INSTRUCTION MANUAL

BREAKER FAILURE RELAY

GRC100

TOSHIBA CORPORATION

(Ver. 1.4)

Safety Precautions

Before using this product, please read this chapter carefully.

This chapter describes the safety precautions recommended when using the GRC100. Before installing and using the equipment, this chapter must be thoroughly read and understood.

Explanation of symbols used

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

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

⚠ DANGER

- **Current transformer circuit**

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

⚠WARNING

- **Exposed terminals**

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

- **Residual voltage**

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

⚠CAUTION

- **Earth**

The earthing terminal of the equipment must be securely earthed.

CAUTION

- **Operating environment**

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

- **Ratings**

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

- **Printed circuit board**

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

- **External circuit**

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

- **Connection cable**

Carefully handle the connection cable without applying excessive force.

- **Modification**

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

- **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. 1.4)

1. Introduction

The GRC100 is a numerical breaker failure relay.

The GRC100 is a member of the G-series multifunction numerical relays which are built on common hardware modules and featured with the following functions:

- Human interfaces on relay front panel, and local and remote PCs
  2 × 16 character LCD and keypad
  RS232C and RS485 communication port
- Metering and recording of events, fault and disturbance data
- IRIG-B time synchronisation
- Automatic supervision
- User configurable binary output

2. Application Notes

2.1 Application

The GRC100 provides the following breaker failure protection schemes:

- BF-trip: Time-delayed tripping of associated breakers as local backup tripping
- Retrip: Instantaneous / time-delayed segregated-phase retripping of the original breaker

The GRC100 can be applied for single busbar, double busbar and one-and-a-half breaker busbar configuration systems.

The GRC100 provides the following metering and recording functions.

- Metering
- Fault record
- Event record
- Disturbance record

The GRC100 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 communication ports.

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 Breaker Failure Protection

When fault clearance fails due to a breaker failure, the breaker failure protection (BFP) clears the fault by backup tripping of adjacent circuit breakers.

If the current continues to flow even after a trip command is output, the BFP judges it as a breaker failure. The existence of the current is detected by an overcurrent element provided for each phase. For high-speed operation of the BFP, high-speed reset overcurrent elements OCBF and EFBF are used. The OCBF is three phase overcurrent element and the EFBF is zero-sequence overcurrent element. These elements reset when the current falls below 80% of the operating value.

In order to prevent the BFP from starting by accident during maintenance work and testing, and thus tripping adjacent breakers, the BFP has the optional function of retripping the original breaker. To make sure that the breaker has actually failed, a trip command is made to the original breaker again before tripping the adjacent breakers to prevent unnecessary tripping of the adjacent breakers following the erroneous start-up of the BFP. It is possible to choose not to use retripping at all, or use retripping with a trip command plus delayed pickup timer, or retripping with a trip command plus overcurrent detection plus delayed pickup timer.

An overcurrent element and delayed pickup timer are provided for each phase which also operate correctly during the breaker failure routine in the event of a developing fault.

Scheme logic

The BFP is performed on a per-phase basis. Figure 2.2.1 shows the scheme logic for one phase (A-phase). The BFP is started by a per-phase based trip signal EXT.TRIPA or a three-phase based trip signal EXT.TRIPOR of the external line protection. This trip signal must continuously exist as long as the fault is present.

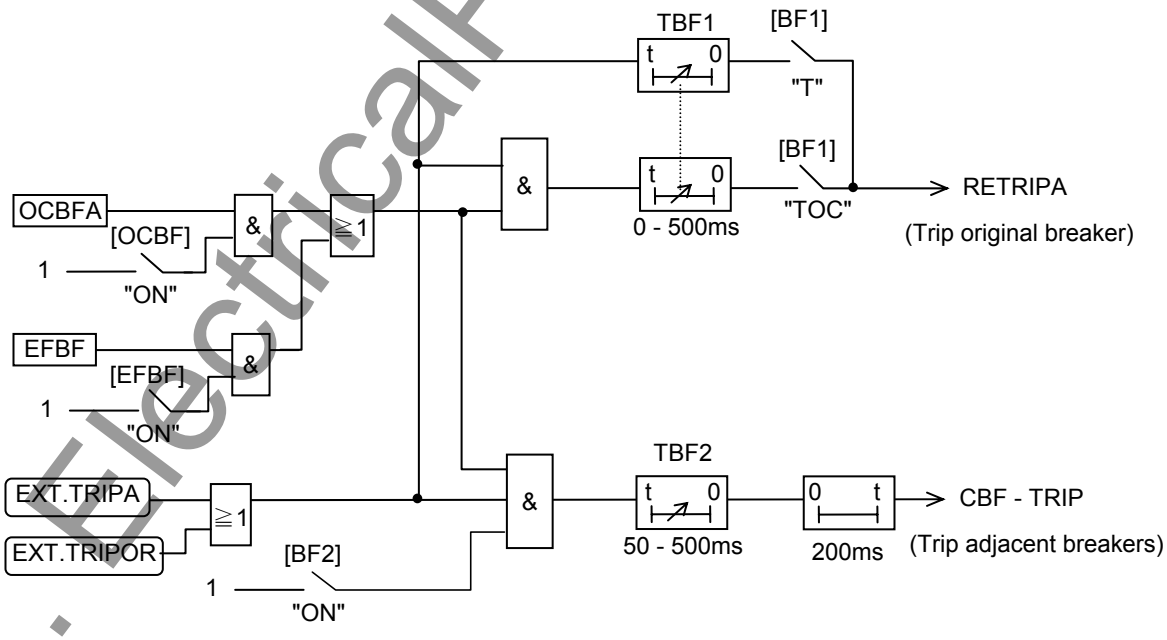


Figure 2.2.1 BFP Scheme Logic

The tripping signal to the adjacent breakers CBF-TRIP is transmitted if the overcurrent element OCBF or EFBF operates continuously for the setting time of the delayed pick-up timer TBF2 after initiation. The OCBF or EFBF can be disabled by the scheme switch [OCBF] or [EFBF].

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

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

Figure 2.2.2 shows a sequence diagram of the BFP when a retrip and backup trip are used. If the circuit breaker trips normally, the OCBF and EFBF reset before timer TBF1 or TBF2 picks up and the BFP resets. As TBF1 and TBF2 start at the same time, the setting value of TBF2 should include that of TBF1.

If the OCBF or EFBF continues to operate, a retrip command is given to the original breaker after the setting time of TBF1. Unless the breaker fails, the OCBF and EFBF are reset by the retrip. The TBF2 does not pickup and the BFP resets. This sequence of events may happen if the BFP is initiated by mistake and unnecessary tripping of the original breaker is unavoidable.

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

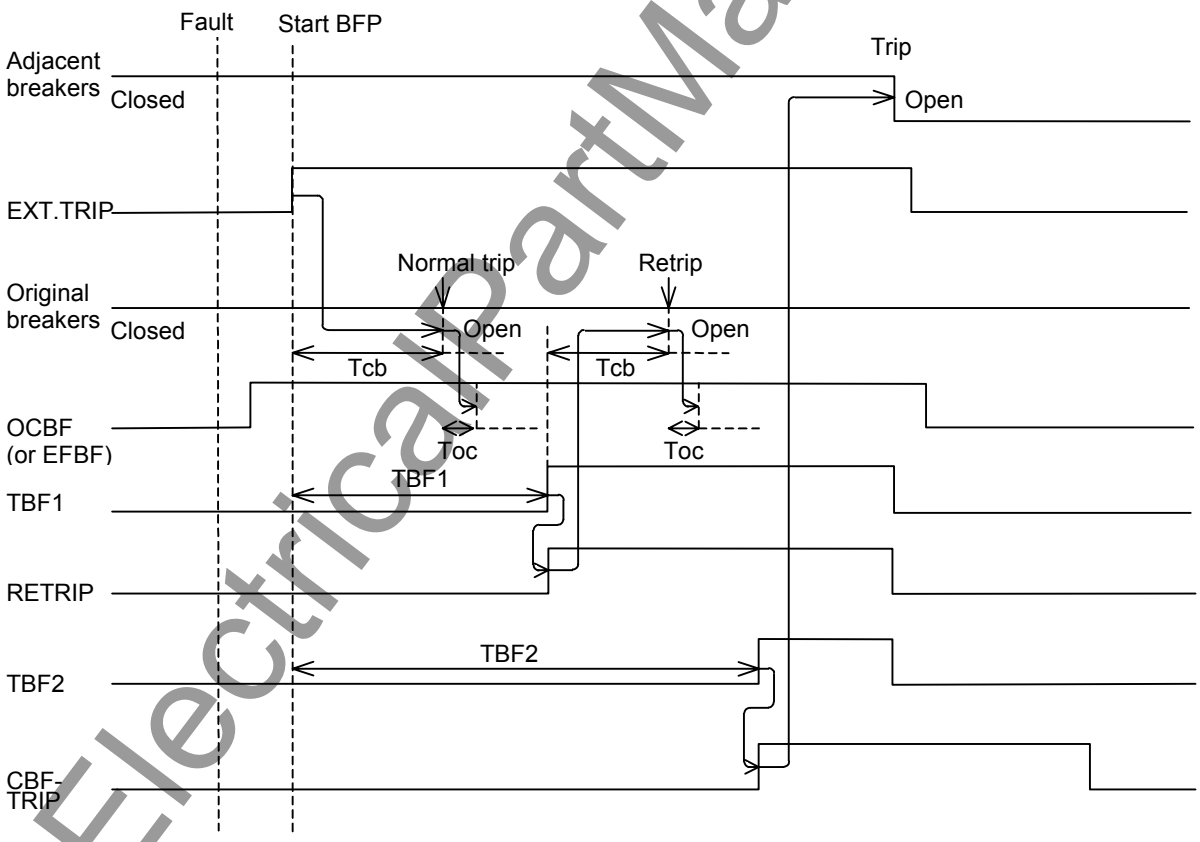


Figure 2.2.2 Sequence Diagram

Setting

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

Element	Range	Step	Default	Remarks
OCBF	0.5 – 10.0 A	0.1 A	4.0 A	Phase overcurrent setting
	(0.1 - 2.0 A	0.1 A	0.8 A) (*)	
EFBF	0.5 – 10.0 A	0.1 A	4.0 A	Zero-sequence overcurrent setting
	(0.1 - 2.0 A	0.1 A	0.8 A) (*)	
TBF1	0 - 500 ms	1 ms	150 ms	Retrip timer
TBF2	50 - 500 ms	1 ms	200 ms	Adjacent breakers trip timer
[BF1]	T/TOC/OFF		TOC	Retrip mode
[BF2]	ON/OFF		ON	Adjacent breakers trip
[OCBF]	ON/OFF		ON	OCBF element
[EFBF]	ON/OFF		OFF	EFBF element

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

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

The settings of TBF1 and TBF2 are determined by the opening time of the original circuit breaker (Tcb in Figure 2.2.2) and the reset time of the overcurrent element (Toc in Figure 2.2.2). The timer setting example when using retrip can be obtained as follows.

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

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

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

The actual tripping time after BFP start will be added the time (approx. 15 to 20ms) consumed by motion of binary input and output to above timer's settings.

2.3 Tripping Output

The tripping logic is shown in Figure 2.3.1. The GRC100 has four tripping output relays for CBF-TRIP and RETRIP. When the tripping mode selection switch [TPMD] is set to "SCM1", the heavy duty, high-speed operation type output relays TP-1 to -4 are used for the adjacent breakers trip. When the switch [TPMD] is set to "SCM2", the TP-1 to -3 are used for the original breaker trip and the TP-4 for the adjacent breakers trip.

The above four tripping output relays each have one normally open contact.

The tripping output relays reset 200ms after the tripping signal disappears by clearing the fault. The tripping circuit must be opened with the auxiliary contact of the breaker prior to reset of the tripping relay to prevent the tripping relay from directly interrupting the tripping current of the breaker.

