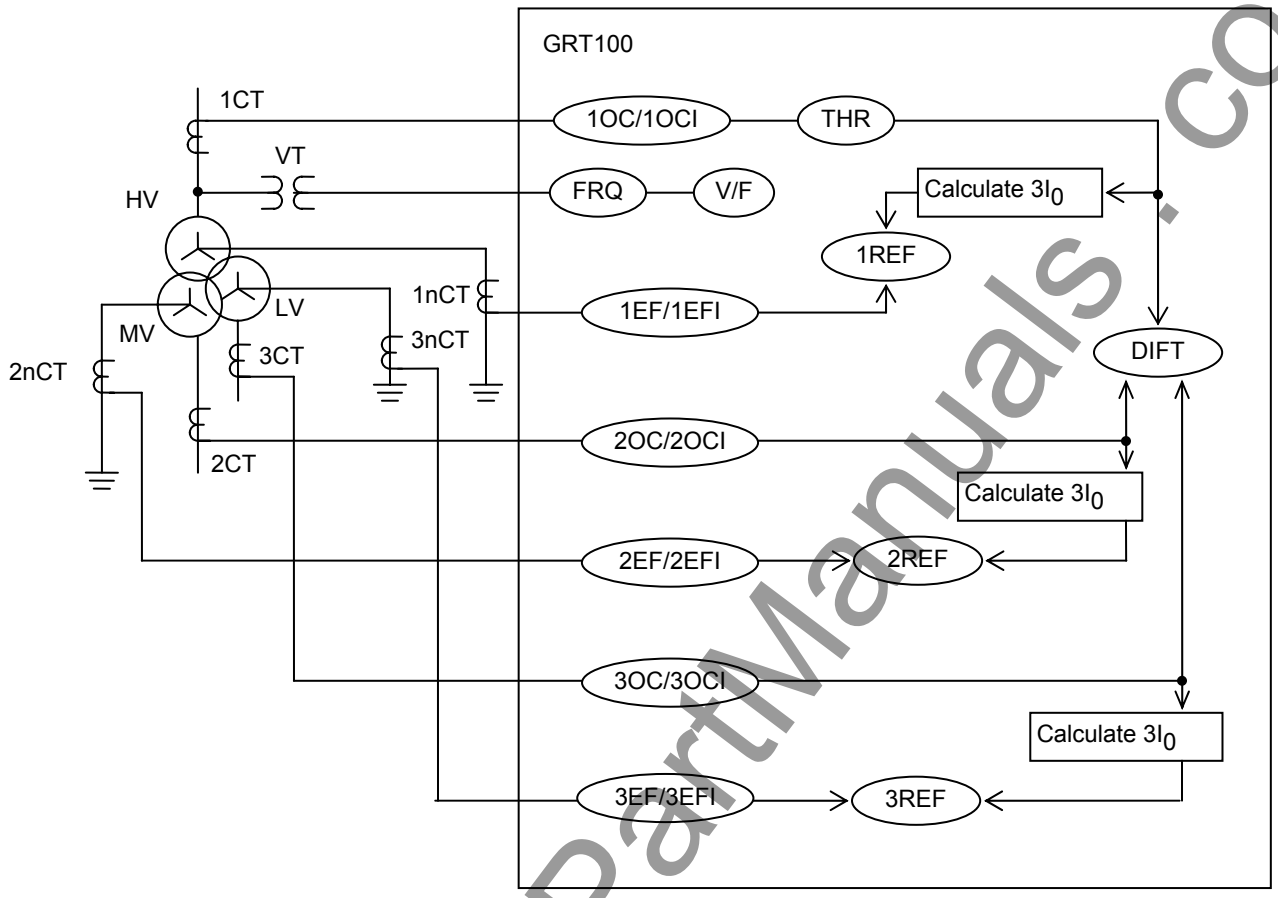


Figure 2.2.2 Measuring Elements of Model 200s

2.3 Current Differential Protection

2.3.1 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 2.3.1 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.

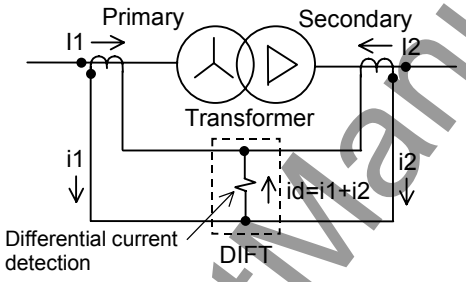


Figure 2.3.1 Current Differential Protection

Scheme logic

Figure 2.3.2 shows the scheme logic of current differential protection. Current differential element DIFT comprises sub-elements HOC, DIF, 2F and 5F which operate for the 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 the 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 CTs in case of an external fault. (For the characteristics, see Section 2.11.)

DIF output signal can be blocked when 2F or 5F element detects second harmonic inrush current during transformer energization or fifth harmonic components during transformer over-excitation. The blocking is enabled by setting the scheme switch [2F-LOCK] or [5F-LOCK] to "ON". The following two blocking scheme is selectable by the scheme switch [DIFTPMD]. (For details, see Table 2.3.1.)

"3POR": When any one phase of 2F or 5F element operates, the trip by DIF element is blocked in all three phases. The "3POR" is recommended for the transformers whose second harmonic component may be low because its block function is stronger than that of the "2PAND" below.

"2PAND": Even if 2F or 5F element operates, the trip by DIF element is allowed when any two phases or more of DIF element operate. The "2PAND" is recommended for the transformers whose second harmonic component is higher. The relay does not operate due to inruch current so long as second harmonic is detected by two

phases of 2F element.

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.

Table 2.3.1 Blocking Scheme during Magnetising inrush

Setting	2PAND	3POR
Scheme	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.	When any one phase of 2F or 5F element operates during manetising inrush, the trip by DIF element is blocked.
Sensitivity of 2F and 5F element	$I_{2f}/I_{1f} \geq 10$ to 50% or $I_{5f}/I_{1f} \geq 10$ to 50%	
Scheme logic	Refer to Figure 2.3.2	
Response against magnetizing inrush	No problem: When second or fifth hartmonic component of any two phases is lower than their sensitivity setting, the DIF may operate.	No problem: When second or fifth hartmonic component of any one phase is higher than their sensitivity setting, the DIF is surely blocked.
Detection at internal fault	No problem	No problem
Application	The “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.	The “3POR” is recommended for a transformer with large capacity whose second harmonic component in inrush current is generally lower. This block function is stronger than that of the “2PAND”.

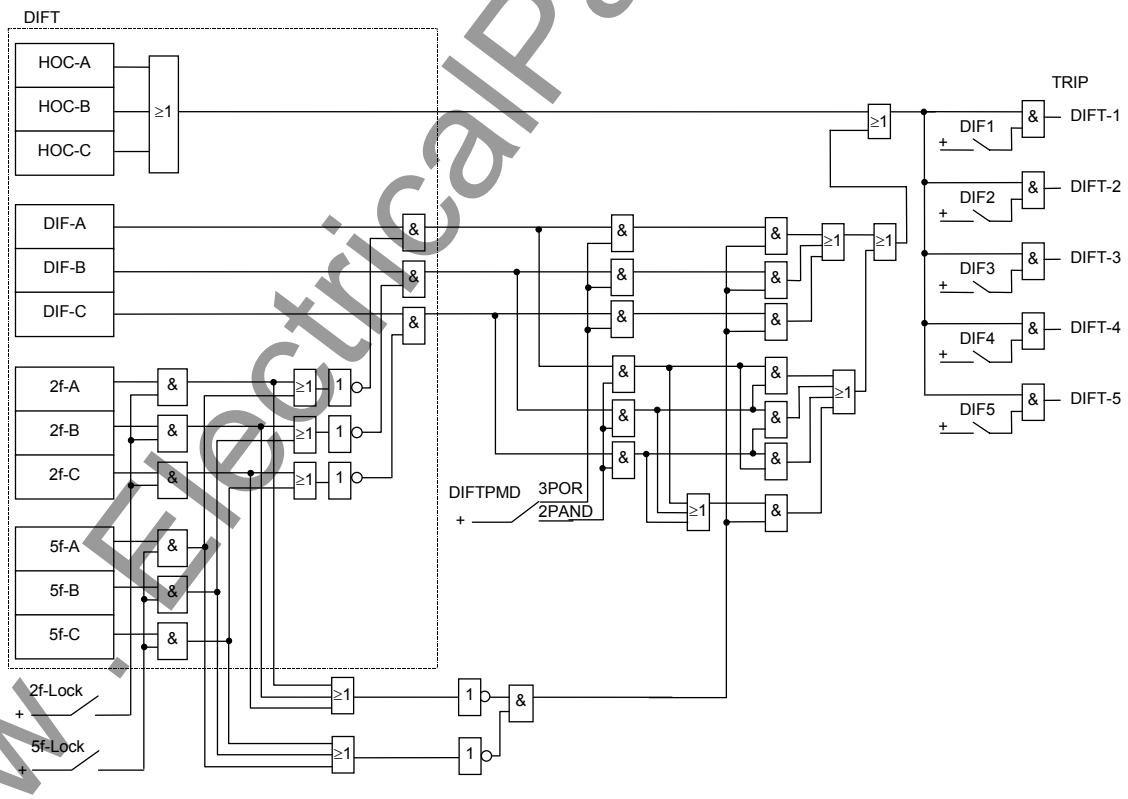


Figure 2.3.2 Scheme Logic of Current Differential Protection

2.3.2 Matching of CT Secondary Currents

In order to restrain erroneous differential currents, the currents supplied to the differential elements must be matched in phase and amplitude under through-load and through-fault conditions.

In GRT100, the matching is performed through the settings.

2.3.2.1 Matching of Phase Angle

It is necessary to compensate for phase angle difference among line currents on each side of the transformer when the transformer windings have both star- and delta-connections.

GRT100 can compensate for the phase angle difference by the setting and does not require CT secondary circuit arrangement such as delta-connection on the star-connected side of the power transformer which was common for the former transformer protection.

The phase angle matching is performed by inputting the phase angle of each winding according to the hands of a clock. For details of the setting, refer to 2.3.4.

2.3.2.2 Matching of CT Ratio

When I_1 to I_3 relevant to 1CT to 3CT secondary currents are supplied, the differential current I_d is calculated employing 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.

The setting kct1 is obtained by using the following equation.

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

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

where

I_n = rated secondary current of the 1CT.

I_{base1} = secondary current of the 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.

The settings kct2 and kct3 are obtained in the same way.

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

$kct1 \times I_1$ to $kct3 \times I_3$ 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.

2.3.3 Connection between CT Secondary Circuit and the GRT100

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

To validate the phase angle matching mentioned above and input in-phase current of each winding to the relay, connect the CT secondary circuits to the current input terminal of the relay as follows;

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

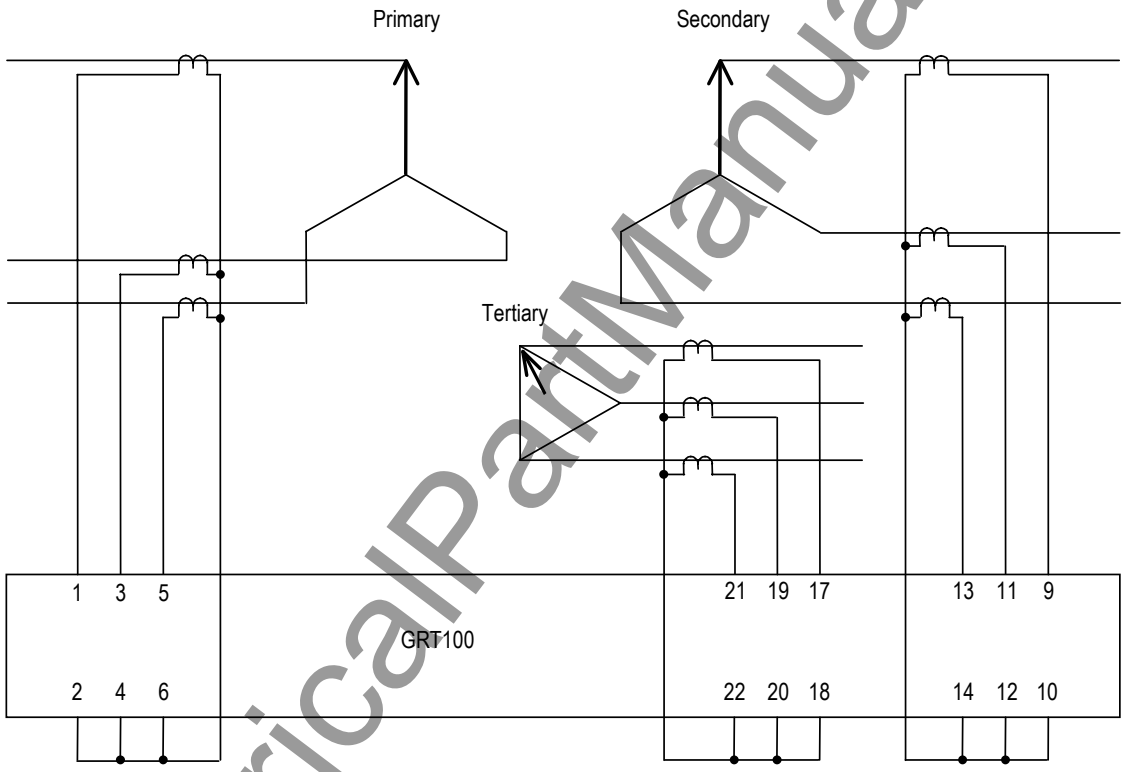


Figure 2.3.3 Connection of CT Secondary Circuit and the GRT100

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	Current of primary winding
		3-4	
		5-6	
		9-10	Current of secondary winding
		11-12	
		13-14	
		17-18	Current of tertiary winding
		19-20	
		21-22	

2.3.4 Setting

The following shows the setting elements necessary for the current differential protection and their setting ranges. The 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	d1	0 – 11	1	0	Primary winding
	d2	0 – 11	1	0	Secondary winding
	d3	0 – 11	1	0	Tertiary winding
Scheme switch					Enable or disable to
[DIFTPMD]		3POR / 2PAND		3POR	Trip mode
[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

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

Setting of ik

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

Minimum setting of 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

Set above the estimated maximum inrush current.

Setting for CT ratio matching

Taking the transformer shown in Figure 2.3.4 as an example, the CT ratio matching settings kct1 to kct3 can be calculated as follows. For transformer capacity, take the maximum one from the rated capacity 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.

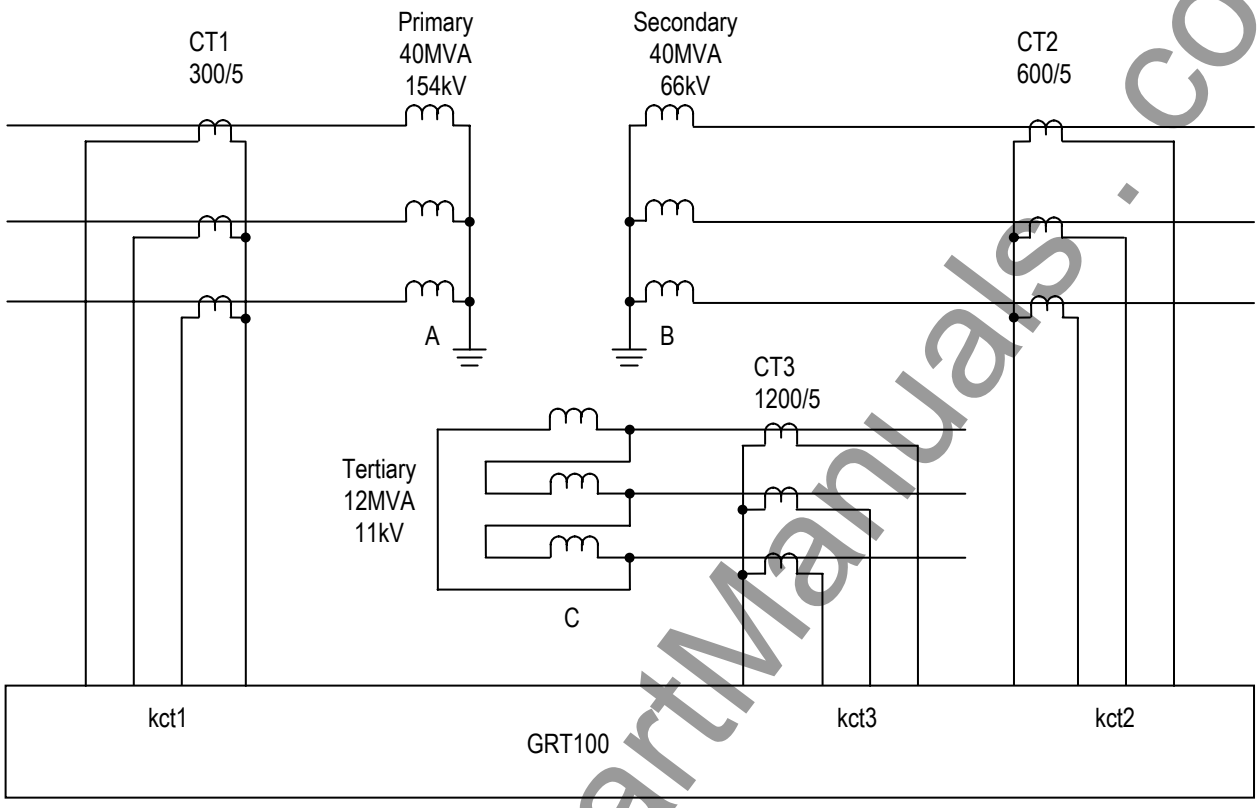


Figure 2.3.4 CT Ratio Matching

Setting for phase angle 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).

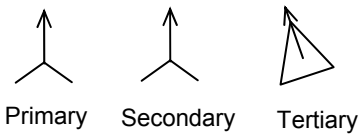
Example 2 If the setting winding is in phase with the reference winding, set 0 (= noon).

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 2.3.2.

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

Example 4 Setting for star/star/delta transformer.



	Setting
Primary	11
Secondary	11
Tertiary	0

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

Setting	Calculation	Remarks
0	Ia = Ia	
1	Ia = (Ia – Ic)/ $\sqrt{3}$	Setting value
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)/ $\sqrt{3}$	

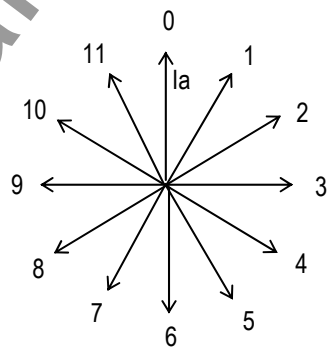
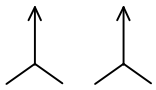
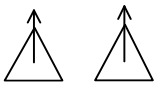
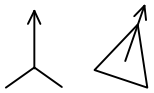
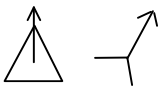
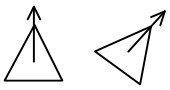
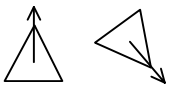
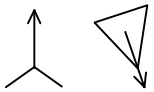
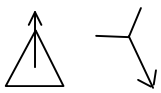
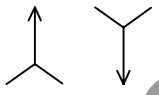
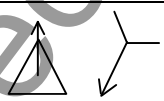
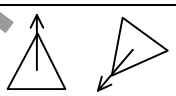
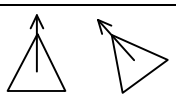
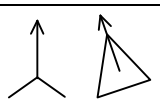
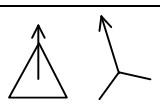
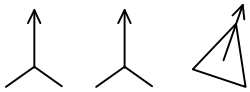
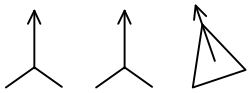
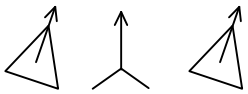
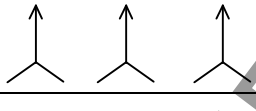


Table 2.3.2 Setting for Phase Angle Matching

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

Transformer connections described in IEC60076-1		Settings for phase angle correction Primary , Secondary	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	

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

Transformer connections described in IEC60076-1		Settings for phase angle correction Primary, Secondary, Tertiary	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.

2.4 Restricted Earth Fault Protection

Restricted earth fault protection (REF) is a zero-phase current differential scheme and applied for 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 residual current derived from the three-phase line currents and the neutral current in the neutral conductor as shown in Figure 2.4.1

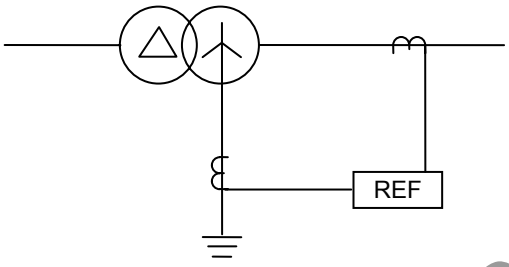


Figure 2.4.1 Restricted Earth Fault Protection

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 models to provide 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 2.4.2 shows the scheme logic of 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.

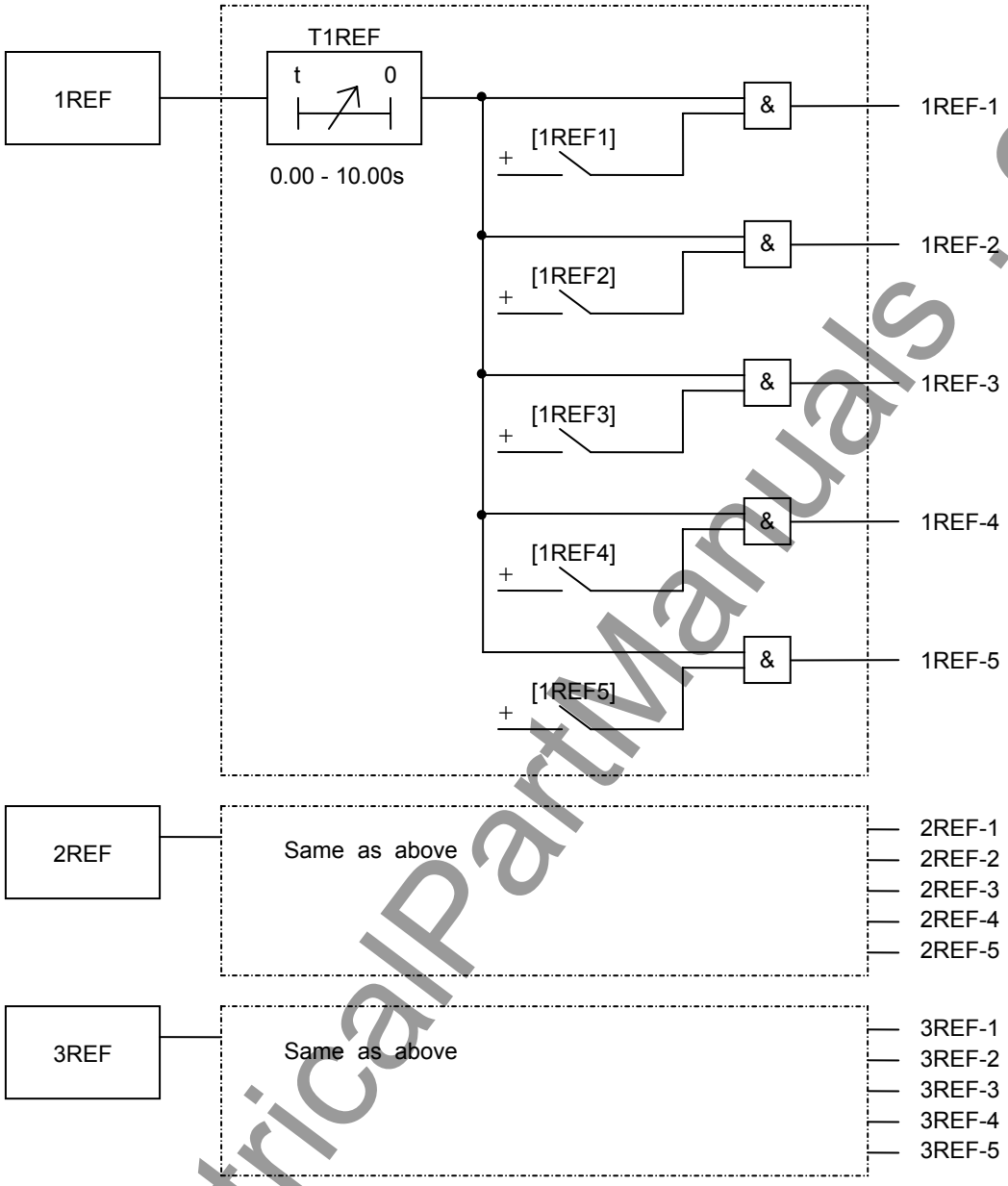


Figure 2.4.2 Scheme Logic of Restricted Earth Fault Protection

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 valid for an auto-transformer protection but the application must refer to 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 the 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 sensitivity
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 sensitivity
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 sensitivity
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

(*): 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 of minimum operating current settings are set as a ratio to the line CT secondary rated current.

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 the 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.

2.5 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 transformers 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.

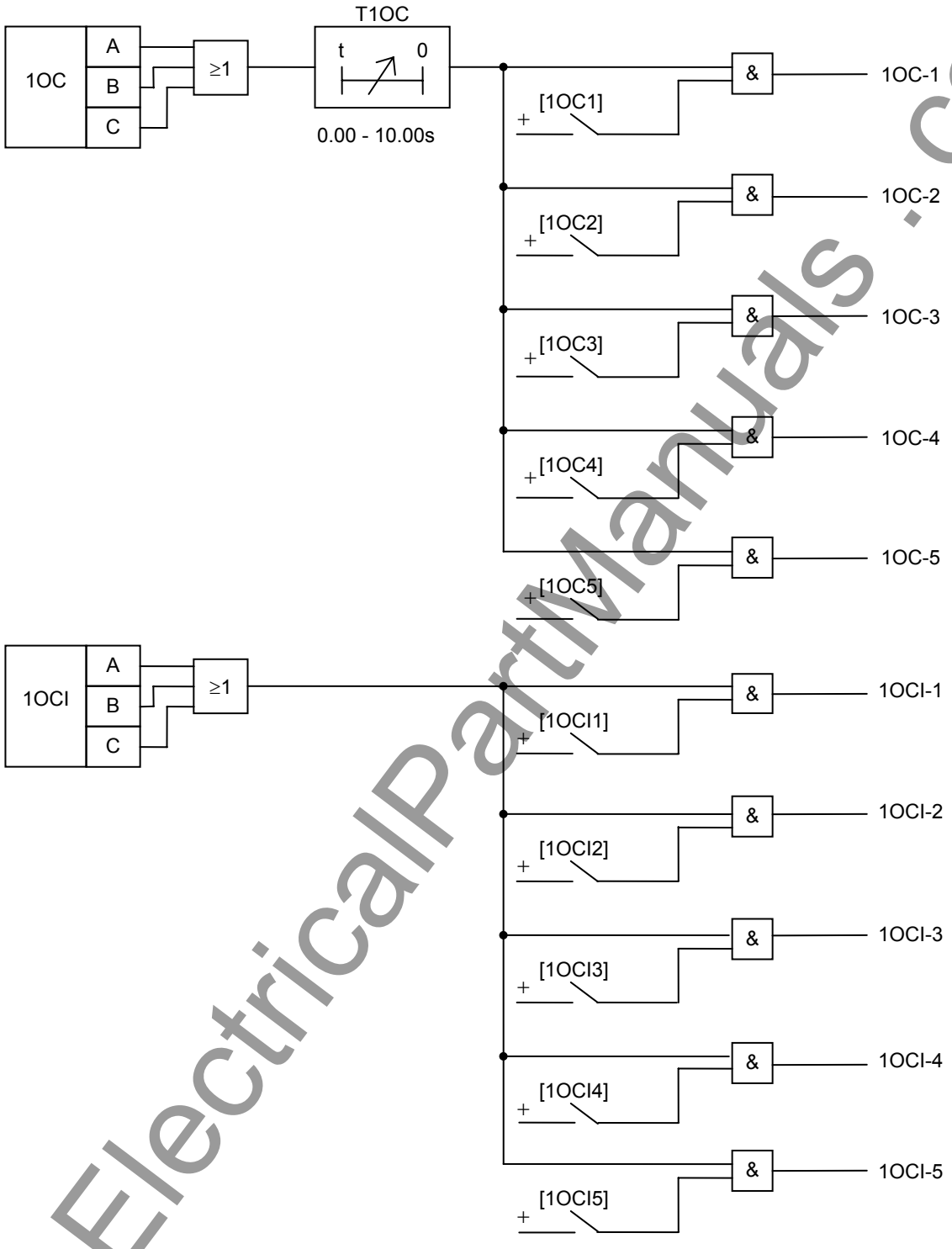
- standard inverse IEC 60255-3
- very inverse IEC 60255-3
- extremely inverse IEC 60255-3

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.

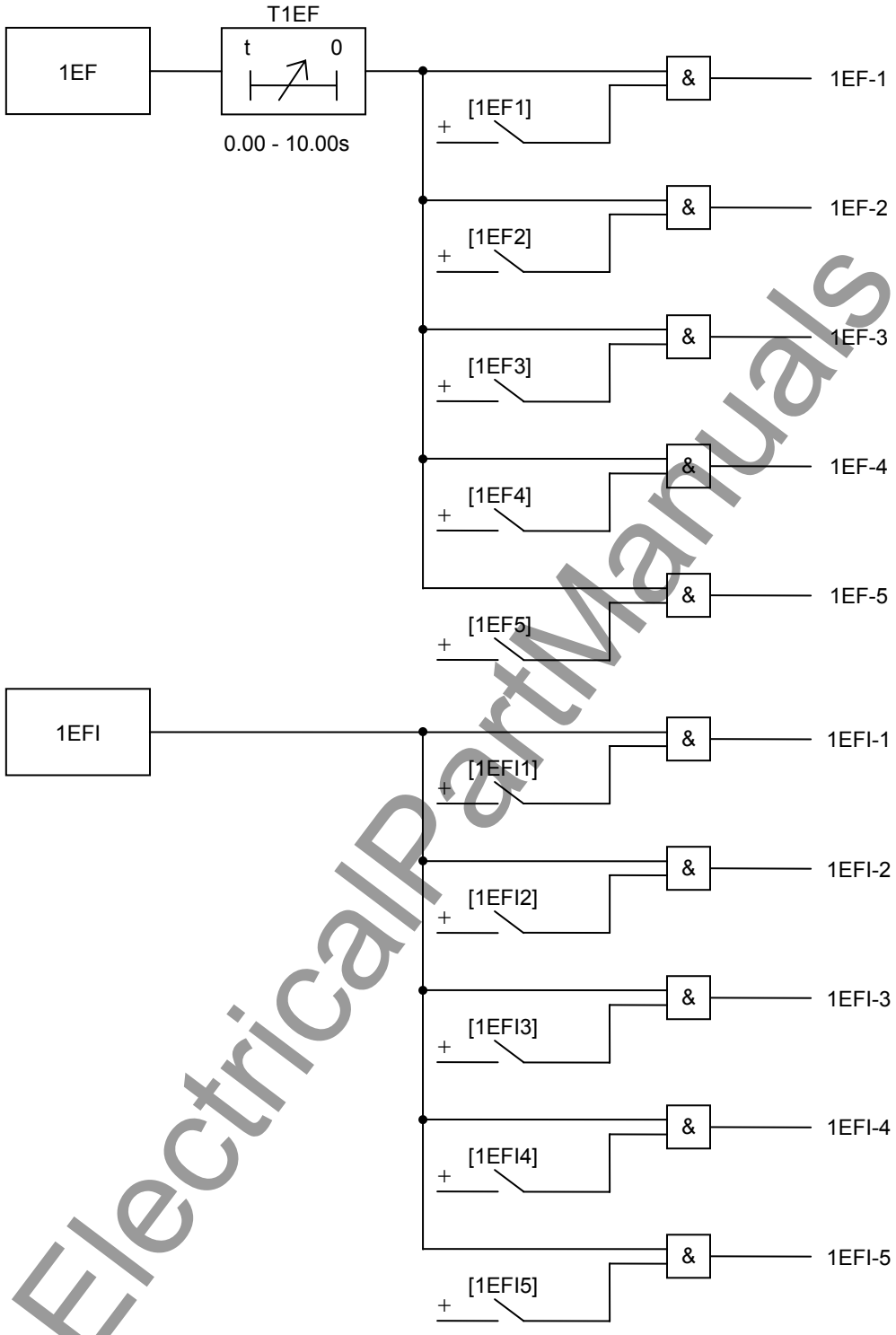
Figure 2.5.1 and Figure 2.5.2 show the scheme logic of overcurrent protection. Each element can perform time-delayed tripping of up to five breakers. The breaker tripping signals are blocked by the scheme switch settings.

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



Note: 2OC and 3OC provides the same logic as 1OC. 2OCI and 3OCI provides the same logic as 1OCI.

Figure 2.5.1 Scheme Logic of the Overcurrent Protection



Note: 2EF and 3EF provides the same logic as 1EF. 2EFI and 3EFI provides the same logic as 1EFI.

Figure 2.5.2 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 three-phase line currents and neutral current together with the differential protection and the restricted earth fault protection. For the setting, following relations between the overcurrent elements and the applying windings must be noticed.

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

2.6 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 IEC 60255-8 standards 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 2.6.1 shows the scheme logic of 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.

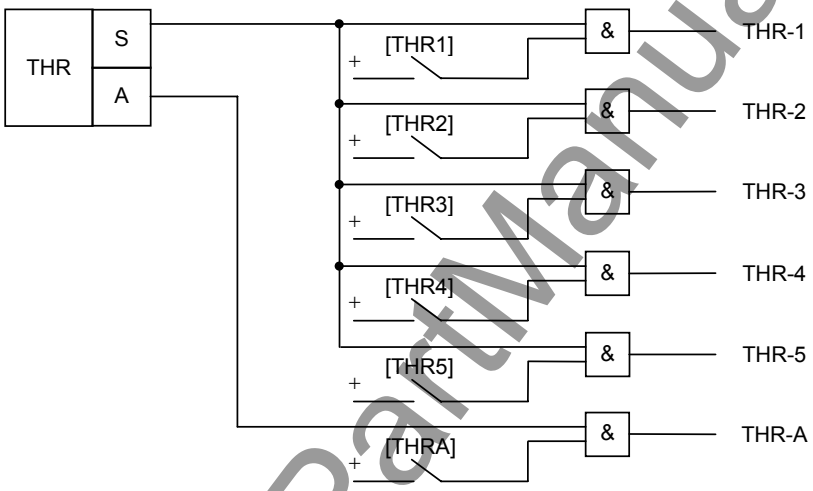


Figure 2.6.1 Scheme Logic of Thermal Overload Protection

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(*)	0.01	1.00	Basic current
Ip	0.00 – 1.00(*)	0.01	0.00	Pre-specified load current
TA	0 – 10min	1min	10min	Time for alarm (before trip)
Scheme switch				Enable or disable
THR1 to THR5	Off/On		(**)	Trip
THRA	Off/On		On	Alarm

(*): Multiplier of CT secondary rated current

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

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.

2.7 Frequency Protection

GRT100 provides an 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 2.7.1 shows the scheme logic of frequency protection. The tripping element 81-1 outputs underfrequency and overfrequency trip signals L1 and H1. Either underfrequency or overfrequency protection is enabled 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 enabled 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.

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.

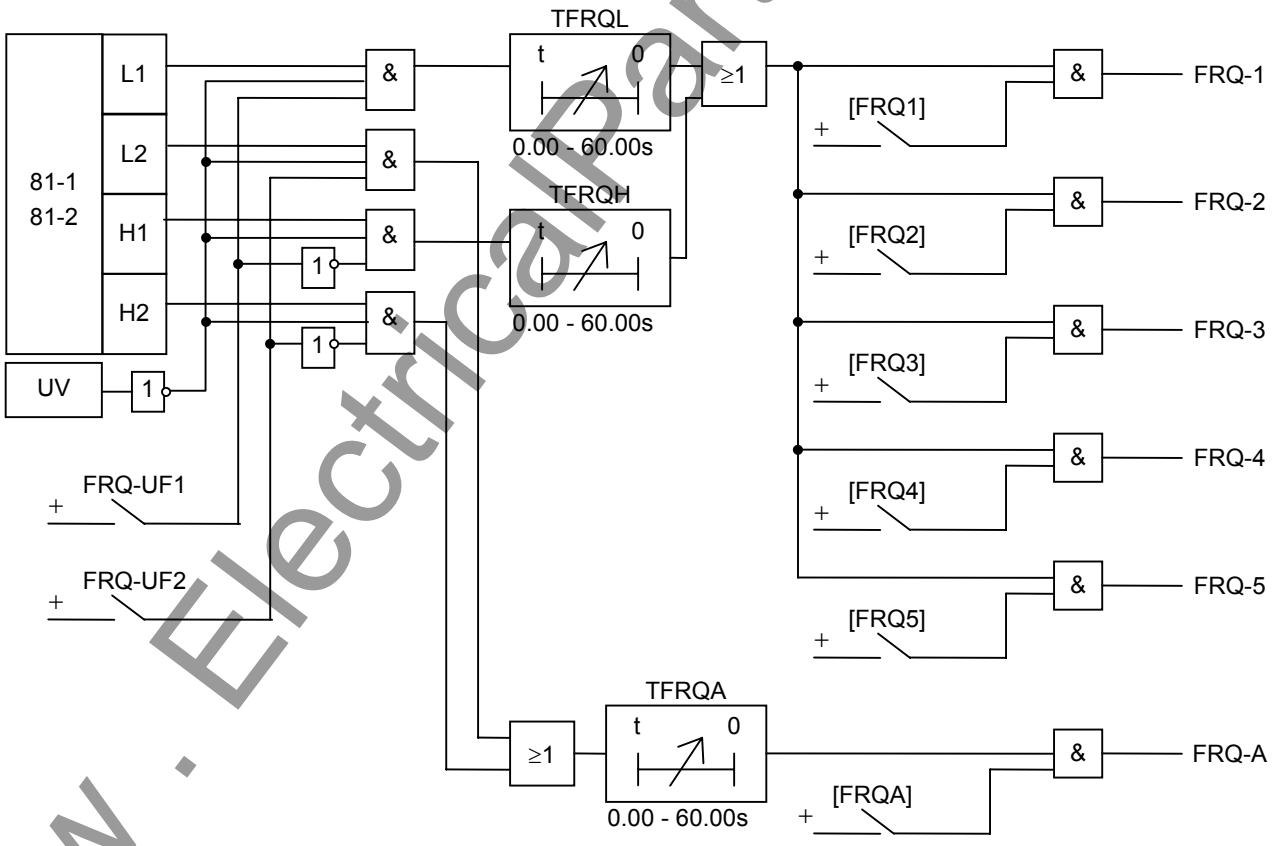


Figure 2.7.1 Scheme Logic of Frequency Protection

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.