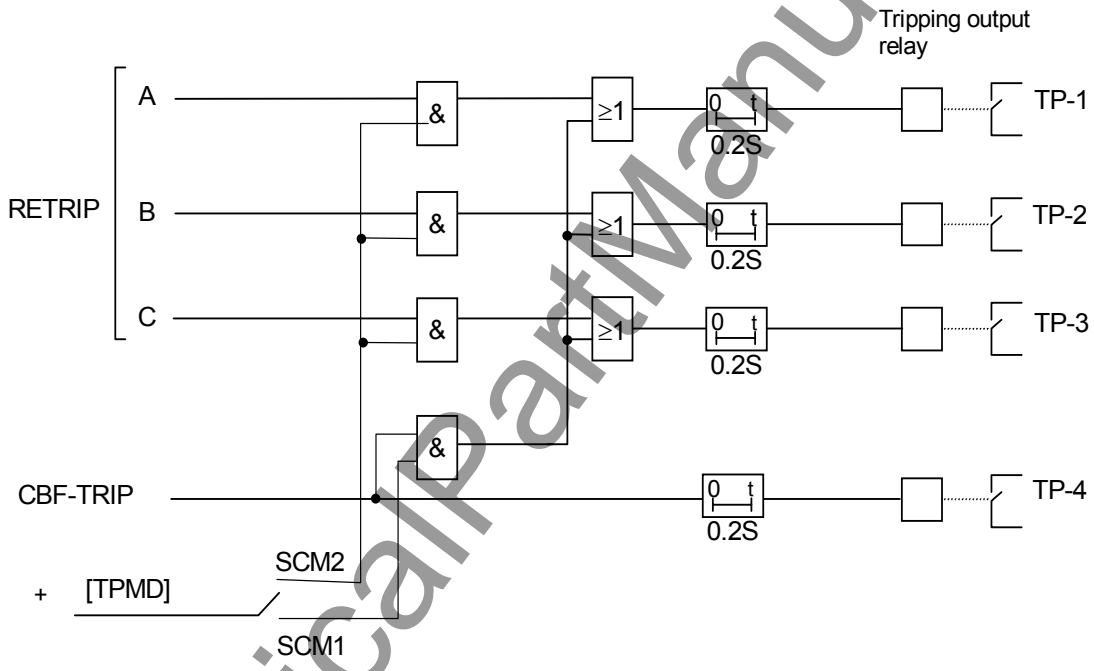


Figure 2.3.1 Tripping Logic

Setting

The setting element necessary for the tripping output circuit and its setting range is as follows:

Element	Range	Step	Default	Remarks
TPMD	SCM1/ SCM2		SCM2	

The scheme switch [TPMD] is used to select the tripping output relays.

3. Technical Description

3.1 Hardware Description

3.1.1 Outline of Hardware Modules

Case outlines of GRC100 is shown in Appendix F.

The hardware structure of GRC100 is shown in Figure 3.1.1.

The GRC100 relay unit consists of the following hardware modules. These modules are fixed in a frame and cannot be taken off individually. The human machine interface module is provided with the front panel.

- Binary input and analogue input module (DI/AI)
- Main processing module (MPU)
- Binary output and communication module (DO/COM)
- Human machine interface module (HMI)

The hardware block diagram of GRC100 is shown in Figure 3.1.2.

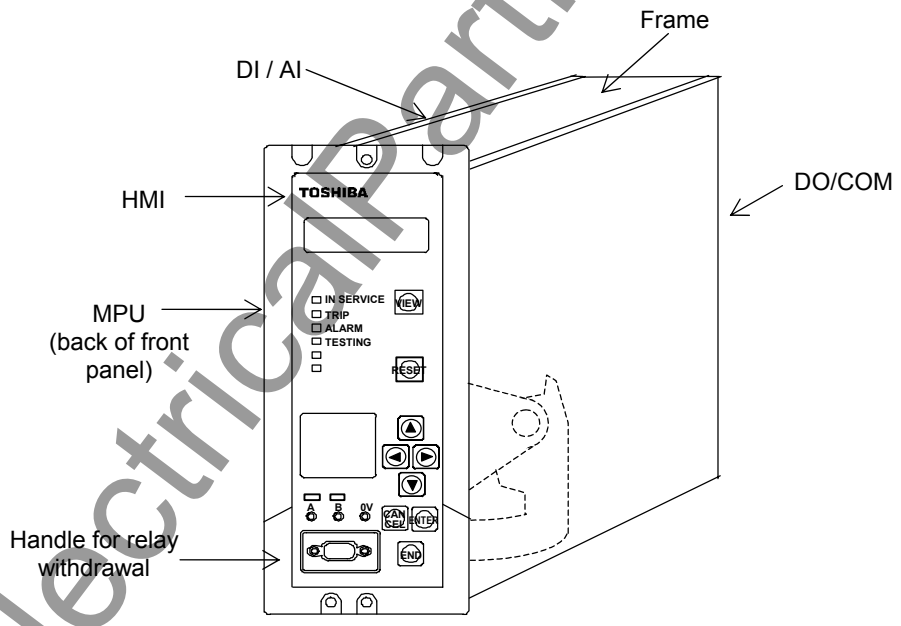


Figure 3.1.1 Hardware Structure without Case

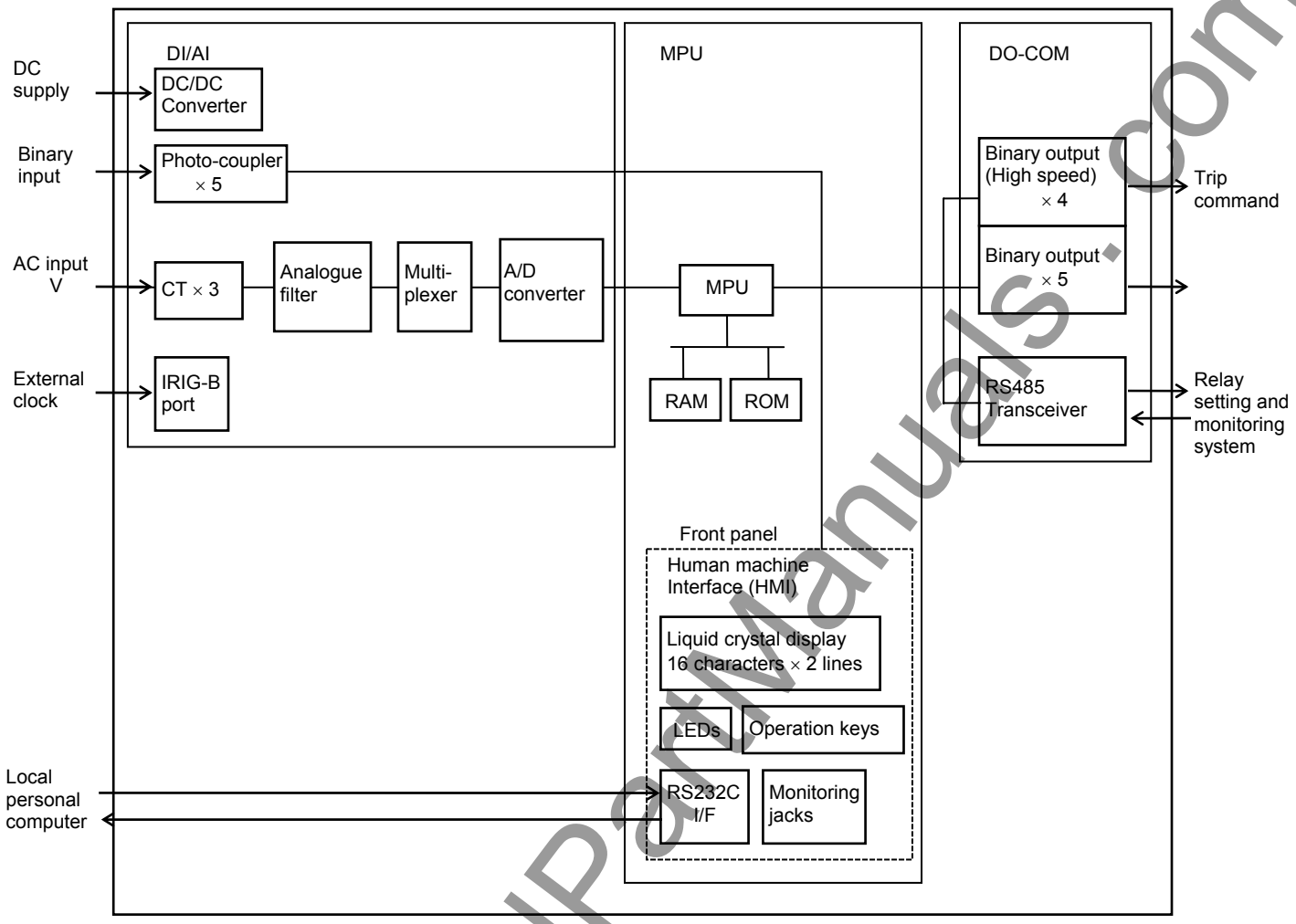


Figure 3.1.2 Hardware Block Diagram

DI/AI Module

The DI/AI 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 three-phase currents.

This module incorporates 3 auxiliary CTs, DC/DC converter, analogue filter, multiplexer, analogue to digital (A/D) converter and photo-coupler circuit for binary input signal.

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

The analogue filter performs low-pass filtering for the corresponding current signals.

The A/D converter has a resolution of 12 bits and samples input signals at sampling frequencies of 2400 Hz (at 50 Hz) and 2880 Hz (at 60 Hz).

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

MPU Module

The MPU module consists of main processing unit (MPU), random access memory (RAM) and read only memory (ROM) and executes all kinds of processing such as protection, measurement, recording and display.

The MPU implements 60 MIPS and uses two RISC (Reduced Instruction Set Computer) type 32-bit microprocessors.

DO/COM Module

The DO/COM module incorporates four auxiliary relays (TP-1 to TP-4) dedicated to the circuit breaker tripping command, 5 auxiliary relays (BO1-BO4 and FAIL) for binary output signals and an RS485 transceiver.

TP-1 to TP-4 are the high-speed operation type and have one normally open contact.

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 BO4 each have one normally open contact.

The RS485 transceiver is used for the link with the relay setting and monitoring (RSM) system. The external signal is insulated from the relay internal signal.

Human Machine Interface (HMI) Module

The operator can access the GRC100 via the human machine interface (HMI) module. As shown in Figure 3.1.3, the HMI panel has a liquid crystal display (LCD), light emitting diodes (LED), view and reset keys, operation keys, monitoring jacks and an RS232C connector on the front panel.

The LCD consists of 16 columns by 2 rows with a back-light and displays recording, status and setting data.

There are a total of 6 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 automatic monitoring function is disabled by the scheme switch [A.M.F] setting.
(LED1)	Red	
(LED2)	Red	

LED1 and LED2 are user-configurable. For the setting, see Section 4.2.6.10.

Once it has started operating, the TRIP LED remains lit even after the trip command disappears. Pressing the RESET key resets it. Other LEDs operates 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 back-light.

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" 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 D.)

The RS232C connector is a 9-way D-type connector for serial RS232C connection. This connector is used for connection with a local personal computer.

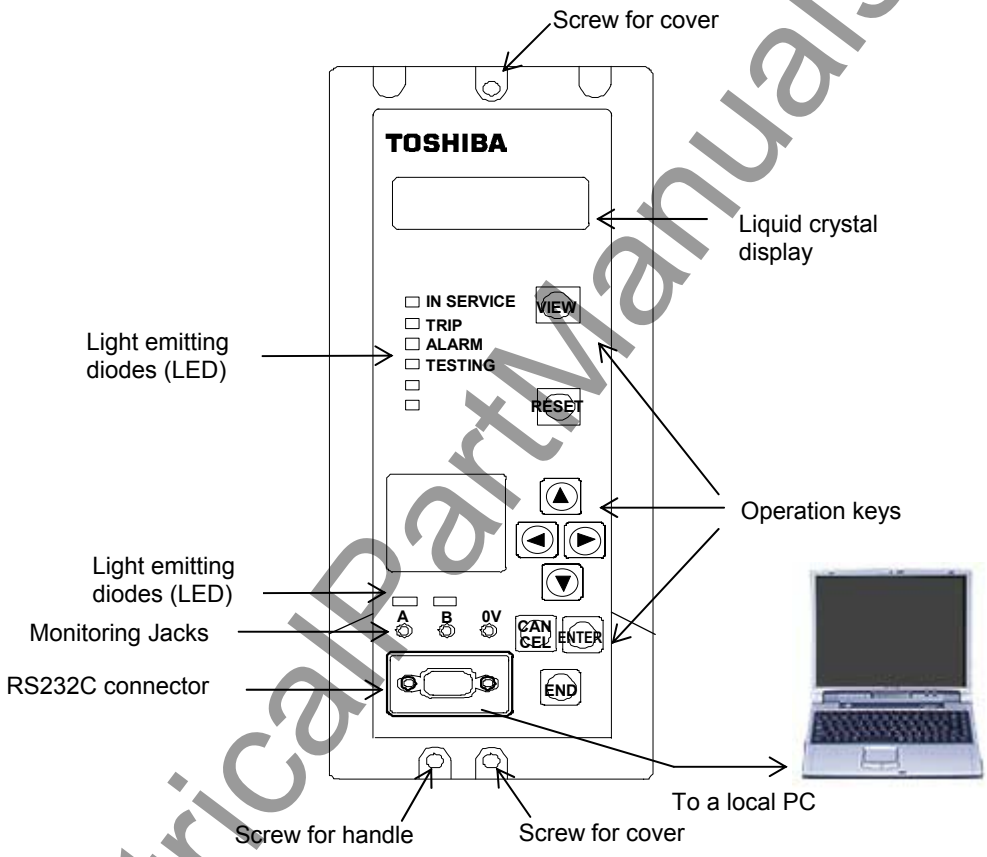


Figure 3.1.3 Front Panel

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 the GRC100 model and their respective input terminal numbers.

Table 3.2.1 AC Input Signals

Terminal No. of TB1	GRC100
1-2	A phase current
3-4	B phase current
5-6	C phase current

Binary input signals

Table 3.2.2 shows the binary input signals necessary for the GRC100, their driving contact conditions and functions enabled. See Appendix G for external connections.

The binary input circuit of the GRC100 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.

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

The minimum operating voltage of binary input signal is 70V DC at 110V/125V DC rating and 100V DC at 220V/250V DC rating.

Table 3.2.2 Binary Input Signals

Signal Names	Driving Contact Condition / Function Enabled	BISW
Ext-trip A		1
Ext-trip B	Closed when external protection operated. / Initiate	2
Ext-trip C	breaker failure protection.	3
Ext-trip OR		4
Indication reset	Closed to reset TRIP LED indication. / Reset indication externally.	5

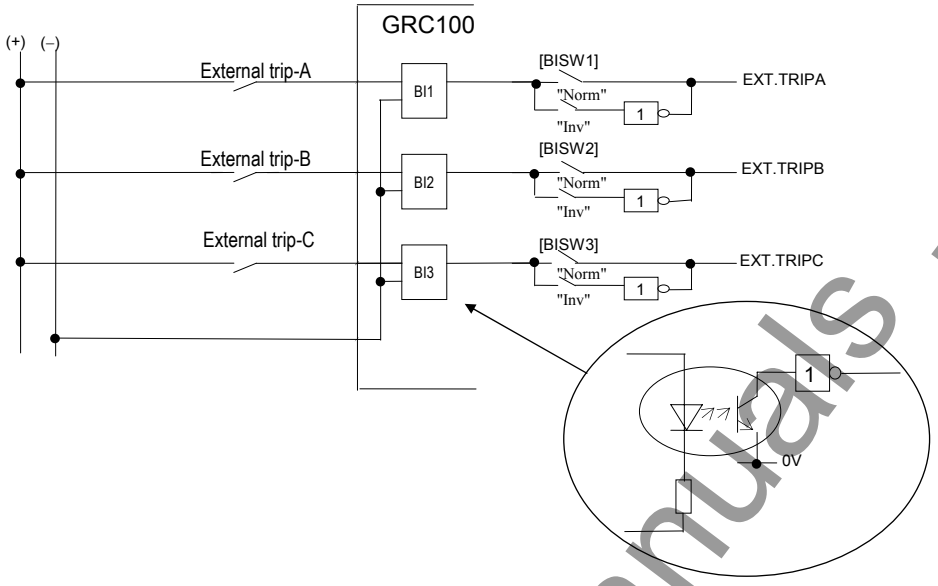


Figure 3.2.1 Logic Level Inversion

3.2.2 Binary Output Signals

The number of binary output signals and their output terminals are as shown in Appendix H. All outputs, except the tripping command and relay failure signal, can be configured.

The signals shown in the signal list in Appendix B can be assigned to the output relay BO1 to BO4 individually or in arbitrary combinations. Signals can be combined using either an AND circuit or OR circuit with 4 gates each as shown in Figure 3.2.2. The output circuit can be configured according to the setting menu. Appendix E 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 the contact when a relay defect or abnormality in the DC power supply circuit is detected.

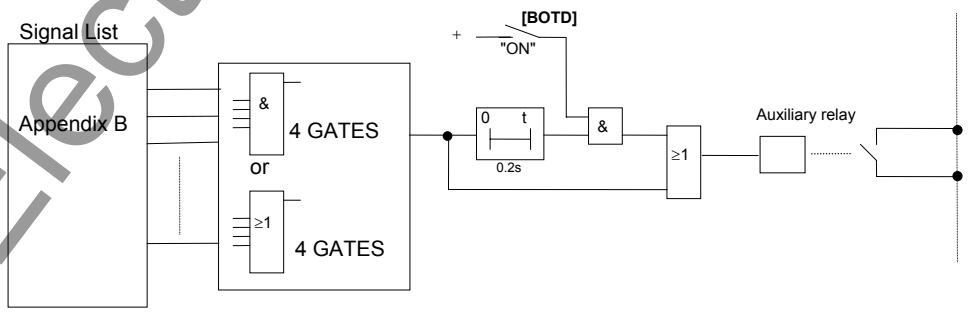


Figure 3.2.2 Configurable Output

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, plays an important role. A numerical relay based on the microprocessor operations is suitable for implementing this automatic supervision function of the protection system. The GRC100 implements the automatic supervision function taking advantage of this feature based on the following concept:

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

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

3.3.2 Relay Monitoring

The relay is supervised with the following items.

AC input imbalance monitoring

The AC current input is monitored to check that the following equation is satisfied and the health of the AC input circuit is checked.

- CT circuit current monitoring

  $\text{Max}(|I_a|, |I_b|, |I_c|) - 4 \times \text{Min}(|I_a|, |I_b|, |I_c|) \geq k_0$

  where,

  $\text{Max}(|I_a|, |I_b|, |I_c|)$ = Maximum amplitude among I_a, I_b and I_c

  $\text{Min}(|I_a|, |I_b|, |I_c|)$ = Minimum amplitude among I_a, I_b and I_c

  k_0 = 20% of rated current

The CT circuit current monitoring allows high sensitivity detection of failures that have occurred in the AC input circuit.

A/D accuracy checking

An analogue reference voltage is input 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 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 the 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 an LCD message, LED indication, external alarm and event recording. Table 3.3.1 summarises the supervision items and alarms.

The LCD messages are shown on the "Auto-supervision" screen which is displayed automatically when a failure is detected or displayed by pressing the VIEW key. The event record messages are shown on the "Event record" screen by opening the "Record" sub-menu.

The alarms are retained until the failure is recovered.

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

When the Watchdog Timer detects that the software is not running normally, LCD display and event recording of the failure may not function normally.

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	(1)	Off	On	(4)	Relay fail
Memory monitoring					
Watchdog Timer	----	Off	On	(4)	----
DC supply monitoring	----	Off	(3)	(4)	Relay fail

(1): Diverse messages are provided as expressed with " Err:---" 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 drop.
(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 is restored when the failure is removed.

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

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

3.3.5 Setting

The setting element necessary for the automatic supervision and its setting range is shown in the table below.

Element	Range	Step	Default	Remarks
SVCNT	ALM&BLK / ALM		ALM&BLK	Alarming and blocking or alarming only

The scheme switch [SVCNT] is set in the "Scheme sw" sub-menu.

3.4 Recording Function

The GRC100 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 GRC100 and the following items are recorded for one fault:

Date and time

Start phase

Trip mode

Power system quantities

Up to the 8 most-recent faults are stored as fault records. If a new fault occurs when 8 faults have been stored, the record of the oldest fault is deleted and the record of the latest fault is then stored.

Date and time occurrence

This is the time at which a tripping command of breaker failure protection has been initiated.

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

Start phase

The phase initiated by a trip signal of the line protection is indicated as an initiation phase.

Trip mode

When the original breaker retrip or the adjacent breakers trip command is output, Retrip or Trip is recorded.

Power system quantities

The phase and residual currents in pre-faults and post-faults are recorded.

- Magnitude of phase current (I_a, I_b, I_c)
- Magnitude of residual current ($3I_0$)

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 and their status change mode to initiate recording.

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	
External trip signal (phase A) input or reset	Ext. trip A	On or Off
External trip signal (phase B) input or reset	Ext. trip B	On or Off
External trip signal (phase C) input or reset	Ext. trip C	On or Off
External trip signal (three-phase) input or reset	Ext. trip OR	On or Off
Retrip command output or reset	Retrip	On or Off
Adjacent breaker trip command output or reset	Trip	On or Off
Relay failed or restored	Relay fail	On or Off
Indication reset input or reset	Ind. reset	On or Off
AC input failed or restored (detected by CT circuit current monitoring)	CT err	On or Off
System setting changed (*)	Sys. change	
Relay setting changed (*)	Rly. change	
Group setting changed (*)	Grp. change	

Note: A change of setting 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

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

Modes	Setting
Not to record the event.	N
To record the event when the status changes to "operate".	O
To record the event when the status changes to "reset".	R
To record the event when the status changes both to "operate" and "reset".	B

For the setting, see the Section 4.2.6.5. The default setting is "B" (=both) for all events except those marked with (*). The events marked with (*) have a default setting of "O" (operate).

3.4.3 Disturbance Recording

Disturbance recording is started when the overcurrent starter element operates or a tripping command is initiated. The records include four analogue signals (I_a, I_b, I_c, $3I_0$), 12 binary signals listed below and the dates and times at which recording started.

- OCBF A	- Retrip A	- Ext. trip A
- OCBF B	- Retrip B	- Ext. trip B
- OCBF C	- Retrip C	- Ext. trip C
- EFBF	- Trip	- Ext. trip OR

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

The 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, the records stored so far are deleted.

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

Recording time	0.1s	0.5s	1.0s	1.5s	2.0s	2.5s	3.0s
50Hz	49	25	15	11	8	7	6
60Hz	40	20	12	9	7	5	5

Settings

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

Element	Range	Step	Default	Remarks
OCP	0.5-250.0 A	0.1 A	5.0 A	Overcurrent detection
	(0.1-50 A	0.1 A	1.0 A) (*)	
EF	0.5-10.0 A	0.1 A	5.0 A	Residual current detection
	(0.1-50.0 A	0.1 A	1.0A	

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

Starting the disturbance recording by a tripping command or the starter element listed above is enabled or disabled by setting the following scheme switches.

Element	Range	Step	Default	Remarks
[Trip]	ON/OFF		ON	Start by tripping command
[OCP]	ON/OFF		ON	Start by OCP operation
[EF]	ON/OFF		OFF	Start by EF operation

3.5 Metering Function

The GRC100 performs continuous measurement of the analogue input quantities. The measurement data shown below is renewed every second and displayed on the LCD of the relay front panel or on the local or remote PC.

- Magnitude of phase current (I_a, I_b, I_c)
- Magnitude of residual current ($3I_0$)

The above system quantities are displayed in values on the primary side or on the secondary side as determined by the setting. To display accurate values, it is necessary to set the CT ratio as well. For the setting method, see "Setting the parameter" in 4.2.6.7.

4. User Interface

4.1 Outline of User Interface

The user can access the relay from the front panel.

Local communication with the relay is also possible using a personal computer (PC) via an RS232C port. Furthermore, remote communication is also possible using RSM (Relay Setting and Monitoring) via an RS485.

This section describes the front panel configuration and the basic configuration of the menu tree of the local human machine communication ports and HMI (Human Machine Interface).

4.1.1 Front Panel

As shown in Figure 3.1.3, the front panel is provided with a liquid crystal display (LCD), light emitting diode (LED), operation keys, VIEW and RESET keys, monitoring jack and RS-232C connector.

LCD

The LCD screen, provided with a 2-line, 16-character display and back-light, provides the user with information such as records, statuses and settings. The LCD screen is normally unlit, but pressing the VIEW key will display the default 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 6 LED displays. The signal labels and LED colors are defined as follows:

Label	Color	Remarks
IN SERVICE	Green	Lit when the relay is in service.
TRIP	Red	Lit when a trip command is issued.
ALARM	Red	Lit when a failure is detected.
TESTING	Red	Lit when automatic monitor function is disabled by the scheme switch [A.M.F] setting.
(LED1)	Red	
(LED2)	Red	

LED1 and LED2 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 operation key is as follows:

① ▼, ▲, ◀, ▶: Used to move between lines displayed on a screen and to enter numerical values and text strings.

② [CANCEL]: Used to cancel entries and return to the upper screen.

③ [END]: Used to end the entering operation, return to the upper screen or turn off the display.

④ [ENTER]: Used to store or establish entries.

[VIEW] and [RESET] keys

Pressing [VIEW] key displays default 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 output to an oscilloscope via a monitoring jack.

RS232C connector

The RS-232C 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 individual interfaces are mounted as communication ports:

- RS232C port
- RS485 port
- IRIG-B port

RS232C port

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

RS485 port

The RS485 port is used to connect between relays and between the relay and the protocol converter G1PR1 to construct a network communication system. (See Figure 4.4.1 in Section 4.4.)

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

IRIG-B port

The IRIG-B port collects serial IRIG-B format data from the external clock to synchronise the relay calendar clock. The IRIG-B port is isolated from the external circuit by using 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.