2.8 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 2.8.1 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.

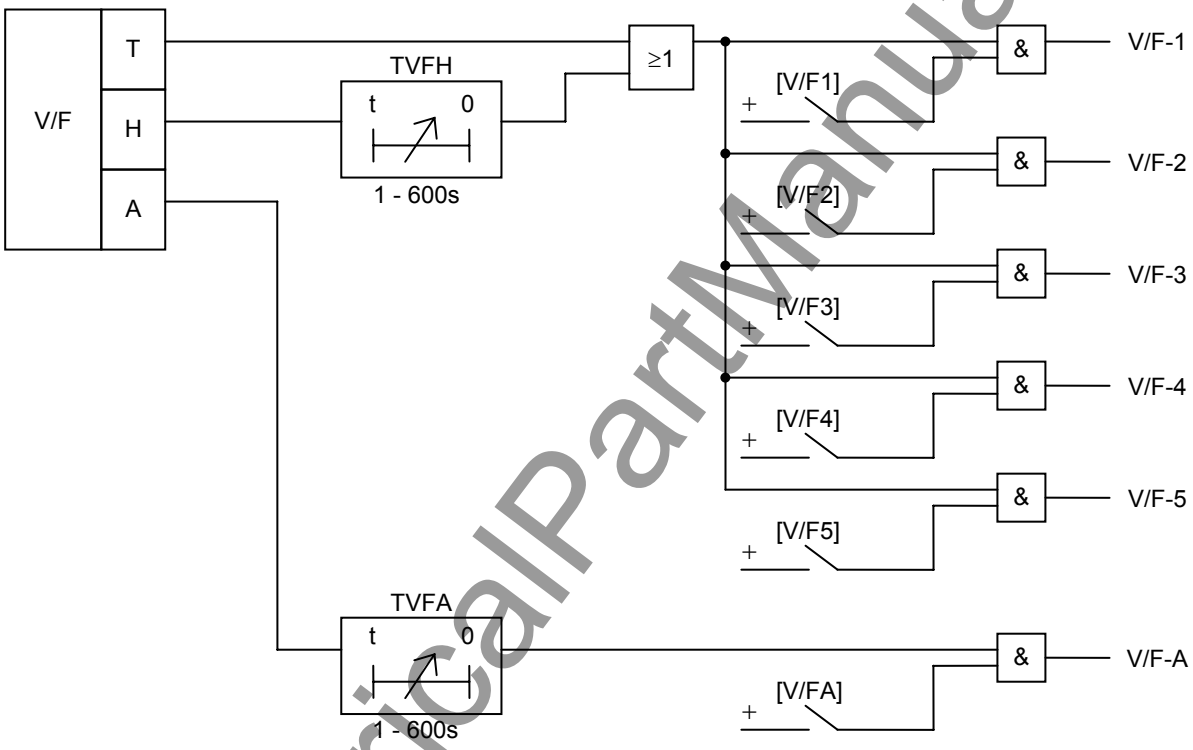


Figure 2.8.1 Scheme Logic of Overexcitation Protection

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.

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.

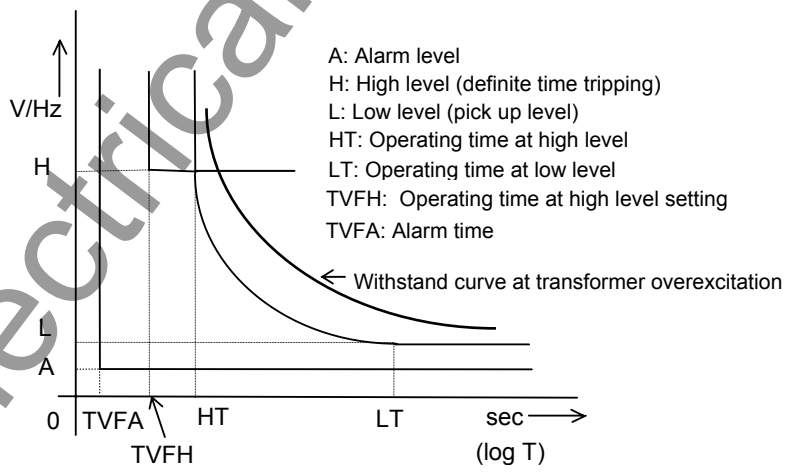


Figure 2.8.2 Setting Points

2.9 Trip by External Devices

Up to four binary signals MECANICAL TRIP1 to MECANICAL TRIP4 can be used for tripping external devices. Figure 2.9.1 shows the scheme logic for the signal MECANICAL TRIP1. The signal can trip up to five breakers. Any of the tripping signals MECHANICAL TRIP1-1 to MECHANICAL TRIP1-5 can be blocked by the scheme switches [M.T1-1] to [M.T1-5] setting.

Other binary signals have the same scheme logic.

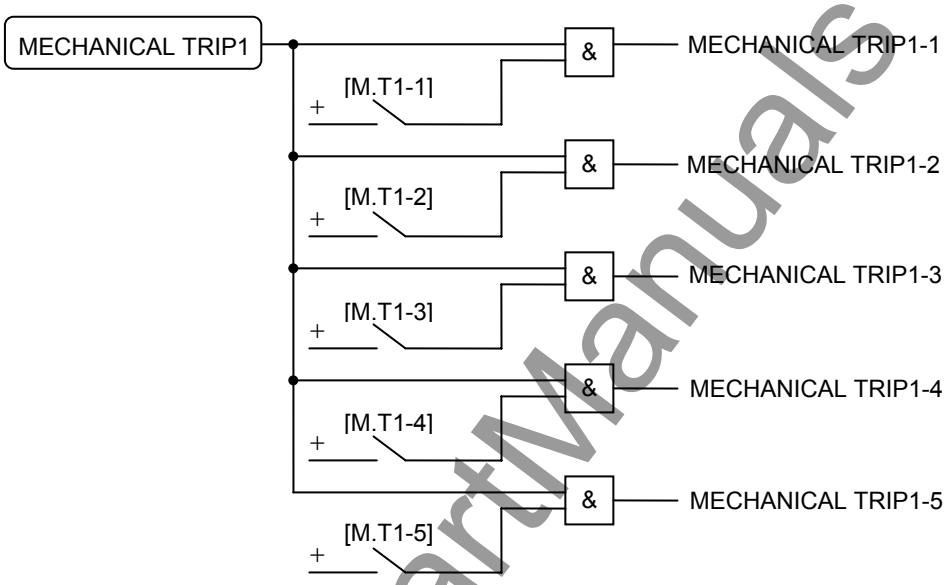


Figure 2.9.1 Scheme Logic of Trip by External Device

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
M.T1-1 to -5 M.T2-1 to -5 M.T3-1 to -5 M.T4-1 to -5	Off/On		(*)	

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

2.10 Tripping Output

Figure 2.10.1 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 high-speed tripping output relays TRIP-1 to TRIP-5.

When the scheme switch [L/O] is set to "ON", the tripping output relays are latched and can only be reset by energising the binary input for 'Indication Reset' operation. 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.

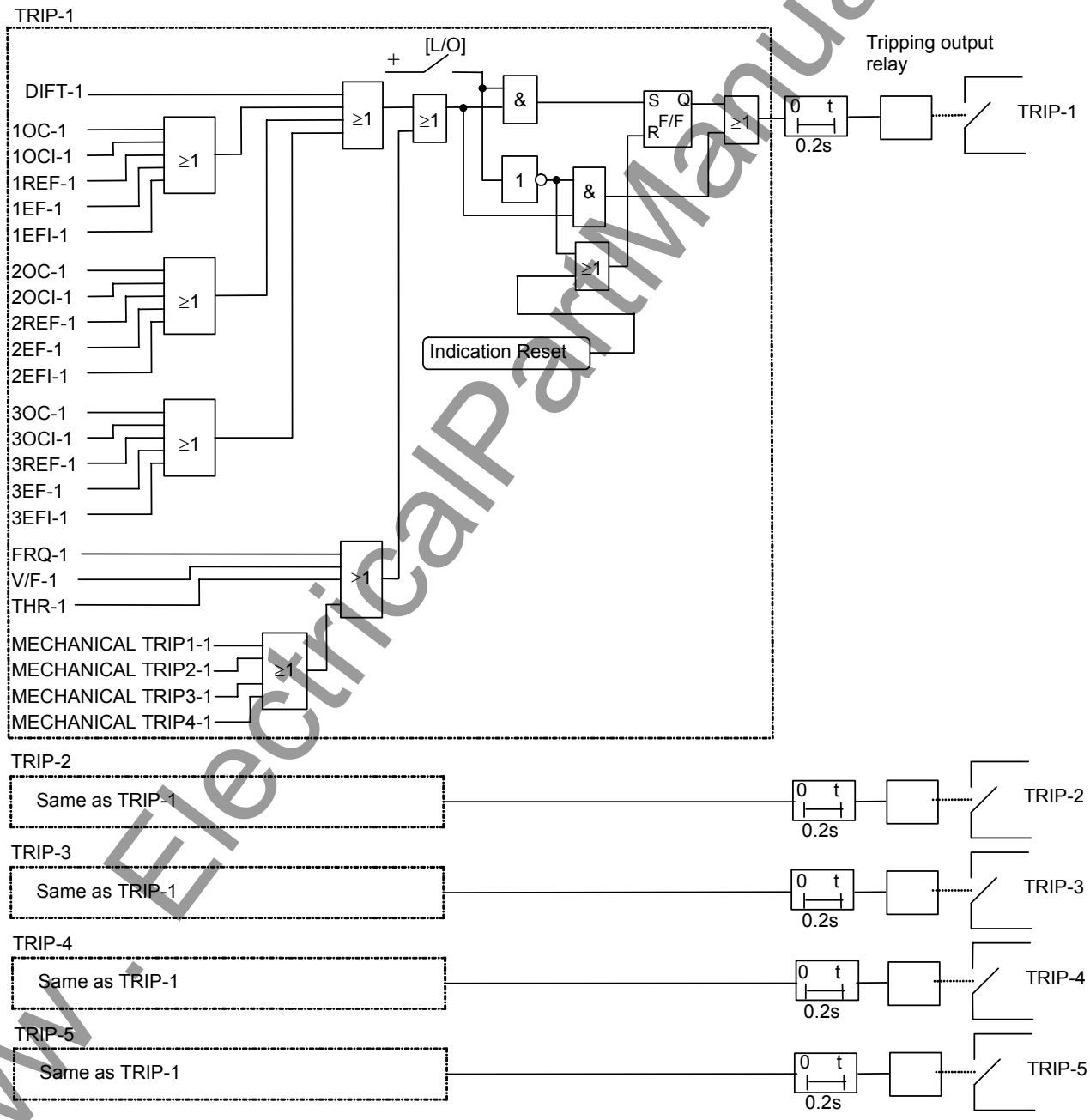


Figure 2.10.1 Tripping Logic

2.11 Characteristics of Measuring Elements

2.11.1 Percentage Current Differential Element DIF

The segregated-phase current differential element DIF has dual percentage restraining characteristics. Figure 2.11.1 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.

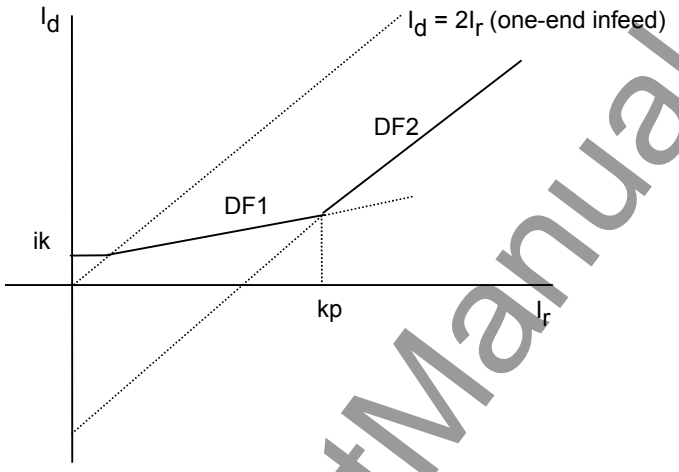


Figure 2.11.1 Current Differential Element

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.

2.11.2 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 cnnot be applied with a sensitive setting.

2.11.3 Restricted Earth Fault Element REF

The restricted earth fault element REF has dual percentage restraining characteristics. Figure 2.11.2 shows the characteristics on the differential current (Id) and restraining current (Ir) plane. Id is a differential current between the residual current of each winding and the neutral current and Ir is a restraining current which is the larger of the residual current and the neutral current.

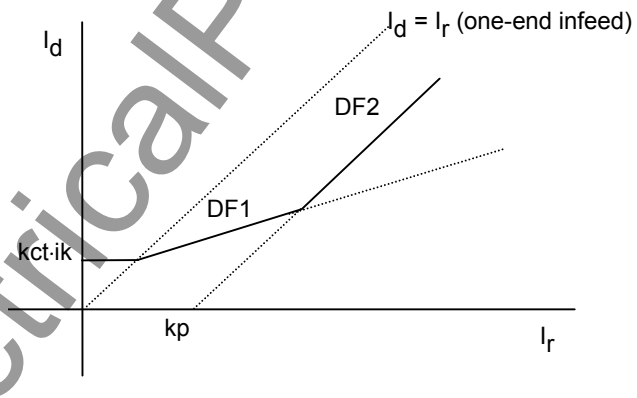


Figure 2.11.2 Restricted Earth Fault Element

Characteristic DF1 is expressed by the following equation:

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

where,

p1: slope of DF1 (fixed to 10%)

ik: minimum operating current

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.)

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

$I_r = \max.(|1kct1 \cdot I_{1a}|, |1kct1 \cdot I_{1b}|, |I1kct1 \cdot I_{1c}|, |1kct2 \cdot I_{2a}|, |1kct2 \cdot I_{2b}|, |1kct2 \cdot I_{2c}|, |1kct3 \cdot I_{3a}|, |1kct3 \cdot I_{3b}|, |kct3 \cdot I_{3c}|, |I_N|)$

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

2.11.4 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 2.11.3. One of these characteristics can be selected.

These characteristics are expressed by the following equations.

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

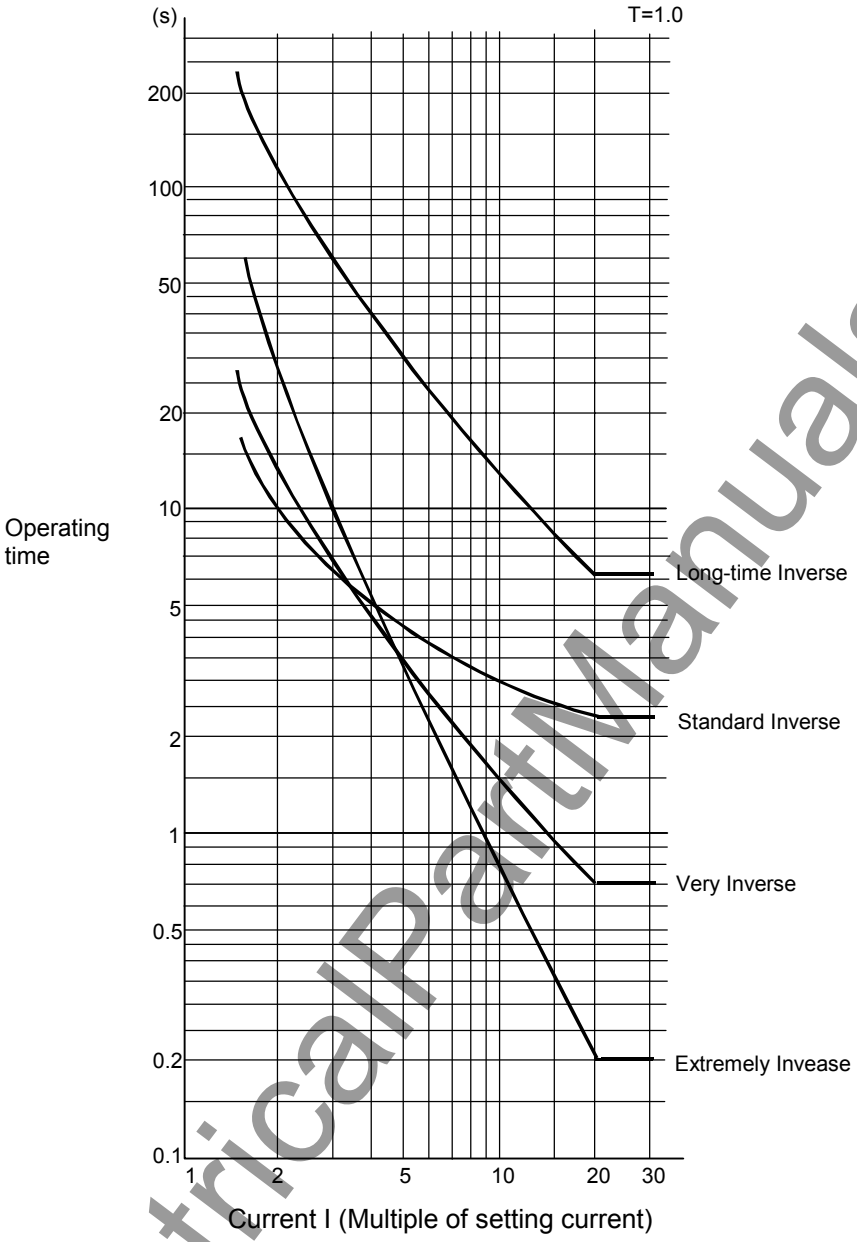


Figure 2.11.3 Characteristics of Inverse Time Overcurrent Element

2.11.5 Definite Time Overcurrent element OC and EF

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

2.11.6 Thermal Overload Element THR

Thermal overload element THR has a characteristic based on thermal replica according to IEC 60255-8 standards (see Appendix N), which evaluates the phase current (A-phase) of CT secondary circuits. Figure 2.11.4 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

Ln : natural logarithm

Figure 2.11.5 shows the thermal curve for a range of time constant settings under cold state when the prior load current Ip is zero.

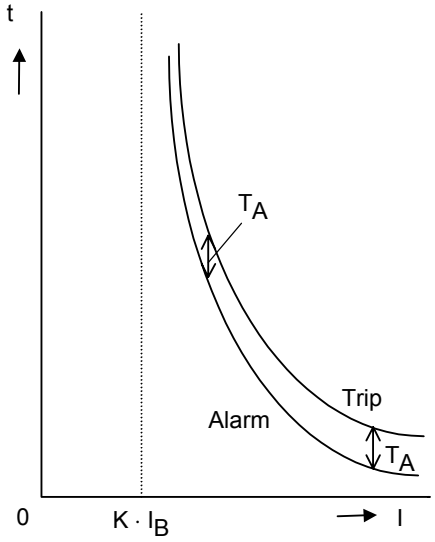


Figure 2.11.4 Characteristic of Thermal Overload Element

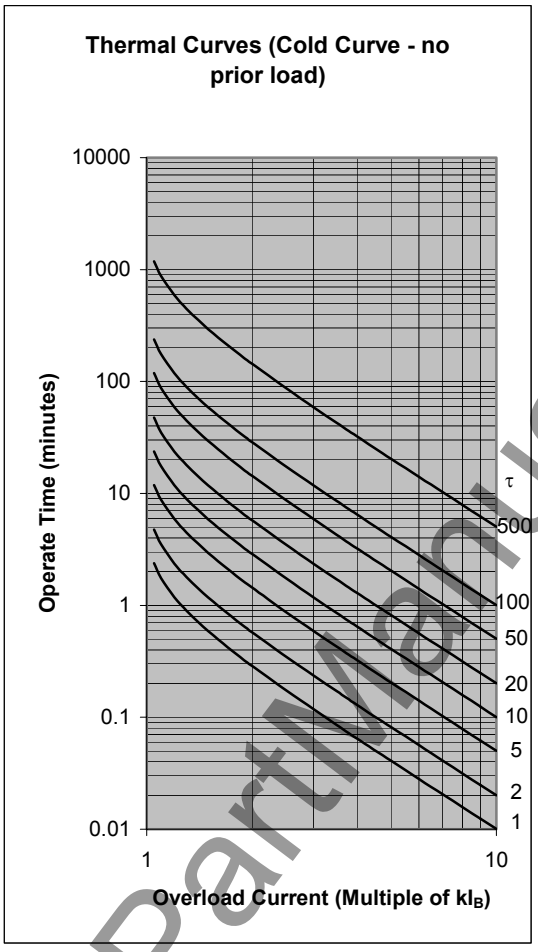


Figure 2.11.5 Thermal Curves

2.11.7 Frequency Element FRQ

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

2.11.8 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 2.11.7.

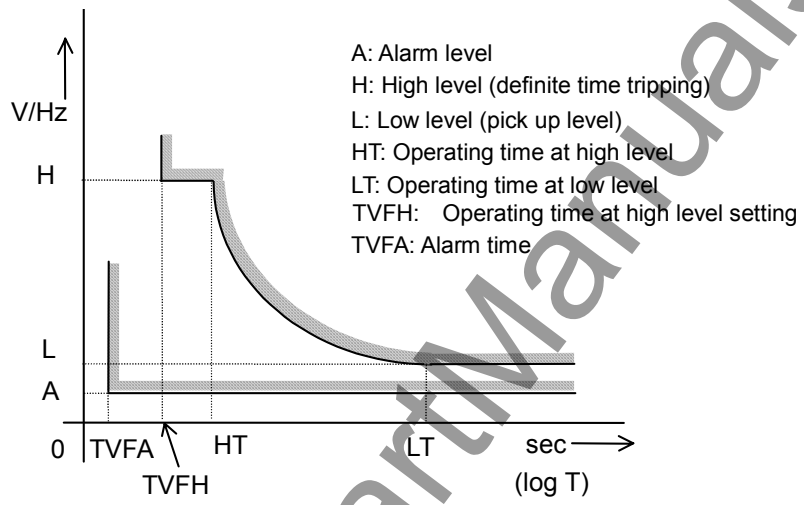


Figure 2.11.7 Characteristic of Overexcitation Element

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

Case outline of GRT100 is shown in Appendix F.

The hardware structures of their models are shown in Figure 3.1.1 to Figure 3.1.4. 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)
- Binary input and output module 2 (IO2)
- Human machine interface module (HMI)

The following hardware modules are added depending on the model.

- Binary output module 3 (IO3)

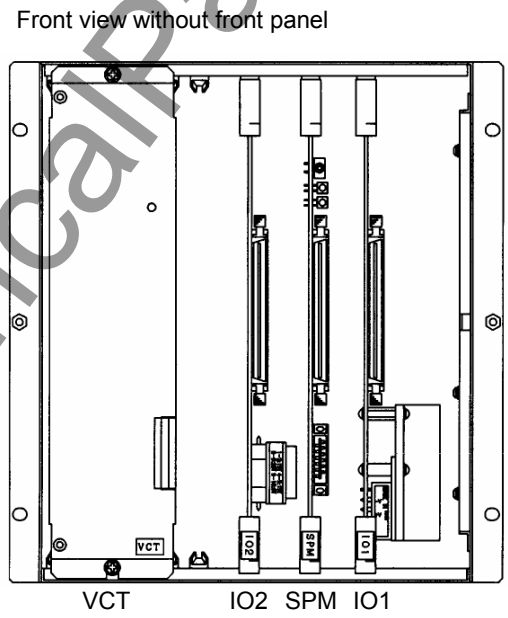


Figure 3.1.1 Hardware Structure (Model: 101, 201)

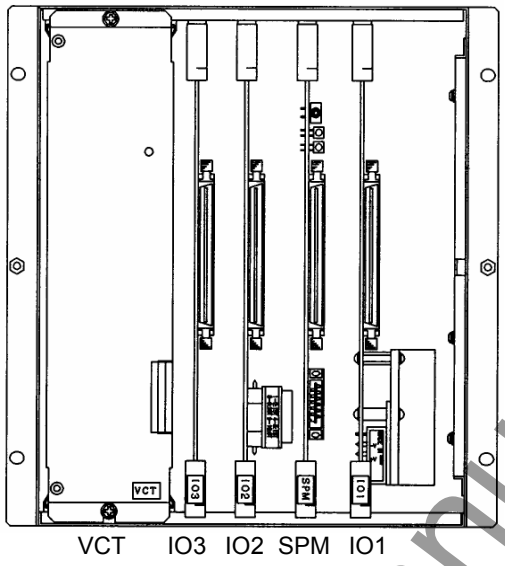


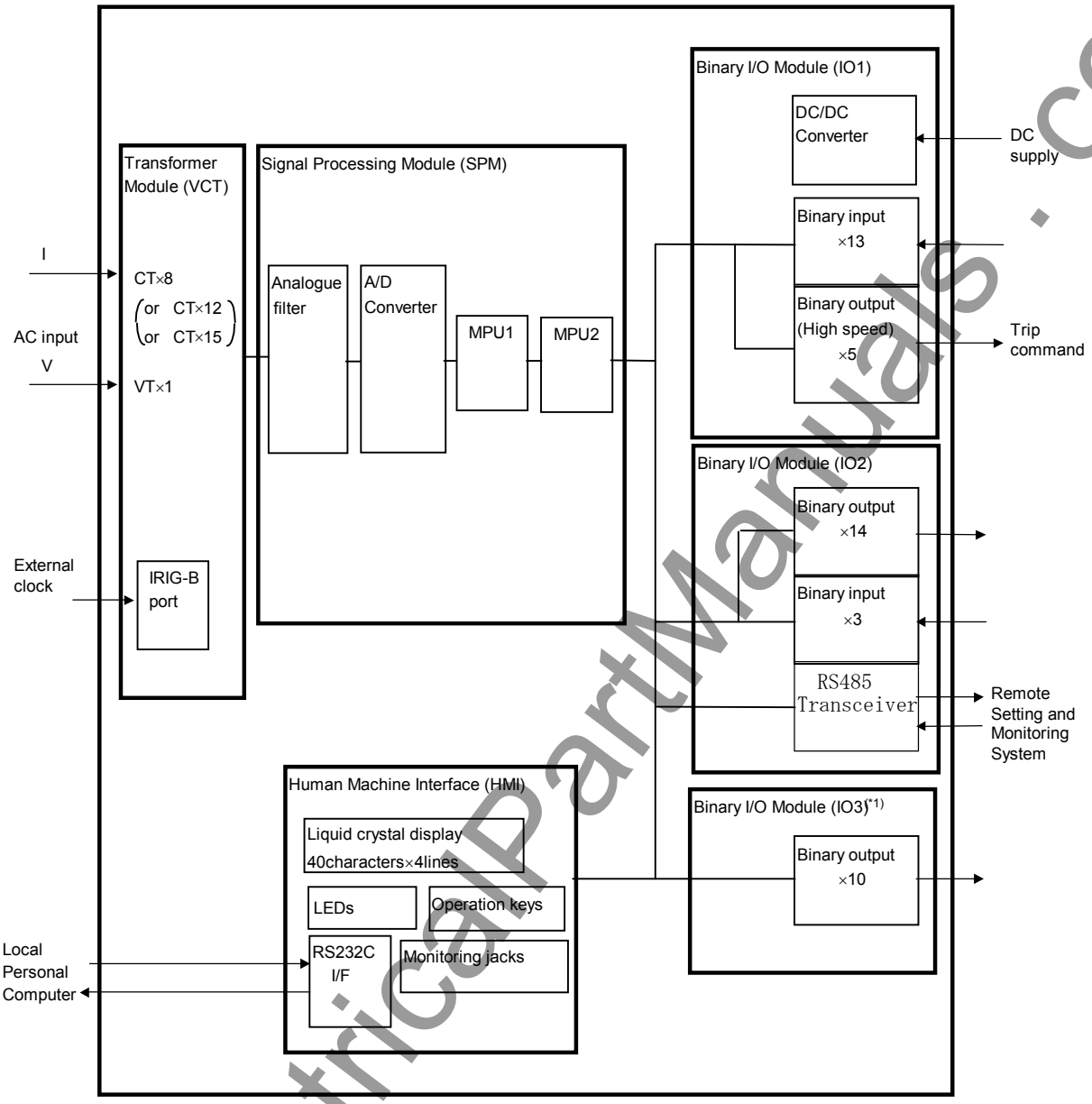
Figure 3.1.2 Hardware Structure (Model: 102, 202)

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

Module \ Models	101	102	201	202
VCT	×	×	×	×
SPM	×	×	×	×
IO1	×	×	×	×
IO2	×	×	×	×
IO3		×		×
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

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

3.1.2 Transformer Module

The transformer module (VCT module) insulates between the internal and external circuits through an auxiliary transformer and transforms the magnitude of AC input signals to suit the electronic circuits. The AC input signals are as follows:

- three-phase currents (I_a, I_b and I_c) for a winding
- neutral current (I_N) for a 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 the external clock for synchronization of the relay calendar clock. The IRIG-B port is insulated from the external circuit by a photo-coupler. A BNC connector is used as the input connector.

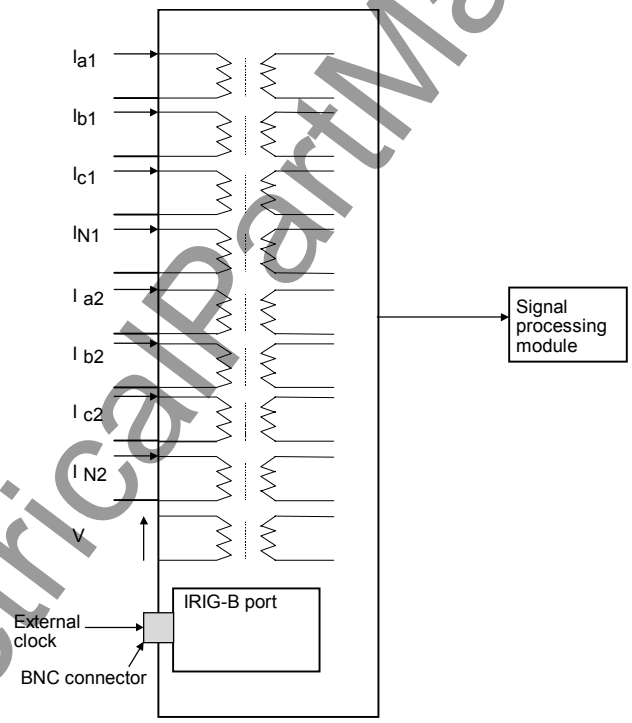


Figure 3.1.4 Transformer Module (e.g. models 101, 102)

3.1.3 Signal Processing Module

As shown in Figure 3.1.5, the signal processing module (SPM) consists of an analogue filter, multiplexer, analogue to digital (A/D) converter and main processing units (MPU1 and MPU2) and executes all kinds of processing such as protection, measurement, recording and display.

The analogue 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 2400 Hz (at 50 Hz) and 2880 Hz (at 60 Hz).

The MPU1 carries out operations for the measuring elements for protection, while the MPU2 carries out scheme logic operations, recording, display and signal transmission control. Both of them implements 60 MIPS and uses two RISC (Reduced Instruction Set Computer) type 32-bit microprocessors.

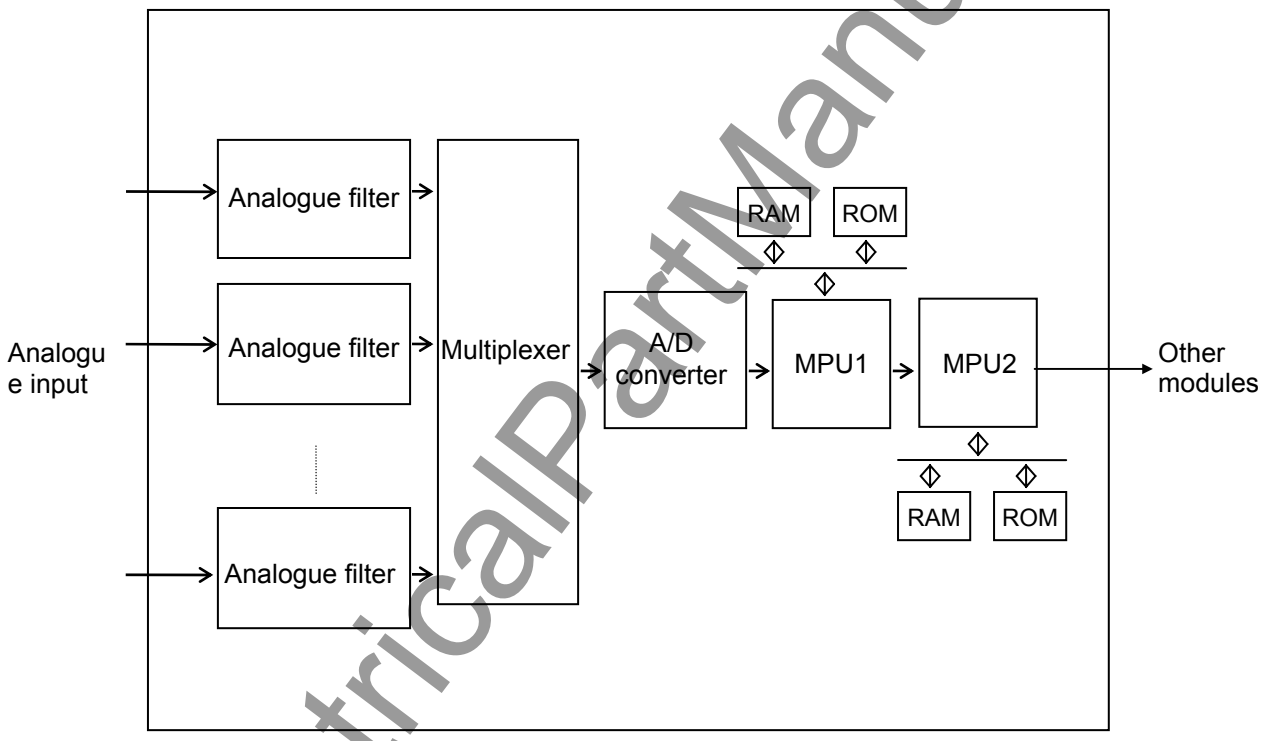


Figure 3.1.5 Signal Processing Module

3.1.4 Binary Input and Output Module

There are four types of binary input and output module (IO module): IO1 to IO3. IO1 and IO2 are used for all the relay models, while IO3 is used depending on the model (see Section 3.1.1).

3.1.4.1 IO1 Module

As shown in Figure 3.1.6, the IO1 module incorporates a DC/DC converter, 13 photo-coupler circuits (BI1-BI13) for binary input signals and 5 auxiliary relays (TP-1 to TP-5) dedicated to the circuit breaker tripping command.

The input voltage rating of the DC/DC converter is 48/60V, 110V/125V or 220V/250V. The normal range of input voltage is –20% to +20%.

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

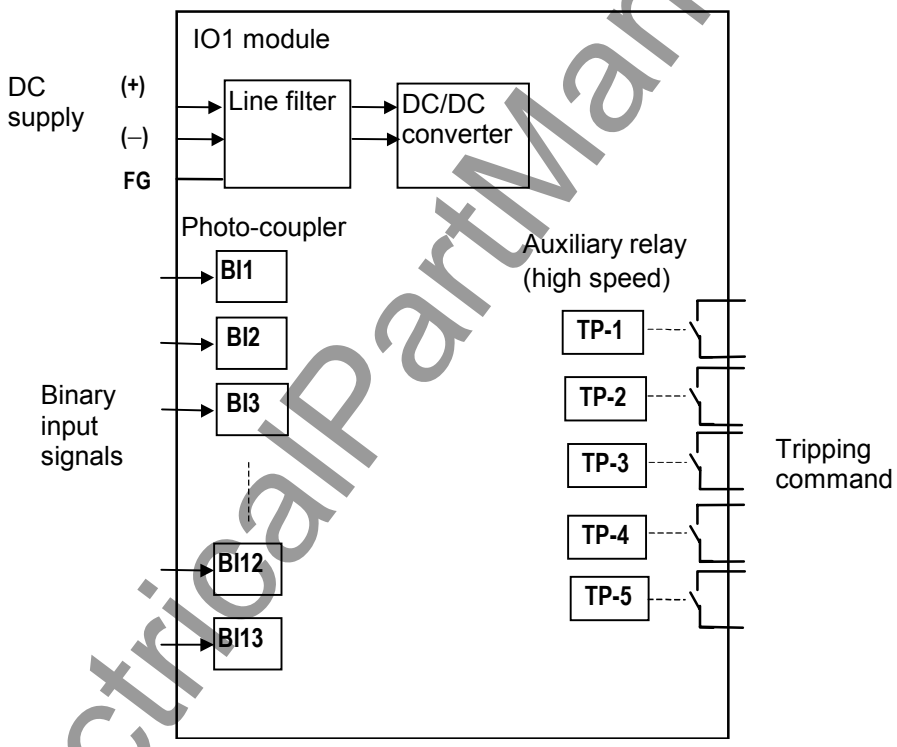


Figure 3.1.6 IO1 Module

3.1.4.2 IO2 Module

As shown in Figure 3.1.7, 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. The BO12 and BO13 are the high-speed operation type.