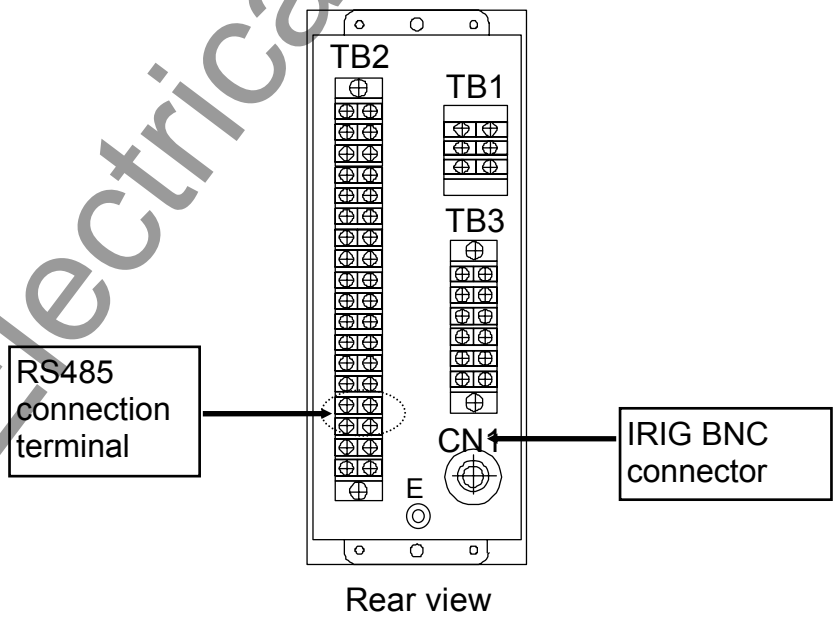


Figure 4.1.1 Locations of RS485 Port and IRIG Port

4.2 Operation of the User Interface

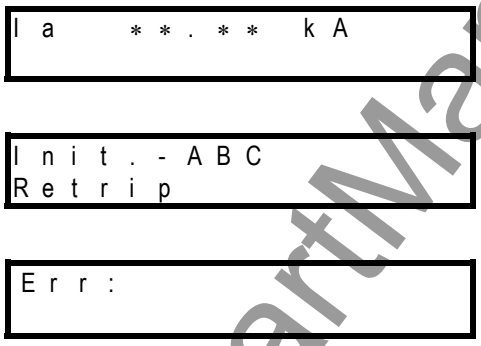
The user can access such functions as recording, measurement, relay setting and testing with the LCD display and operation keys.

4.2.1 LCD and LED Displays

Displays during normal operation

When the GRC100 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 "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 default screens and can be displayed without entering the menu screens.



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 breaker failure 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 default 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.

While any of the menu screens is displayed, the VIEW and RESET keys do not function. To return to the default 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 default 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 default screens in turn including the "Metering" and "Latest fault" screens.

Press the RESET key to turn off the LCD display. 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 default "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 default 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 GRC100. The menu has five sub-menus, "Records", "Status", "Set. (view)", "Set. (change)", and "Test". For details of the menu hierarchy, see Appendix E.

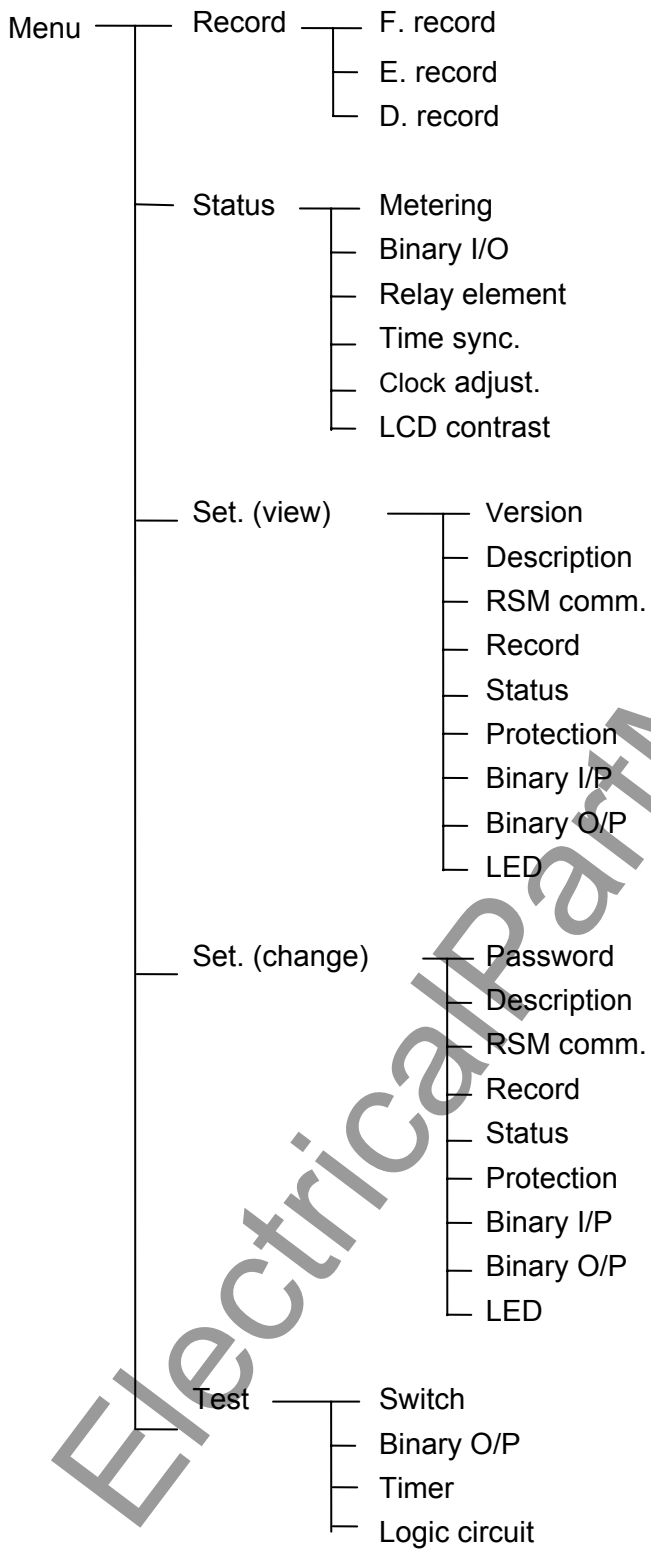


Figure 4.2.1 Relay Menu

Record

In the "Record" menu, the fault record, event record and disturbance records can be 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 synchronisation (IRIG-B or RSM) and adjusts a clock.

Set. (view)

The "Set. (view)" menu displays the relay version, description, relay address in RSM, the current settings of record, status, protection, binary inputs, configurable binary outputs and configurable LEDs.

Set. (change)

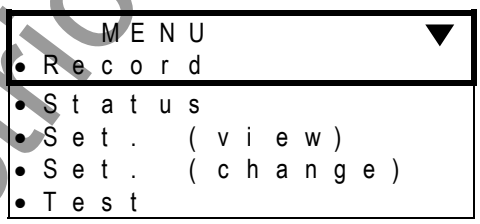
The "Set. (change)" menu is used to change the settings of password, description, relay address in RSM, record, status, protection, binary inputs, configurable binary outputs and configurable LEDs.

Since this is an important menu and is used to 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 timers 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.



To display the "MENU" screen when the default 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. The last item is not displayed for all the screens. "▼" or "▲" displayed on the far right shows that lower or upper lines exist.

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

```
/ 5  Trip                    ▼
• Scheme sw
• Prot. element
```

To return to the higher screen or move from the right side screen to the left side screen in Appendix E, 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 "Record" to display the "Record" sub-menu.

```
/ 1  Record                  ▼
• F. record
• E. record
• D. record
```

- Select "F. record" to display the "Fault record" screen.

```
/ 2  F. record               ▼
• Display
• Clear
```

- Select "Display" to display the dates and times of fault records stored in the relay from the top in new-to-old sequence.

```
/ 3  F. record               ▼

#1  16/Oct/1997
    18:13:57.031
#2  20/Sep/1997
    15:29:22.101
#3  04/Jul/1997
    11:54:53.299
#4  28/Feb/1997
    07:30:18.412
```

- 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  F. record  #1           ▼
```

```
16/Oct/1997
18:13:57.031
Init.-ABC
Retrip
Prefault values
Ia  **.**  kA
Ib  **.**  kA
Ic  **.**  kA
3I0**.**  kA
Fault values
Ia  **.**  kA
Ib  **.**  kA
Ic  **.**  kA
3I0**.**  kA
16/Oct/1997
18:13:57.531
Trip
```

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 "F. record" to display the "Fault record" screen.
- Select "Clear" to display the following confirmation screen.

```
Clear record?
END=Y   CANCEL=N
```

- Press the [END] (= Y) 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 default screens is not displayed.

4.2.3.2 Displaying Event Records

To display event records, do the following:

- Open the top "MENU" screen by pressing any keys other than the [VIEW] and [RESET] keys.
- Select "Record" to display the "Record" sub-menu.
- Select "E. record" to display the "Event record" screen.
- Select "Display" to display the events with date from the top in new-to-old sequence.

```
/3  E.record      ▼

16/Oct/1997
Ext.trip A    Off
16/Oct/1997
Trip          On
16/Oct/1997
Ry. change
```

The time is displayed by pressing the ▶ key.

```
/3  E.record          ▼
18:13:58.255
Ext.trip A      Off
18:13:58.028
Trip            On
18:13:57.773
Rly. change
```

Press the ◀ key to return the screen with date.

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 "E. record" to display the "Event record" screen.
- Select "Clear" to display the following confirmation screen.

```
Clear record?
END=Y    CANCEL=N
```

- Press the [END] (= Y) key to clear all the event records stored in non-volatile memory.

4.2.3.3 Displaying Disturbance Records

Details of disturbance records can be displayed on the PC screen only (*); the LCD displays only the recorded date and time for all disturbances stored in the relay. They are displayed in the following sequence.

(*) 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 "Record" to display the "Record" sub-menu.
- Select "D. record" to display the "Disturbance record" screen.
- Select "Display" to display the date and time of the disturbance records from the top in new-to-old sequence.

```
/3  D.record          ▼
#1  16/Oct/1997
    18:13:57.401
#2  20/Sep/1997
    15:29:22.388
#3  04/Jul/1997
    11:54:53.444
#4  28/Feb/1997
    07:30:18.876
```

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 "D. record" to display the "Disturbance record" screen.
- Select "Clear" to display the following confirmation screen.

```
Clear record?
END=Y    CANCEL=N
```

- Press the [END] (= Y) 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 status condition can be displayed on the LCD:

Metering data of the protected line, apparatus, etc.

Status of binary inputs and outputs

Status of measuring elements output

Status of time synchronization source

The data are updated every second.

This sub-menu is also used to adjust the time of the internal clock.

4.2.4.1 Displaying Metering Data

To display metering data on the LCD, do the following:

- Select "Status" on the top "MENU" screen to display the "Status" screen.

```
/1 Status                ▼
• Metering
• Binary I/O
• Relay element
• Time sync.
• Clock adjust.
• LCD contrast
```

- Select "Metering" to display the "Metering" screen.

```
/2 Metering              ▼
Ia  **.**  kA
Ib  **.**  kA
Ic  **.**  kA
3I0 **.**  kA
```

4.2.4.2 Displaying the Status of Binary Inputs and Outputs

To display the binary input and output status, do the following:

- Select "Status" on the top "MENU" screen to display the "Status" screen.
- Select "Binary I/O" to display the binary input and output status.

```
/2 Binary I/O            ▼
```

```
I P  [ 0 0 0  0 0          ]
O P 1 [ 0 0 0  0           ]
O P 2 [ 0 0 0  0 0         ]
```

The display format is shown below.

	[■	■	■	■	■	■	■	■]
Input (IP)	BI1	BI2	BI3	BI4	BI5	—	—	—
Output (OP1)	TP-1	TP-2	TP-3	TP-4	—	—	—	—
Output (OP2)	BO1	BO2	BO3	BO4	FAIL	—	—	—

Line 1 shows the binary input status. BI1 to BI5 correspond to each binary input signal. For the binary input signal, see Appendix G. The status is expressed with logical level "1" or "0" at the photo-coupler output circuit.

Lines 2 and 3 show the binary output status. TP-1 to TP-4 of line 2 and correspond to the tripping command outputs. FAIL of line 3 corresponds to the relay failure output. Other outputs expressed with BO1 to BO4 are configurable. The status of these outputs is expressed with logical level "1" or "0" at the input circuit of the output relay driver. That is, the output relay is energized when the status is "1".

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

4.2.4.3 Displaying the Status of Measuring Elements

To display the status of measuring elements on the LCD, do the following:

- Select "Status" on the top "MENU" screen to display the "Status" screen.
- Select 3 "Ry element" to display the status of the relay elements.

```
/ 2   R y   e l e m e n t
      [ 0 0 0  0           ]
```

The operation status of phase and residual overcurrent elements are shown as below.

[■ ■ ■ ■ ■ ■ ■ ■]

OCBF, EFBF — A B C — OCBF — EFBF

The status of each element is expressed with logical level "1" or "0". Status "1" means the element is in operation.

4.2.4.4 Displaying the Status of the Time Synchronisation Source

The internal clock of the GRC100 can be synchronised with external clocks such as the IRIG-B time standard signal clock or RSM (relay setting and monitoring system) clock. To display on the LCD whether these clocks are active (=Act.) or inactive (=Inact.) and which clock the relay is synchronised with, do the following:

- Select "Status" on the top "MENU" screen to display the "Status" screen.
- Select "Time sync." to display the status of time synchronisation sources.

```
/ 2   T i m e   s y n c .   ▼
* I R I G :   A c t .
  R S M :     I n a c t .
```

The asterisk on the far left shows that the internal clock is synchronised with the marked source

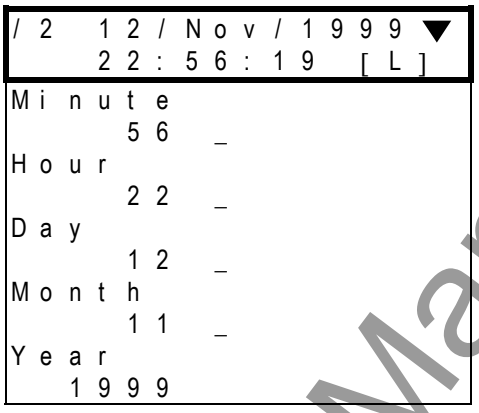
clock. If the marked source clock is inactive, the internal clock runs locally.

For details of the setting time synchronisation, see Section 4.2.6.6.

4.2.4.5 Clock Adjustment

To adjust the clock when the internal clock is running locally, do the following:

- Select "Status" on the top "MENU" screen to display the "Status" screen.
- Select "Clock adjust." to display the setting screen.



Line 1 shows the current date, time and time synchronisation source with which the internal clock is synchronised. The time can be adjusted only when [L] is indicated on the top line, showing that the clock is running locally. When [IRIG] or [RSM] is indicated, the adjustment is invalid.

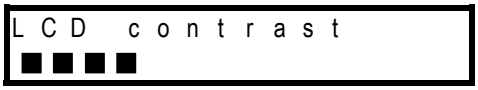
- Enter a numerical value for each item and press the ENTER key. For details to enter a numerical value, see 4.2.6.1.
- Press the END key to adjust the internal clock to the set hours without fractions and return to the previous screen.

If a date which does not exist in the calendar is set and END is pressed, "**** Error ****" is displayed on the top line and the adjustment is discarded. Adjust again.

4.2.4.6 LCD Contrast

To adjust the contrast of LCD screen, do the following:

- Select "Status" on the top "MENU" screen to display the "Status" screen.
- Select "LCD contrast" to display the setting screen.



- Press the ◀ or ▶ key to adjust the contrast. The screen becomes dark by pressing the ◀ key and light by pressing the ▶ key.

4.2.5 Viewing the Settings

The sub-menu "Set. (view)" is used to view the settings made using the sub-menu "Set. (change)".

The following items are displayed:

Relay version

Description

Relay address in the RSM (relay setting and monitoring system)

Recording setting

Status setting

Protection setting

Binary input setting

Binary output setting

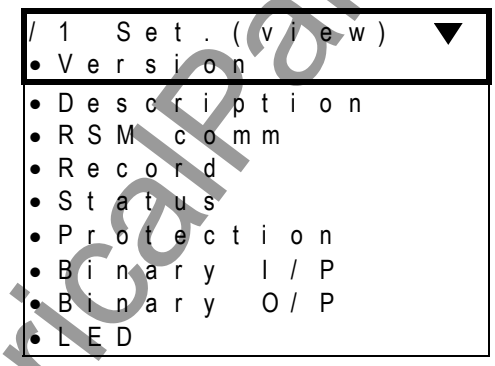
LED setting

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

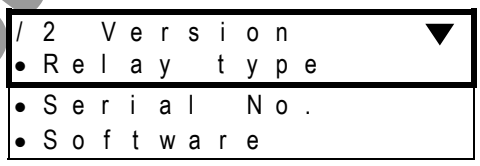
4.2.5.1 Relay Version

To view the relay version, do the following.

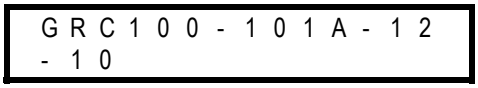
- Press the "Set.(view)" on the main menu.



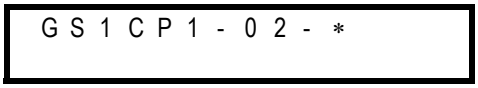
- Press the "Version" on the "Set.(view)" menu.



- Select "Relay type" to display the relay type form and model number



- Select "Serial number" to display the relay manufacturing number.
- Select "Software" to display the relay software type form.



4.2.5.2 Settings

The "Description", "RSM comm.", "Record", "Status", "Protection", "Binary I/P", "Binary O/P" and "LED" screens display the current settings input using the "Set. (change)" sub-menu.

4.2.6 Changing the Settings

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

Password

Description

Relay address in the RSM

Recording

Status

Protection

Binary input

Binary output

LED

All of the above settings except the password can be seen using the "Set. (view)" sub-menu.

4.2.6.1 Setting Method

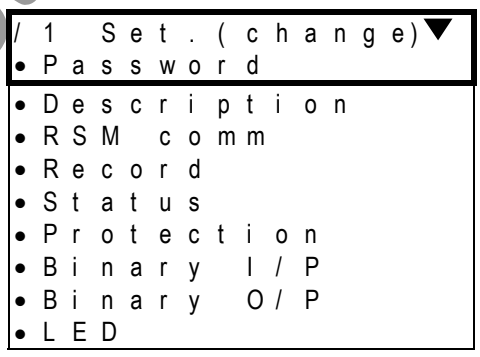
There are three setting methods as follows:

- To enter a selected item
- To enter a text string
- To enter numerical values

To enter a selected item

If a screen as shown below is displayed, perform setting as follows.

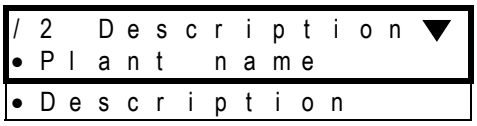
The cursor can be moved to upper or lower lines within the screen by pressing the ▲ and ▼ keys. If setting (change) is not required, skip the line with the ▲ and ▼ keys.



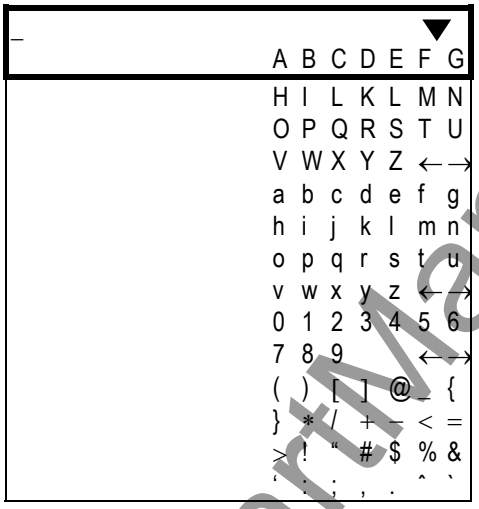
- Move the cursor to a setting item.
- Press the ENTER key.

To enter a text string

Texts strings are entered under "Plant name" or "Description" screen.



To select a character, use keys ▼, ▲, ◀ and ▶ to move blinking cursor down, left, up and right. "→" and "←" on each of lines 4, 8 and 10 indicate a space and backspace, respectively. A maximum of 22 characters can be entered.



- Set the cursor position in the bracket by selecting "→" or "←" and pressing the ENTER key.
- Move the blinking cursor to a selecting character.
- Press the ENTER key 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 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  Prot. element▼

OCBF                  A
     0.5  _
EFBF                  A
     0.5  _
TBF1                 ms
      50  _
TBF2                 ms
      50  _
```

- Move the cursor to a setting line.
- Press the ◀ or ▶ key to set a desired value. The value is up or down by pressing the ▶ or ◀ key.
- Press the [ENTER] key to enter the value.
- 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 correcting 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 screen returns to the upper one.

To complete the setting

Enter after making entries on each setting screen by pressing the [ENTER] key, the new settings are not yet used for operation, though stored in the memory. To validate the new settings, take the following steps.

- Press the [END] key to return to the upper screen. Repeat this until the confirmation screen shown below is displayed. The confirmation screen is displayed just before returning to the "Set. (change)" sub-menu.

```
Change settings?
ENTER=Y  CANCEL=N
```

- 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 "Set. (change)" sub-menu.

4.2.6.2 Password

For the sake of security of setting changes, password protection can be set as follows:

- Select "Set. (change)" on the main "MENU" screen to display the "Setting change" screen.
- Select "Password" to display the "Password" screen.
- Enter a 4-digit number within the brackets after "Input" and press the ENTER key.

```
I n p u t          [ _        ]
0 1 2 3 4 5 6 7 8 9 ←
```

- For confirmation, enter the same 4-digit number in the brackets after "Retype".

```
R e t y p e        [ _        ]
0 1 2 3 4 5 6 7 8 9 ←
```

- 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.

  "Unmatch passwd"

  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 "Set. (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.

```
P a s s w o r d    [ _        ]
0 1 2 3 4 5 6 7 8 9 ←
```

Canceling or changing the password

To cancel the password protection, enter "0000" in the two brackets on the "Password" screen. The "Set. (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.

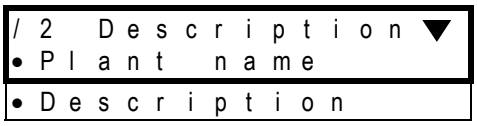
If you forget the password

Press CANCEL and RESET keys together for one second on the top "MENU" screen. The screen goes off, and the password protection of the GRC100 is canceled. Set the password again.

4.2.6.3 Plant Name

To enter the plant name and other data, do the following. These data are attached to records.

- Select "Set. (change)" on the main "MENU" screen to display the " Set. (change)" screen.
- Select "Description" to display the "Description" screen.



- To enter the plant name, select "Plant name" on the "Description" screen.

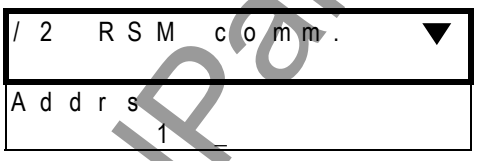
To enter special items, select "Description" on the "Description" screen.

- Enter the text string.

4.2.6.4 Address for RSM

If the relay is linked with RSM (relay setting and monitoring system), the relay address must be set. Do this as follows:

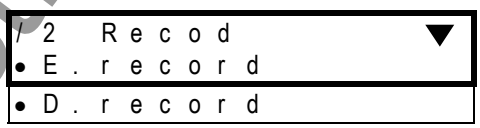
- Select "Set. (change)" on the main "MENU" screen to display the "Set. (change)" screen.
- Select "RSM comm" to display the "RSM comm" screen.
- Enter the address number and press the ENTER key.



4.2.6.5 Setting the Recording

To set the recording function as described in Section 4.2.3, do the following:

- Select "Set. (change)" on the main "MENU" screen to display the "Set. (change)" screen.
- Select "Record" to display the "Record " screen.



Setting the event recording

- Select "E. record" to display the "E. record" screen.

```
/ 3  E. record          ▼

Ext. trip A  1  1 _
N/ O/ R/ B
Ext. trip B  1  1 _
N/ O/ R/ B
Ext. trip C  1  1 _
N/ O/ R/ B
Ext. trip OR 1  1 _
N/ O/ R/ B
Retrip       1  1 _
N/ O/ R/ B
Trip         1  1 _
N/ O/ R/ B
Ind. reset   1  1 _
N/ O/ R/ B
Relay fail   1  1 _
N/ O/ R/ B
CT err       1  1 _
N/ O/ R/ B
Sys. change  1  1 _
N/ O
Rly. change  1  1 _
N/ O
Grp. change  1  1 _
N/ O
```

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

  Enter 0 (= N) not to record the event.
  Enter 1 (= O) to record the event when the status changes to "operate".
  Enter 2 (= R) to record the event when the status changes to "reset".
  Enter 3 (= B) to record the event when the status changes both to "operate" and "reset".

Setting the disturbance recording

- Select "D. record" to display the "D. record" screen.

```
/ 3  D. record          ▼
• Time/ starter
• Scheme sw
```

- Select "Time/starter" to display the "Time/starter" screen.

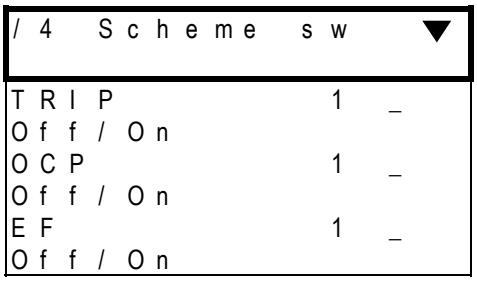
```
/ 4  Time/ starter      ▼

Time              s
    2. 0  _
OCP               A
   10. 0  _
EF                A
   10. 0  _
```

- Enter the recording time and starter element settings.

To set each starter to use or not to use, do the following:

- Select "Scheme sw" on the "D. record" screen to display the "Scheme sw" screen.