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

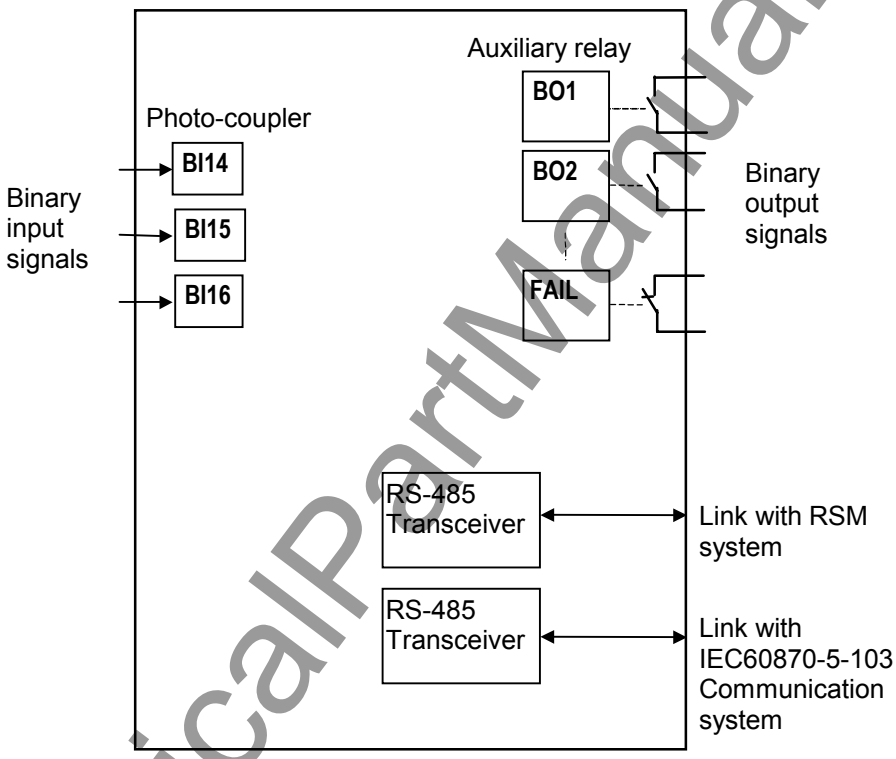


Figure 3.1.7 IO2 Module

3.1.4.3 IO3 Module

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

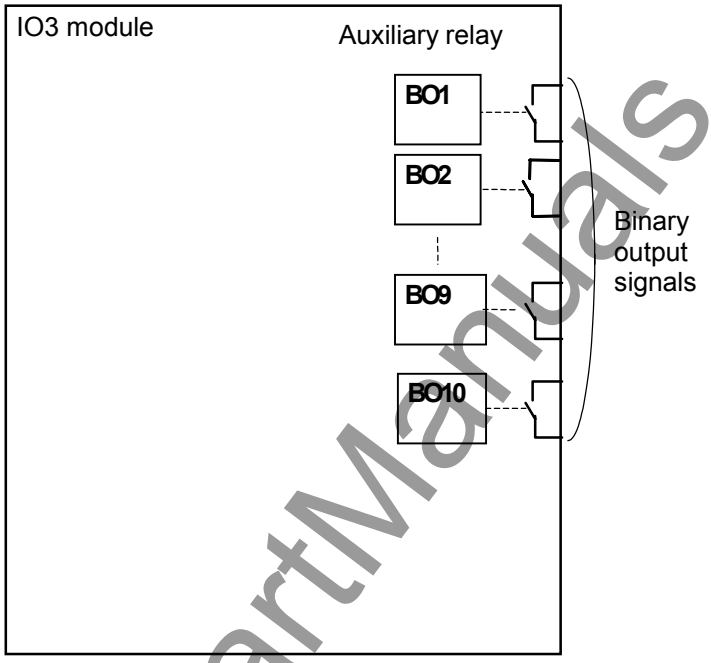


Figure 3.1.8 IO3 Module

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 3.1.9, 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.

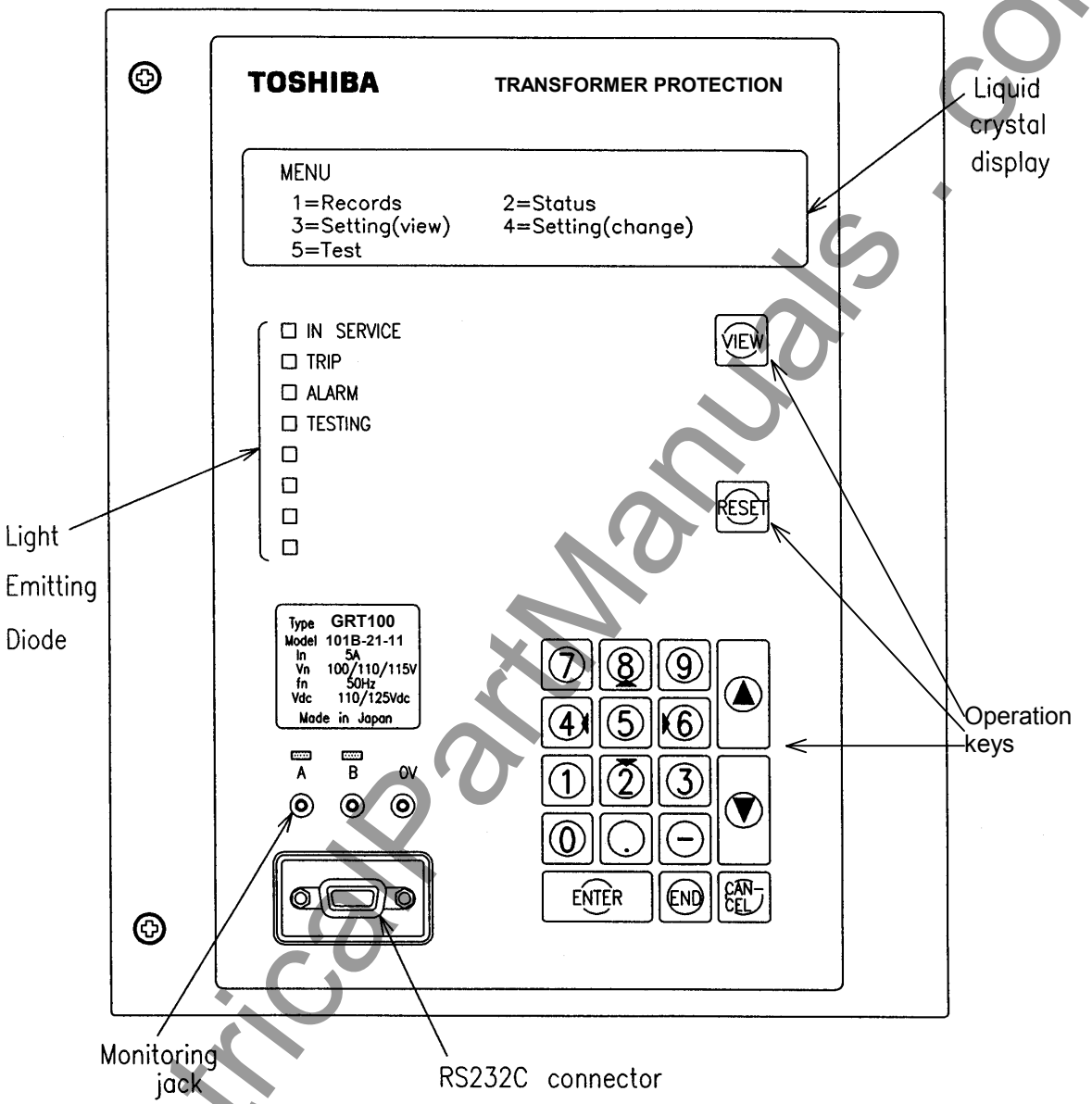


Figure 3.1.9 Front Panel

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
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*
Mechanical trip	Closed when external device operated. / Initiate trip command from operation of external device.	1
Mechanical trip	Closed when external device operated. / Initiate trip command from operation of external device.	2
Mechanical trip	Closed when external device operated. / Initiate trip command from operation of external device.	3
Mechanical trip	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
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

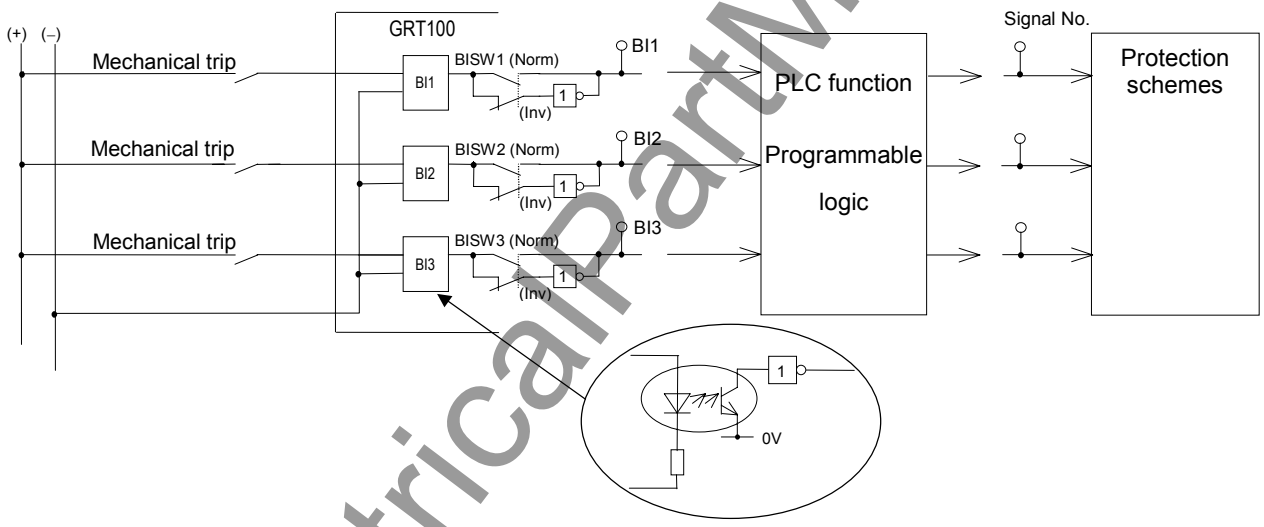


Figure 3.2.1 Logic Level Inversion

3.2.2 Binary Output Signals

The number of output binary signals and their output terminals vary depending on the relay models. 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.

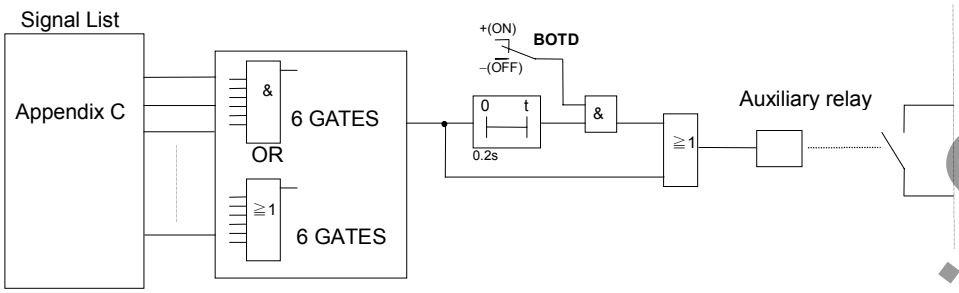


Figure 3.2.2 Configurable Output

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 editor 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 editor tool, refer to PLC TOOL instruction manual.

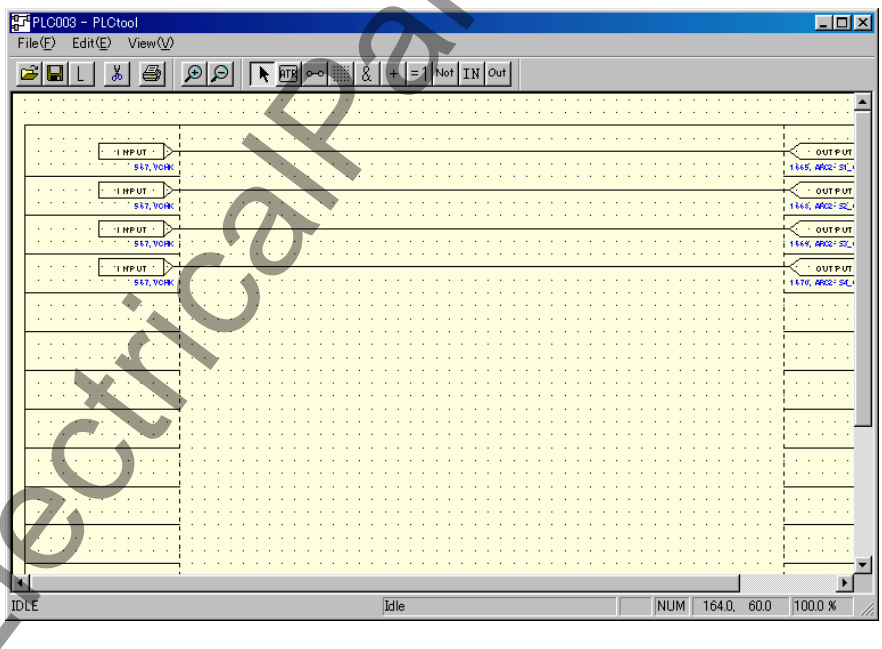


Figure 3.2.3 Sample Screen of PLC Editor

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. The numerical relay based on the microprocessor operations is suitable for implementing this automatic supervision function of the protection system. The GRT100 implements the automatic supervision function taking advantage of this feature based on the following concept:

- The supervising function should not affect protection performance.
- Perform supervision with no omissions wherever possible.
- When a failure occurs, it should be able 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 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 running 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 Memory monitoring	(1)	Off	On	(4)	Relay fail
Watchdog Timer	----	Off	On	(4)	----
DC supply monitoring	----	Off	(3)	(4)	Relay fail

(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.

3.3.4 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.

3.3.5 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

3.4 Recording Function

The 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. 4) 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 4 most-recent faults can be stored as fault records. If a new fault occurs when 4 faults have been stored, the record of the oldest fault is deleted and the record of the latest fault is then stored.

Date and time of fault occurrence

The time resolution is 1 ms using the relay internal clock.

To be precise, this is the time at which a tripping command has been 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.

The operating or fault phase is determined by differential element (DIFT) and high-set overcurrent element (HOC) operating phase.

The fault phase recording is available when the primary winding of the transformer is star-connected. However, the operating phase recording is recommended in case of a star-delta power transformer because the fault phase at the delta-winding side cannot be recorded.

The fault phase is expressed taking that of primary winding as a reference phase.

Tripping command

The tripping output relay(s) operated is shown in terms of 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 in pre-faults and faults are recorded.

(However, the power system quantities are not recorded for evolving faults.)

- 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})
- Frequency

Phase angles above are expressed taking that of voltage as a reference phase angle. If the voltage input is not provided, that of positive sequence current of primary winding is used as a reference phase angle.

3.4.2 Event Recording

The events shown in Table 3.4.1 are recorded with the 1 ms resolution time-tag when the status changes. The user can select the recording items.

Up to 96 records can be stored. If an additional event occurs when 96 records have been stored, the oldest event record is deleted and the latest event record is then stored.

Table 3.4.1 Event Record Items

Event	LCD Indication	
Mechanical trip 1 command output or reset	Mech. trip 1	On or Off
Mechanical trip 2 command output or reset	Mech. trip 2	On or Off
Mechanical trip 3 command output or reset	Mech. trip 3	On or Off
Mechanical trip 4 command output or reset	Mech. trip 4	On or Off
Trip command output or reset	Trip	On or Off
Indication reset input or rest	Ind. reset	On or Off
Relay failure detected or restored	Relay fail	On or Off
CT1 current circuit failure detected or restored	CT1 err	On or Off
CT2 current circuit failure detected or restored	CT2 err	On or Off
CT3 current circuit failure detected or restored	CT3 err	On or Off
External event signal 1 output or reset	Event 1	On or Off
External event signal 2 output or reset	Event 2	On or Off
External event signal 3 output or reset	Event 3	On or Off
System setting changed (*)	Sys. set change	
Relay setting changed (*)	Rly. set change	
Group setting changed (*)	Grp. set change	

(*): The event of setting change is classified into three events. The event "System setting changed" corresponds to all the setting changes except setting changes in the sub-menu "Protection". (See section 4.2.6 for changing the settings). The event "Relay setting changed" corresponds

to setting change of measuring elements and timers in the sub-menu "Protection". The event "Group setting changed" corresponds to other setting changes in the sub-menu "Protection".

Setting

The recording mode can be set for each event. One of the following four modes is selectable.

Modes	Setting
Not to record the event.	None
To record the event when the status changes to "operate".	Operate
To record the event when the status changes to "reset".	Reset
To record the event when the status changes both to "operate" and "reset".	Both

For the setting, see the Section 4.2.6.5. The default setting is "Both" for all events except those marked with (*) in Table 3.4.1. The events marked with (*) have a default setting of "Operate".

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). Following binary signals listed below and the dates and times at which recording started are also recorded.

-Trip-1	-5F	-2OCI	-FRQ
-Trip-2	-1REF	-3OCI	-V/F
-Trip-3	-2REF	-1EF	-THR
-Trip-4	-3REF	-2EF	-Mec. Trip
-Trip-5	-1OC	-3EF	
-DIFT	-2OC	-1EFI	
-HOC	-3OC	-2EFI	
-2F	-1OCI	-3EFI	

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

The pre-fault recording time is fixed at 0.3s and post-fault recording time can be set between 0.1 and 3.0s.

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	50HZ	40	21	12	9	7	6	5
102	60Hz	35	17	10	7	6	5	4
201	50HZ	31	15	9	7	5	4	3
202	60Hz	26	13	8	5	4	3	3

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})
- Frequency

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

The above system quantities are displayed in values on the primary side or on the secondary side of the CT by the 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), equipped with the RSM (Remote Setting and Monitoring) software via an RS232C port. Furthermore, remote communication is also possible using a PC equipped with the RSM via an RS485 and a protocol converter.

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	
(LED2)	Red	
(LED3)	Red	
(LED4)	Red	

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 three interfaces are provided as communication ports:

- RS232C port
- RS485 port
- IRIG-B port

RS232C port

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

RS485 port

Two RS485 ports can be provided.

One RS485 port (PORT-1: COM1) is used to connect between relays and between the relay and the protocol converter G1PR2 to construct a network communication system. (For the system configuration, see Figure 4.4.1 in Section 4.4.) The other port (PORT-2: COM2) is used to communicate substation control and monitoring system (Protocol: IEC 60870-5-103).

This port is on the back of the relay, as shown in Figure 4.1.1.

IRIG-B port

The IRIG-B port is mounted on the transformer module, and collects serial IRIG-B format data from the external clock to synchronize the relay calendar clock. The IRIG-B port is isolated from the external circuit by a photo-coupler. A BNC connector is used as the input connector.

This port is on the back of the relay, as shown in Figure 4.1.1.

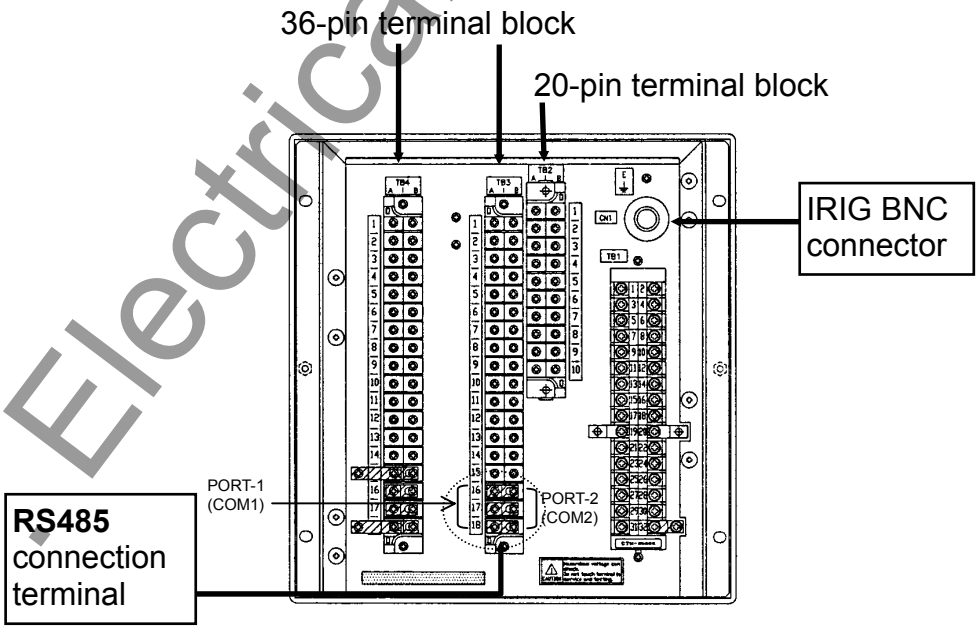


Figure 4.1.1 Locations of Communication Port

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

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

```
Auto-supervision    08/Dec/1997   22:56

 DIO  err
```

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

If a fault occurs and a tripping command is initiated when the LCD is off, the "Latest fault" screen is displayed on the LCD automatically and the red "TRIP" LED lights.

Press the VIEW key to display the digest screens in turn including the "Metering" and "Auto-supervision" screens.

Press the RESET key to turn off the LEDs and LCD display.

If the tripping command is initiated when any of the screens is displayed, the current screen remains displayed and the red "TRIP" LED lights.

When any of the menu screens is displayed, the VIEW and RESET keys do not function. To return to the digest 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 "TRIP" LED and LCD.

Displays in automatic supervision operation

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 LCD display. However, the "ALARM" LED remains lit if the failure continues.

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.

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.

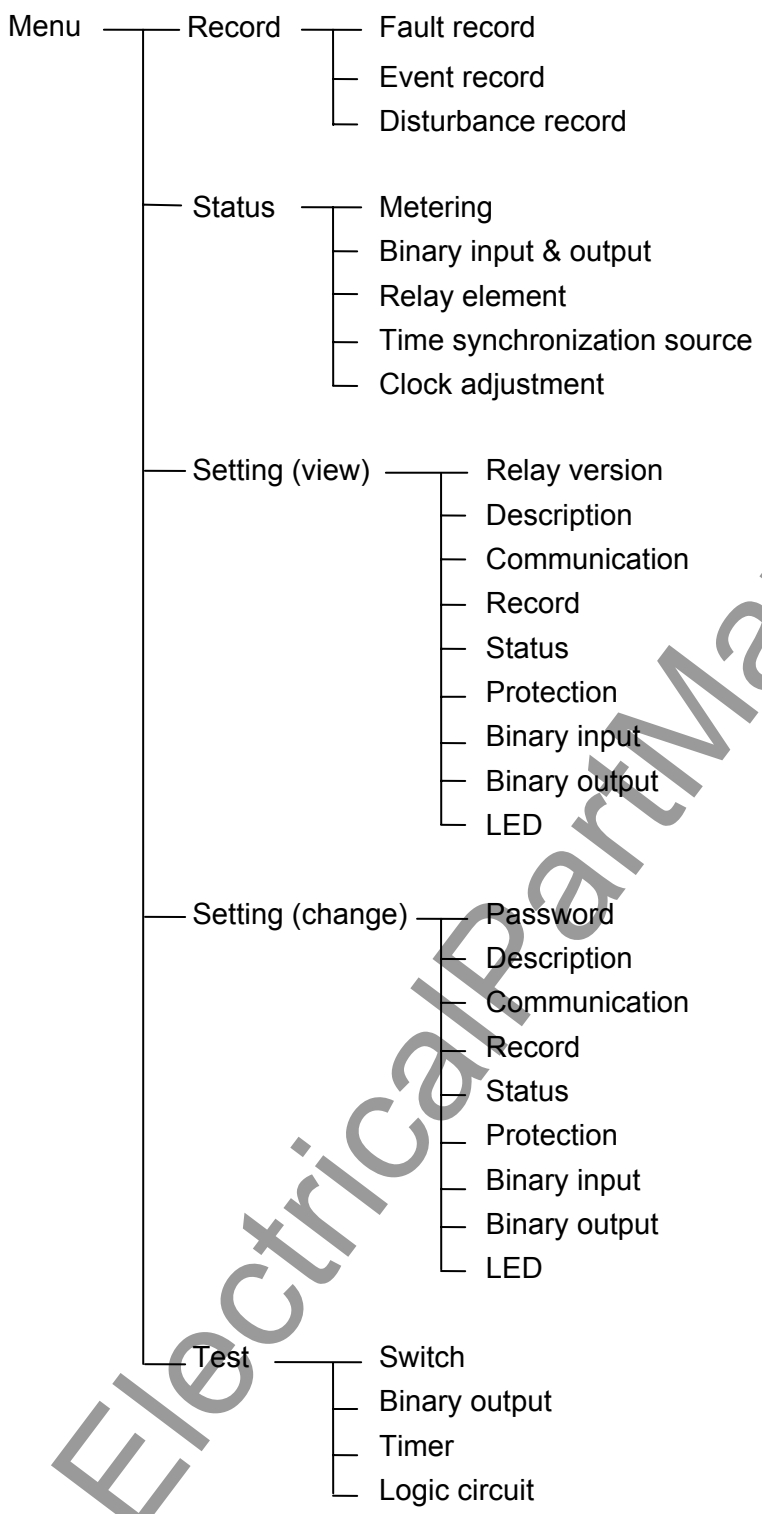


Figure 4.2.1 Relay Menu

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.

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.

```
／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
```

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.

```
/2 Binary input & output                    3/ 5
Input (IO1)          [000 000 000 000 0     ]
Input (IO2)          [000                   ]
Output(IO1-trip)     [000 00                ]
Output(IO2)          [000 000 000 000 00    ]
Output(IO3)          [000 000 000 0         ]
```

The display format is shown below.

	[■	■	■	■	■	■	■	■	■	■	■	■	■	■	■]
Input (IO1)	BI1	BI2	BI3	BI4	BI5	BI6	BI7	BI8	BI9	BI10	BI11	BI12	BI13	—	—
Input (IO2)	BI14	BI15	BI16	—	—	—	—	—	—	—	—	—	—	—	—
Output (IO1-trip)	TP-1	TP-2	TP-3	TP-4	TP-5	—	—	—	—	—	—	—	—	—	—
Output (IO2)	BO1	BO2	BO3	BO4	BO5	BO6	BO7	BO8	BO9	BO10	BO11	BO12	FAIL	BO13	—
Output (IO3)	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. IO1 and IO2 in the table indicate 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 output. 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".

IO1 to IO3 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 Relay 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 internal clock of the GRT100 can be synchronized with external clocks such as the IRIG-B time standard signal clock, RSM (relay setting and monitoring system) clock, or IEC60870-5-103. 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          1/ 3
*IRIG:   Active
 RSM:    Inactive
 IEC:    Inactive
```

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] 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
Communication (Relay address and baud rate in the RSM or IEC60870-5-103)
Recording setting
Status setting
Protection setting
Binary input setting
Binary output setting
LED setting

Enter a number on the LCD to display each item as described in the previous sections.

4.2.5.1 Relay Version

To view the relay version, do the following.

- Press 3 (= Setting (view)) on the main "MENU" screen to display the "Setting (view)" screen.

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

- Press 1 (= Version) on the "Setting (view)" screen and the "Relay version" screen appears.

```
/2 Relay version                          3/ 5
Relay type:
Serial No.:
Main software:
PLC data:
IEC103 data:
```

4.2.5.2 Settings

The "Description", "Comm.", "Record", "Status", "Protection", "Binary input", "Binary output" and "LED" screens display the current settings input using the "Setting (change)" sub-menu.

4.2.6 Changing the Settings

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

Password
Description
Communication (Relay address and baud rate in the RSM or IEC60870-5-103)
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=2PAND                              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
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
DIF4     0=Off   1=On                                 1
DIF5     0=Off   1=On                                 1
1REF1    0=Off   1=On                                 1
1REF2    0=Off   1=On                                 1
1REF3    0=Off   1=On                                 1
1REF4    0=Off   1=On                                 1
1REF5    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, 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.

Password trap

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

If 4 (= Setting (change)) is entered on the top "MENU" screen, the password trap screen "Password" is displayed. If the password is not entered correctly, it is not possible to move to the "Setting (change)" sub-menu screens.

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

Canceling or changing the password

To cancel the password protection, enter "0000" in the two brackets on the "Password" screen. The "Setting (change)" screen is then displayed without having to enter a password.

The password can be changed by entering a new 4-digit number on the "Password" screen in the same way as the first password setting.

If you forget the password

Press CANCEL and RESET together for one second on the top "MENU" screen. The screen disappears, and the password protection of the 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) or IEC60870-5-103, 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
2=Switch
```

- Press 1 (= Address) to enter the relay address number.

```
/3 Address                                    1/2
HDLC (      1-     32):        1_
IEC  (      0-    254):        2
```

- Enter the address number on "HDLC" column for RSM and "IEC" column for IEC60870-5-103 and press the [ENTER] key.

  CAUTION: Do not overlap the relay address number.

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

```
/3 Switch                                     1/3
232C      1=9.6  2=19.2  3=38.4  4=57.6  1 _
IECBR     1=9.6  2=19.2                  2
IECBLK    1=Normal  2=Blocked            1
```

- Select the number corresponding to the system and press the [ENTER] key.

<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.

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  0=None      3= Both  1/16
Mech. Trip1      1=Operate 2=Reset  3_
Mech. Trip2      1=Operate 2=Reset  3
Mech. Trip3      1=Operate 2=Reset  3
```

- Enter 0 or 1 or 2 or 3 and press the [ENTER] key. Repeat this for all events.

  Enter 0 (= None) not to record the event.

  Enter 1 (= Operate) to record the event when the status changes to "operate".

  Enter 2 (= Reset) to record the event when the status changes to "reset".

  Enter 3 (= Both) to record the event when the status changes both to "operate" and "reset".

Setting the disturbance recording

- Press 3 (= Disturbance record) to display the "Disturbance record" screen.

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

- 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
10CPS( 0.10-  20.00):  1.00            pu
20CPS( 0.10-  20.00):  1.00            pu
10CPG( 0.05-  20.00):  1.00            pu
20CPG( 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                                    1/16
TRIP1    0=Off   1=On                               1 _
TRIP2    0=Off   1=On                               1
TRIP3    0=Off   1=On                               1
TRIP4    0=Off   1=On                               1
TRIP5    0=Off   1=On                               1
```

- Enter 1 to use as a starter or enter 0 if not to use. Repeat this for all items.
- Enter the signal number to record binary signals in Appendix B.

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 the external IRIG-B time standard signal, RSM or IEC clock. This is selected by setting as follows.

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

```
/3 Time synchronization                             1/1
Sync  0=Off  1=IRIG  2=RSM  3=IEC                   1 _
```

- Enter the selected number and press the [ENTER] key.

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

Setting the time zone

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

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

```
/3 Time zone                                    1/1
GMT   (    -12-    +12):       +9 _       hrs
```

- Enter the difference between GMT and local time and press the [ENTER] key.

4.2.6.7 Protection

The 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=Scheme switch
2=Protection element
```

Setting the scheme switch

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

```
/6 Scheme switch                                    1/***
DIFTPMD  1=3POR  2=2PAND                             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
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
DIF4     0=Off   1=On                                1
DIF5     0=Off   1=On                                1
1REF1    0=Off   1=On                                1
1REF2    0=Off   1=On                                1
1REF3    0=Off   1=On                                1
1REF4    0=Off   1=On                                1
1REF5    0=Off   1=On                                1
  :                :                                 :
```

- 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 2 (= 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                                                    1/13
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
d1   (       0-     11):      10
d2   (       0-     11):       1
d3   (       0-     11):       3
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/ 8
BISW 1   Mechanical trip1                1 _
BISW 2   Mechanical trip2                1
BISW 3   Mechanical trip3                1
BISW 4   Mechanical trip4                1
BISW 5   Indication reset                1
BISW14   Event 1                         1
BISW15   Event 2                         1
BISW16   Event 3                         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. (This differs depending on the relay model; the following is for Models 102 and 202.)

```
/2 Binary output
1=IO2        2=IO3
```

- 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 from bottom of the front panel are user-configurable. One of the signals listed in Appendix B can be assigned to each LED as follows:

- Press 9 (= LED) on the "Setting (change)" screen to display the "LED" screen.

```
/2 LED                                1/ 4
LED1 (      0-  3071):      21 _
LED2 (      0-  3071):       4
LED3 (      0-  3071):      67
LED4 (      0-  3071):       0
```

- Enter the number corresponding to a signal to assign signals to each LED.

If an LED is not used, enter "0" or the default value will be assigned.

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.

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=I01    2=I02    3=I03
```

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
I02    B01   :TB3- A1. A2                    1
I02    B02   :TB3- B1. A2                    1
I02    B03   :TB3- B2. A2                    1
I02    B04   :TB3- A3. B3                    0
I02    B05   :TB3- A4. B4                    0
I02    B06   :TB3- A5. B5                    0
I02    B07   :TB3- A6. B6                    0
I02    B08   :TB3- A7. B7                    0
I02    B09   :TB3- A8. B8                    0
I02    B010  :TB3- A9. B9                    0
I02    B011  :TB3-A10.B10                    0
I02    B012  :TB3-A11.B11                    0
I02    FAIL  :TB3-A12.B12                    0
I02    B013  :TB3-A13.B13                    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-     15) :       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 Relay Setting and Monitoring System

The Relay Setting and Monitoring (RSM) system is a system that retrieves and analyses the data on power system quantities, fault and event records and views or changes settings in individual relays via a telecommunication network using a remote PC.

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

Figure 4.4.1 shows the typical configuration of the RSM system via a protocol converter G1PR2. The relays are connected through twisted pair cables, and the maximum 256 relays can be connected since the G1PR2 can provide up to 8 ports. The total length of twisted pair wires should not exceed 1200 m. Relays are mutually connected using an RS485 port on the relay rear panel and connected to a PC RS232C port via G1PR2. Terminal resistor (150 ohms) is connected the last relay. The transmission rate used is 64 kbits/s.

Figure 4.4.2 shows the configuration of the RSM system with Ethernet LAN (option). The relays are connected to HUB through UTP cable using RJ-45 connector at the rear of the relay. The relay recognizes the transmission speed automatically.

In case of the optional fiber optic interface (option), the relays are connected through graded-index multi-mode 50/125μm or 62.5/125μm type optical fiber using ST connector at the rear of the relay.

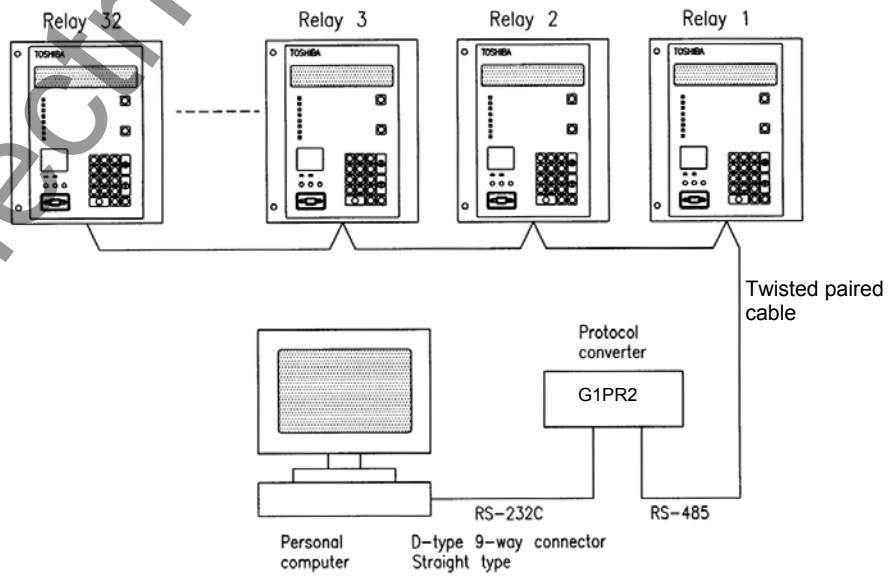


Figure 4.4.1 Relay Setting and Monitoring System (1)

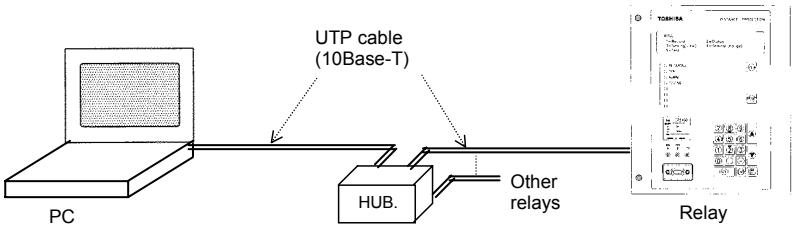


Figure 4.4.2 Relay Setting and Monitoring System (2)

4.5 IEC 60870-5-103 Interface

The GRT100 can support the IEC60870-5-103 communication protocol. This protocol is mainly used when the relay communicates with a control system and is used to transfer the following measurand, status data and general command from the relay to the control system.

- Measurand data: current, voltage, frequency
- Status data: events, fault indications, etc.

The IEC60870-5-103 function in the relay can be customized with the original software "IEC103 configurater". It runs on a personal computer (PC) connected to the relay, and can help setting of Time-tagged messages, General command, Metering, etc. For detais of the setting method, refer to "IEC103 configurater" manual. For the default setting of IEC60870-5-103, see Appendix O.

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 connection is similar to Figure 4.4.1.

The relays supports two baud-rates 9.6kbps and 19.2kbps. The data transfer from the relay can be blocked by the setting. For the settings, see the Section 4.2.6.4.

4.6 Clock Function

The clock function (Calendar clock) is used for time-tagging for the following purposes:

- Event records
- Disturbance records
- Fault records
- Metering
- Automatic supervision
- Display of the system quantities on the digest screen
- Display of the fault records on the digest screen
- Display of the automatic monitoring results on the digest screen

The calendar clock can run locally or be synchronized with the external IRIG-B time standard signal, RSM 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, 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.

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.

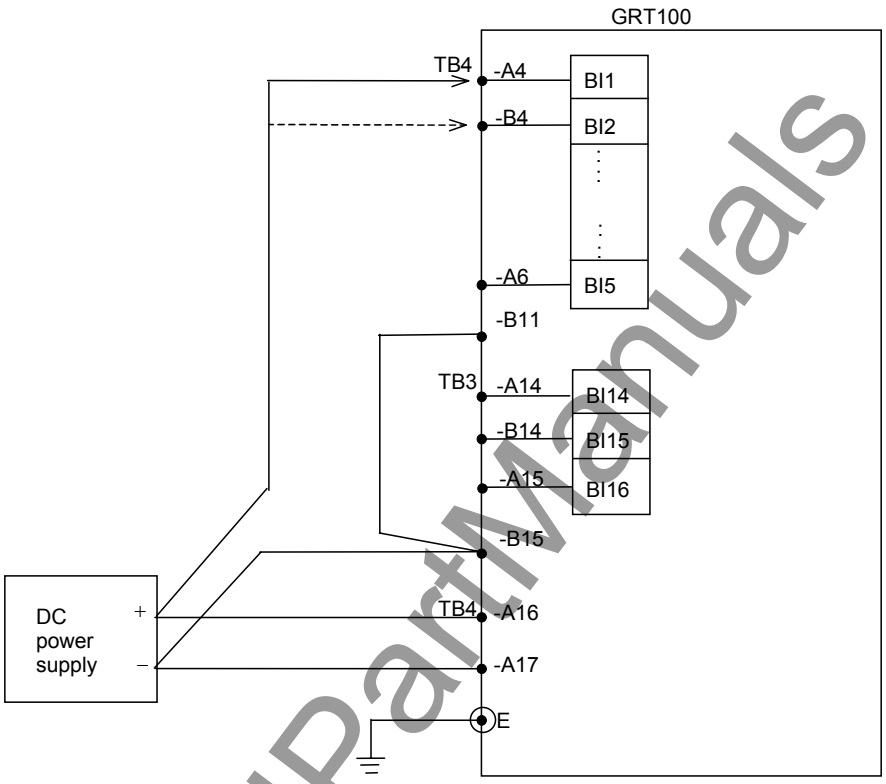


Figure 6.4.1 Testing Binary Input Circuit (Model 100s, 200s)

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

```
/2 Binary input & output                    3/  5
Input (I01)            [000 000 000 000 0    ]
Input (I02)            [000                  ]
Output(I01-trip)       [000 00               ]
Output(I02)            [000 000 000 000 00   ]
Output(I03)            [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=I01    2=I02    3=I03
```

- 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 B0              (0=Disable 1=Enable)   1/14
I02    B01   :TB2- A1, A2                  1
I02    B02   :TB2- B1, A2                  1
I02    B03   :TB2- B2, A2                  1
I02    B04   :TB2- A3, B3                  0
I02    B05   :TB2- A4, B4                  0
I02    B06   :TB2- A5, B5                  0
I02    B07   :TB2- A6, B6                  0
I02    B08   :TB2- A7, B7                  0
I02    B09   :TB2- A8, B8                  0
I02    B010  :TB2- A9, B9                  0
I02    B011  :TB2-A10,B10                  0
I02    B012  :TB2-A11,B11                  0
I02    FAIL  :TB2-A12,B12                  0
I02    B013  :TB2-A13,B13                  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 B0
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.)

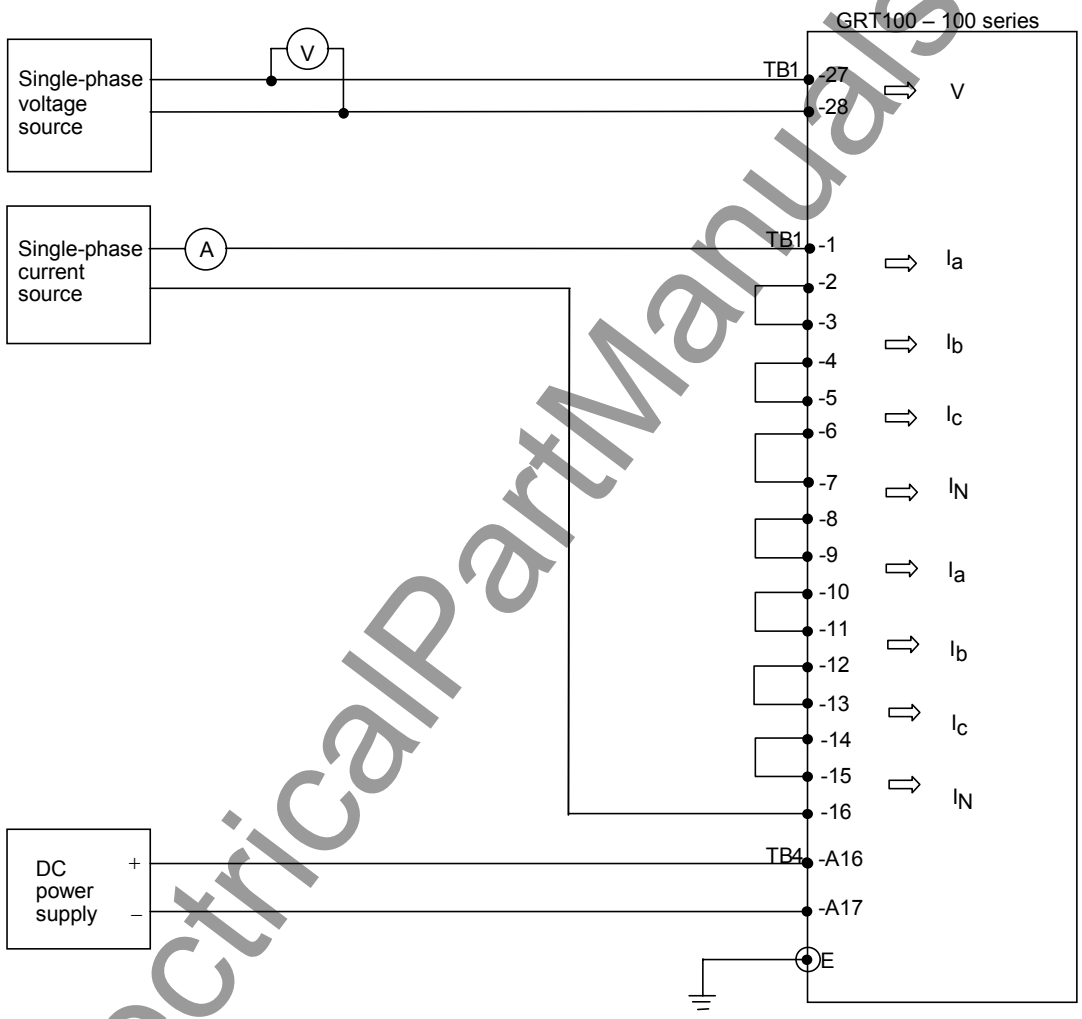


Figure 6.4.2 Testing AC Input Circuit (Model 100s)

- 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-    333) :       1
TermB(      0-    333) :      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.

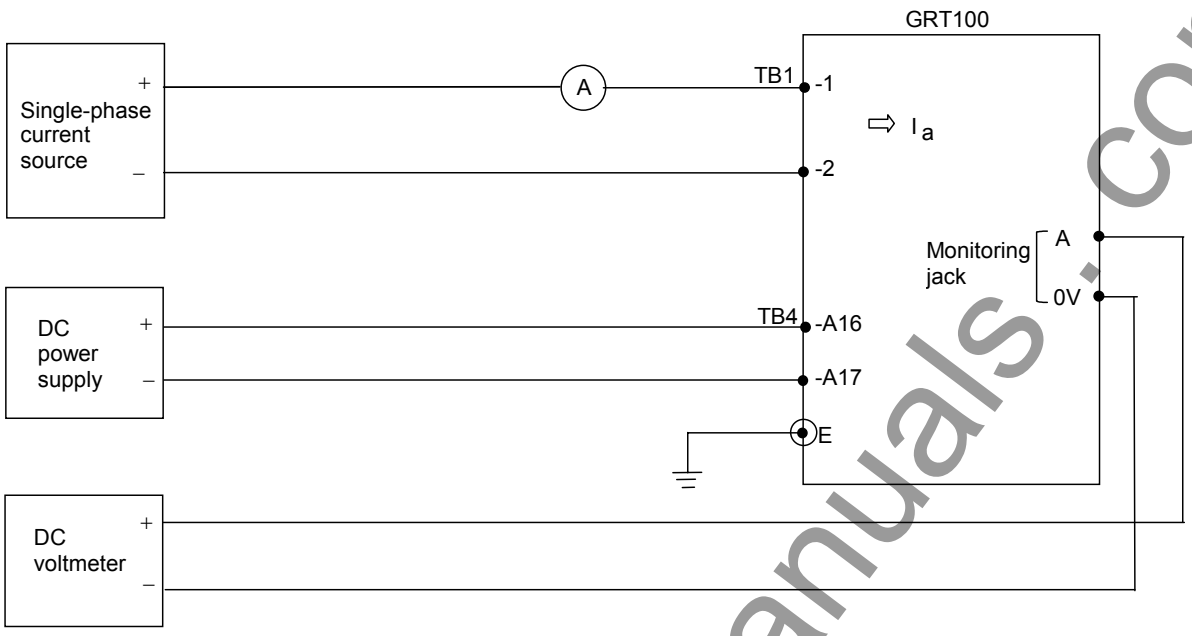


Figure 6.5.1 Operating Current Value Test Circuit (Model 100s, 200s)

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.

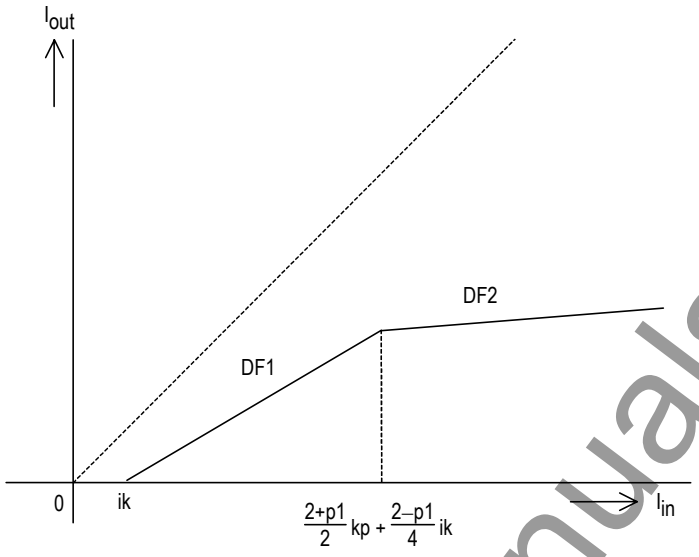


Figure 6.5.2 Current Differential Element (I_{out} - I_{in} Plane)

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

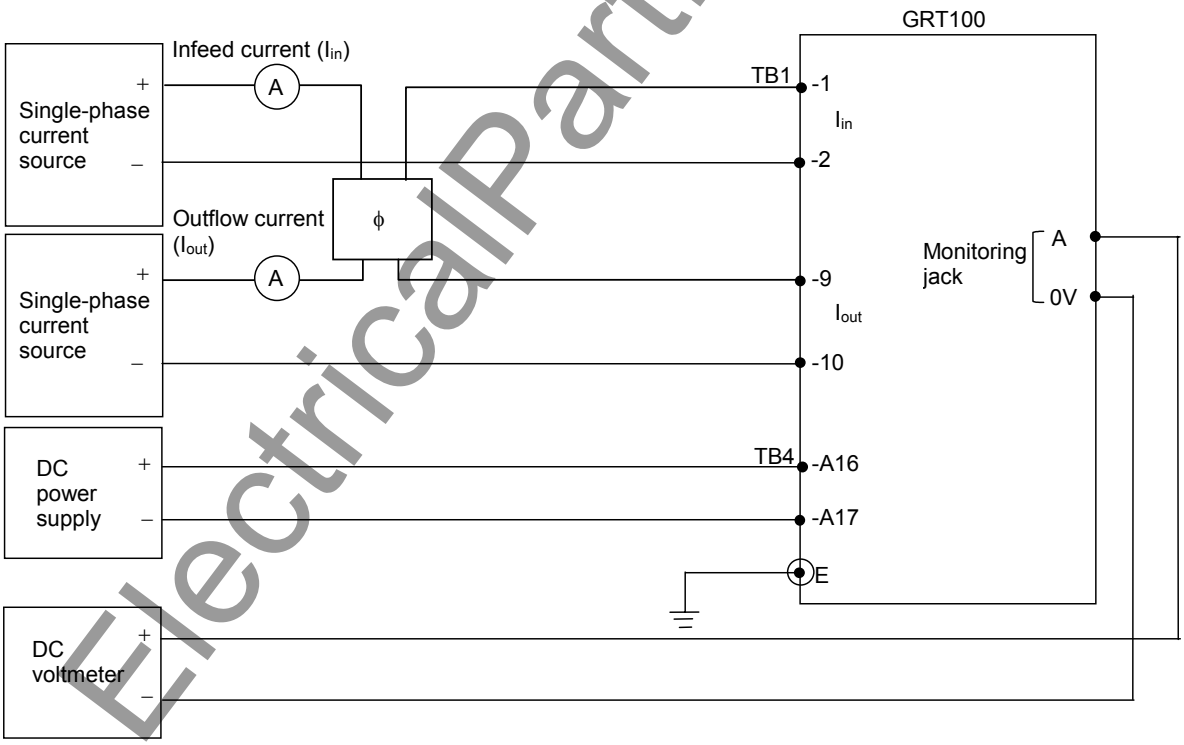


Figure 6.5.3 Percentage Restraining Characteristic Test of DIF (Model 100s, 200s)

- 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:

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

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.

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

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.

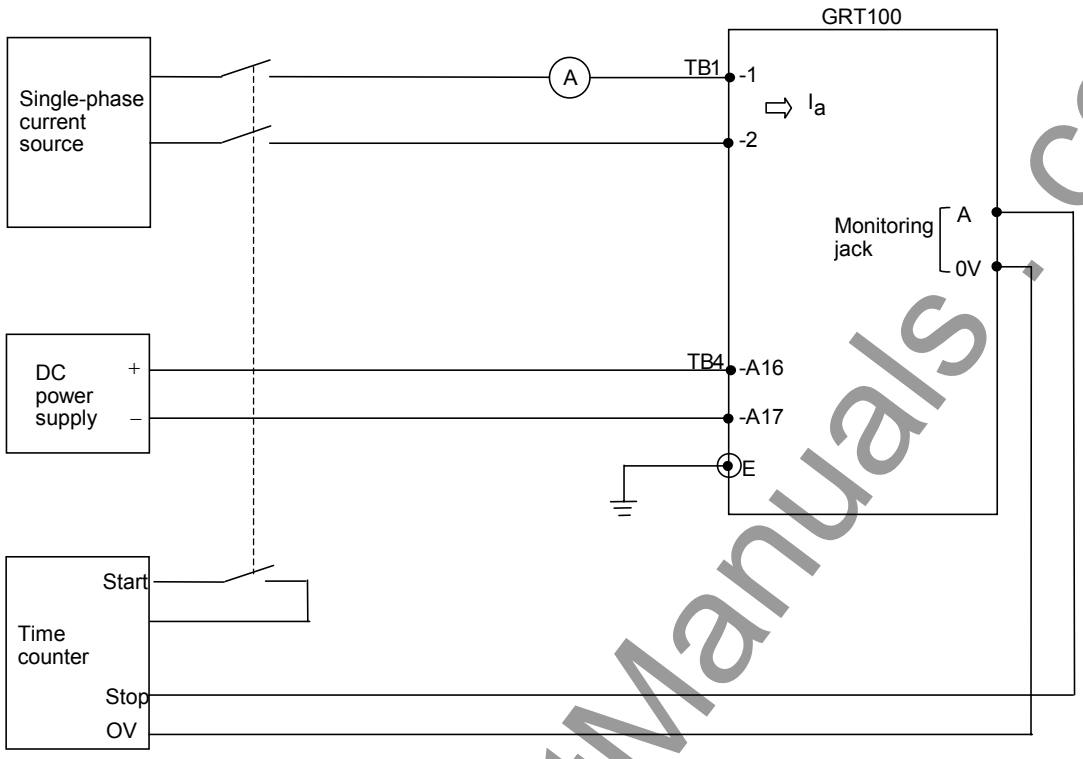


Figure 6.5.4 Operating Time Test (Model 100s, 200s)

- 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.

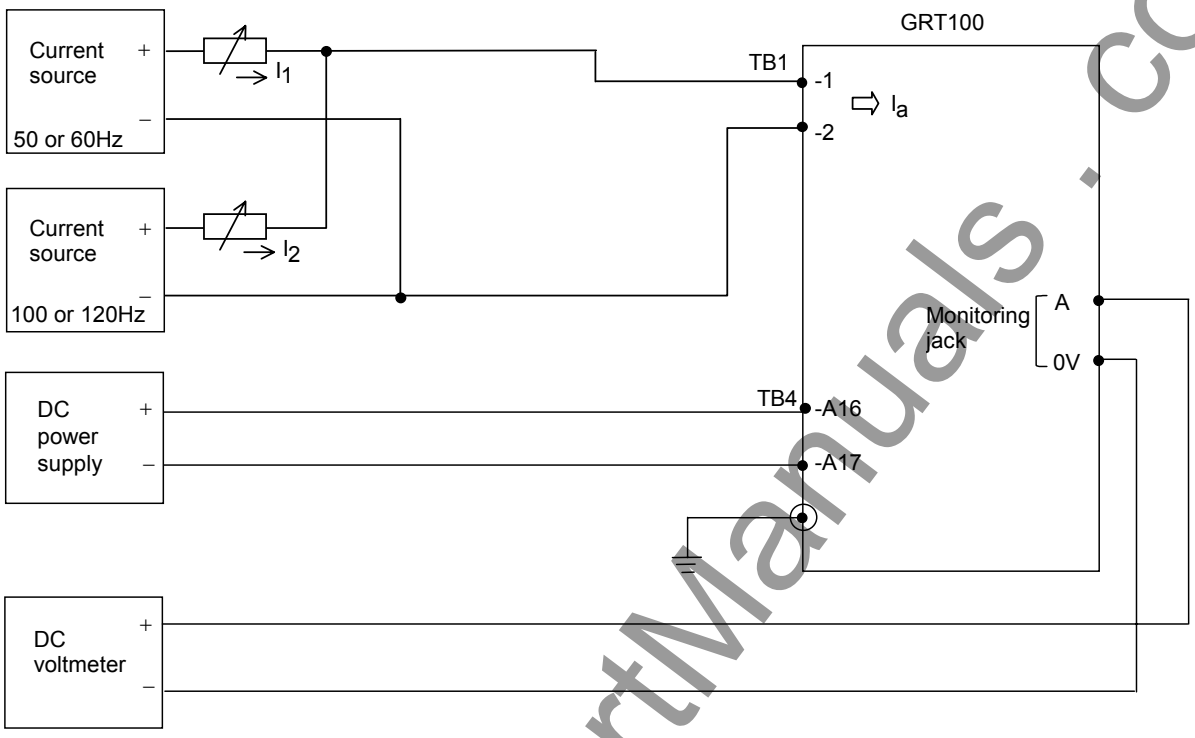


Figure 6.5.5 Testing 2F Element (Model 100s, 200s)

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.

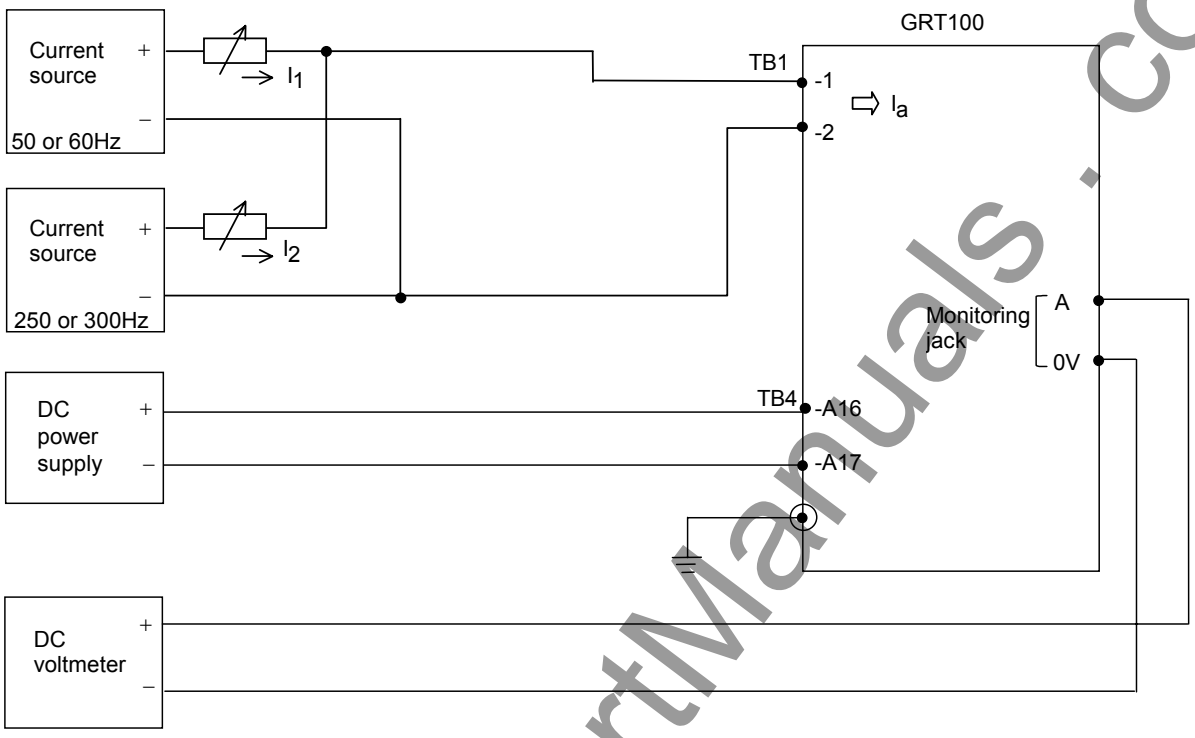


Figure 6.5.6 Testing 5F Element (Model 100s, 200s)

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.

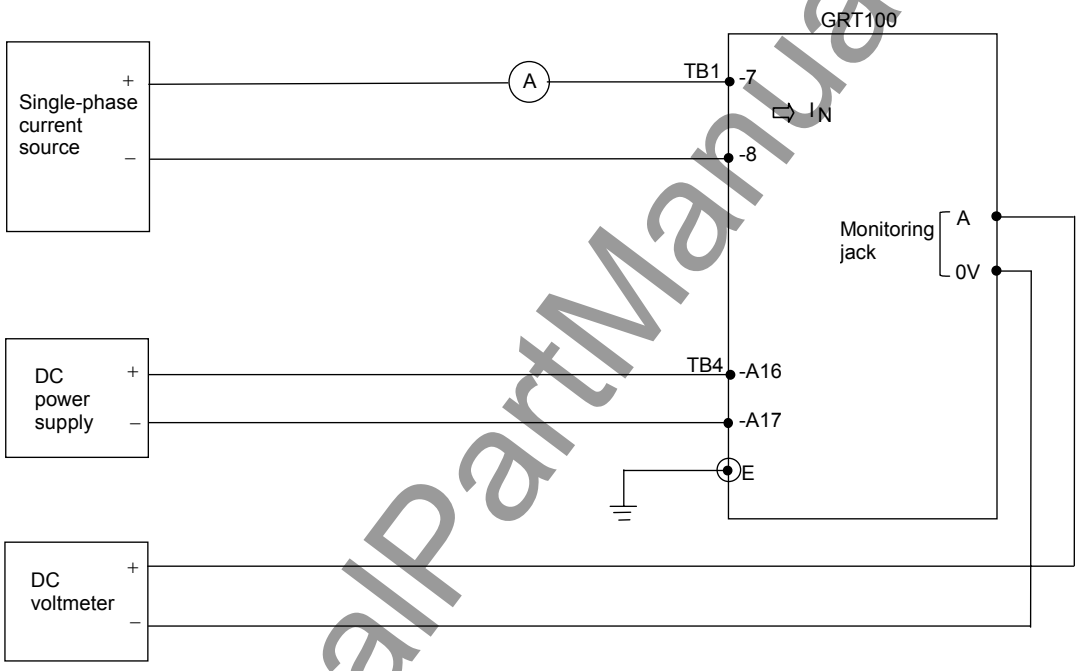


Figure 6.5.7 Operating Current Value Test of REF element (Model 100s, 200s)

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

Element	Input terminal number	Output signal number
1REF	TB1-7 and –8	71
2REF	TB1-15 and –16	74
3REF	TB1-23 and –24	77

- Press 4 (= Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter the signal number 71 to observe the 1REF 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.

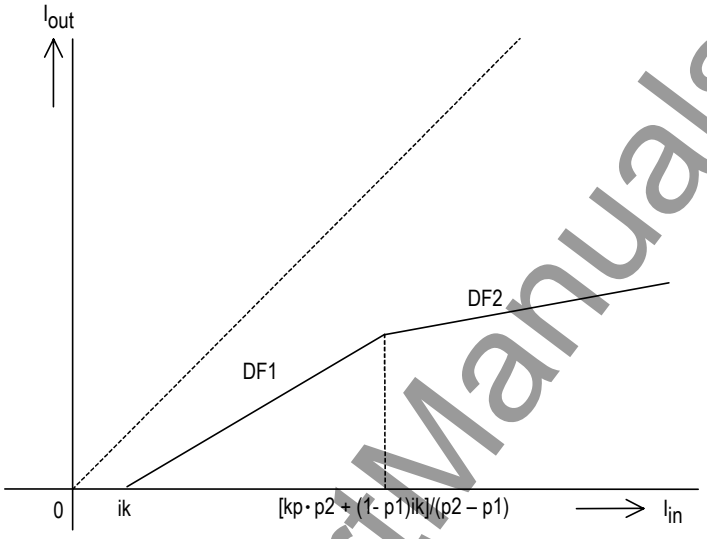


Figure 6.5.8 Restricted Earth Fault Element (I_{out} - I_{in} Plane)

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

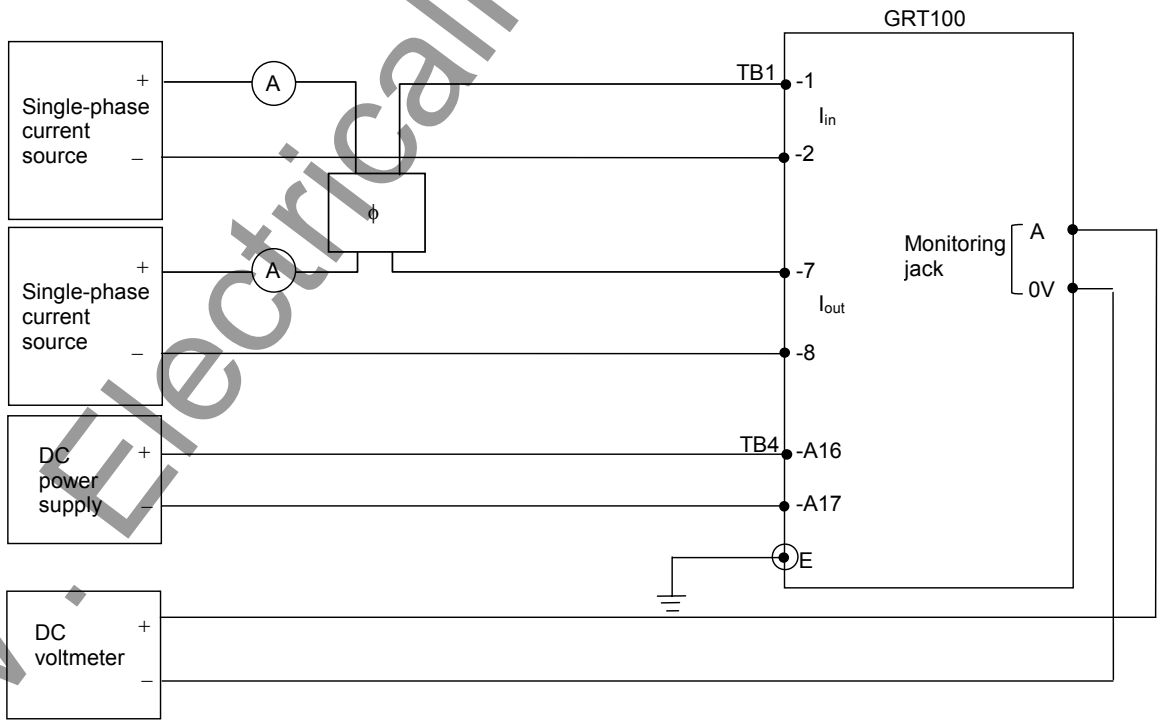


Figure 6.5.9 Testing Restricted Earth Fault Element (Model 100s, 200s)

- Enter a signal number 71 to observe the 1REF 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.

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

where,

p_1 = 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

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

where,

p_2 = slope setting of DF2

kp = sensitivity 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.

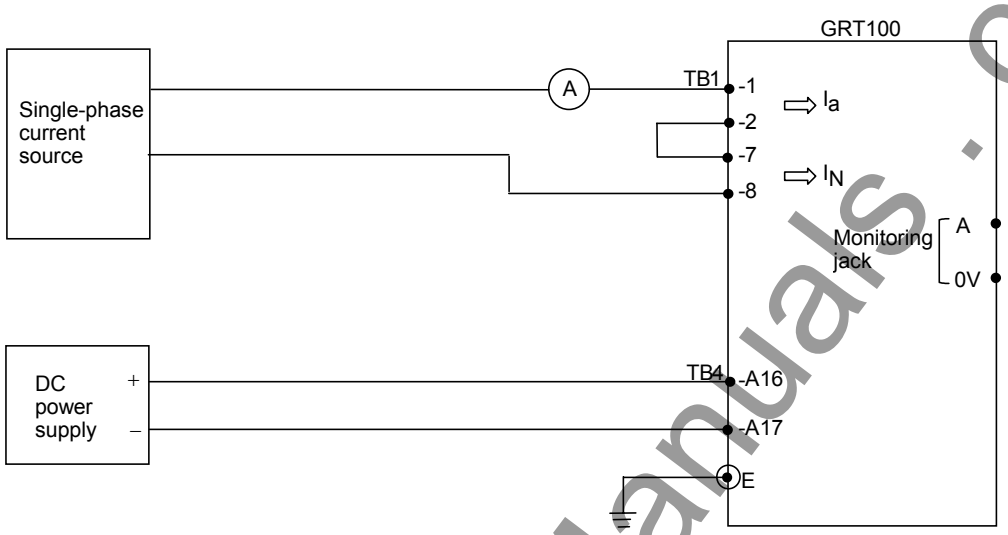


Figure 6.5.10 Testing OC and EF (Model 100s, 200s)

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.

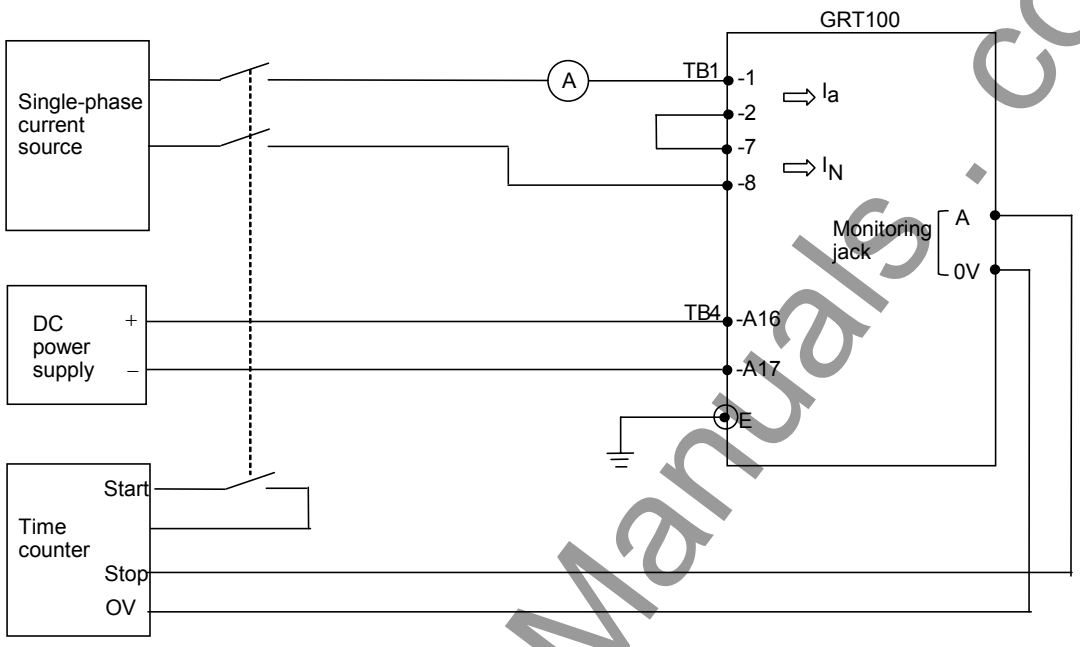


Figure 6.5.11 Testing OCI and EFI (Model 100s, 200s)

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 $1.2 \times I_S$ to $20 \times I_S$, 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.

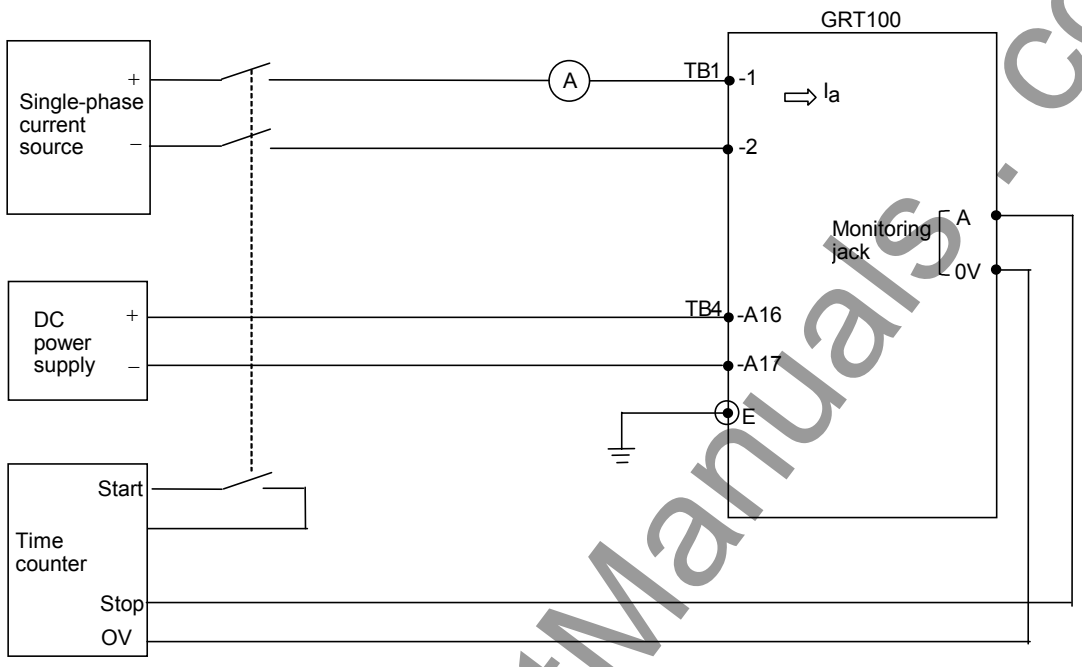


Figure 6.5.12 Testing THR (Model 100s, 200s)

This test is performed using time-shortened output signals because the operating time is in the order of minutes. The operating time of the time-shortened signals is one sixtieth that of the regular signals.

The time-shortened output signal number of the THR element is as follows:

Element	Signal number	Remarks
THR-A_TEST	88	Alarm
THR-S_TEST	84	Trip

The short-time testing procedure is as follows:

- Set the relay : τ = 60.0min, k = 1.30, I_B = 1.00, I_P = 0.80, T_A = 10min
- Press 4 (= Logic circuit) on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number to observe the THR short-time output at monitoring jack A and press the [ENTER] key.
- Apply a test current to 200% of the rated current and measure the operating time.
- Check that the measured operating time is within ±10% of the following value.

Element	Operating time (±10%)
THR-A	11.5s (10.3s – 12.7s)
THR-S	22.5s (20.2s – 24.8s)

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.

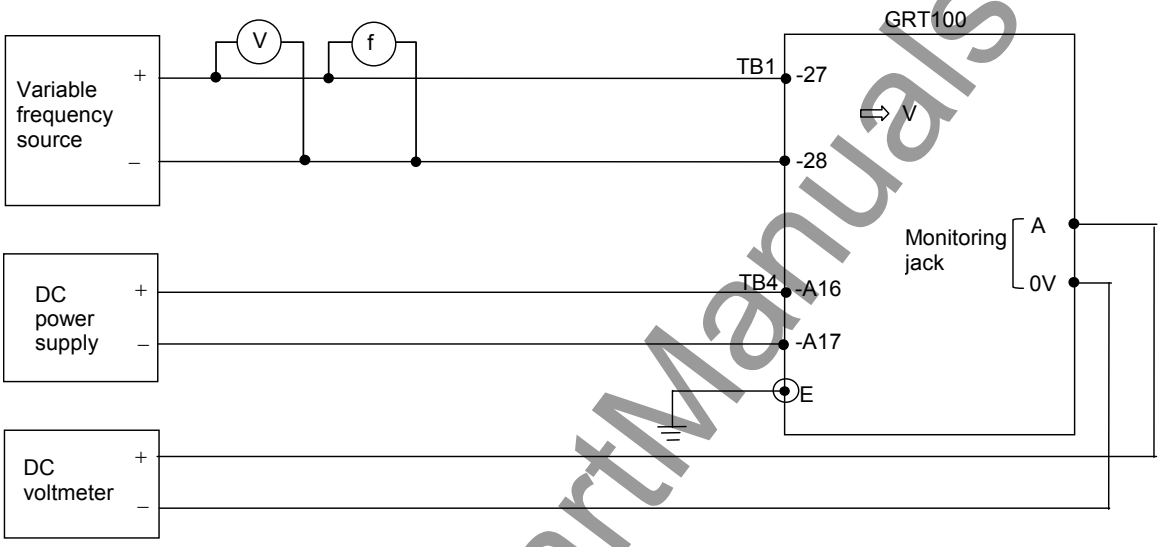


Figure 6.5.13 Testing Frequency Element (Model 100s, 200s)

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.

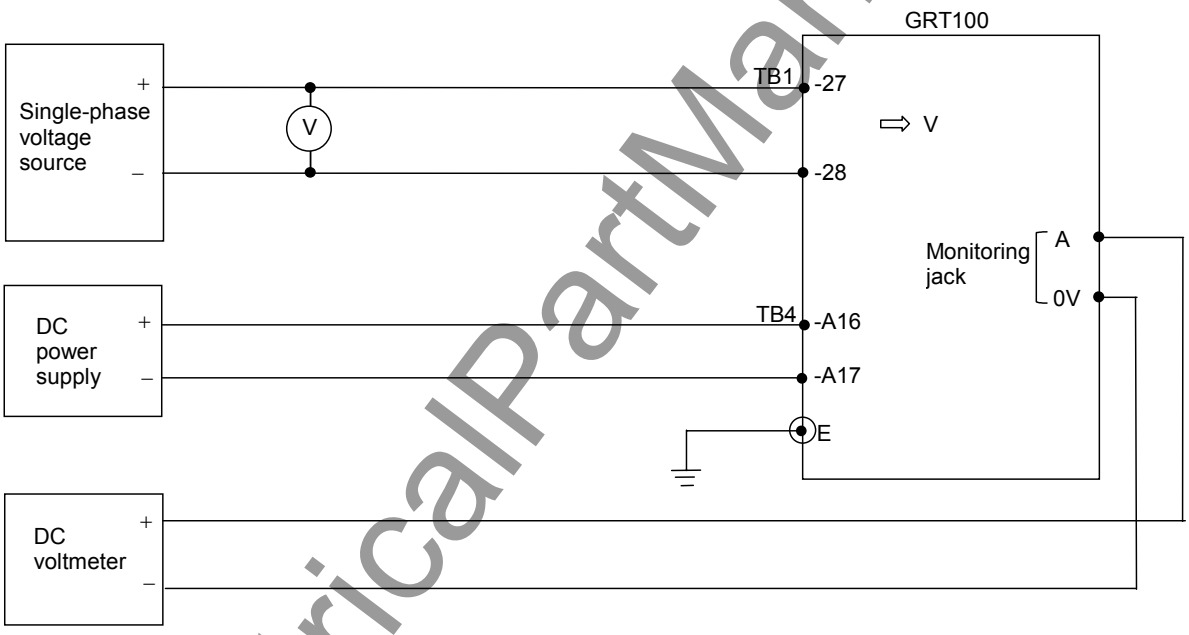


Figure 6.5.14 Operating Value Test of V/F (Model 100s, 200s)

- 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.