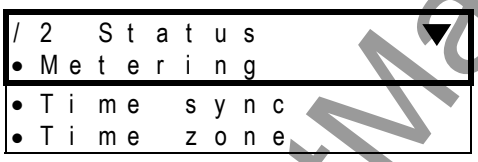


- Enter 1 to use as a starter. If not to be used as a starter, enter 0.

4.2.6.6 Status

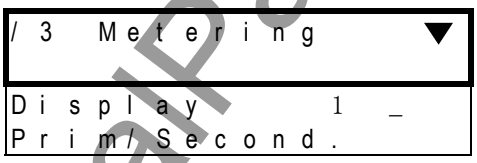
To set the status display described in Section 4.2.4, do the following:

Select "Status" on the "Set. (change)" sub-menu to display the "Status " screen.



Setting the metering

- Select "Metering" to display the "Metering" screen.

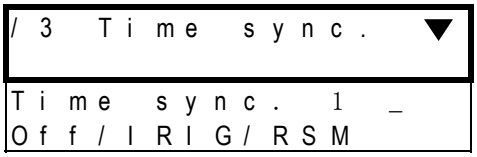


- Enter 0 (=Primary side) or 1 (=Secondary side) and press the ENTER key.

Setting the time synchronisation

The calendar clock can run locally or be synchronised with the external IRIG-B time standard signal or RSM clock. This is selected by setting as follows.

- Select "Time sync" to display the "Time sync" screen.



- Enter 0 or 1 or 2 and press the ENTER key.

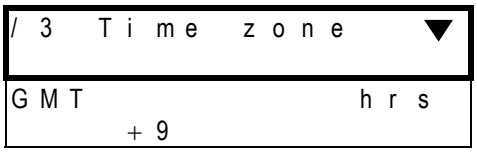
  Enter 0 (=off) not to be synchronised with any external signals.
  Enter 1 (=IRIG) to be synchronised with the external IRIG-B time standard signal.
  Enter 2 (=RSM) to be synchronised with the RSM clock.

  Note: When to select IRIG-B or RSM, check that they are active on the "Status" screen in "Status" sub-menu. If it is set to an inactive IRIG-B or RSM, the calendar clock runs locally.

Setting the time zone

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

- Select "Time zone" to display the "Time zone" screen.

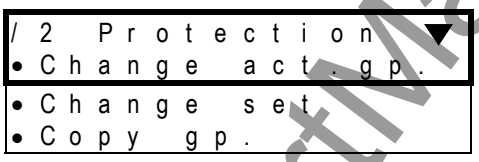


- Enter the difference between GMT and local time and press the ENTER key.

4.2.6.7 Protection

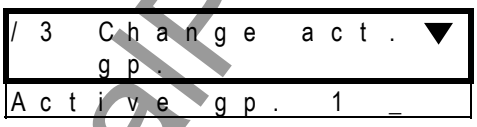
The GRC100 can have 4 setting groups for protection in order to accommodate changes in the operation of the power system, one setting group is assigned active. To set protection, do the following:

- Select "Protection" on the "Set. (change)" screen to display the "Protection" screen.



Changing the active group

- Select "Change act. gp." to display the "Change act gp." screen.

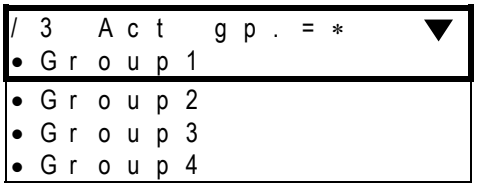


- Enter the group number and press the ENTER key.

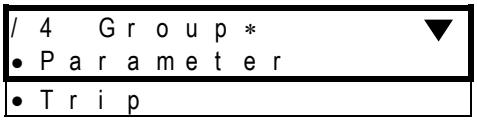
Changing the settings

Almost all the setting items have default values that are set when the product was shipped. For the default values, see Appendix C and H. To change the settings, do the following:

- Select "Change set." to display the "Act gp.= *" screen.



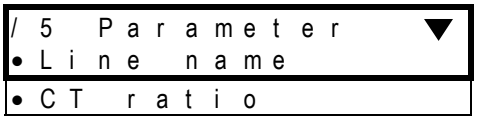
- Select the group number to change the settings and press the ENTER key.



Setting the parameter

Enter the line name and the CT ratio as follows:

- Select "Parameter" on the "Group ∗" screen to display the "Parameter" screen.

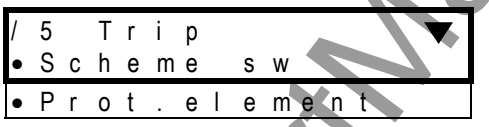


- Select "Line name" to display the "Line name" screen.
- Enter the line name as a text string and press the END key.
- Select "CT ratio" to display the "CT ratio" screen.
- Enter the CT ratio and press the ENTER key.

Setting the trip function

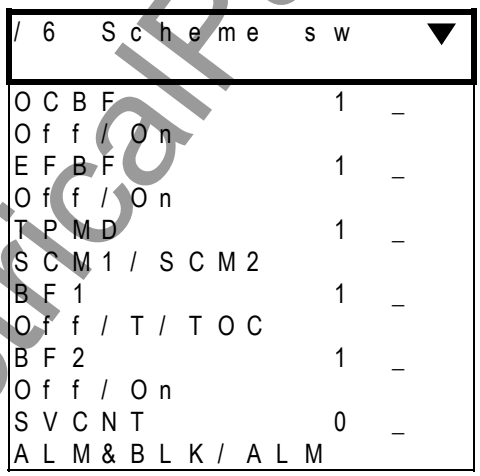
To set the scheme switches and protection elements, do the following.

- Select "Trip" on the "Group ∗" screen to display the "Trip" screen.



Setting the scheme switch

- Select "Scheme sw" to display the "Scheme sw" screen.



<OCBF, EFBF>

- Enter 1 (=On) to use OCBF element and press the ENTER key. If not using the OCBF, enter 0 (=Off) and press the ENTER key.
- Enter 1 (=On) to use EFBF element and press the ENTER key. If not using the EFBF, enter 0 (=Off) and press the ENTER key.

<TPMD>

To set the tripping mode CBF-TRIP(SCM1) or RETRIP(SCM2), do the following.

- Enter 0 (=SCM1) or 1 (=SCM2) and press the ENTER key.

<BF1>

To set the retrip mode (RETRIP), do the following.

- Enter 0 (=Off) not to perform the RETRIP and press the ENTER key.
- Enter 1 (=T) to perform the RETRIP without OCBF control and press the ENTER key.
- Enter 2 (=TOC) to perform the RETRIP with OCBF control and press the ENTER key.

<BF2>

To set the backup trip mode (CBF-TRIP), do the following.

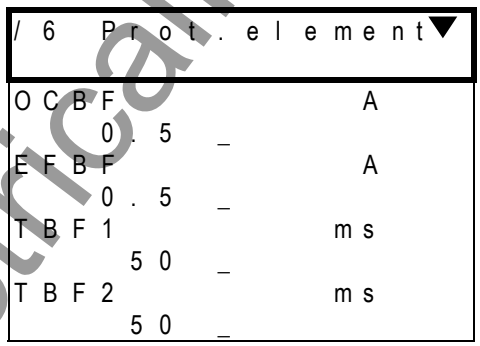
- Enter 0 (=Off) not to perform the CBF-TRIP and press the ENTER key.
- Enter 1 (=On) to perform the CBF-TRIP and press the ENTER key.

<SVCNT>

- Enter 0 (= ALM&BLK) to output an alarm and to block the trip function by the AC input imbalance monitoring.
- Enter 1 (= ALM) to output an alarm only.
- Press the END key to return to the "Trip" screen.

Setting the protection elements

- Select "Prot. element" to display the "Prot.element" screen.



<OCBF, EFBF>

- Enter the numerical value and press the ENTER key.

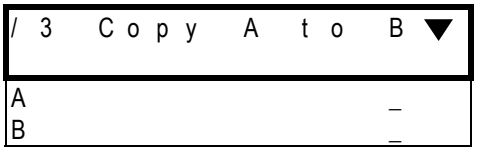
<TBF1, TBF2>

- Enter the numerical value and press the ENTER key.
- After setting, press the END key to return to the "Trip" screen.

Setting group copy

To copy the settings of one group and overwrite them to another group, do the following:

- Select "Copy gp." on the "Protection" screen to display the "Copy A to B" screen.

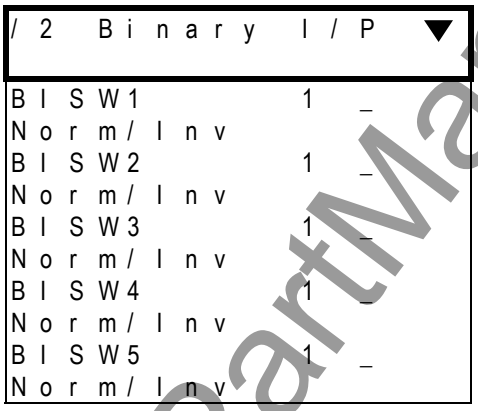


- Enter the group number to be copied in line A and press the ENTER key.
- Enter the group number to be overwritten by the copy in line B and press the ENTER key.

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 requirements described in Table 3.2.2.

- Select "Binary I/P" on the "Set. (change)" sub-menu to display the "Binary I/P" screen.



- Enter 0 (= Norm) or 1 (= Inv) and press the ENTER key.

4.2.6.9 Binary Output

All the binary outputs of the GRC100 except the tripping command, and relay failure signal are user-configurable. It is possible to assign one signal or up to four ANDing or ORing signals to one output relay. Available signals are listed in Appendix B.

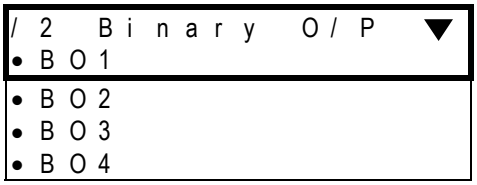
It is also possible to attach delayed drop-off time of 0.2 second to these signals. The delayed drop-off time is disabled by the scheme switch [BOTD].

Appendix C shows the factory default settings.

To configure the binary output signals, do the following:

Selection of output relay

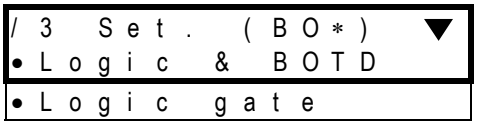
- Select "Binary O/P" on the "Set. (change)" screen to display the "Binary O/P " screen.



Note: The setting is required for all the binary outputs. If any of the binary outputs are not used, enter 0 to logic gates #1 to #4 in assigning signals.

- Select the output relay number (BO number) and press the ENTER key to display the "Set.

(BO∗)" screen.



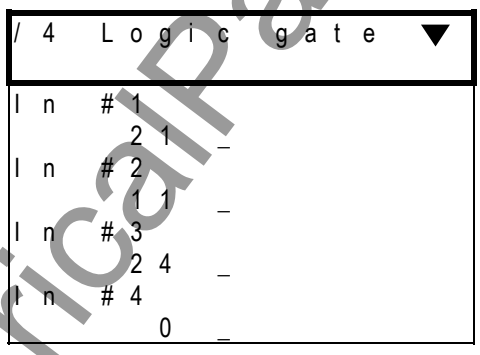
Setting the logic gate type and timer

- Select "Logic & BOTD" to display the "Logic & BOTD" screen.

- Enter 0 (= OR) or 1 (= AND) to use an OR gate or AND gate and press the ENTER key.
- Enter 0 (= Off) or 1 (= On) to add 0.2s delayed drop-off time to the output relay if required and press the ENTER key.
- Press the END key to return to the "Setting" screen.

Assigning signals

- Select "Logic gate" on the "Set. (BO**) " screen to display the "Logic gate" screen.



- Assign signals to gates (In #1 to #4) by entering the number corresponding to each signal referring to Appendix B.

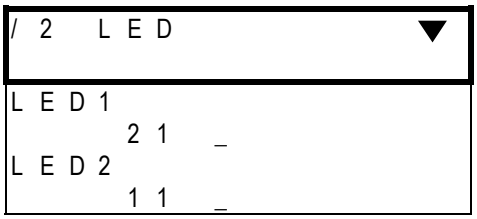
Note: If signals are not assigned to all the gates #1 to #4, enter 0 for the unassigned gate(s).

Repeat this process for the outputs to be configured.

4.2.6.10 LEDs

Two LEDs of the GRC100 are user-configurable. One of the signals listed in Appendix B can be assigned to each LED as follows:

- Select "LED" on the "Set. (change)" screen to display the "LED" screen.



- 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 disabling the automatic monitoring function, forced operation of binary outputs, and logic signal observation.

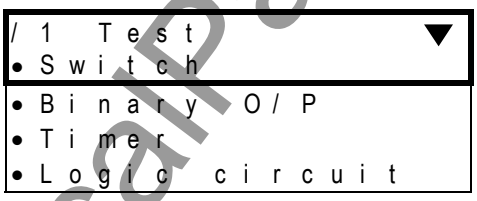
4.2.7.1 Scheme Switch

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

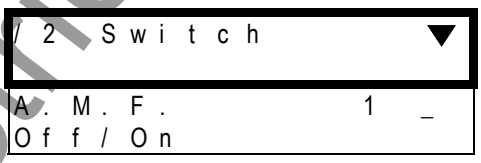
Disabling the A.M.F. inhibits trip blocking even in the event of a failure in the items being monitored by this function. It also prevents failures from being displayed on the "ALARM" LED and LCD described in Section 4.2.1. No events related to A.M.F. are recorded, either.

Disabling A.M.F. is useful for blocking the output of unnecessary alarms during testing.

- Select "Test" on the top "MENU" screen to display the "Test" screen.



- Select "Switch" to display the "Switch" screen.

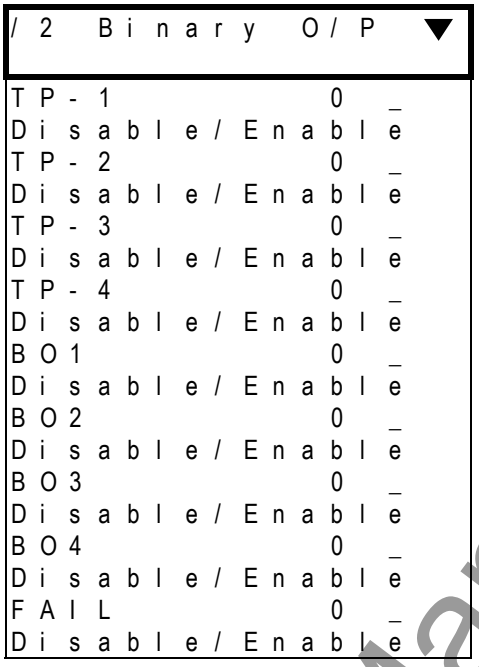


- Enter 0 or 1 to disable the A.M.F. or not and press the [ENTER] key for each switch.
- Press the [END] key to return to the "Test" screen.

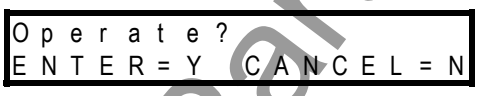
4.2.7.2 Binary Output Relay

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.

- Select "Binary O/P" on the "Test" screen to display the "Binary O/P" screen. Then the LCD displays the name of the output relay.



- Enter 1 (=Enable) and press the [ENTER] key to operate the output relays forcibly.
- After completing the entries, press the [END] key. Then the LCD displays the screen shown below.

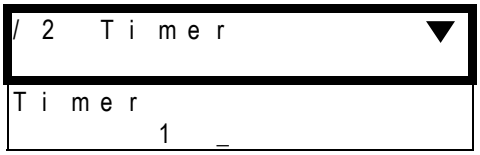


- Keep pressing the [ENTER] key to operate the assigned output relays.
- Release pressing the [ENTER] key to reset the operation.
- Press the [CANCEL] key to return to the upper "Binary output" screen.

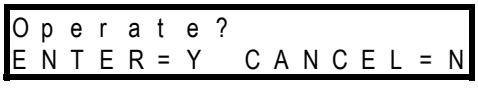
4.2.7.3 Timer

The pick-up 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.

- Select "Timer" on the "Test" screen to display the "Timer" screen.



- Enter the number corresponding to the timer to be observed and press the [ENTER] key. The timers and related numbers are listed in Appendix D.
- Press the [END] key to display the following screen.



- Press the [ENTER] key to operate the timer. The "TESTING" LED turns on, and the timer is

initiated and the following display appears. The input and output signals of the timer can be observed at monitoring jacks A and B respectively. The LEDs above monitoring jacks A or B are also lit if the input or output signal exists.

```
Reset ?
END=Y      CANCEL=N
```

- Press the END key to reset the input signal to the timer. The "TESTING" LED turns off.
- Press the CANCEL key to test the 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.

- Select "Logic circuit" on the "Test" screen to display the "Logic circuit" screen.

```
/ 2  Logic          ▼
     circuit
TermA
        1  _
TermB
       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 RS232C port on the front panel. On the personal computer, the following analysis and display of the fault currents are available in addition to the items available on the LCD screen.

- Display of 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.

Figure 4.4.1 shows the configuration of the RSM system.

The relays are connected through twisted pair wires and up to 32 relays can be connected. The total length of twisted pair wires should not exceed 1200 m.

Relays are mutually connected using an RS485 port and connected to a PC RS232C port via the protocol converter G1PR1.

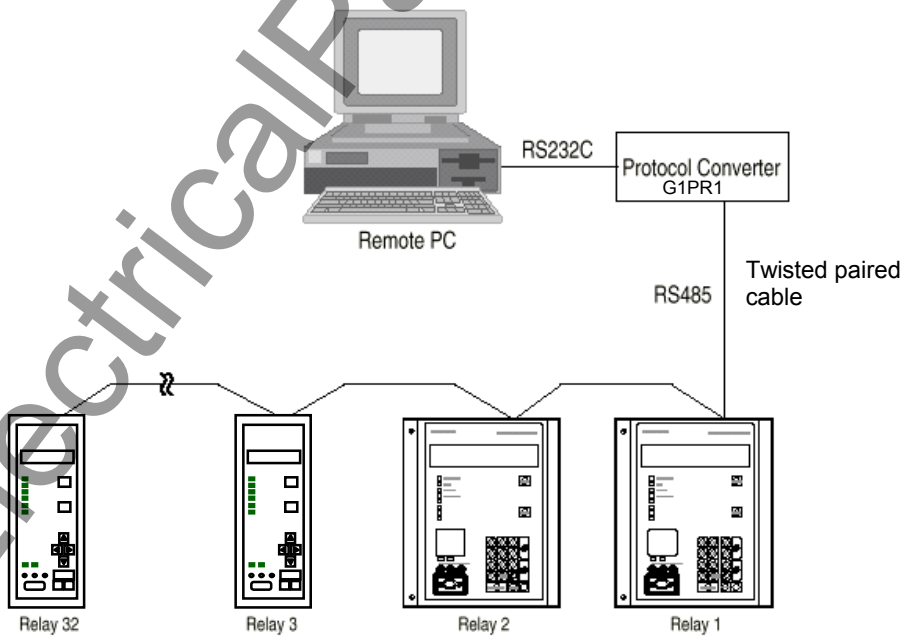


Figure 4.4.1 Relay Setting and Monitoring System

4.5 Clock Function

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

- Event records
- Disturbance records
- Fault records

The calendar clock can run locally or be synchronised with the external IRIG-B time standard signal or RSM clock. This can be selected by setting.

If it is necessary for the synchronisation with the IRIG-B time standard signal, it is possible to transform GMT to the local time by setting.

When the relays are connected with the RSM system as shown in Figure 4.4.1 and selected "RSM" in the time synchronisation setting, the calendar clock of each relay is synchronised with the RSM clock. If the RSM clock is synchronised 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.

Always store the relays in a clean, dry environment.

5.2 Relay Mounting

A flush mounting relay is delivered. Appendix F shows the case outlines.

For details of relay withdrawal and insertion, see Section 6.7.3.

5.3 Electrostatic Discharge

⚠CAUTION

Do not take out the relay unit 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 potentials 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 relay unit unnecessarily.

The relay unit incorporates the highest practicable protection for its semiconductor devices. However, if it becomes necessary to withdraw the relay unit, the precautions should be taken to preserve the high reliability and long life for which the equipment has been designed and manufactured.

⚠CAUTION

- Before removing the relay unit, ensure that you are at the same electrostatic potential as the equipment by touching the case.
- Use the handle to draw out the relay unit. Avoid touching the electronic components, printed circuit board or connectors.
- Do not pass the relay unit to another person without first ensuring you are both at the same electrostatic potential. Shaking hands achieves equipotential.

- Place the relay unit on an anti-static surface, or on a conducting surface which is at the same potential as yourself.
- Do not place the relay unit 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 aforementioned IEC 60747.

5.5 External Connections

External connections for each relay model are shown in Appendix G.

6. Commissioning and Maintenance

6.1 Outline of Commissioning Tests

The GRC100 is fully numerical and the hardware is continuously monitored.

Commissioning tests can be kept to a minimum and need only include hardware tests and the 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.

Measuring elements
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:

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 an earthing terminal.
  Before starting the work, always make sure the relay rack is earthed.
- 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 drawout/insert the relay unit.
- 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.
- If dc power has not been supplied to the relay for two days or more, then it is recommended that all fault records, event records and disturbance records be cleared soon after restoring the power. This is because the back-up RAM may have discharged and may contain uncertain data.
- Be careful that the relay 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.

6.3 Preparations

Test equipment

The following test equipment is required for the commissioning tests.

1 Single-phase current source
1 DC power supply
1 DC voltmeter
1 AC ammeter
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 C 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 current and frequency ratings, and auxiliary DC supply voltage rating.

Local PC

When using a local PC, connect it with the relay via the RS232C port on the front of the relay. RSM100 software is required to run the PC.

For the details, see the separate volume "PC INTERFACE RSM100".

6.4 Hardware Tests

The tests can be performed without external wiring, but a DC power supply and AC current source is 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 will display the "ERR: " screen when the DC voltage is applied.

- Press the [RESET] key for one second or more 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 one second or more and check that remaining five LEDs 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.

Other operation keys

- Press any key 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.

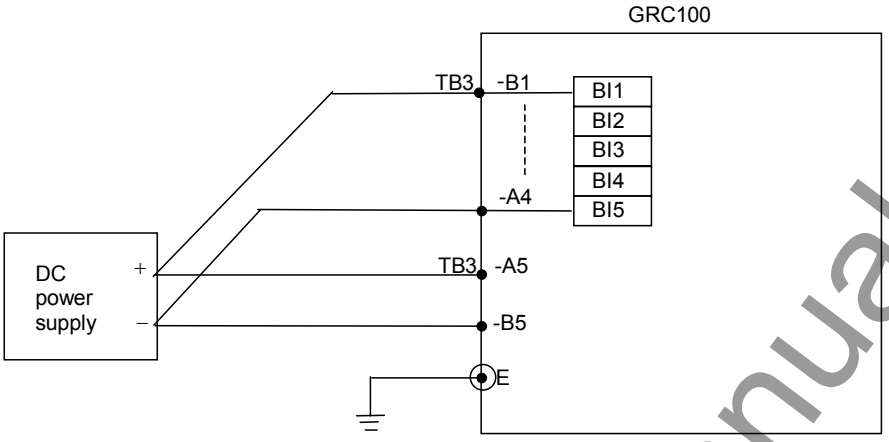


Figure 6.4.1 Testing Binary Input Circuit

- Display the "Binary I/O" screen from the "Status" sub-menu.

```
/ 2  B i n a r y  I / O  ▼
I P  [ 0 0 0  0 0       ]
O P 1 [ 0 0 0  0        ]
O P 2 [ 0 0 0  0 0      ]
```

- Apply the rated DC voltage to terminal B1, A2, ..., B3 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.

- Select "Binary O/P" on the "Test" screen to display the "Binary O/P" screen. The LCD displays the name of the output relay.

```
/ 2  B i n a r y  O / P  ▼

T P - 1              0  _
D i s a b l e / E n a b l e
T P - 2              0  _
D i s a b l e / E n a b l e
T P - 3              0  _
D i s a b l e / E n a b l e
T P - 4              0  _
D i s a b l e / E n a b l e
B O 1                0  _
```

- Enter 1 and press the [ENTER] key.
- After completing the entries, press the [END] key. The LCD will display the screen shown below. If 1 is entered for all the output relays, the following forcible operation can be performed collectively.