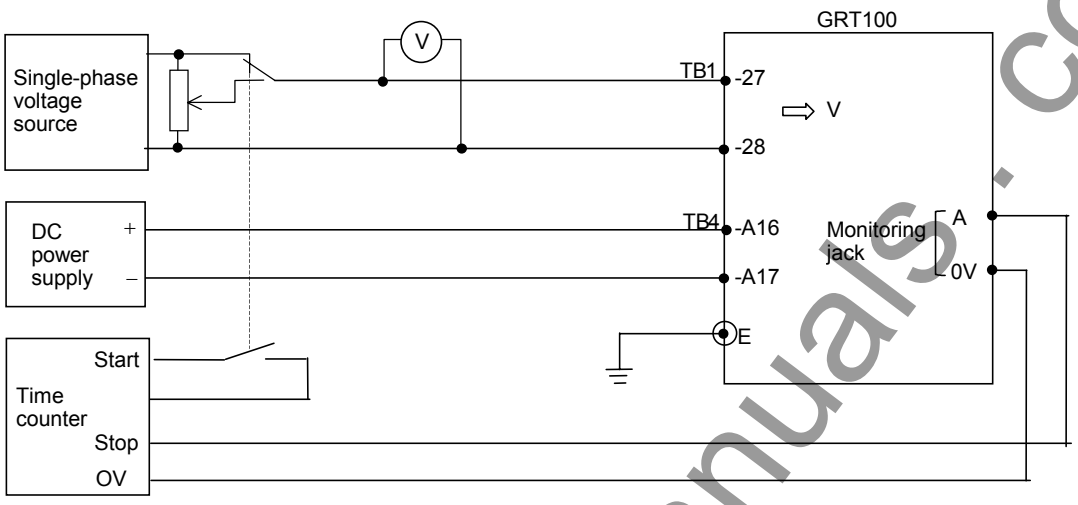


Figure 6.5.15 Operating Time Characteristic Test of V/F (Model 100s, 200s)

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.
- 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.

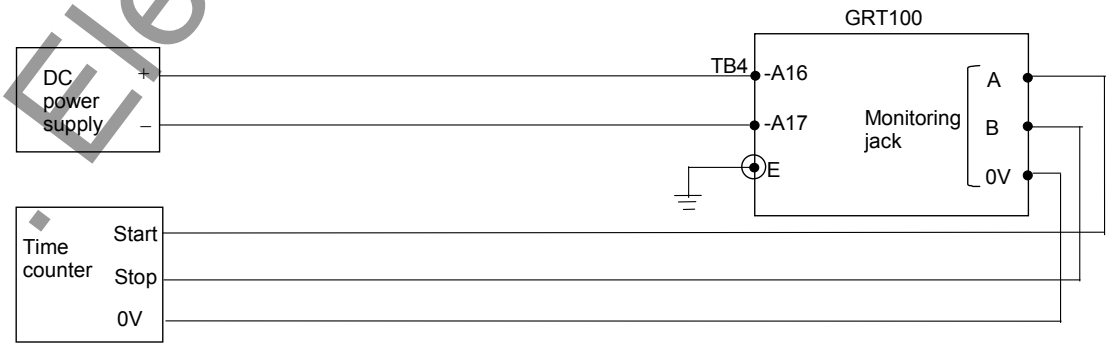


Figure 6.5.16 Testing Variable Timer (Model 100s, 200s)

- 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
IO1    TP-1    :TB4-A1, B1                 0 _
IO1    TP-2    :TB4-A2, B2                 0
IO1    TP-3    :TB4-A3, B3                 0
IO1    TP-4    :TB4-A12, B12               0
IO1    TP-5    :TB4-A13, B13               0
```

TP-1 to 5 are output relays with one normally open contact.

- 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	IO2	IO3	HMI	AC cable
Checksum err		×					
ROM-RAM err		×					
SRAM err		×					
BU-RAM err		×					
DPRAM err		×					
EEPROM err		×					
A/D err		×					
CT1 err	× (2)	× (1)					× (2)
CT2 err	× (2)	× (1)					× (2)
CT3 err	× (2)	× (1)					× (2)
Sampling err		×					
DIO err		× (2)	× (1)	× (1)	× (1)		
RSM err		× (2)	× (1)				
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 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-□□□□
HMI	--

The software name is indicated on the memory device on the module with letters such as GS1TM1-***, GS1TM2-***, 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 the PLC and IEC103, 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 (blind panel) (*) by unscrewing the two binding screws located on the right side of the panel.

  (*) This blind panel is attached only to models assembled in the type B case.

- Detach the module holding bar by unscrewing the binding screw located on the left side of the bar.
- Unplug the ribbon cable on the SPM 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 (blind panel) (*) by unscrewing the two binding screws located on the right side of the panel.

  (*) This panel is attached only to models assembled in the type B case.
- Detach the module holding bar by unscrewing the binding screw located on the left side of the bar.
- Unplug the ribbon cable running among the modules by nipping the catch (in case of black connector) and by pushing the catch outside (in case of gray connector) on the connector.
- 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.

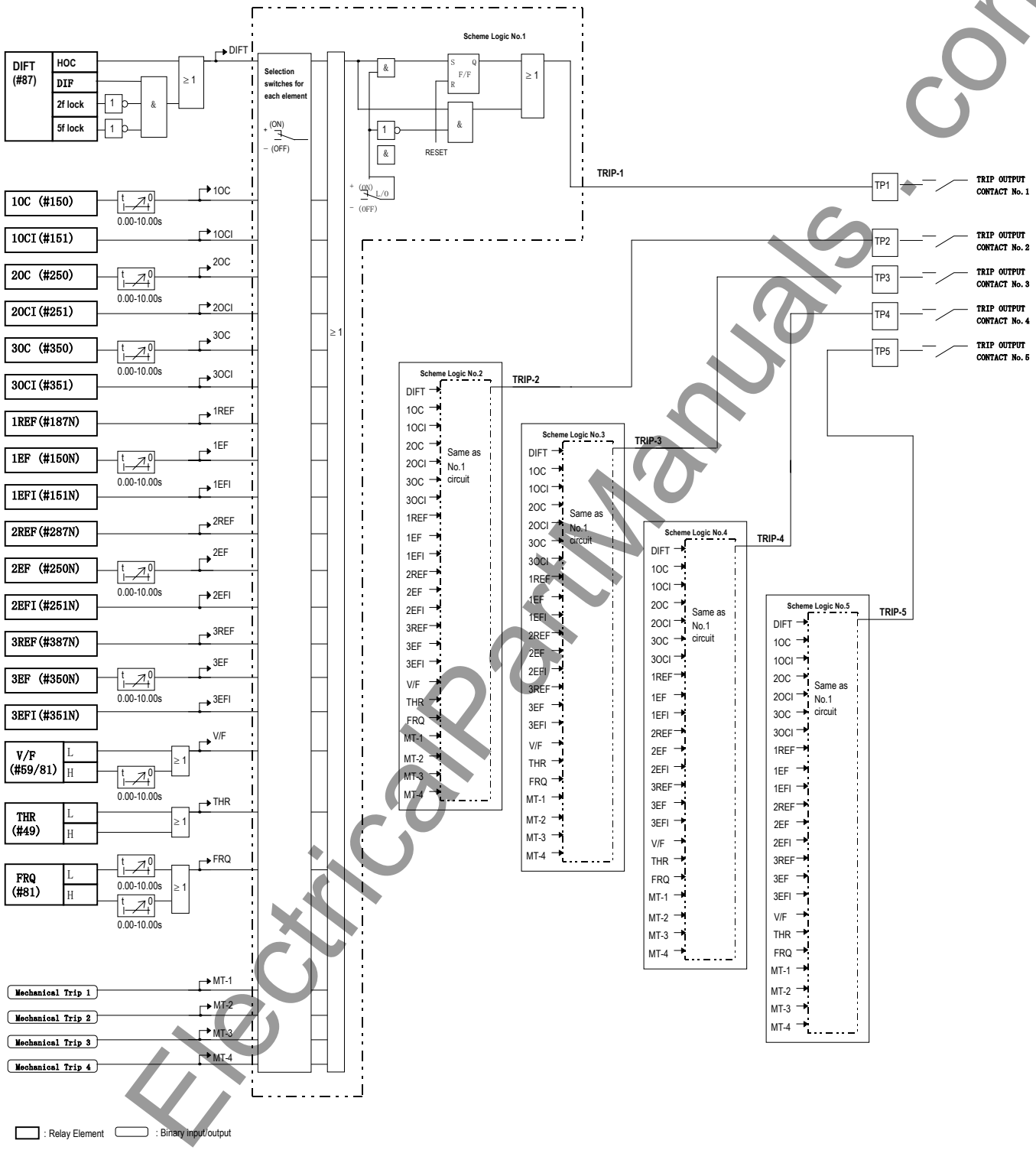
7. Putting Relay into Service

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



Block Diagram of Transformer Differential Relay GRT100

Appendix B

Signal List

Signal list

No.	Signal Name	Contents
0		
1	MECHANICAL TRIP1	BI (MECHANICAL TRIP 1)
2	MECHANICAL TRIP2	BI (MECHANICAL TRIP 2)
3	MECHANICAL TRIP3	BI (MECHANICAL TRIP 3)
4	MECHANICAL TRIP4	BI (MECHANICAL TRIP 4)
5	IND. RESET	BI (lidication reset)
6		
7		
8		
9		
10		
11		
12		
13		
14	EVENT1	BI (External event signal)
15	EVENT2	ditto
16	EVENT3	ditto
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
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	THR-S (FOR TESTING)	ditto
85		
86		
87	THR-A	Thermal overload relay
88	THR-A (FOR TESTING)	ditto
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		
96		
97		
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117		
118		
119		
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	MECHANICAL TRIP1-1	Machanical trip 1
259	MECHANICAL TRIP1-2	ditto
260	MECHANICAL TRIP1-3	ditto
261	MECHANICAL TRIP1-4	ditto
262	MECHANICAL TRIP1-5	ditto
263	MECHANICAL TRIP2-1	Machanical trip 2
264	MECHANICAL TRIP2-2	ditto
265	MECHANICAL TRIP2-3	ditto
266	MECHANICAL TRIP2-4	ditto
267	MECHANICAL TRIP2-5	ditto
268	MECHANICAL TRIP3-1	Machanical trip 3
269	MECHANICAL TRIP3-2	ditto
270	MECHANICAL TRIP3-3	ditto
271	MECHANICAL TRIP3-4	ditto
272	MECHANICAL TRIP3-5	ditto
273	MECHANICAL TRIP4-1	Machanical trip 4
274	MECHANICAL TRIP4-2	ditto
275	MECHANICAL TRIP4-3	ditto
276	MECHANICAL TRIP4-4	ditto
277	MECHANICAL TRIP4-5	ditto
278	WINDING1 RELAY OR-1	Element for trip 1
279	WINDING2 RELAY OR-1	ditto
280	WINDING3 RELAY OR-1	ditto

Signal list

No.	Signal Name	Contents
281	WINDING4 RELAY OR-1	ditto
282	MECHANICAL TRIP OR-1	ditto
283	ELEMENT OR-1	ditto
284	TRIP-1	Trip O/P-1
285	WINDING1 RELAY OR-2	Element for trip 2
286	WINDING2 RELAY OR-2	ditto
287	WINDING3 RELAY OR-2	ditto
288	WINDING4 RELAY OR-2	ditto
289	MECHANICAL TRIP OR-2	ditto
290	ELEMENT OR-2	ditto
291	TRIP-2	Trip O/P-2
292	WINDING1 RELAY OR-3	Element for trip 3
293	WINDING2 RELAY OR-3	ditto
294	WINDING3 RELAY OR-3	ditto
295	WINDING4 RELAY OR-3	ditto
296	MECHANICAL TRIP OR-3	ditto
297	ELEMENT OR-3	ditto
298	TRIP-3	Trip O/P-3
299	WINDING1 RELAY OR-4	Element for trip 4
300	WINDING2 RELAY OR-4	ditto
301	WINDING3 RELAY OR-4	ditto
302	WINDING4 RELAY OR-4	ditto
303	MECHANICAL TRIP OR-4	ditto
304	ELEMENT OR-4	ditto
305	TRIP-4	Trip O/P-4
306	WINDING1 RELAY OR-5	Element for trip 5
307	WINDING2 RELAY OR-5	ditto
308	WINDING3 RELAY OR-5	ditto
309	WINDING4 RELAY OR-5	ditto
310	MECHANICAL TRIP OR-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		
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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		
1264		
1265		
1266		
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		
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1288		
1289		
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Signal list

No.	Signal Name	Contents
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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1421		
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1432		
1433		
1434	F.Record_DONE	fault location completed
1435	F.Record_CLR	Fault record clear
1436	E.Record_CLR	Event record clear
1437	D.Record_CLR	Disturbance record clear
1438		
1439		
1440		
1441		
1442		
1443		
1444		
1445	PLC_data_CHG	PLC data change
1446		
1447		
1448	Sys.set_change	System setting change
1449	Rly.set_change	Relay setting change
1450	Grp.set_change	Group setting change
1451		
1452		
1453		
1454		
1455		
1456	KEY-VIEW	VIEW key status (1:pressed)
1457	KEY-RESET	RESET key status (2:pressed)
1458	KEY-ENTER	ENTER key status (3:pressed)
1459	KEY-END	END key status (4:pressed)
1460	KEY-CANCEL	CANCEL key status (5:pressed)
1461		
1462		
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1470		

Signal list

No.	Signal Name	Contents
1471		
1472	SUM_err	Program ROM checksum error
1473		
1474	SRAM_err	SRAM memory monitoring error
1475	BU-RAM_err	BU-RAM memory monitoring error
1476	DP-RAM_err	DP-RAM memory monitoring error
1477	EEPROM_err	EEPROM memory monitoring error
1478	SUB-CPU_err	Sub-CPU stopped
1479	A/D_err	A/D accuracy checking error
1480		
1481		
1482		
1483		
1484	DIO_err	DIO card connection error
1485		
1486	LCD_err	LCD panel connection error
1487		
1488		
1489		
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1493		
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Signal list

No.	Signal Name	Contents
1536		
1537		
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2601		
2602		
2603		
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2628		
2629		
2630		
2631		
2632	D.RECORD1	Disturbance record stored command 1
2633	D.RECORD2	2
2634	D.RECORD3	3
2635	D.RECORD4	4
2636		
2637		
2638		
2639		
2640	SET.GROUP1	Active setting group changed commamd (Change to group1)
2641	SET.GROUP2	2
2642	SET.GROUP3	3
2643	SET.GROUP4	4
2644	SET.GROUP5	5
2645	SET.GROUP6	6
2646	SET.GROUP7	7
2647	SET.GROUP8	8
2648		
2649		
2650		
2651		
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Signal list

No.	Signal Name	Contents
2661		
2662		
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2682		
2683		
2684		
2685		
2686	PROT_COM_RECV	protection inactivate command received
2687		
2688	TPLED_RST_RCV	TRIP LED RESET command received
2689		
2690		
2691		
2692		
2693		
2694		
2695		
2696		
2697		
2698		
2699		
2700		
2701		
2702		
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2800		
2801		
2802		
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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

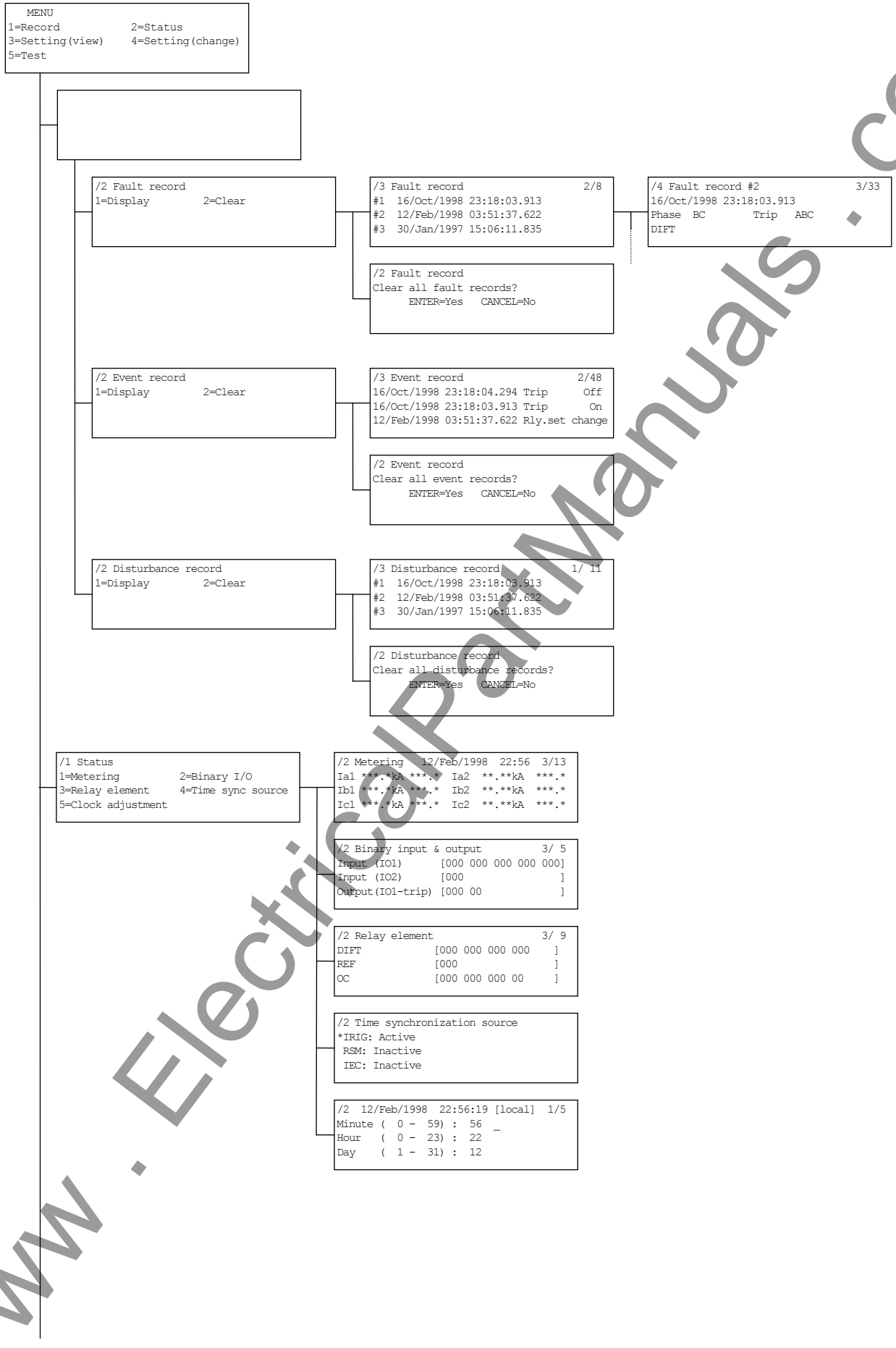
Binary Output Default Setting List

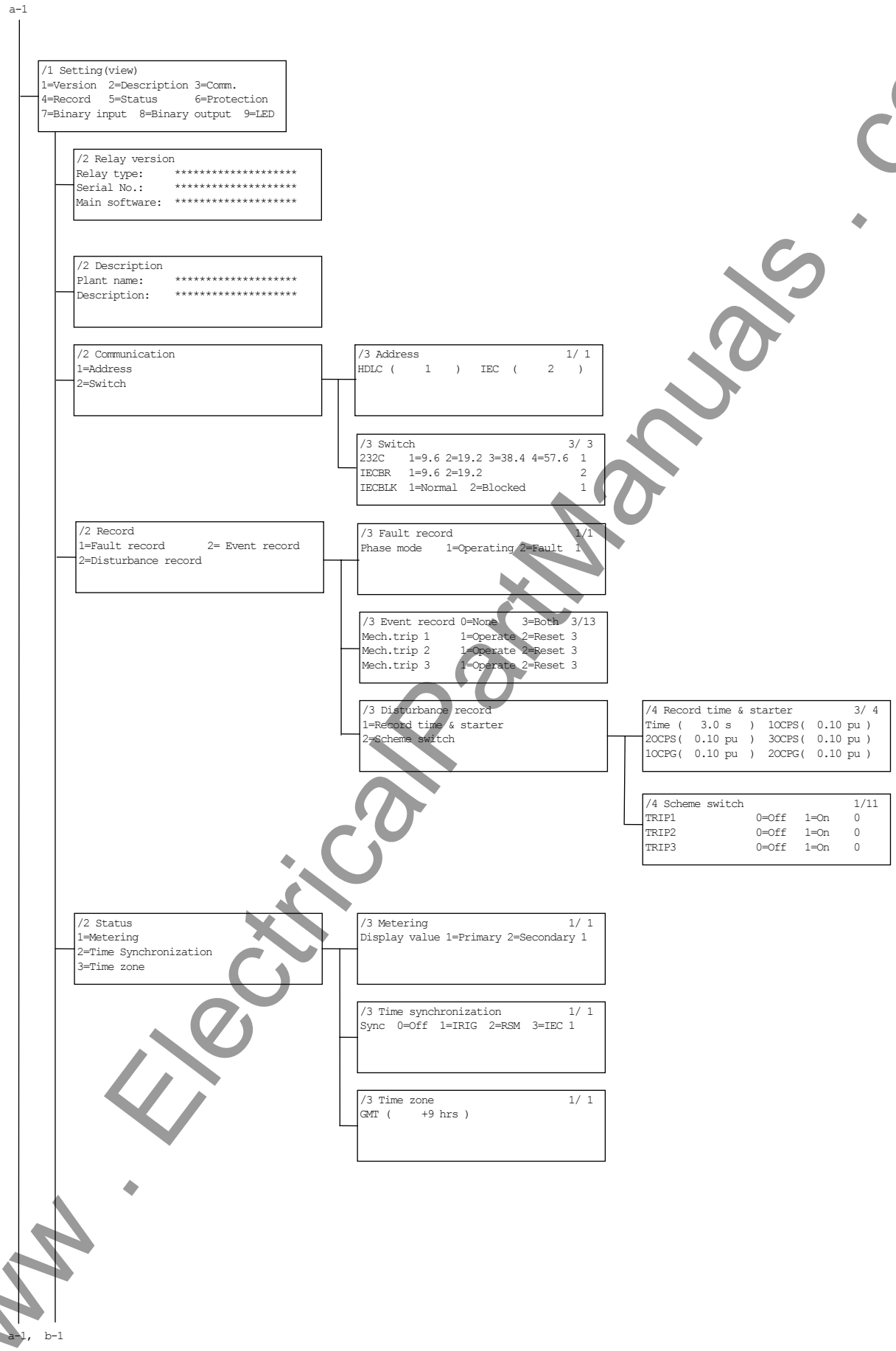
Relay Model	Module Name	BO No.	Terminal No.	Signal Name	Contents	Setting		
						Signal No.	Logic (OR: 1, AND: 2)	Timer (OFF: 0, ON: 1)
GRT100			TB3:					
-101	IO2	BO1	A2-A1	TRIP-1	TRIP First	284	1	1
		BO2	A2-B1	TRIP-2	TRIP Second	291	1	1
		BO3	A2-B2	DIFT	DIFT relay operating	224	1	1
		BO4	A3-B3	1OC, 1OCI	1OC or 1OCI relay operating	129, 225	1	1
		BO5	A4-B4	2OC, 2OCI	2OC or 2OCI relay operating	140, 226	1	1
		BO6	A5-B5	1REF, 1EF, 1EFI	1REF, 1EF or 1EFI relay operating	173, 174, 73	1	1
		BO7	A6-B6	2REF, 2EF, 2EFI	2REF, 2EF or 2EFI relay operating	190, 191, 76	1	1
		BO8	A7-B7	FRQ	FRQ relay operating	230	1	1
		BO9	A8-B8	V/F	V/F-L, H relay operating	229	1	1
		BO10	A9-B9	V/F-A	V/F-A relay operating	242	1	1
		BO11	A10-B10	THR	THR-L, H relay operating	83	1	1
		BO12	A11-B11	THR-A	THR-A relay operating	248	1	1
		BO13	A13-B13	M. TRIP-OR	Mechanical relay trip	1, 2, 3, 4	1	1
GRT100			TB3:					
-102	IO2	BO1	A2-A1	TRIP-1	TRIP First	284	1	1
		BO2	A2-B1	TRIP-2	TRIP Second	291	1	1
		BO3	A2-B2	DIFT	DIFT relay operating	224	1	1
		BO4	A3-B3	1OC, 1OCI	1OC or 1OCI relay operating	129, 225	1	1
		BO5	A4-B4	2OC, 2OCI	2OC or 2OCI relay operating	140, 226	1	1
		BO6	A5-B5	1REF	1REF relay operating	173	1	1
		BO7	A6-B6	2REF	2REF relay operating	190	1	1
		BO8	A7-B7	1EF, 1EFI	1EF or 1EFI relay operating	174, 73	1	1
		BO9	A8-B8	2EF, 2EFI	2EF or 2EFI relay operating	191, 76	1	1
		BO10	A9-B9	FRQ	FRQ relay operating	230	1	1
		BO11	A10-B10	V/F-T	V/F-T relay operating	81	1	1
		BO12	A11-B11	V/F-H	V/F-H relay operating	235	1	1
		BO13	A13-B13	V/F-A	V/F-A relay operating	242	1	1
			TB2:					
	IO3	BO1	A2-A1	THR	THR-L, H relay operating	83	1	1
		BO2	A2-B1	THR-A	THR-A relay operating	248	1	1
		BO3	A2-B2	TRIP-1	TRIP First	284	1	1
		BO4	A3-B3	TRIP-2	TRIP Second	291	1	1
		BO5	A4-B4	TRIP-1	TRIP First	284	1	1
		BO6	A5-B5	TRIP-2	TRIP Second	291	1	1
		BO7	A6-B6	MEC. TRIP-1	Mechanical relay trip 1	1	1	1
		BO8	A7-B7	MEC. TRIP-2	Mechanical relay trip 2	2	1	1
		BO9	A8-B8	MEC. TRIP-3	Mechanical relay trip 3	3	1	1
		BO10	A9-B9	MEC. TRIP-4	Mechanical relay trip 4	4	1	1

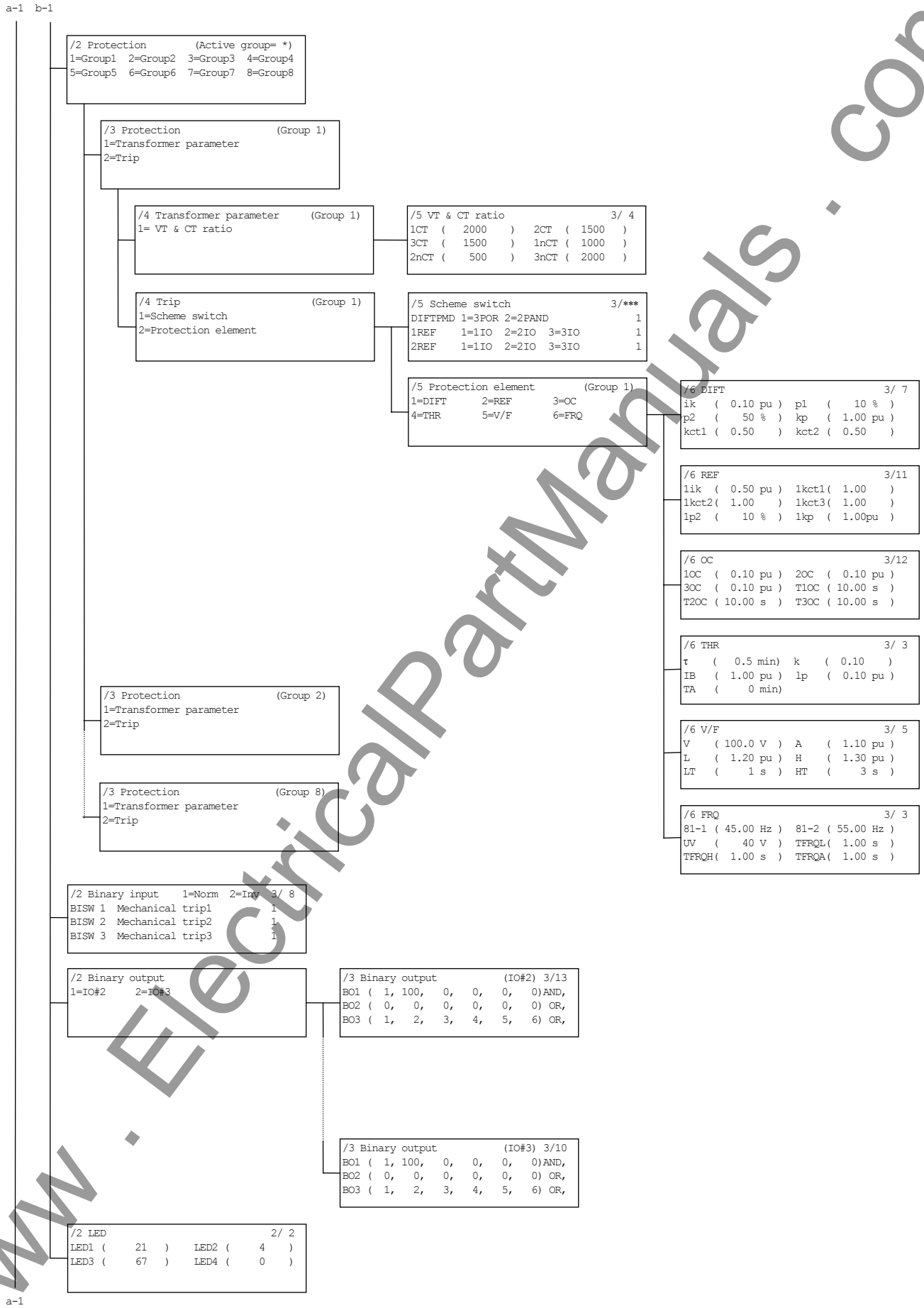
Relay Model	Module Name	BO No.	Terminal No.	Signal Name	Contents	Setting		
						Signal No.	Logic (OR: 1, AND: 2)	Timer (OFF: 0, ON: 1)
GRT100			TB3:					
-201	IO2	BO1	A2-A1	TRIP-1	TRIP First	284	1	1
		BO2	A2-B1	TRIP-2	TRIP Second	291	1	1
		BO3	A2-B2	TRIP-3	TRIP Third	298	1	1
		BO4	A3-B3	DIFT	DIFT relay operating	224	1	1
		BO5	A4-B4	1OC, 1OCI, 1REF, 1EF, 1EFI	1OC, 1OCI, 1REF, 1EF or 1EFI relay operating	129, 225, 173, 174, 73	1	1
		BO6	A5-B5	2OC, 2OCI, 2REF, 2EF, 2EFI	2OC, 2OCI, 2REF, 2EF or 2EFI relay operating	140, 226, 190, 191, 76	1	1
		BO7	A6-B6	3OC, 3OCI, 3REF, 3EF, 3EFI	3OC, 3OCI, 3REF, 3EF or 3EFI relay operating	151, 227, 207, 208, 79	1	1
		BO8	A7-B7	FRQ	FRQ relay operating	230	1	1
		BO9	A8-B8	V/F	V/F-L, H relay operating	229	1	1
		BO10	A9-B9	V/F-A	V/F-A relay operating	242	1	1
		BO11	A10-B10	THR	THR-L, H relay operating	83	1	1
		BO12	A11-B11	THR-A	THR-A relay operating	248	1	1
		BO13	A13-B13	M. TRIP-OR	Mechanical relay trip	1, 2, 3, 4	1	1
GRT100			TB3:					
-202	IO2	BO1	A2-A1	TRIP-1	TRIP First	284	1	1
		BO2	A2-B1	TRIP-2	TRIP Second	291	1	1
		BO3	A2-B2	TRIP-3	TRIP Third	298	1	1
		BO4	A3-B3	DIFT	DIFT relay operating	224	1	1
		BO5	A4-B4	1OC, 1OCI	1OC or 1OCI relay operating	129, 225	1	1
		BO6	A5-B5	2OC, 2OCI	2OC or 2OCI relay operating	140, 226	1	1
		BO7	A6-B6	3OC, 3OCI	3OC or 3OCI relay operating	151, 227	1	1
		BO8	A7-B7	1REF	1REF relay operating	173	1	1
		BO9	A8-B8	2REF	2REF relay operating	190	1	1
		BO10	A9-B9	3REF	3REF relay operating	207	1	1
		BO11	A10-B10	1EF, 1EFI	1EF or 1EFI relay operating	174, 73	1	1
		BO12	A11-B11	2EF, 2EFI	2EF or 2EFI relay operating	191, 76	1	1
		BO13	A13-B13	3EF, 2EFI	3EF or 3EFI relay operating	208, 79	1	1
			TB2:					
	IO3	BO1	A2-A1	FRQ	FRQ relay operating	230	1	1
		BO2	A2-B1	V/F-T	V/F-T relay operating	81	1	1
		BO3	A2-B2	V/F-H	V/F-H relay operating	235	1	1
		BO4	A3-B3	V/F-A	V/F-A relay operating	242	1	1
		BO5	A4-B4	THR	THR-L, H relay operating	83	1	1
		BO6	A5-B5	THR-A	THR-A relay operating	248	1	1
		BO7	A6-B6	MEC. TRIP-1	Mechanical relay trip 1	1	1	1
		BO8	A7-B7	MEC. TRIP-2	Mechanical relay trip 2	2	1	1
		BO9	A8-B8	MEC. TRIP-3	Mechanical relay trip 3	3	1	1
		BO10	A9-B9	MEC. TRIP-4	Mechanical relay trip 4	4	1	1

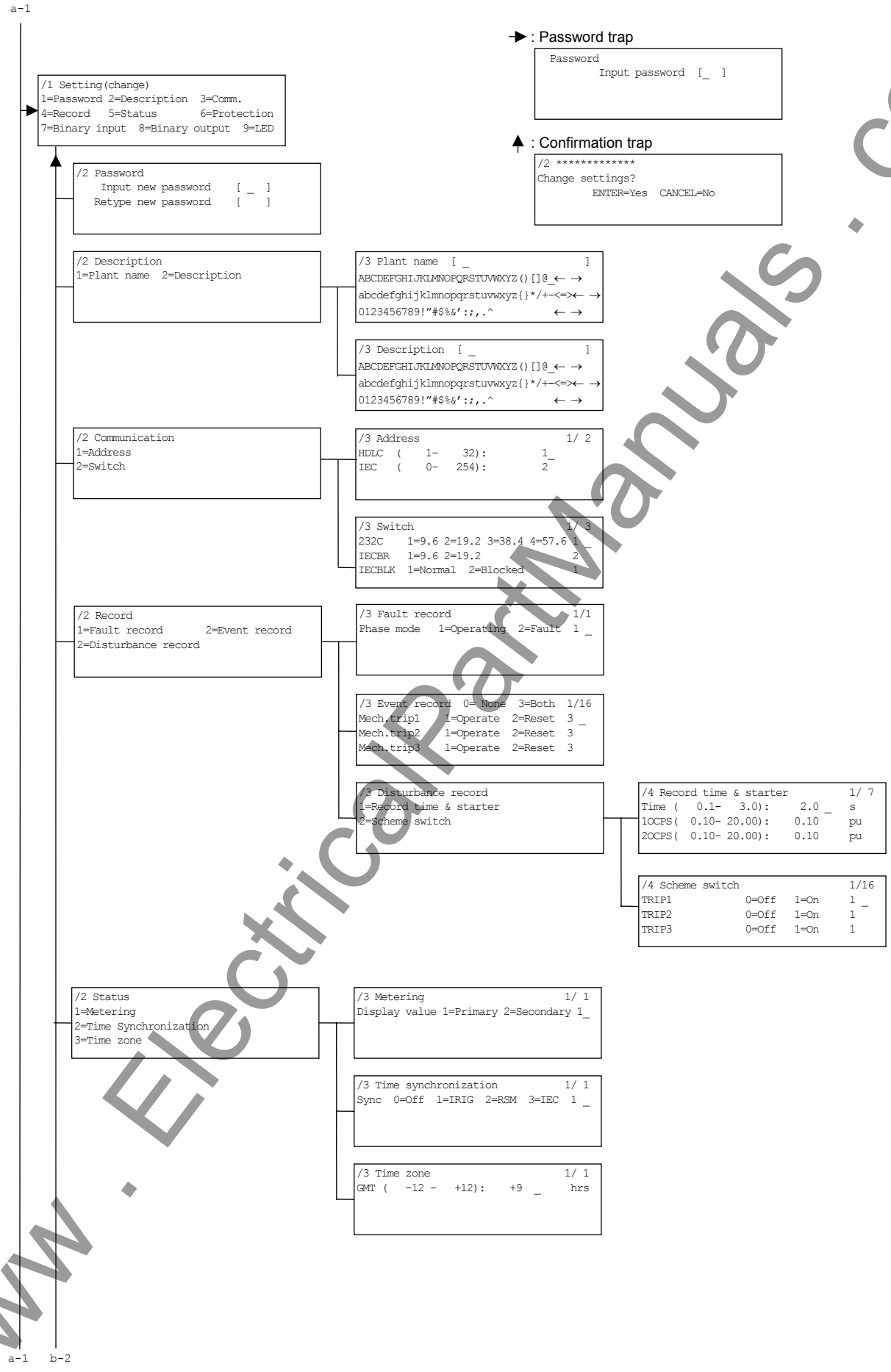
Appendix E

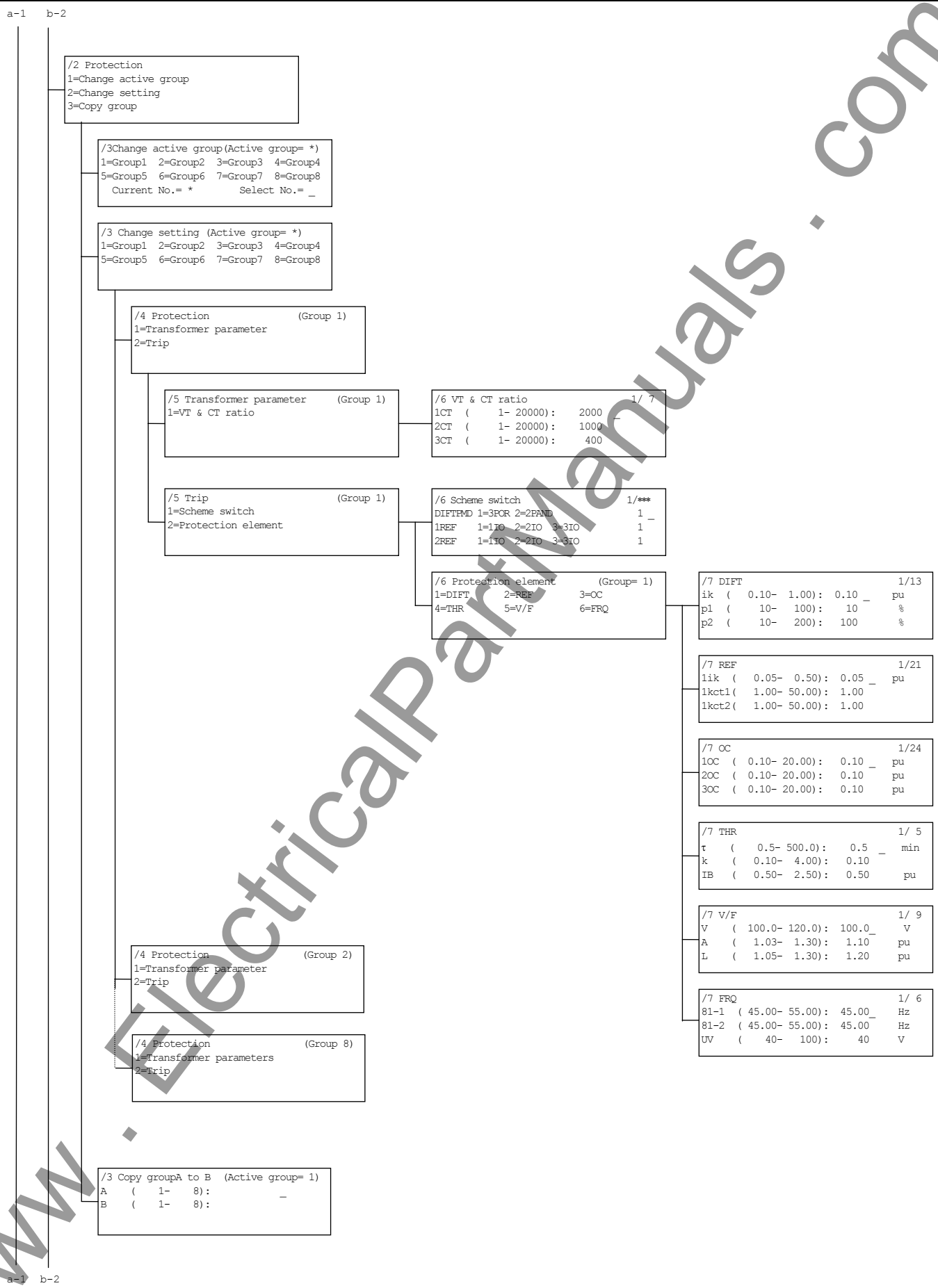
Details of Relay Menu and LCD and Button Operation

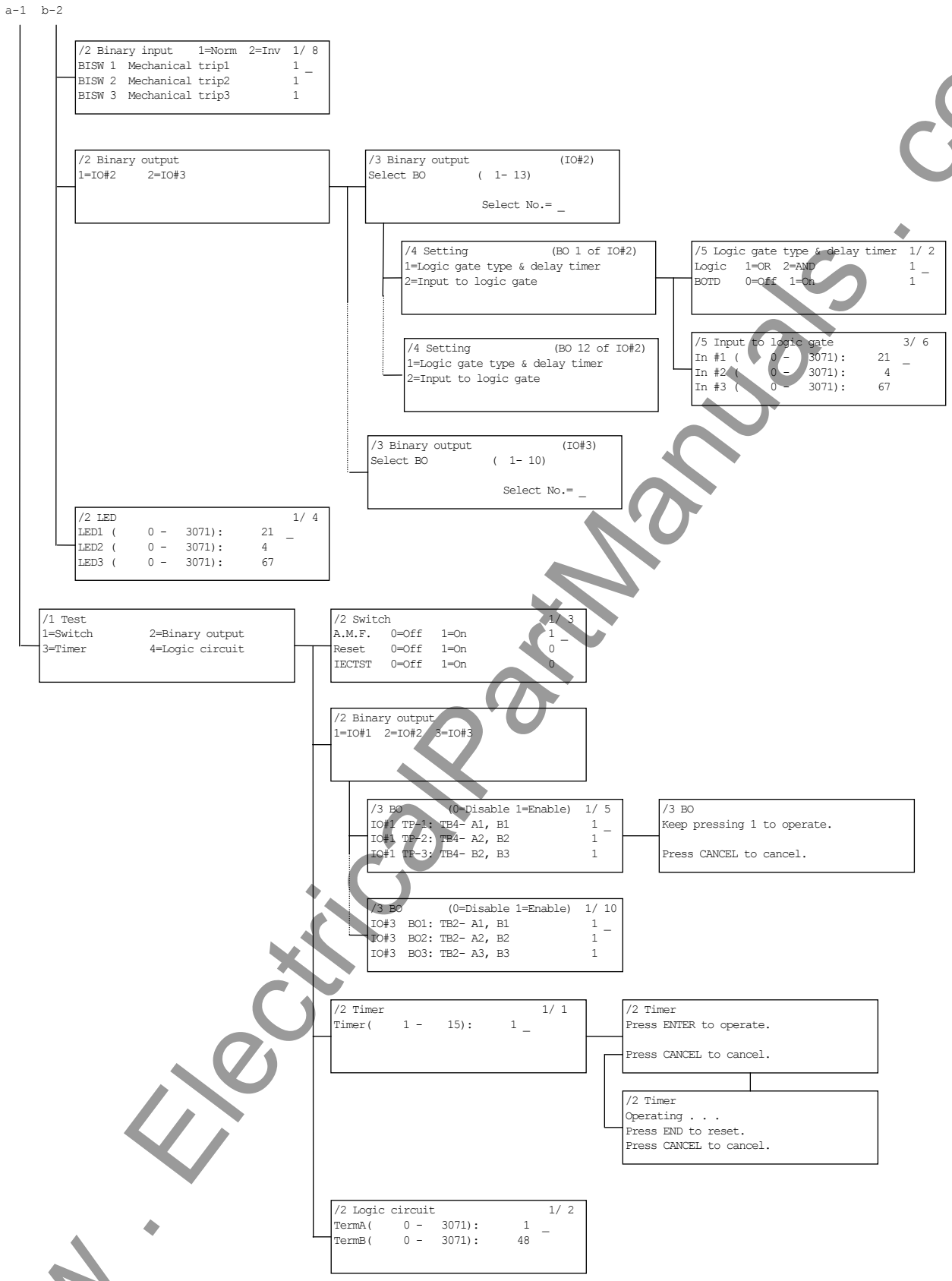




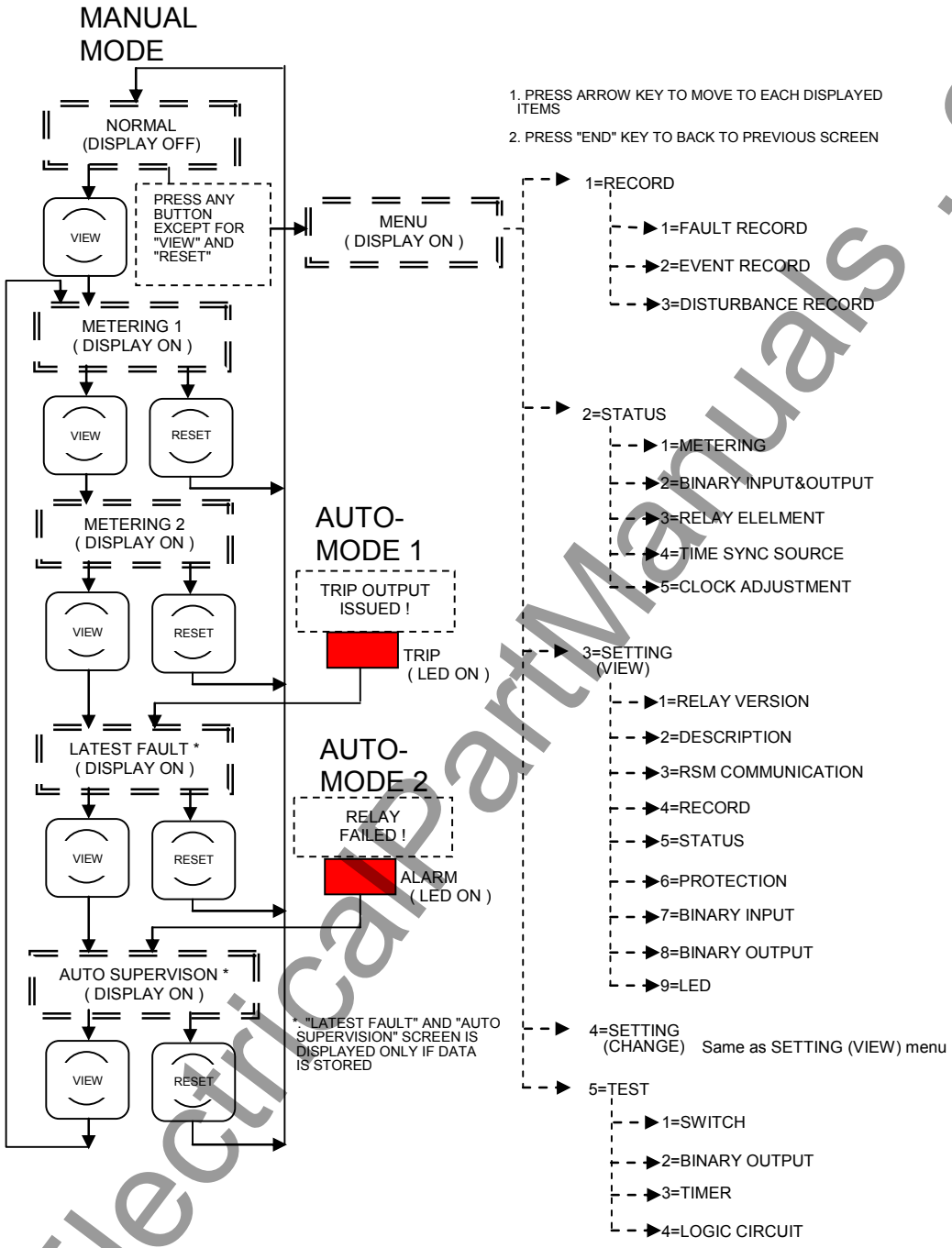








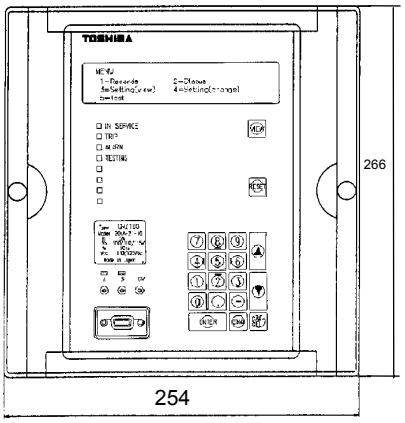
LCD AND BUTTON OPERATION INSTRUCTION



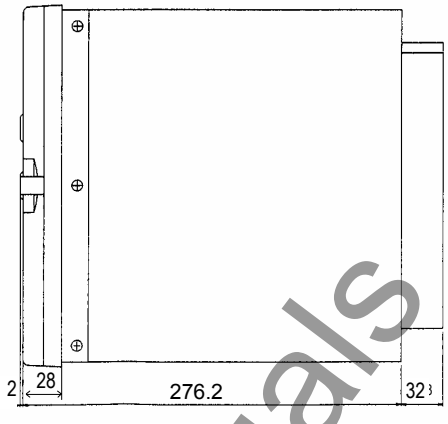
Appendix F

Case Outline

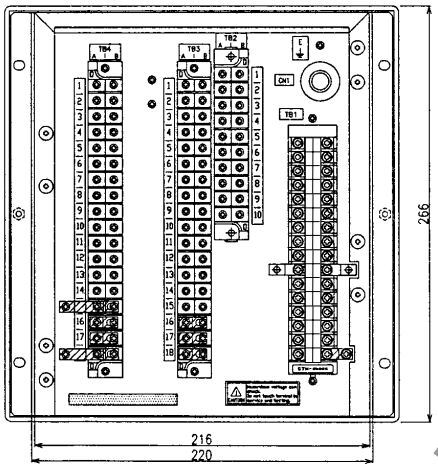
- Flush Mount Type
- Rack Mount Type



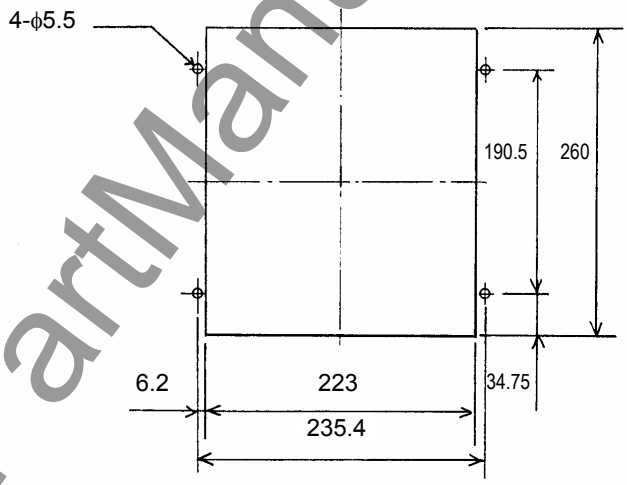
Front View



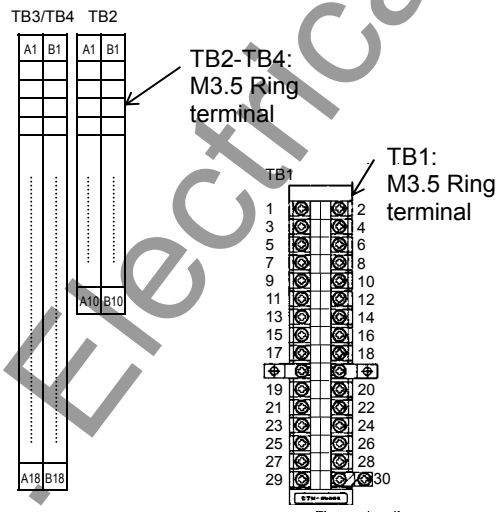
Side view



Rear view

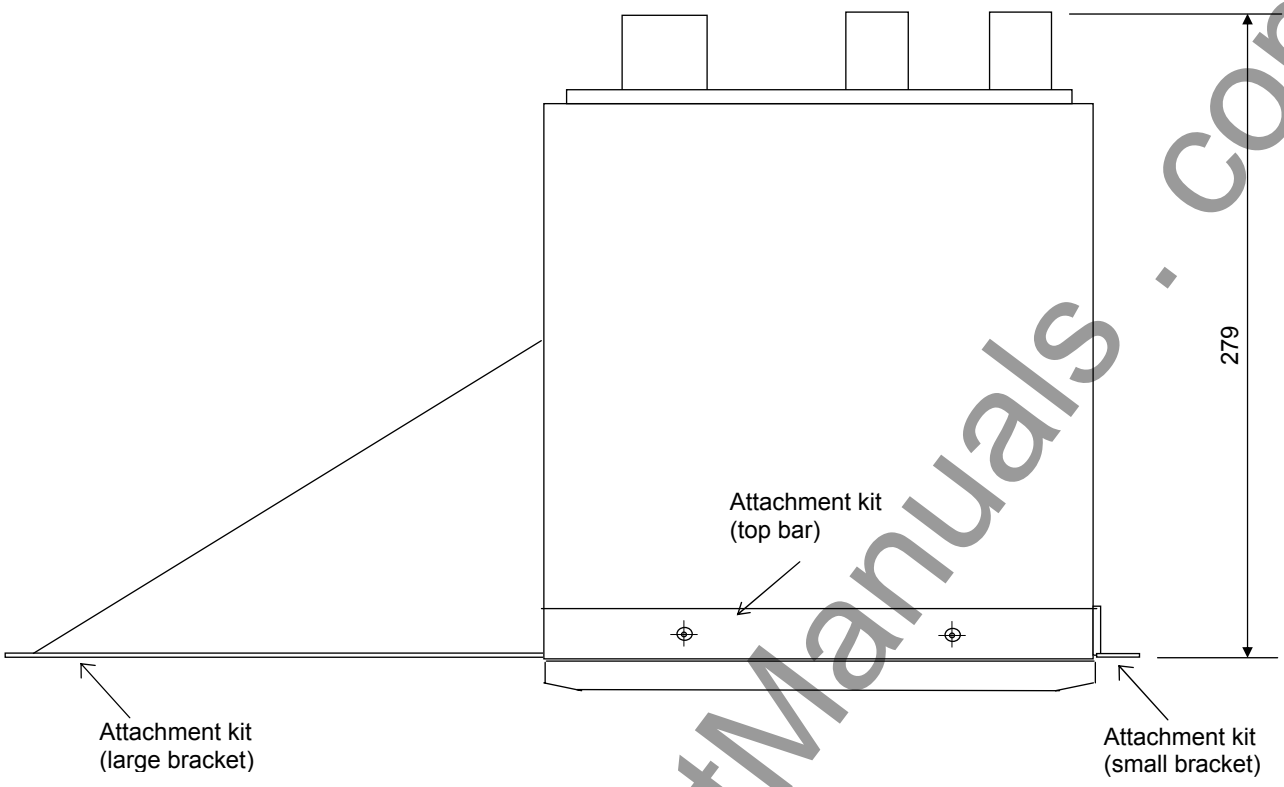


Panel cut-out

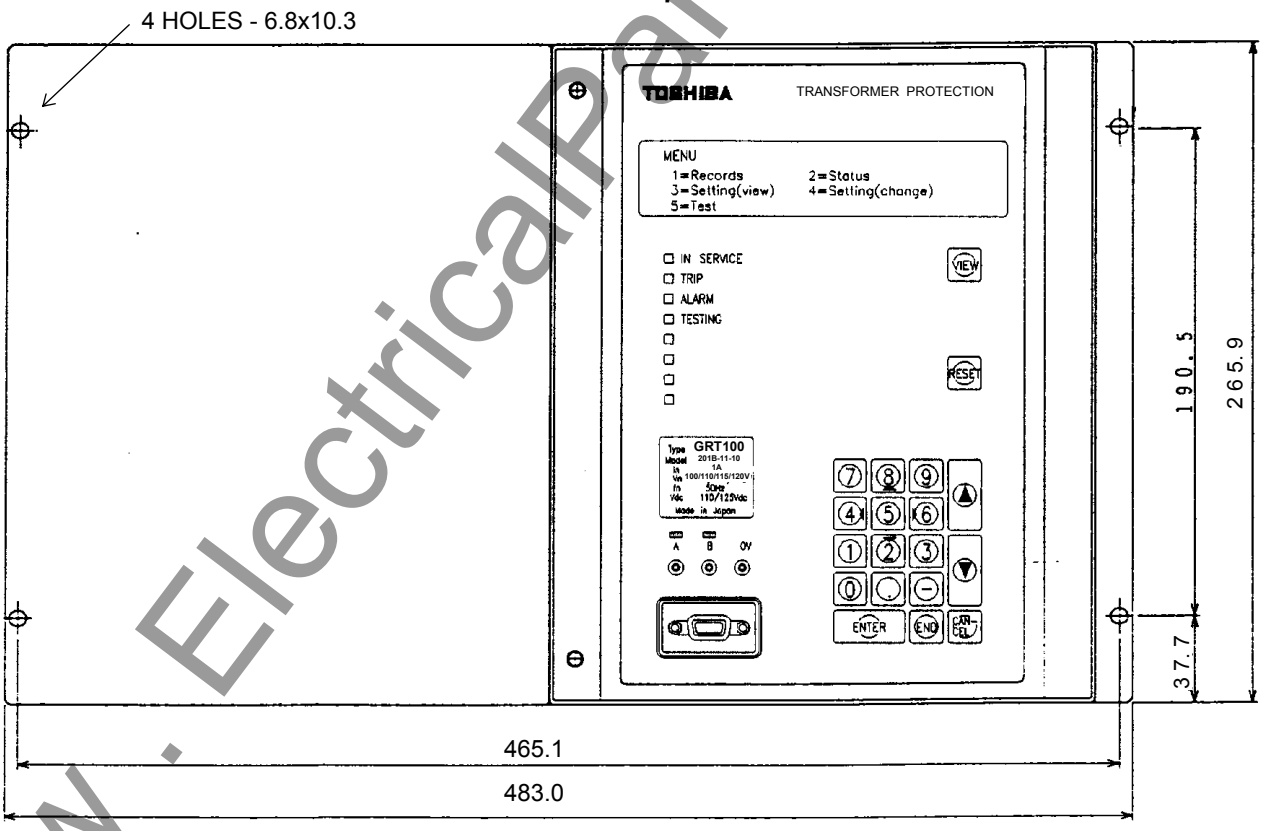


Terminal block

Case Outline : Flush Mount Type

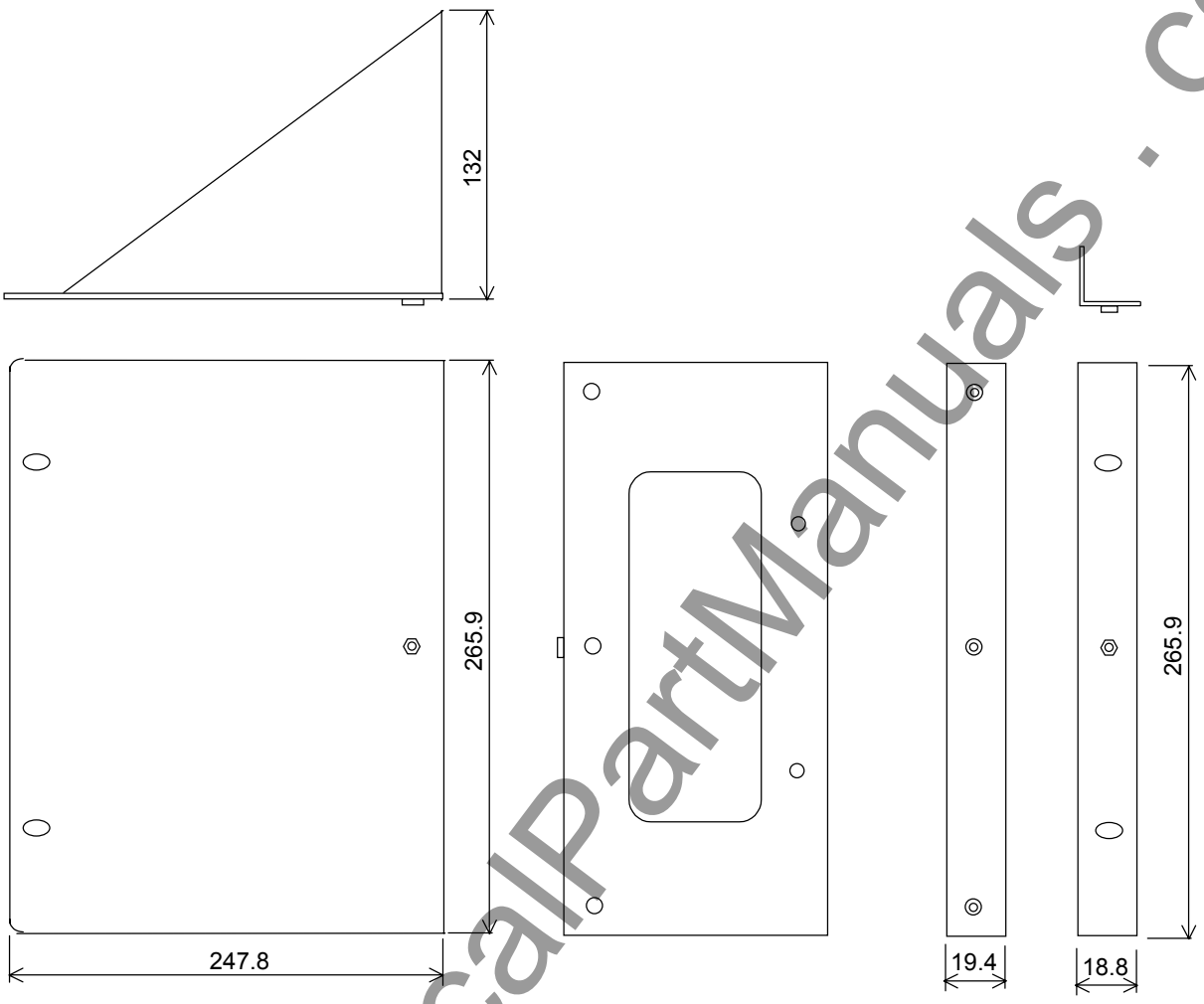


Top View

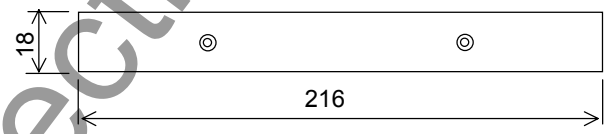


Front View

Case Outline: Rack Mount Type



(a) Large Bracket **(b) Small Bracket**



(c) Bar for Top and Bottom of Relay

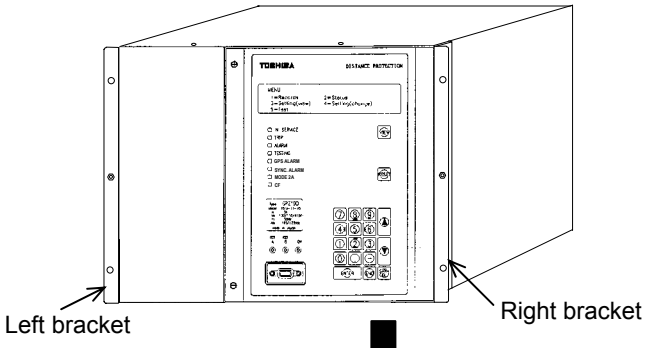
	Parts
(a) ◆	1 Large bracket, 5 Round head screws with spring washers and washers (M4x10)
(b)	1 Small bracket, 3 Countersunk head screws (M4x6)
(c)	2 Bars, 4 Countersunk head screws (M3x8)

Dimensions of Attachment Kit EP-101

How to Mount Attachment Kit for Rack-Mounting

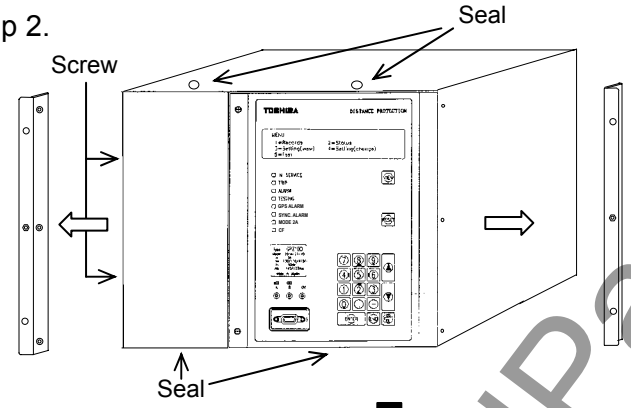
Caution: Be careful that the relay modules or terminal blocks, etc., are not damage while mounting.
Tighten screws to the specified torque according to the size of screw.

Step 1.



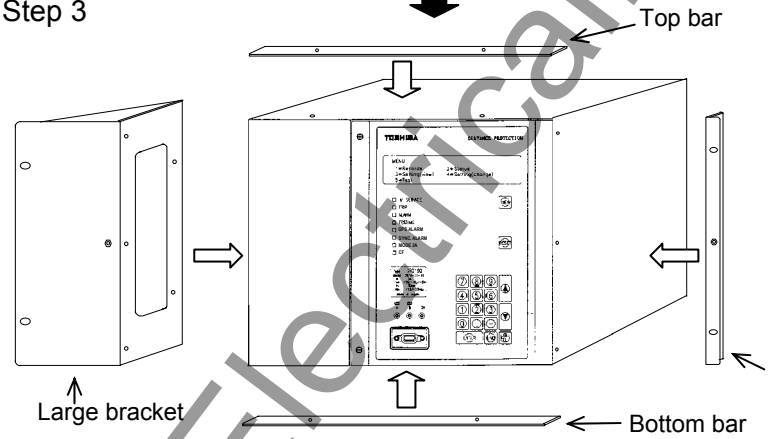
Remove case cover.

Step 2.



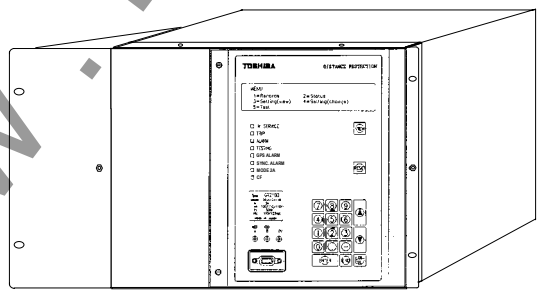
Remove the left and right brackets by unscrewing the three screws respectively, then remove two screws on left side of the relay.
And then, remove four seals on the top and bottom of the relay.

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.

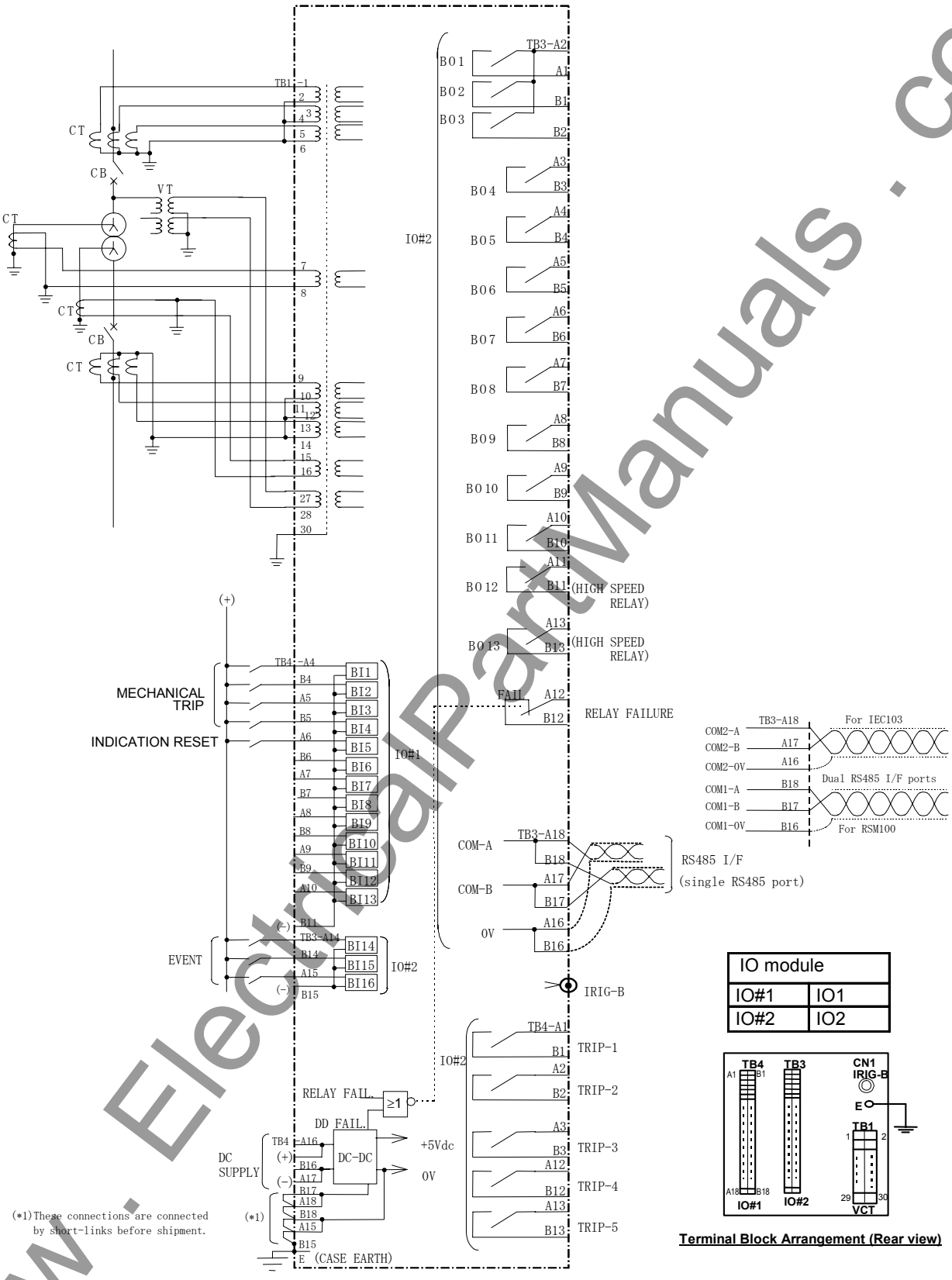
Step 4



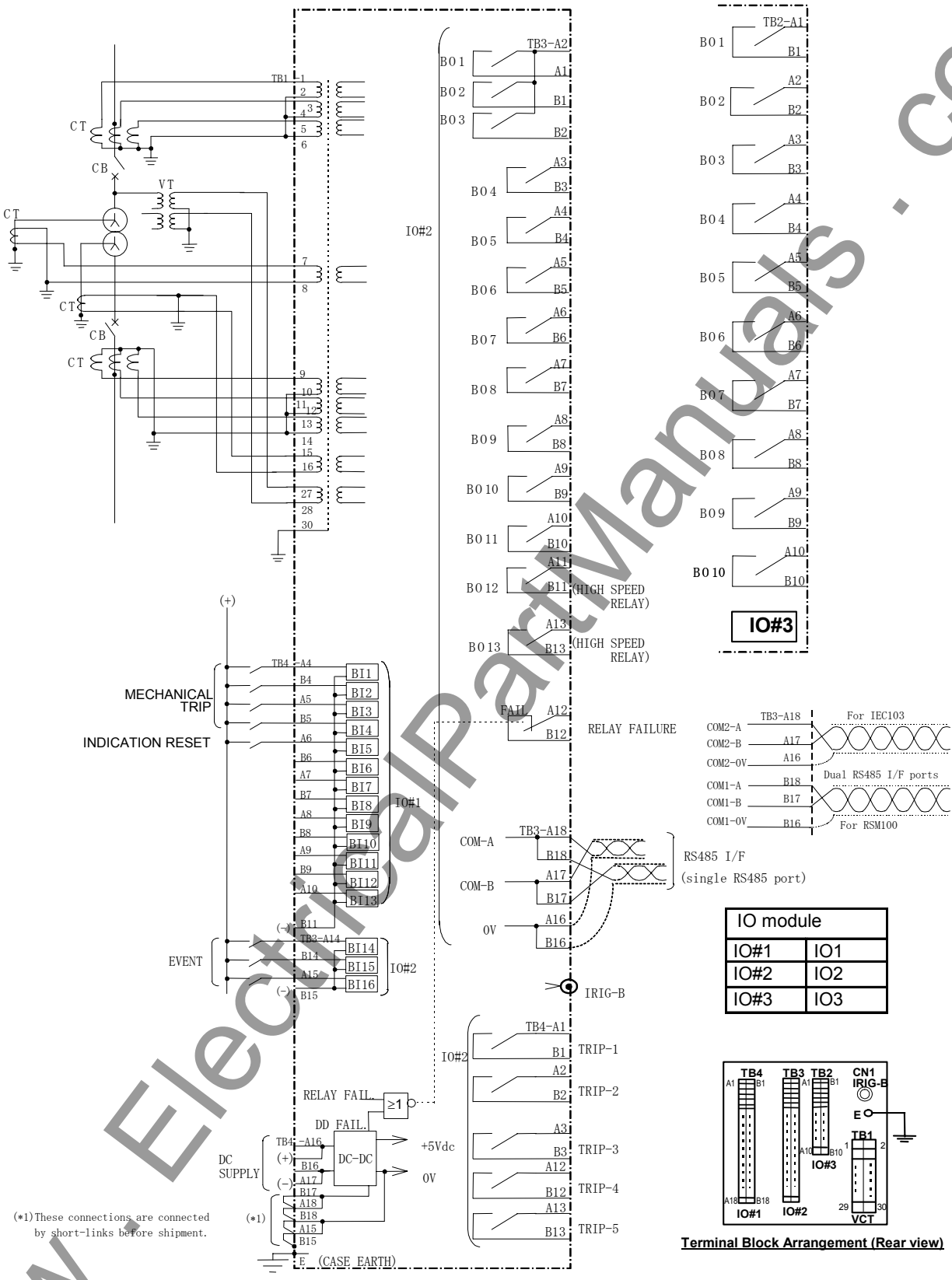
Completed.

Appendix G

External Connections



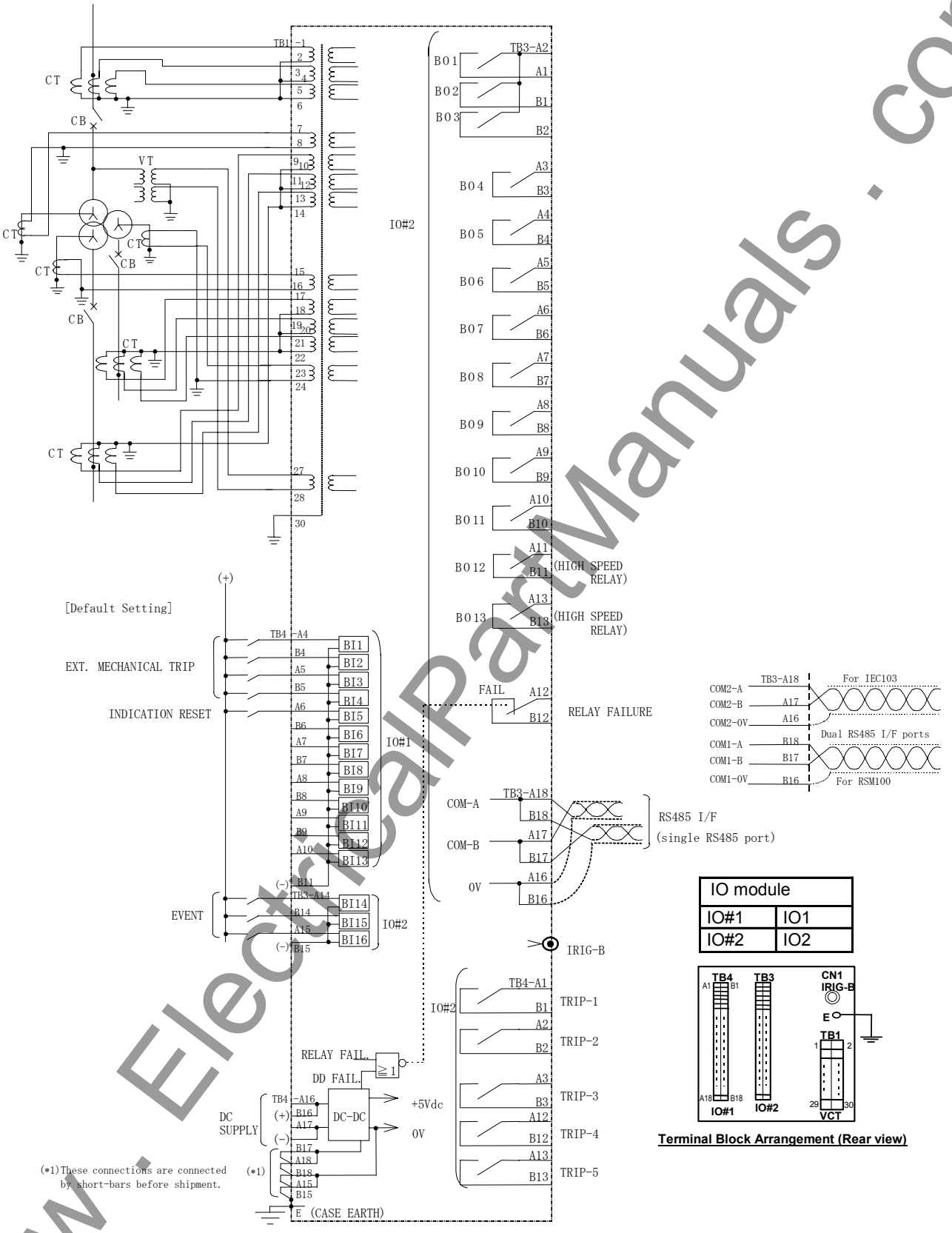
Typical External Connection of Model 101



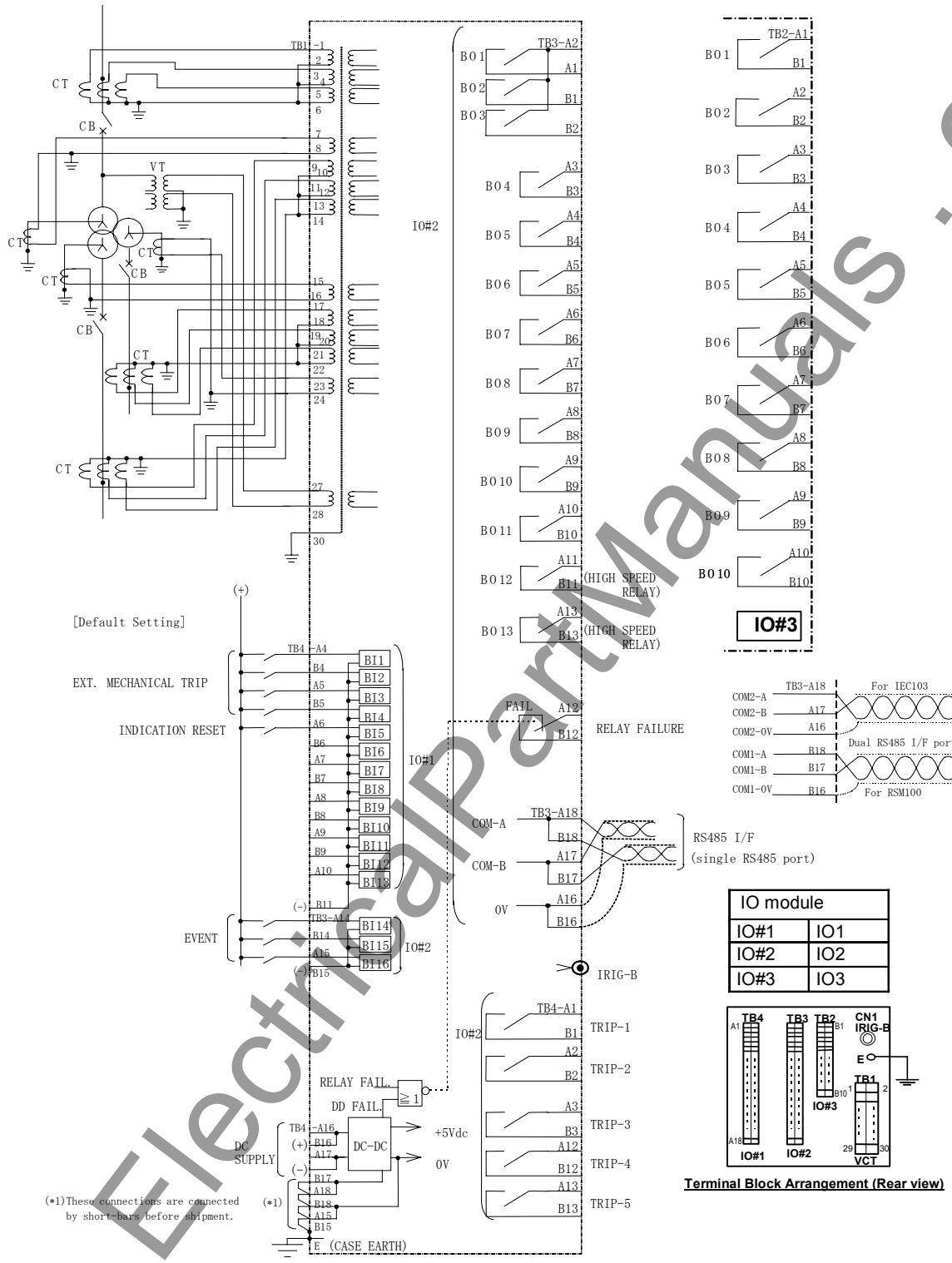
IO module	
IO#1	IO1
IO#2	IO2
IO#3	IO3

Terminal Block Arrangement (Rear view)

Typical External Connection of Model 102



Typical External Connection of Model 201



Terminal Block Arrangement (Rear view)

Typical External Connection of Model 202

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	Standard Range 50Hz	Standard Range 60Hz	Units	Contents	Default Setting of Relay Series (50Hz / 60Hz) 2-Winding 101	2-Winding 102	3-Winding 201	3-Winding 202	User Setting
1	Active group	1 - 8		—	Active setting group	1				
2	1CT	1 - 20000		—	CT ratio	2000				
3	2CT	1 - 20000		—	ditto	2000				
4	3CT	1 - 20000		—	ditto	--		2000		
5	1nCT	1 - 20000		—	ditto	2000				
6	2nCT	1 - 20000		—	ditto	400				
7	3nCT	1 - 20000		—	ditto	--		400		
8	VT	1 - 20000		—	VT ratio	400				
9	DIFTPMD	3POR - 2PAND		—	DIF trip mode	3POR				
10	1REF	1I0 - 2I0		—	Transformer type for REF	1I0		--		
		1I0 - 2I0 - 3I0				--		1I0		
11	2REF	1I0 - 2I0		—	ditto	1I0		--		
		1I0 - 2I0 - 3I0				--		1I0		
12	3REF	1I0 - 2I0 - 3I0		—	ditto	--		1I0		
13	M1OCI	Long - Std - Very - Ext		—	OCI back-up trip	Std				
14	M2OCI	Long - Std - Very - Ext		—	ditto	Std				
15	M3OCI	Long - Std - Very - Ext		—	ditto	--		Std		
16	M1EFI	Long - Std - Very - Ext		—	EFI back-up trip	Std				
17	M2EFI	Long - Std - Very - Ext		—	ditto	Std				
18	M3EFI	Long - Std - Very - Ext		—	ditto	--		Std		
19	L/O	Off - On		—	Trip signal lock out	Off				
20	2F-LOCK	Off - On		—	2F restraint	On				
21	5f-LOCK	Off - On		—	5F restraint	On				
22	DIF1	Off - On		—	Current differential trip	On				
23	DIF2	Off - On		—	ditto	On				
24	DIF3	Off - On		—	ditto	Off		On		
25	DIF4	Off - On		—	ditto	Off				
26	DIF5	Off - On		—	ditto	Off				
27	1REF1	Off - On		—	Restricted earth fault trip	On				
28	1REF2	Off - On		—	ditto	On				
29	1REF3	Off - On		—	ditto	On				
30	1REF4	Off - On		—	ditto	Off				
31	1REF5	Off - On		—	ditto	Off				
32	1OC1	Off - On		—	OC trip	On				
33	1OC2	Off - On		—	ditto	Off				
34	1OC3	Off - On		—	ditto	Off				
35	1OC4	Off - On		—	ditto	Off				
36	1OC5	Off - On		—	ditto	Off				
37	1OCI1	Off - On		—	OCI trip	On				
38	1OCI2	Off - On		—	ditto	Off				
39	1OCI3	Off - On		—	ditto	Off				
40	1OCI4	Off - On		—	ditto	Off				
41	1OCI5	Off - On		—	ditto	Off				
42	1EF1	Off - On		—	EF trip	On				
43	1EF2	Off - On		—	ditto	Off				
44	1EF3	Off - On		—	ditto	Off				
45	1EF4	Off - On		—	ditto	Off				
46	1EF5	Off - On		—	ditto	Off				
47	1EFI1	Off - On		—	EFI trip	On				
48	1EFI2	Off - On		—	ditto	Off				
49	1EFI3	Off - On		—	ditto	Off				
50	1EFI4	Off - On		—	ditto	Off				
51	1EFI5	Off - On		—	ditto	Off				
52	2REF1	Off - On		—	Restricted earth fault trip	On				
53	2REF2	Off - On		—	ditto	On				
54	2REF3	Off - On		—	ditto	On				
55	2REF4	Off - On		—	ditto	Off				
56	2REF5	Off - On		—	ditto	Off				
57	2OC1	Off - On		—	OC trip	Off				
58	2OC2	Off - On		—	ditto	On				
59	2OC3	Off - On		—	ditto	Off				
60	2OC4	Off - On		—	ditto	Off				
61	2OC5	Off - On		—	ditto	Off				
62	2OCI1	Off - On		—	OCI trip	Off				
63	2OCI2	Off - On		—	ditto	On				
64	2OCI3	Off - On		—	ditto	Off				
65	2OCI4	Off - On		—	ditto	Off				
66	2OCI5	Off - On		—	ditto	Off				
67	2EF1	Off - On		—	EF trip	Off				
68	2EF2	Off - On		—	ditto	On				
69	2EF3	Off - On		—	ditto	Off				
70	2EF4	Off - On		—	ditto	Off				
71	2EF5	Off - On		—	ditto	Off				

№	Name	Standard Range 50Hz	Standard Range 60Hz	Units	Contents	Default Setting of Relay Series (50Hz / 60Hz) 2-Winding 101	2-Winding 102	3-Winding 201	3-Winding 202	User Setting
72	2EFI1	Off - On		—	EFI trip	Off				
73	2EFI2	Off - On		—	ditto	On				
74	2EFI3	Off - On		—	ditto	Off				
75	2EFI4	Off - On		—	ditto	Off				
76	2EFI5	Off - On		—	ditto	Off				
77	3REF1	Off - On		—	Restricted earth fault trip	--		On		
78	3REF2	Off - On		—	ditto	--		On		
79	3REF3	Off - On		—	ditto	--		On		
80	3REF4	Off - On		—	ditto	--		Off		
81	3REF5	Off - On		—	ditto	--		Off		
82	3OC1	Off - On		—	OC trip	--		Off		
83	3OC2	Off - On		—	ditto	--		Off		
84	3OC3	Off - On		—	ditto	--		On		
85	3OC4	Off - On		—	ditto	--		Off		
86	3OC5	Off - On		—	ditto	--		Off		
87	3OCI1	Off - On		—	OCI trip	--		Off		
88	3OCI2	Off - On		—	ditto	--		Off		
89	3OCI3	Off - On		—	ditto	--		On		
90	3OCI4	Off - On		—	ditto	--		Off		
91	3OCI5	Off - On		—	ditto	--		Off		
92	3EF1	Off - On		—	EF trip	--		Off		
93	3EF2	Off - On		—	ditto	--		Off		
94	3EF3	Off - On		—	ditto	--		On		
95	3EF4	Off - On		—	ditto	--		Off		
96	3EF5	Off - On		—	ditto	--		Off		
97	3EFI1	Off - On		—	EFI trip	--		Off		
98	3EFI2	Off - On		—	ditto	--		Off		
99	3EFI3	Off - On		—	ditto	--		On		
100	3EFI4	Off - On		—	ditto	--		Off		
101	3EFI5	Off - On		—	ditto	--		Off		
102	FRQ-UF1	Off - On		—	FRQ trip	On				
103	FRQ-UF2	Off - On		—	ditto	On				
104	FRQ1	Off - On		—	ditto	On				
105	FRQ2	Off - On		—	ditto	On				
106	FRQ3	Off - On		—	ditto	Off		On		
107	FRQ4	Off - On		—	ditto	Off				
108	FRQ5	Off - On		—	ditto	Off				
109	FRQA	Off - On		—	ditto	On				
110	V/F1	Off - On		—	V/F trip	On				
111	V/F2	Off - On		—	ditto	On				
112	V/F3	Off - On		—	ditto	Off		On		
113	V/F4	Off - On		—	ditto	Off				
114	V/F5	Off - On		—	ditto	Off				
115	V/FA	Off - On		—	ditto	On				
116	THR1	Off - On		—	THR trip	On				
117	THR2	Off - On		—	ditto	On				
118	THR3	Off - On		—	ditto	Off		On		
119	THR4	Off - On		—	ditto	Off				
120	THR5	Off - On		—	ditto	Off				
121	THRA	Off - On		—	ditto	On				
122	M.T1-1	Off - On		—	Mechanical trip1	On				
123	M.T1-2	Off - On		—	ditto	On				
124	M.T1-3	Off - On		—	ditto	Off		On		
125	M.T1-4	Off - On		—	ditto	Off				
126	M.T1-5	Off - On		—	ditto	Off				
127	M.T2-1	Off - On		—	Mechanical trip2	On				
128	M.T2-2	Off - On		—	ditto	On				
129	M.T2-3	Off - On		—	ditto	Off		On		
130	M.T2-4	Off - On		—	ditto	Off				
131	M.T2-5	Off - On		—	ditto	Off				
132	M.T3-1	Off - On		—	Mechanical trip3	On				
133	M.T3-2	Off - On		—	ditto	On				
134	M.T3-3	Off - On		—	ditto	Off		On		
135	M.T3-4	Off - On		—	ditto	Off				
136	M.T3-5	Off - On		—	ditto	Off				
137	M.T4-1	Off - On		—	Mechanical trip4	On				
138	M.T4-2	Off - On		—	ditto	On				
139	M.T4-3	Off - On		—	ditto	Off		On		
140	M.T4-4	Off - On		—	ditto	Off				
141	M.T4-5	Off - On		—	ditto	Off				
142	SVCNT	ALM&BLK - ALM		—	Super visor control	ALM&BLK				

№	Name		Standard Range 50Hz	Standard Range 60Hz	Units	Contents	Default Setting of Relay Series (50Hz / 60Hz) 2-Winding 101	2-Winding 102	3-Winding 201	3-Winding 202	User Setting
143	DIFT	ik	0.10 - 1.00		pu	Minimum operating current	0.30				
144		p1	10 - 100		%	% slope of small current region	100				
145		p2	10 - 200		%	% slope of large current region	200				
146		kp	1.00 - 20.00		pu	Break point of DIF characteristic	1.00				
147		kct1	0.05 - 50.00		—	CT ratio	1.00				
148		kct2	0.05 - 50.00		—	ditto	1.00				
149		kct3	0.05 - 50.00		—	ditto	--		1.00		
150		d1	0 - 11		—	Phase angle	0				
151		d2	0 - 11		—	ditto	0				
152		d3	0 - 11		—	ditto	--		0		
153		k2f	10 - 50		%	2f restraint	15				
154		k5f	10 - 100		%	5f restraint	30				
155		kh	2.00 - 20.00		pu	HOC operaing current	2.00				
156	REF	1ik	0.05 - 0.50		pu	Minimum sensitivity for 1REF	0.50				
157		1kct1	1.00 - 50.00		—	CT ratio for 1REF	1.00				
158		1kct2	1.00 - 50.00		—	ditto	1.00				
159		1kct3	1.00 - 50.00		—	ditto	--		1.00		
160		1p2	50 - 100		%	Percent slope for 1REF	100				
161		1kp	0.50 - 2.00		pu	DF2 sensitivity	1.00				
162		2ik	0.05 - 0.50		pu	Minimum sensitivity for 2REF	0.50				
163		2kct1	1.00 - 50.00		—	CT ratio for 2REF	1.00				
164		2kct2	1.00 - 50.00		—	ditto	1.00				
165		2kct3	1.00 - 50.00		—	ditto	--		1.00		
166		2p2	50 - 100		%	Percent slope for 2REF	100				
167		2kp	0.50 - 2.00		pu	DF2 sensitivity	1.00				
168		3ik	0.05 - 0.50		pu	Minimum sensitivity for 3REF	--		0.50		
169		3kct1	1.00 - 50.00		—	CT ratio for 3REF	--		1,00		
170		3kct2	1.00 - 50.00		—	ditto	--		1,00		
171		3kct3	1.00 - 50.00		—	ditto	--		1.00		
172		3p2	50 - 100		%	Percent slope for 3REF	--		100		
173		3kp	0.50 - 2.00		pu	DF2 sensitivity	--		1.00		
174		T1REF	0.00 - 10.00		s	1REF delay trip timer	0.00				
175		T2REF	0.00 - 10.00		s	2REF delay trip timer	0.00				
176		T3REF	0.00 - 10.00		s	3REF delay trip timer	--		0.00		
177	OC	1OC	0.10 - 20.00		pu	OC element	2.00				
178		2OC	0.10 - 20.00		pu	ditto	2.00				
179		3OC	0.10 - 20.00		pu	ditto	--		2.00		
180		T1OC	0.00 - 10.00		s	OC delay trip timer	1.00				
181		T2OC	0.00 - 10.00		s	ditto	1.00				
182		T3OC	0.00 - 10.00		s	ditto	--		1.00		
183		1OCI	0.10 - 5.00		pu	OCI element	1.00				
184		2OCI	0.10 - 5.00		pu	ditto	1.00				
185		3OCI	0.10 - 5.00		pu	ditto	--		1.00		
186		T1OCI	0.05 - 1.00		—	OCI delayed tripping timer	1.00				
187		T2OCI	0.05 - 1.00		—	ditto	1.00				
188		T3OCI	0.05 - 1.00		—	ditto	--		1.00		
189		1EF	0.10 - 20.00		pu	EF element	2.00				
190		2EF	0.10 - 20.00		pu	ditto	2.00				
191		3EF	0.10 - 20.00		pu	ditto	--		2.00		
192		T1EF	0.00 - 10.00		s	EF delay trip timer	1.00				
193		T2EF	0.00 - 10.00		s	ditto	1.00				
194		T3EF	0.00 - 10.00		s	ditto	--		1.00		
195		1EFI	0.10 - 5.00		pu	EFI element	1.00				
196		2EFI	0.10 - 5.00		pu	ditto	1.00				
197		3EFI	0.10 - 5.00		pu	dittp	--		1.00		
198		T1EFI	0.05 - 1.00		—	EFI delayed tripping timer	1.00				
199		T2EFI	0.05 - 1.00		—	ditto	1.00				
200		T3EFI	0.05 - 1.00		—	ditto	--		1.00		
201	THR	t	0.5 - 500.0		min	Time constant	60.0				
202		k	0.10 - 4.00		—	Constant	1.30				
203		IB	0.50 - 2.50		pu	Basic current	1.00				
204		Ip	0.00 - 1.00		pu	Pre-load current	0.00				
205		TA	0 - 10		min	Time for alarming	10				
206	V/F	V	100.0 - 120.0		V	Voltage	100.0				
207		A	1.03 - 1.30		pu	Alarm level	1.03				
208		L	1.05 - 1.30		pu	Low level	1.05				
209		H	1.10 - 1.40		pu	High level	1.40				
210		LT	1 - 600		s	Inverce time delay for high level	600				
211		HT	1 - 600		s	Inverce time delay fir low level	1				
212		RT	60 - 3600		s	Radiant heat time	250				
213		TVFH	1 - 600		s	Delay time for high level	10				
214		TVFA	1 - 600		s	Delay time for alarm level	10				

№	Name		Standard Range 50Hz	Standard Range 60Hz	Units	Contents	Default Setting of Relay Series (50Hz / 60Hz) 2-Winding 101	2-Winding 102	3-Winding 201	3-Winding 202	User Setting
215	FRQ	81-1	45.00 - 55.00	54.00 - 66.00	Hz	Frequency	49.00 / 59.00				
216		81-2	45.00 - 55.00	54.00 - 66.00	Hz	ditto	48.00 / 58.00				
217		UV	40 - 100		v	Voltage	40				
218		TFRQL	0.00 - 60.00		s	TRIP delay timer for low level	10.0				
219		TFRQH	0.00 - 60.00		s	TRIP delay timer for high level	10.0				
220		TFRQA	0.00 - 60.00		s	TRIP delay timer for alarm level	10.0				
221	BISW1		Norm - Inv		–	Binary input	Norm				
222	BISW2		Norm - Inv		–	ditto	Norm				
223	BISW3		Norm - Inv		–	ditto	Norm				
224	BISW4		Norm - Inv		–	ditto	Norm				
225	BISW5		Norm - Inv		–	ditto	Norm				
226	BISW14		Norm - Inv		–	ditto	Norm				
227	BISW15		Norm - Inv		–	ditto	Norm				
228	BISW16		Norm - Inv		–	ditto	Norm				
229	LED1		O - 333		–	Configrable LEDs	0				
230	LED2		O - 333		–	ditto	0				
231	LED3		O - 333		–	ditto	0				
232	LED4		O - 333		–	ditto	0				
233	Plant name		Specified by user		–	Plant name	Specified by user				
234	Description		ditto		–	Memorandum for user	Specified by user				
235	Address-HDLC		1 - 32		–	Relay ID No. for RSM	1				
236	Address-IEC		1 - 254		–	Relay ID No. for IEC103	2				
237	232C		9.6 - 19.2 - 38.4 - 57.6		–	Comm. speed for RSM	9.6				
238	IECBR		9.6 - 19.2		–		19.2				
239	IECBLK		Normal - Block		–		Normal				
240	Phase mode		Operating - Fault		–	Phase indication of Fault recording	Operating				
241	Mech.trip1		None - Operate - Reset - Both		–	Event record trigger	Both				
242	Mech.trip2		None - Operate - Reset - Both		–	ditto	Both				
243	Mech.trip3		None - Operate - Reset - Both		–	ditto	Both				
244	Mech.trip4		None - Operate - Reset - Both		–	ditto	Both				
245	Trip		None - Operate - Reset - Both		–	ditto	Both				
246	Ind.Reset		None - Operate - Reset - Both		–	ditto	Both				
247	Relay fail		None - Operate - Reset - Both		–	ditto	Both				
248	CT1 err		None - Operate - Reset - Both		–	ditto	Both				
249	CT2 err		None - Operate - Reset - Both		–	ditto	Both				
250	CT3 err		None - Operate - Reset - Both		–	ditto	--		Both		
251	Event1		None - Operate - Reset - Both		–	ditto	Both				
252	Event2		None - Operate - Reset - Both		–	ditto	Both				
253	Event3		None - Operate - Reset - Both		–	ditto	Both				
254	Sys. Set change		None - Operate		–	ditto	Operate				
255	Rly. Set change		None - Operate		–	ditto	Operate				
256	Grp. Set change		None - Operate		–	ditto	Operate				
257	Time		0.1 - 3.0		s	Disturbance record	1.0				
258	1OCPS		0.10 - 20.00		pu	OC element for disturbance	1.00				
259	2OCPS		0.10 - 20.00		pu	recorder initiation	1.00				
260	3OCPS		0.10 - 20.00		pu		--		1.00		
261	1OCPG		0.05 - 20.00		pu		1.00				
262	2OCPG		0.05 - 20.00		pu		1.00				
263	3OCPG		0.05 - 20.00		pu		--		1.00		
264	TRIP1		Off - On		–	Disturbance trigger	On				
265	TRIP2		Off - On		–	ditto	On				
266	TRIP3		Off - On		–	ditto	Off		On		
267	TRIP4		Off - On		–	ditto	Off				
268	TRIP5		Off - On		–	ditto	Off				
269	1OCPS		Off - On		–	ditto	On				
270	2OCPS		Off - On		–	ditto	On				
271	3OCPS		Off - On		–	ditto	--		On		
272	1OCPG		Off - On		–	ditto	On				
273	2OCPG		Off - On		–	ditto	On				
274	3OCPG		Off - On		–	ditto	--		On		
275	2F		Off - On		–	ditto	On				
276	5F		Off - On		–	ditto	On				
277	EVENT1		Off - On		–	ditto	On				
278	EVENT2		Off - On		–	ditto	On				
279	EVENT3		Off - On		–	ditto	On				
280	Display value		Primary - Secondary		–	Metering	Primary				
281	Time sync		Off - IRIG - RSM - IEC		–	Time	Off				
282	GMT		-12 - +12		hour	Time	0				

PLC default setting

Output		Timing				Logic expression		Delay Time / Flip Flop								
		Cycle						Flip Flop			Timer					
№	Signal	30	90	User	Turn	Model 100s	Model 200s	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															
1597																
1598																
1599																

Output		Timing				Logic expression		Delay Time / Flip Flop								
		Cycle						Flip Flop			Timer					
№	Signal	30	90	User	Turn	Model 100s	Model 200s	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	
1605																
1606																
⋮																
⋮																
⋮																
1790																
1791																
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
1797																
1798																
⋮																
⋮																
⋮																
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																
⋮																
⋮																
⋮																
2681																
2682																
2683																
2684																
2685																
2686	PROT COM RECV															
2687																
2688	TPLED RST RCV															
2689																
⋮																
⋮																
⋮																
2814																
2815																

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)
	× I_k	
	× 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)
	× I_k	
	× 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: 101B- 22-10)

Product No.: _____

Serial No. : _____

Date: _____

1. Why the relay is being returned ?
   - ☐ mal-operation
   - ☐ does not operate
   - ☐ increased error
   - ☐ investigation
   - ☐ others

     _____

     _____

     _____

     _____

2. Fault records, event records or disturbance records stored in the relay and relay settings are very helpful information to investigate the incident.

   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 14W (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)	50 to 200% in 1% steps
kp	1.00 to 10.00pu in 0.01pu steps
Vector group compensation (Winding 1 to 3) (d1 – d3)	0 to 11 (0 to 330deg in 30deg 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 a 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 to 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.
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
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	Munsell No. 10YR8/0.5
Installation	Flush mounting or rack mounting

CT requirement

The CT knee point voltage Vk is required as follows:

The CT should not be saturated by maximum through fault current.

$$Vk \geq (RCT + R1 + Vb/n^2) \cdot Ifm/N$$

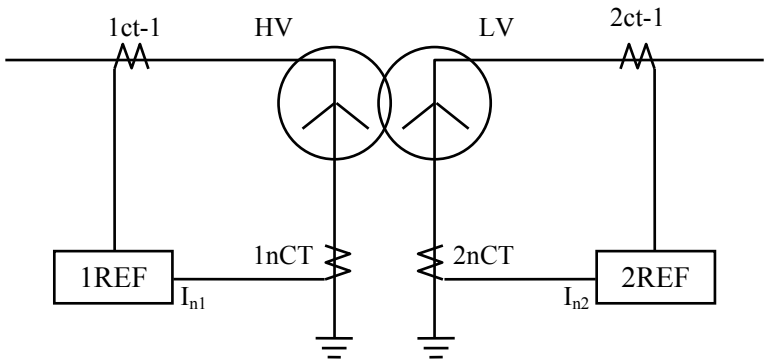
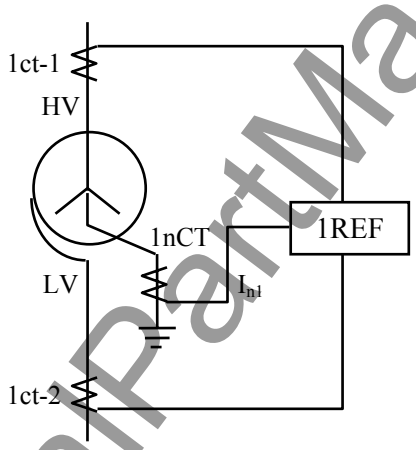
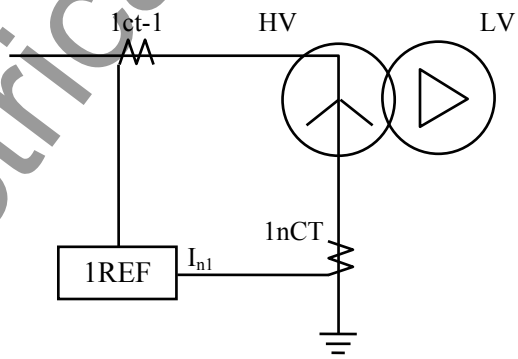
Ifm: Maximum through fault current
N: CT ratio
RCT: CT secondary resistance
R1: CT cable resistance
Vb: Relay burden
n: CT secondary rating

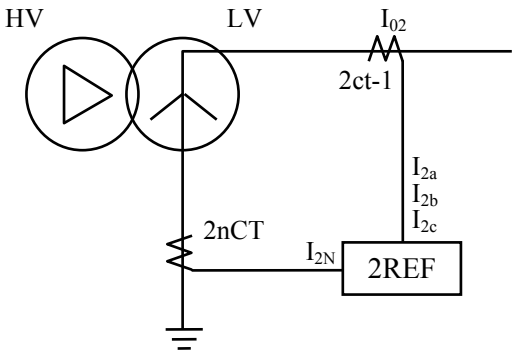
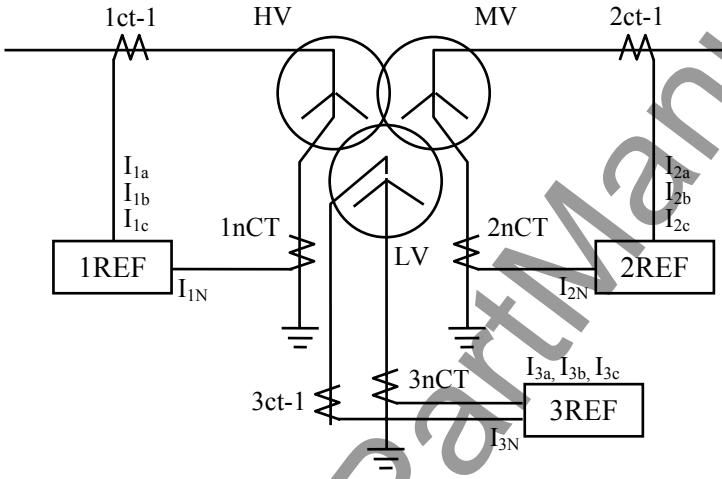
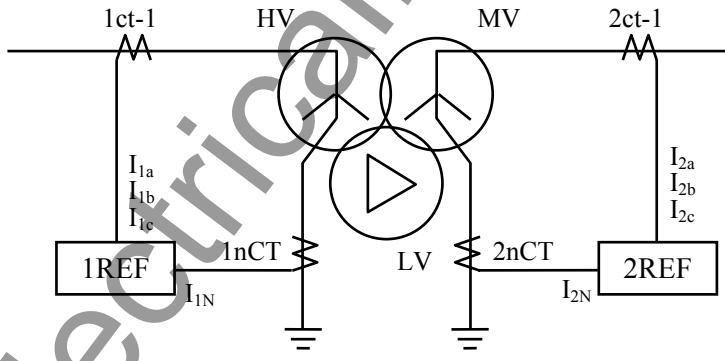
ENVIRONMENTAL PERFORMANCE CLAIMS

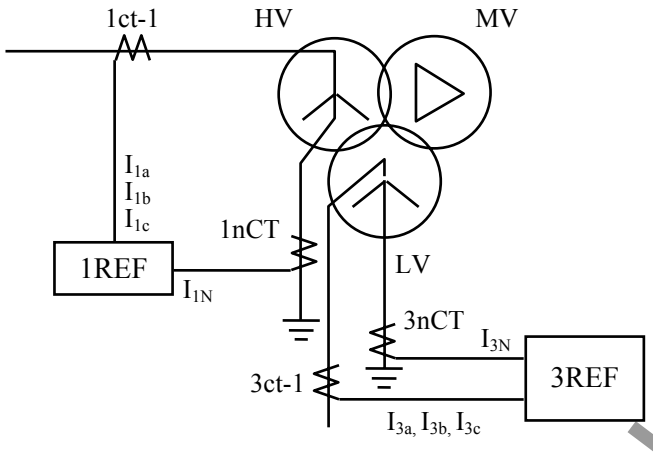
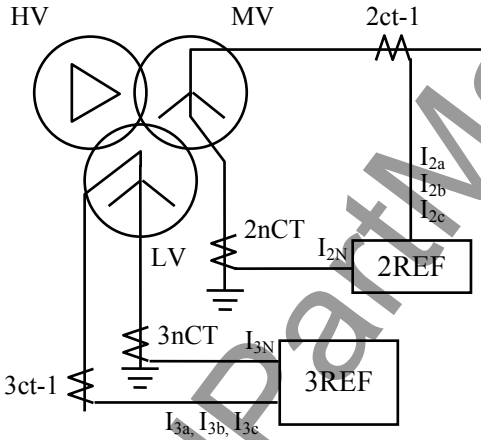
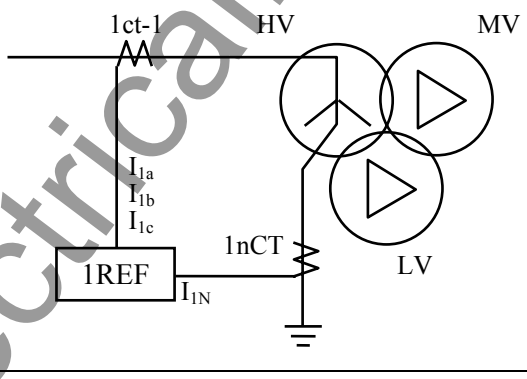
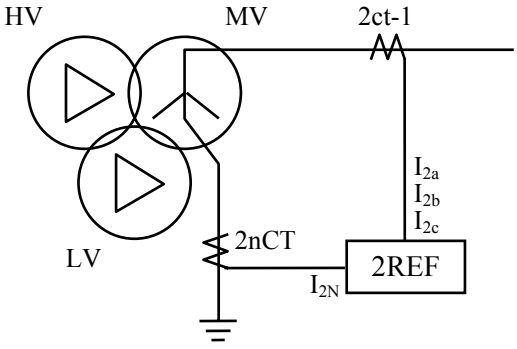
Test	Standards	Details
Atmospheric Environment		
Temperature	IEC60068-2-1/2	Operating range: -10°C to +55°C. Storage / Transit: -25°C to +70°C.
Humidity	IEC60068-2-78	56 days at 40°C and 93% relative humidity.
Enclosure Protection	IEC60529	IP51 (Rear: IP20)
Mechanical Environment		
Vibration	IEC60255-21-1	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
High Voltage 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	IEC60255-22-1 Class 3	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	6kV contact discharge. 8kV air discharge.
Radiated RF Electromagnetic Disturbance	IEC60255-22-3	Field strength 10V/m for frequency sweeps of 80MHz to 1GHz. Additional spot tests at 80, 160, 450, 900 and 1890MHz.
Fast Transient Disturbance	IEC60255-22-4 Class 4	4kV, 2.5kHz, 5/50ns applied to all inputs.

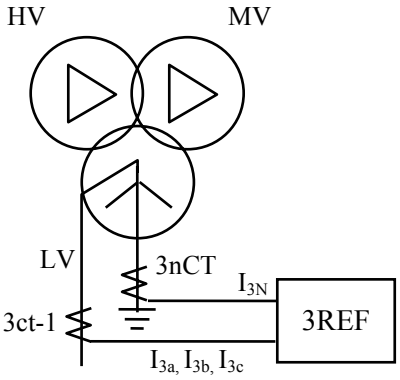
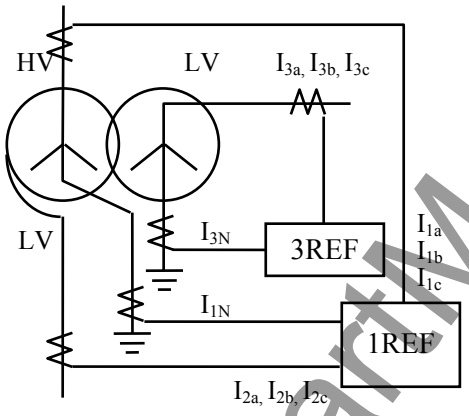
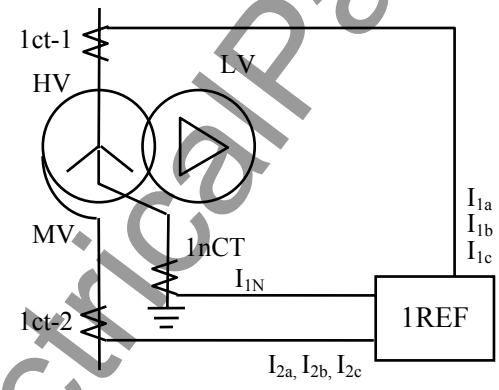
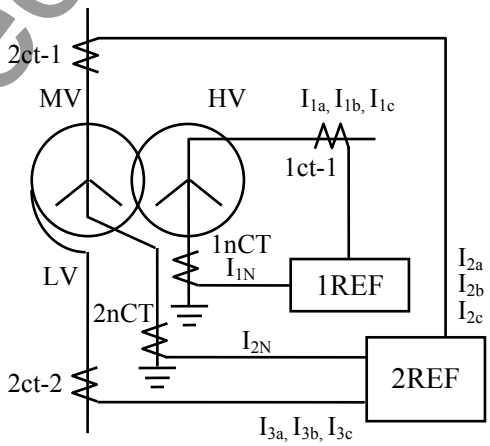
Appendix L

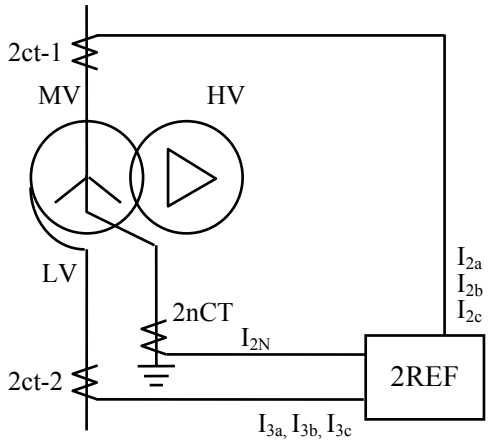
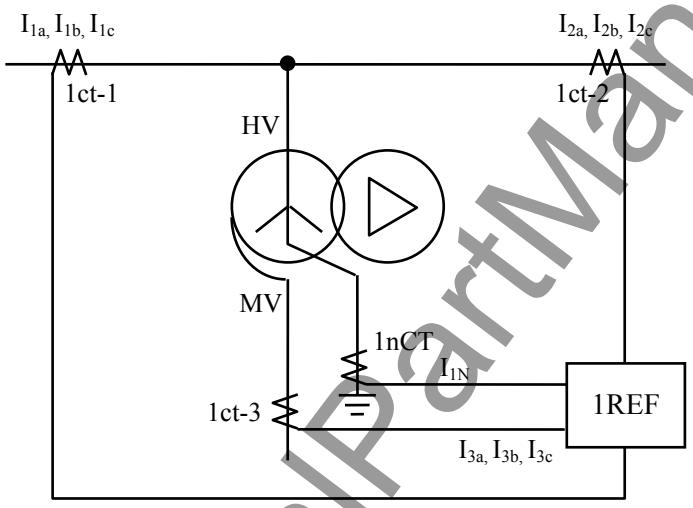
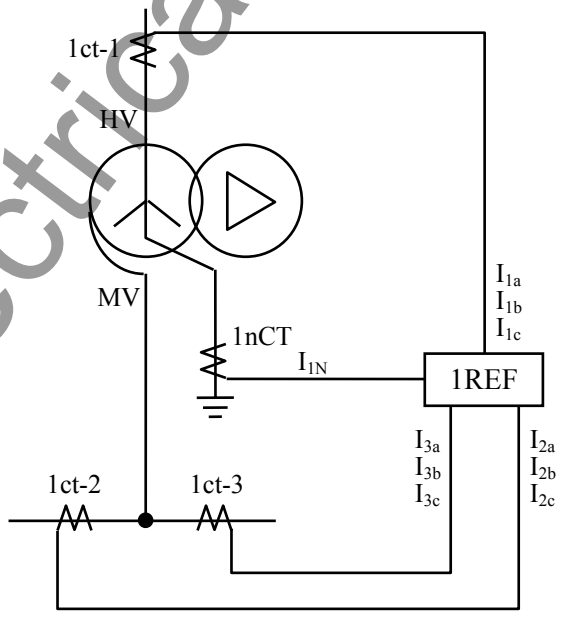
Setting of REF Element

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

Type of transformer	Scheme switch setting
	3REF = 1I0 1REF1 to 5 = OFF 3REF1 to 5 = OFF
	1REF = 2I0 3REF = 1I0 2REF1 to 5 = OFF
	1REF = 2I0 2REF1 to 5 = OFF 3REF1 to 5 = OFF
	1REF = 1I0 2REF = 2I0 3REF1 to 5 = OFF

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 ▭ : Measuring element output signal

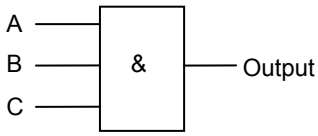
Marked with ⬭ : Binary signal input from or output to the external equipment

Marked with [ ] : Scheme switch

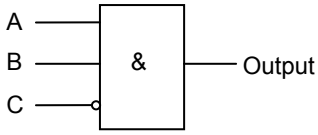
Marked with " " : Scheme switch position

Unmarked : Internal scheme logic signal

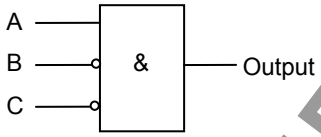
AND gates



A	B	C	Output
1	1	1	1
Other cases			0

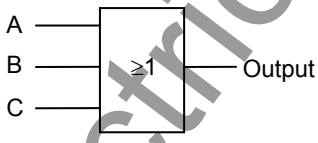


A	B	C	Output
1	1	0	1
Other cases			0

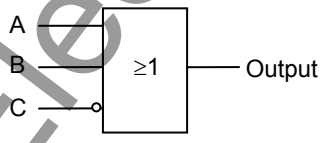


A	B	C	Output
1	0	0	1
Other cases			0

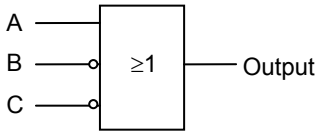
OR gates



A	B	C	Output
0	0	0	0
Other cases			1

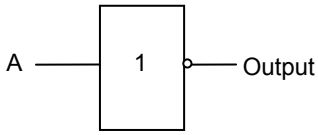


A	B	C	Output
0	0	1	0
Other cases			1



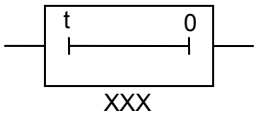
A	B	C	Output
0	1	1	0
Other cases			1

Signal inversion



A	Output
0	1
1	0

Timer

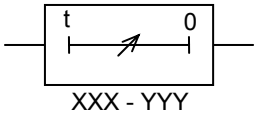


Delaye pick-up timer with fixed setting

XXX: Set time

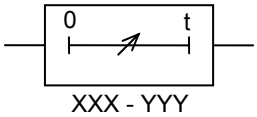
Delayed drop-off timer with fixed setting

XXX: Set time



Delaye pick-up timer with variable setting

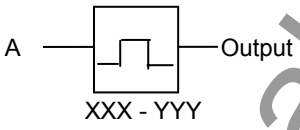
XXX - YYY: Setting range

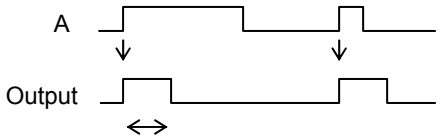


Delayed drop-off timer with variable setting

XXX - YYY: Setting range

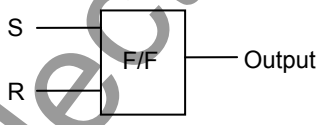
One-shot timer





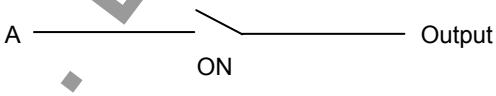
XXX - YYY: Setting range

Flip-flop

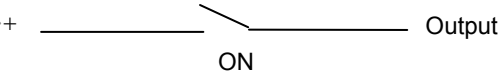


S	R	Output
0	0	No change
1	0	1
0	1	0
1	1	0

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} = 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.

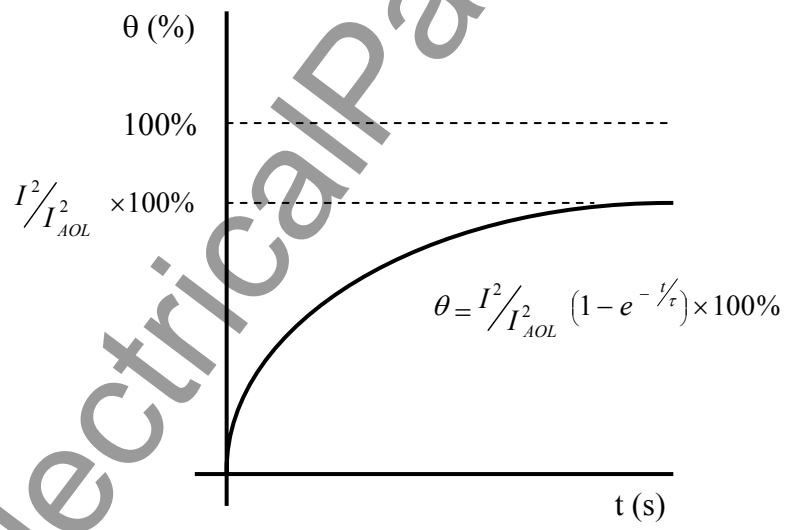


Figure N-1

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.

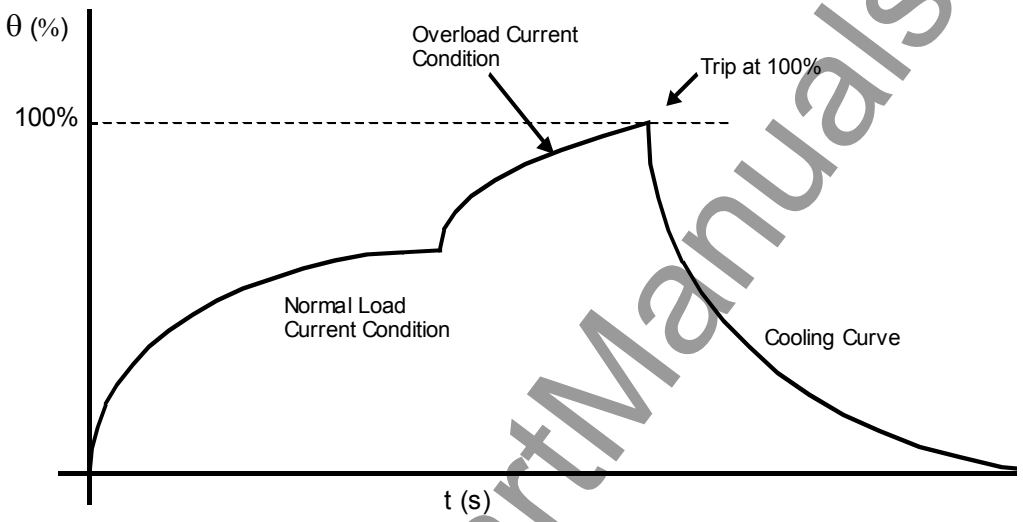


Figure N-2 (1) Thermal Curve without Prior Load Current

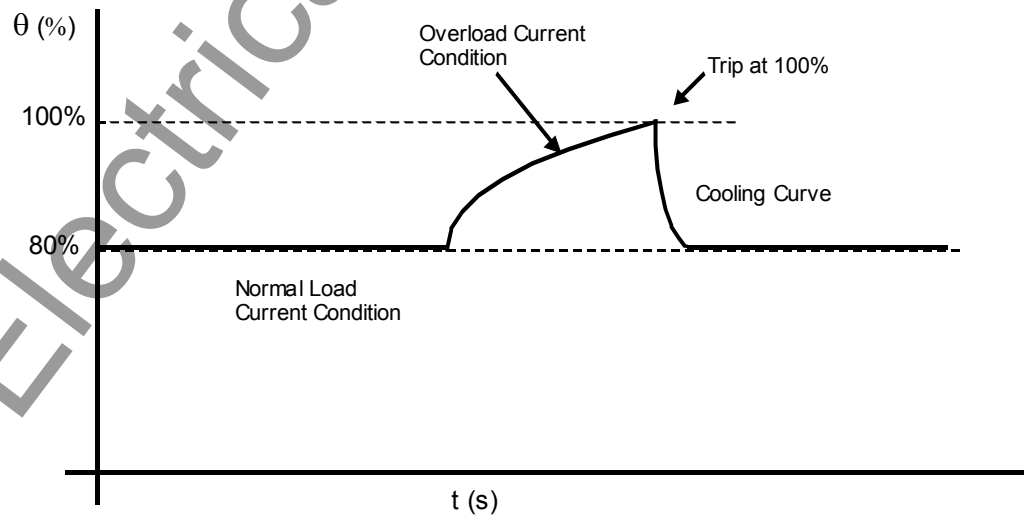


Figure N-2 (2) Thermal curve with Prior Load Current (θ=80%)

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			

(*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:

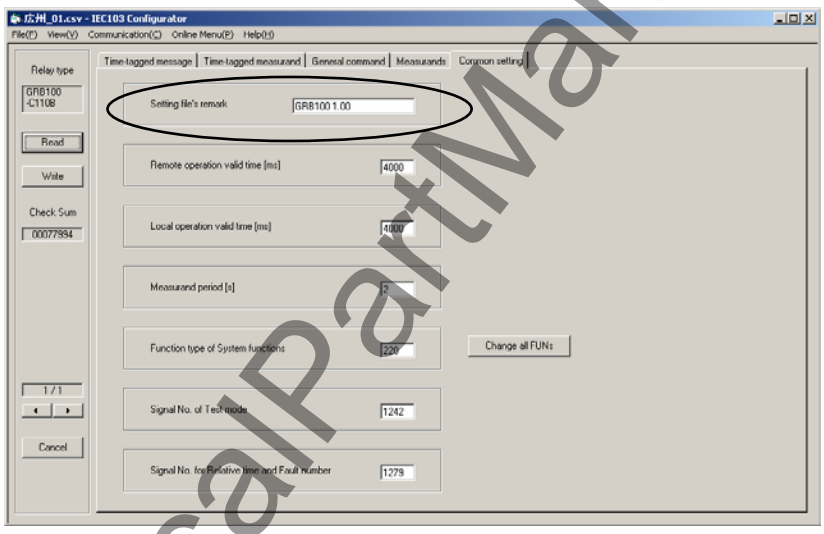
First draft: ******_01.csv

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

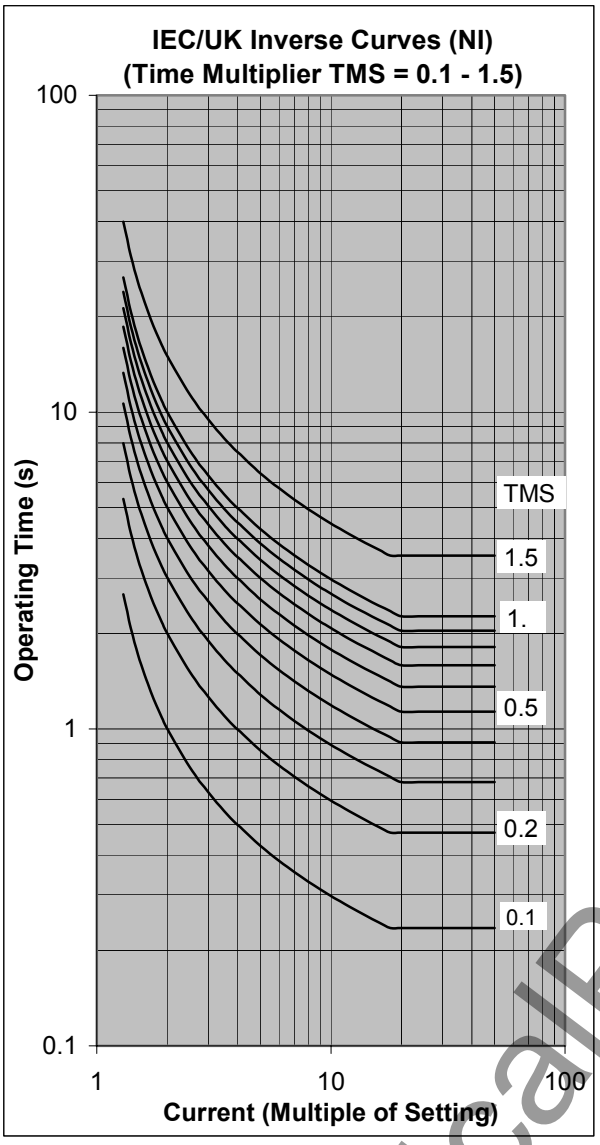
<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Phenomena</th><th rowspan="2">Supposed causes</th><th colspan="2">Check / Confirmation</th></tr>
<tr><th>Object</th><th>Procedure</th></tr>
<tr><td rowspan="11">1</td><td rowspan="11">Communication trouble （IEC103 communication is not available.）</td><td>Address setting is incorrect.</td><td>BCU
RY</td><td>Match address setting between BCU and relay.
Avoid duplication of address with other relay.</td></tr>
<tr><td>Transmission baud rate setting is incorrect.</td><td>BCU
RY</td><td>Match transmission baud rate setting between BCU and relay.</td></tr>
<tr><td>Start bit, stop bit and parity settings of data that BCU transmits to relay is incorrect.</td><td>BCU</td><td>Go over the following settings by BCU. Relay setting is fixed as following settings.
- Start bit: 1bit
- Stop bit: 1bit
- Parity setting: even</td></tr>
<tr><td>The PRTCL1 setting is incorrect. (The model with PRTCL1 setting.)</td><td>RY</td><td>Change the PRTCL1 setting. Relation between PRTCL1 setting and available transmission protocol is referred to the following table.
<table>
<tr><td>RS485 port at the back of the relay</td><td>PRTCL1 =HDLC</td><td>PRTCL1 =IEC</td></tr>
<tr><td>COM1 (CH1)</td><td>HDLC</td><td>IEC</td></tr>
<tr><td>COM2 (CH2)</td><td>IEC</td><td>—</td></tr>
</table></td></tr>
<tr><td>RS485 or optical cable interconnection is incorrect.</td><td>Cable</td><td>- Check the connection port.(CH1/CH2)
- Check the interconnection of RS485 A/B/COM
- Check the send and received interconnection of optical cable.</td></tr>
<tr><td>The setting of converter is incorrect. (RS485/optic conversion is executed with the transmission channel, etc.)</td><td>Converter</td><td>In the event of using G1IF2, change the DIPSW setting in reference to INSTRUCTION MANUAL (6F2S0794).</td></tr>
<tr><td>The relationship between logical “0/1” of the signal and Sig.on/off is incorrect. (In the event of using optical cable)</td><td>BCU</td><td>Check the following;
Logical0 : Sig.on
Logical1:Sig.off</td></tr>
<tr><td>Terminal resistor is not offered. (Especially when RS485 cable is long.)</td><td>cable</td><td>Impose terminal resistor (150[ohms]) to both ends of RS 485 cable.</td></tr>
<tr><td>Relay cannot receive the requirement frame from BCU.
(The timing coordination of sending and receiving switch control is irregular in half-duplex communication.)</td><td>BCU</td><td>Check to secure the margin more than 15ms between receiving the reply frame from the relay and transmitting the next requirement frame on BCU.</td></tr>
<tr><td>The requirement frame from BCU and the reply frame from relay contend.
(The sending and receiving timing coordination is irregular in half-duplex communication.)</td><td>BCU</td><td>Check to set the time-out of reply frame from the relay.
Time-out setting: more than 100ms (acceptable value of response time 50ms plus margin)</td></tr>
</table>

No.	Phenomena	Supposed causes	Check / Confirmation	
			Object	Procedure
2	HMI does not display IEC103 event on the SAS side.	The relevant event sending condition is not valid.	RY	Change the event sending condition (signal number) of IEC103 configurator if there is a setting error. When the setting is correct, check the signal condition by programmable LED, etc.
		The relevant event Information Number (INF) and/or Function Type (FUN) may be different between the relay and SAS.	RY 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.

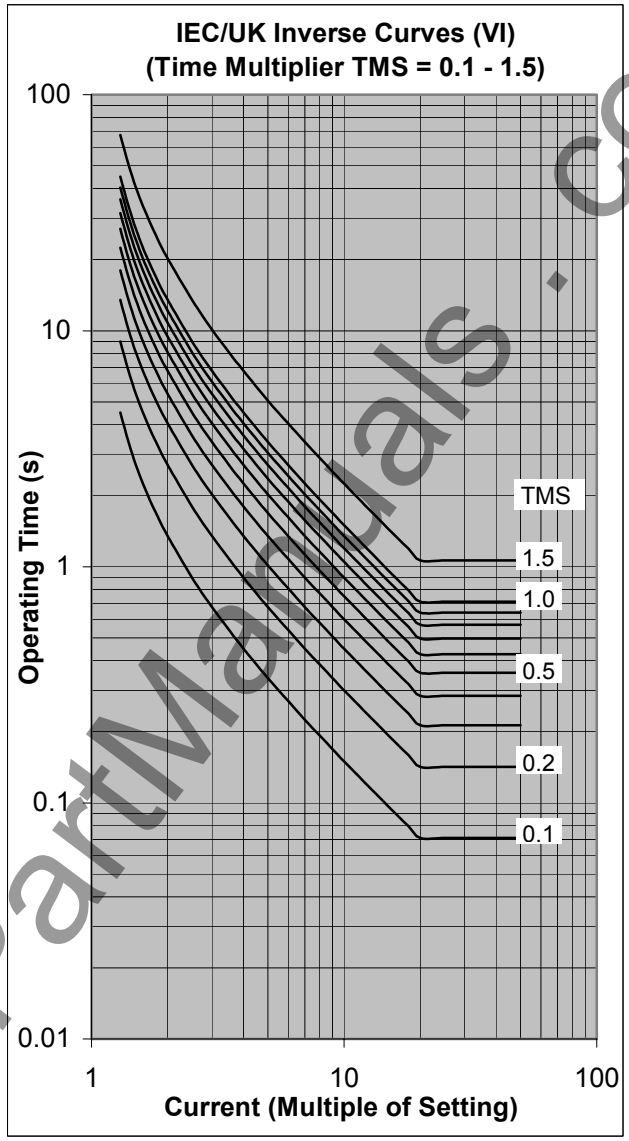
(Note) BCU: Bay control unit, RY: Relay

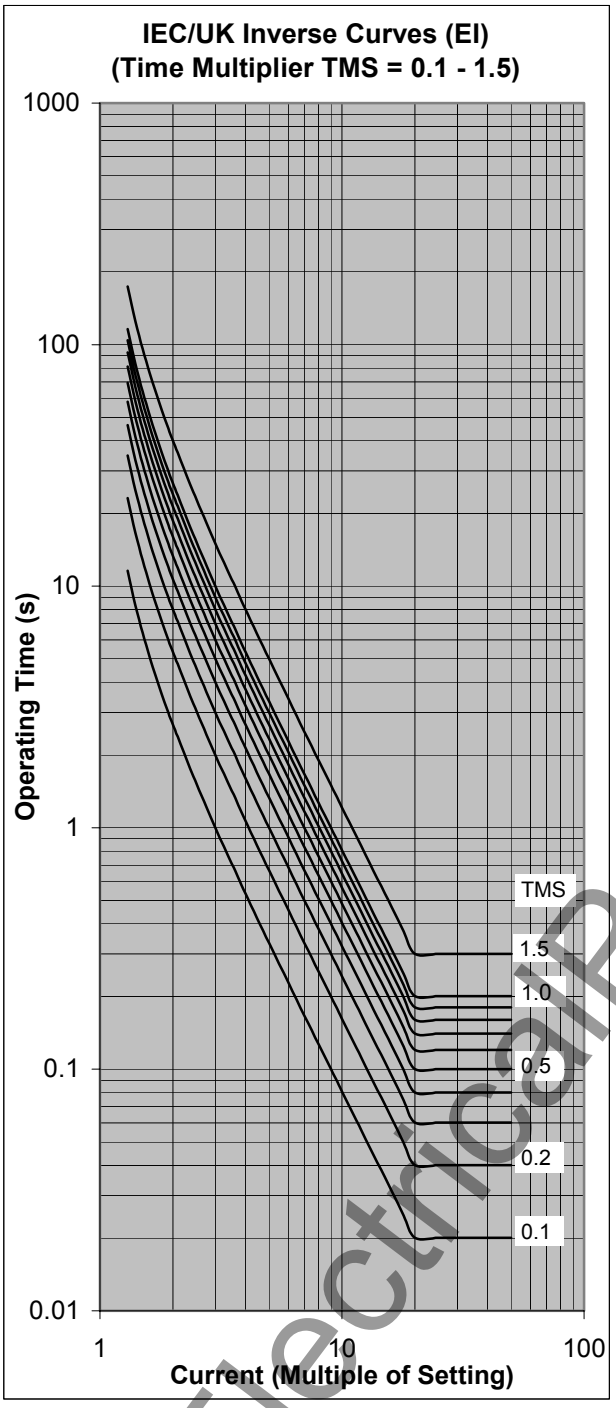
Appendix P

Inverse Time Characteristics

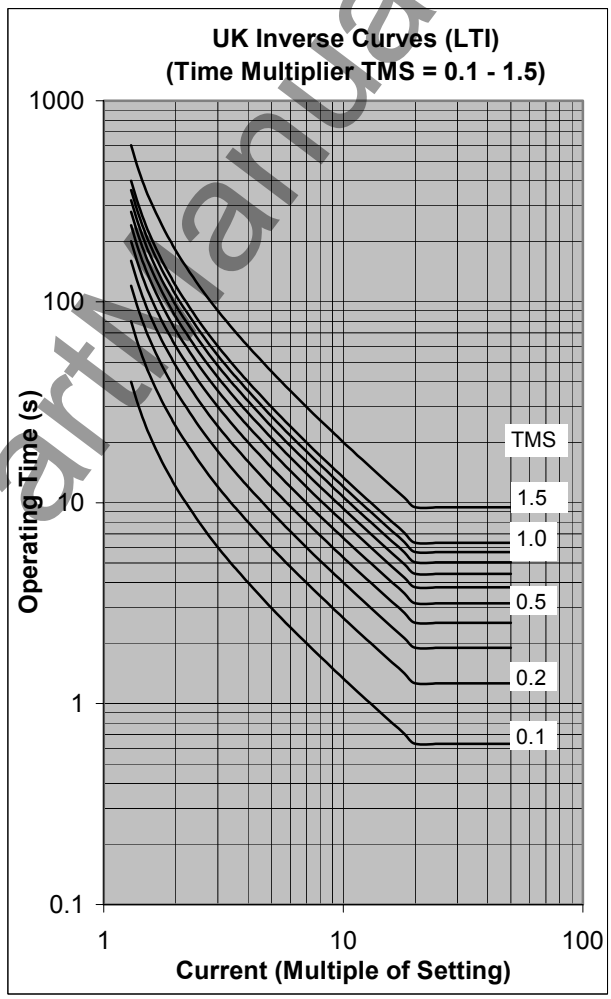


Normal Inverse





Extremely Inverse



Long Time Inverse

Appendix Q

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.

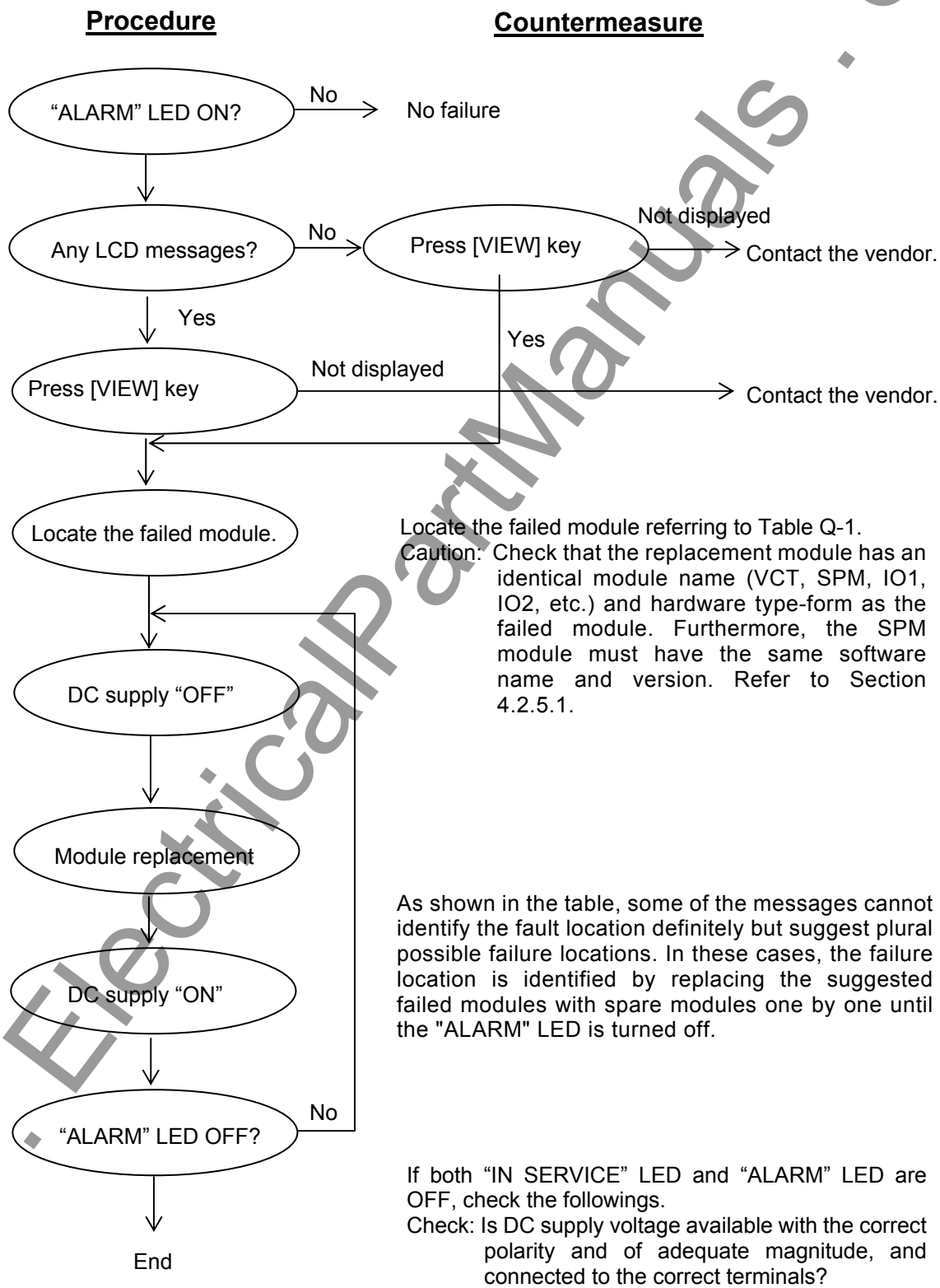


Table Q-1 LCD Message and Failure Location

Message	Failure location						
	VCT	SPM	IO1	IO2	IO3	HMI	AC cable
Checksum err		×					
ROM-RAM err		×					
SRAM err		×					
BU-RAM err		×					
DPRAM err		×					
EEPROM err		×					
A/D err		×					
CT1 err	× (2)	× (1)					× (2)
CT2 err	× (2)	× (1)					× (2)
CT3 err	× (2)	× (1)					× (2)
Sampling err		×					
DIO err		× (2)	× (1)	× (1)	× (1)		
RSM err		× (2)	× (1)				
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 and IEC103, etc. are restored the original settings.

The initial replacement procedure is as follows:

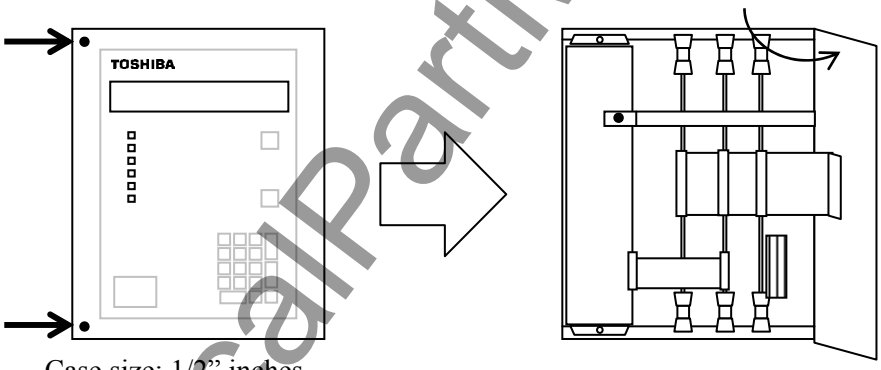
1). Switch off the DC power supply.

⚠ 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.

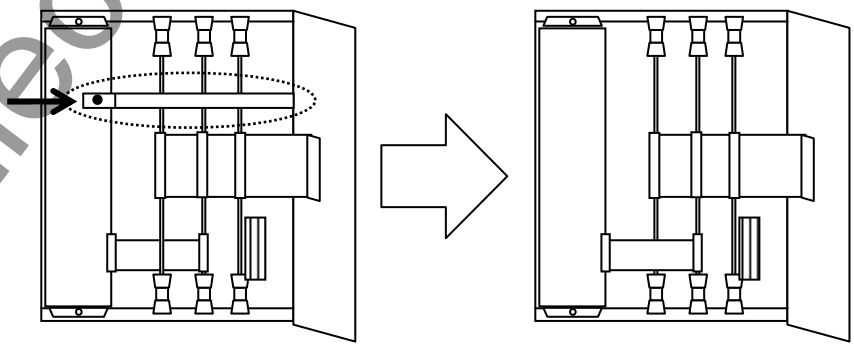
Open the front panel of the relay by unscrewing the binding screw located on the left side of the front panel.



Case size: 1/2" inches

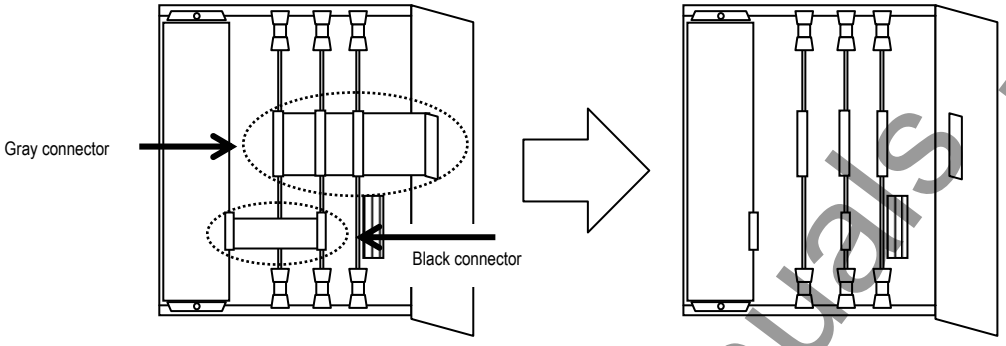
4). Detach the holding bar.

Detach the module holding bar by unscrewing the binding screw located on the left side of the bar.



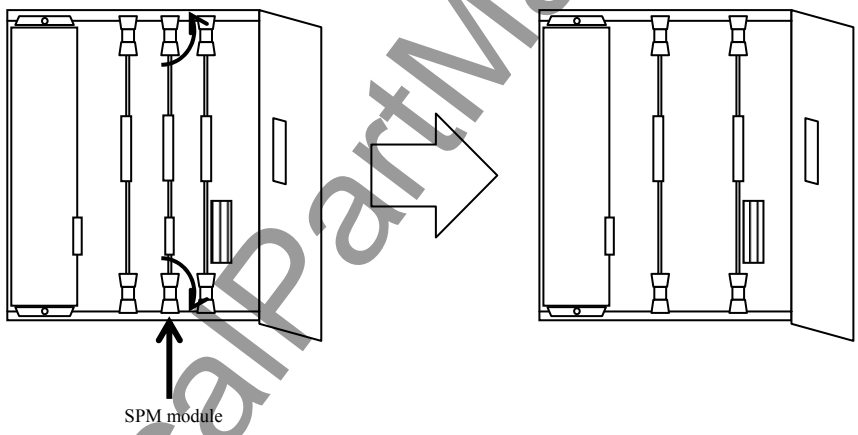
5). Unplug the cables.

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).



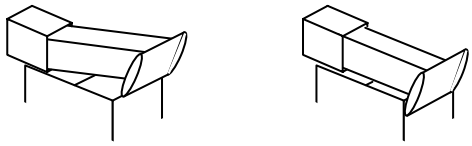
7). Insert the replacement module.

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)



×Not enough ○Enough

9). Lamp Test

- RESET key is pushed 1 second or more by LCD display off.
- It checks that all LCDs and LEDs light on.

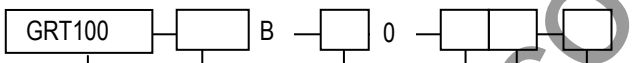
10). Check the automatic supervision functions.

- LCD not display “Auto-supervision” screens in turn, and Event Records
- Checking the “IN SERVICE” LED light on and “ALARM LED” light off.

Appendix R

Ordering

Ordering



Type:	
Transformer protection Relay	GRT100
Model:	
-Model 100 series: 2 three-phase current inputs for 2-winding transformer	
- 13 N/O configurable output contacts	101
- 23 N/O configurable output contacts	102
-Model 200 series: 3 three-phase current inputs for 3-winding transformer	
- 13 N/O configurable output contacts	201
- 23 N/O configurable output contacts	202
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/54/60Vdc	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
Communications:	
RS485	1
Dual RS485	3
Miscellaneous:	
	0
LED label:	
Standard	None
Option: User configurable LED label	J

Version-up Records

Version No.	Date	Revised Section	Contents
0.0	Feb. 4, 2004	--	First issue
0.1	Apr. 21, 2004	2.3.1 2.3.2.2 2.3.4 4.2.5.1, 4.2.6.7 Appendices	Modified the description and the Figure 2.3.2. Modified the description. Modified the setting table. Modified samples of LCD screens. Modified the Appendix E, H, K and P, and added the Appendix P
0.2	Aug. 23, 2004	3.2.1 3.2.3 4.5 6.7.3 Appendices	Modified the description. Added the Section 3.2.3. Modified the description. Modified the description. Modified the Appendix H, K and O. Added the Appendix Q.
0.3	May. 30, 2005	2.3.1 2.3.4 3.2.1 5.1 6.7.3 Appendices	Modified Table 2.3.1 and 2.3.2. Modified the description of 'Setting for CT ratio matching'. Modified the description of 'Binary input signals'. Modified the description. Modified the description. Modified the Appendix K, O and P.
0.4	Sep. 06, 2005	4.2.6.5 Appendices	Modified the description. (Disturbance record) Modified the Appendix O and P.
0.5	Jan. 31, 2006	2.3.1 2.3.4 2.4 2.5 2.11.2 Appendices	Modified the description. Modified the description. Modified the description of the 'Setting'. Modified the description. Modified the description. Modified the Appendix B (Signal name of No. 242 and 248), J and K.
0.6	Aug. 29, 2006	4.2.5.1 Appendices	Modified the LCD sample screen. (Relay version) Modified the Appendix P and Q.
0.7	Aug. 10, 2007	3.4.3 4.2.6.7 4.4 6.7.2 6.7.3 Appendices	Modified the description. Added 'CAUTION' in the 'Setting the transformer parameters'. Modified the description. Modified the description and Table 6.7.1. Modified the description of 'CAUTION'. Modified Appendix E, G, K, O, Q and R, and added Appendix P.
0.8	Oct. 2, 2007	4.2.4.3	Modified the description.

TOSHIBA CORPORATION