```
Operate?
ENTER=Y  CANCEL=N
```

- Keep pressing the [ENTER] key to operate the output relays forcibly.
- Check that the output contacts operate at the terminal.
- Stop pressing the [ENTER] key to reset the operation

6.4.4 AC Input Circuits

This test can be performed by applying the checking currents to the AC input circuits and verifying that the values applied coincide with the values displayed on the LCD screen.

The testing circuit is shown in Figure 6.4.2. A single-phase current source is required.

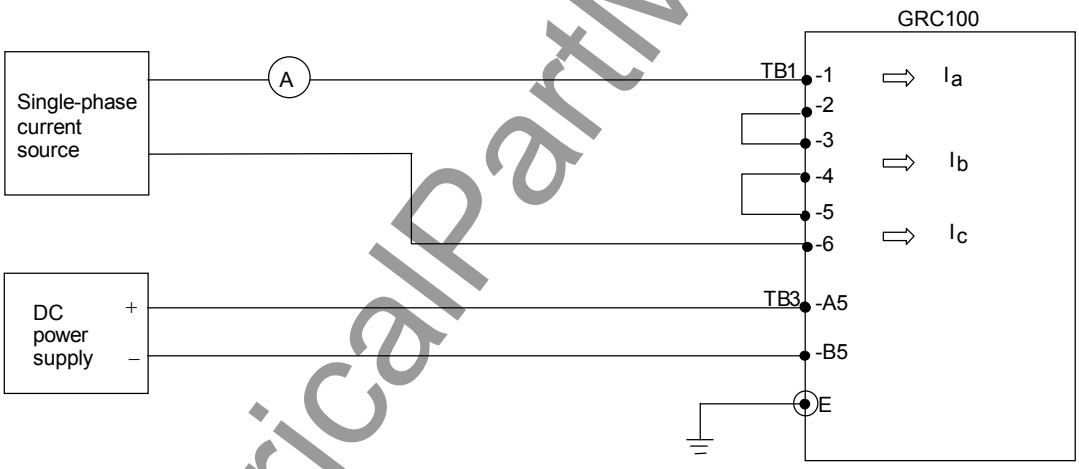


Figure 6.4.2 Testing AC Input Circuit

To check the metering data on the "Metering" screen, do the followings.

"Set. (view)" sub-menu → "Status" screen → "Metering" screen

If the setting is 0 (= Primary), change the setting to 1 (Secondary) in the "Set. (change)" sub-menu.

"Set. (change)" sub-menu → "Status" screen → "Metering" screen

Remember to reset it to the initial setting after the test is finished.

- Open the "Metering" screen in the "Status" sub-menu.

  "Status" sub-menu → "Metering" screen

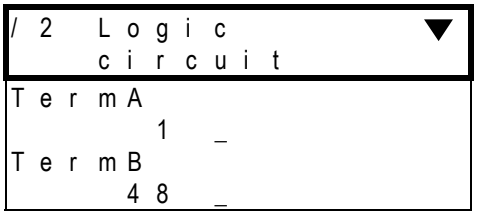
- Apply AC currents and check that the displayed values are within ±5% of the input values.

6.5 Function Test

6.5.1 Measuring Element

Measuring element characteristics are realised by software, so it is possible to verify the overall characteristics by checking representative points.

Operation of the element under test is observed by the binary output signal at monitoring jacks A or B or by the LED indications above the jacks. In any case, the signal number corresponding to each element output must be set on the "Logic circuit" screen of the "Test" sub-menu.



When a signal number is entered for the Term A line, the signal is observed at monitoring jack A and when entered for the Term B line, it is observed at monitoring jack B.

Note: The voltage level at the monitoring jacks is +5V for logic level "1" and less than 0.1V for logic level "0".

CAUTION

- Use test equipment with more than 1 kΩ of internal impedance when observing the output signal at the monitoring jacks.
- Do not apply an external voltage to the monitoring jacks.
- Do not leave the A or B terminal shorted to 0V terminal for a long time.

In case of a three-phase element, it is sufficient to test for a representative phase. The A-phase element is selected hereafter.

6.5.1.1 Overcurrent element OCBF, EFBF

The overcurrent element is checked on the operating current value.

Figure 6.5.1 shows a testing circuit. The minimum operating current value is checked by increasing the magnitude of the current applied.

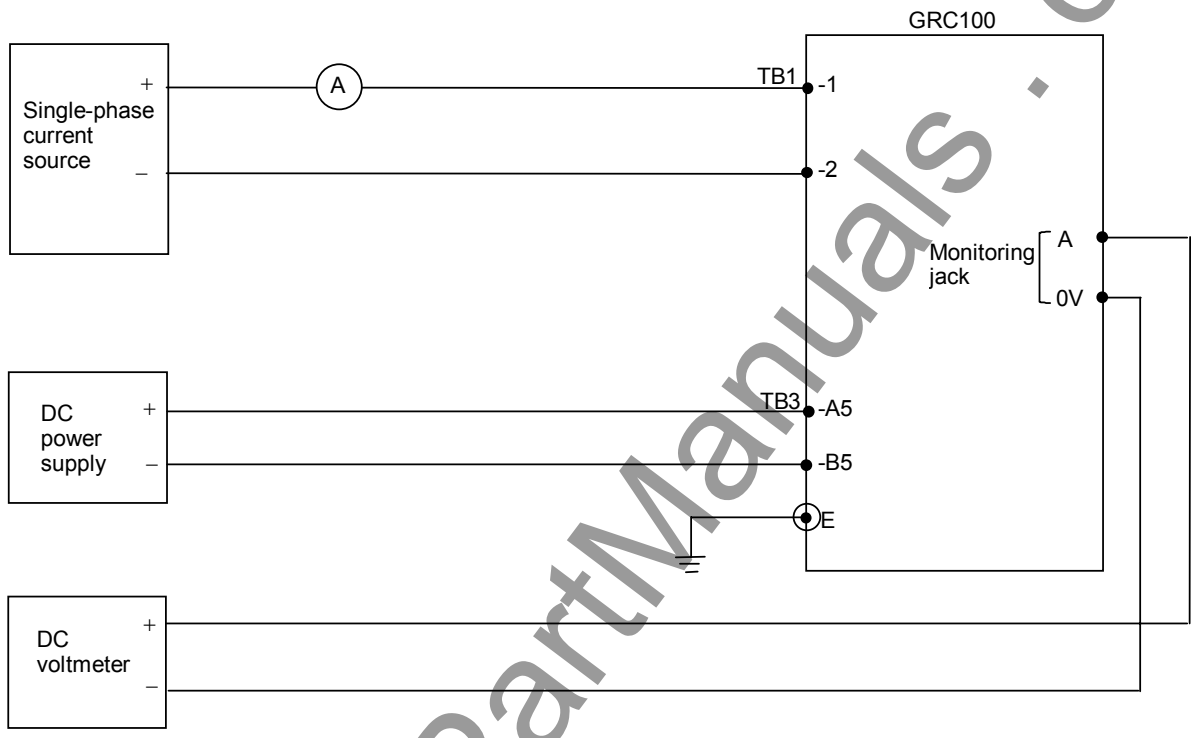


Figure 6.5.1 Operating Current Value Test Circuit

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

Element	Signal number	Remarks
OCBF-A	11	
OCBF-B	12	
OCBF-C	13	
EFBF	14	

- Select "Logic circuit" on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter signal number 11 to observe the OCBF-A operation 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 setting value.

The EFB element is tested with the same steps as mentioned above.

6.5.2 Timer

The pick-up delay time of the variable timer can be measured by connecting the monitoring jacks A and B to a time counter as shown in Figure 6.5.2. Jacks A and B are used to observe the input signal and output signal of the timer, respectively.

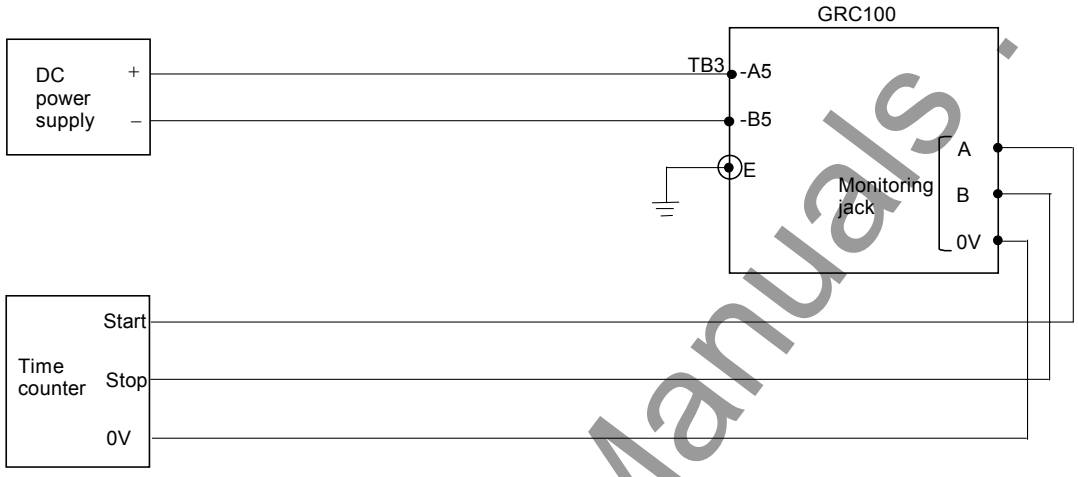
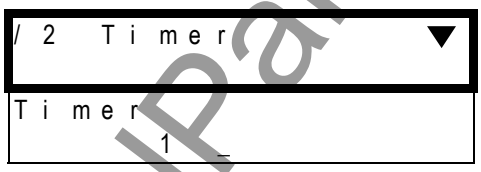
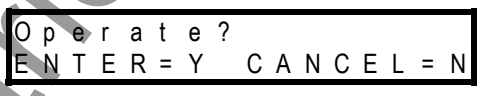


Figure 6.5.2 Testing Variable Timer

- Select the "Timer" on the "Test" screen to display the "Timer" screen.



- Enter the number corresponding to the timer to be observed. The timers and assigned numbers are listed in Appendix C.
- Press the END key to display the following screen.



- Press the ENTER key to operate the time. The "TESTIMG" LED turns on, and the timer is initiated and the following display appears. Check that the measured time is within ± 10ms of the setting time.

- Press the END key to reset the input signal to the timer. The "TESTIMG" LED turns off.
- Press the CANCEL key to test the 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 TP-1 to -4.

- Set the scheme switch [BF1] to "T" or "TOC", [BF2] to "ON" and [TPMD] to "SCM2".
- Apply a fault, retain it and input an external trip signal. Check that the retrip output relays TP-1 to TP-3 operate after the time setting of the TBF1 and the adjacent breaker tripping output relay TP-4 operates after the time setting of the TBF2.

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 fault concerned.

Recording events are listed in Table 3.4.1. The top 4 events and eighth event are external events and others are internal events. Event recording on the external event 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 current transformers and the load current with the metering displays on the LCD screen.

- Open the "Auto-supervision" screen check that no message appears.
- Open the following "Metering" screen from the "Status" sub-menu to check the load current.

```
/ 2   M e t e r i n g        ▼
I a   * * . * *   k A
I b   * * . * *   k A
I c   * * . * *   k A
3 I 0 * * . * *   k A
```

Note: The magnitude of 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.)

6.6.2 Tripping Circuit Test

The tripping circuit including the circuit breaker is checked by forcibly operating the output relay and monitoring the circuit breaker to confirm that it 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.
- Select "Binary O/P" on the "Test" sub-menu screen to display the "Binary O/P" screen.

TP-1 to -4 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.

```
O p e r a t e ?
E N T E R = Y   C A N C E L = N
```

- Keep pressing the [ENTER] key to operate the output relay TP-1 and check that the A-phase breaker is tripped.
- Stop pressing the [ENTER] key to reset the operation.
- Repeat the above for TP-2 to -4.

6.7 Maintenance

6.7.1 Regular Testing

The relay is almost completely self-supervised. The circuits that can not be supervised are binary input and output circuits and human interfaces.

Therefore, regular testing is minimised 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 relay 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 "Err: " screen on the LCD. Table 6.7.1 shows LCD messages and failure locations.

The locations marked with (1) have a higher probability than locations marked with (2).

Table 6.7.1 LCD Message and Failure Location

Message	Failure location	
	Relay Unit	AC cable
Err: Sum	×(Flash memory)	
Err: MEM	×(ROM or RAM)	
Err: RAM	×(RAM)	
Err: BRAM	×(Backup RAM)	
Err: ROM	×(EEPROM)	
Err: A/D	×(A/D converter)	
Err: SP	×(Sampling signal circuit)	
Err: DI	×(Binary input circuit)	
Err: DO	×(Binary output drive circuit)	
Err: LCD	×(LCD circuit)	
Err: CT	× (AC input circuit)(1)	× (2)

( ): Probable failure location in the relay unit including its peripheral circuits.

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. If the "ALARM" LED is off, the failure is in the DC power supply circuit. If the LED is lit, the failure is in the microprocessors. Replace the relay unit in both cases after checking if the correct DC voltage is applied to the relay.

If a failure is detected by automatic supervision or regular testing, replace the failed relay unit.

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 is applied.
- Correct AC inputs are applied.
- Test procedures comply with those stated in the manual.

6.7.3 Replacing Failed Relay Unit

If the failure is identified to be in the relay unit and the user has a spare relay unit, the user can recover the protection by replacing the failed relay unit.

Repair at the site should be limited to relay unit replacement. Maintenance at the component level is not recommended.

Check that the replacement relay unit has an identical Model Number and relay version (software type form) as the removed relay.

The Model Number is indicated on the front of the relay. For the relay version, see Section 4.2.5.1.

Replacing the relay unit

CAUTION After replacing the relay unit, check the settings.

The procedure of relay withdrawal and insertion 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 about 30 seconds for the voltage to discharge.

- Disconnect the trip outputs.
- Short-circuit all AC current inputs.
- Unscrew the relay front cover.
- Unscrew the binding screw on the handle.
- To remove the relay unit from its case, pull up the handle and pull the handle towards you. (See Figure 6.7.1.)
- Insert the (spare) relay unit in the reverse procedure.

CAUTION To avoid risk of damage:
- Keep the handle up when inserting the relay unit into the case.
- Do not catch the handle when carrying the relay unit.

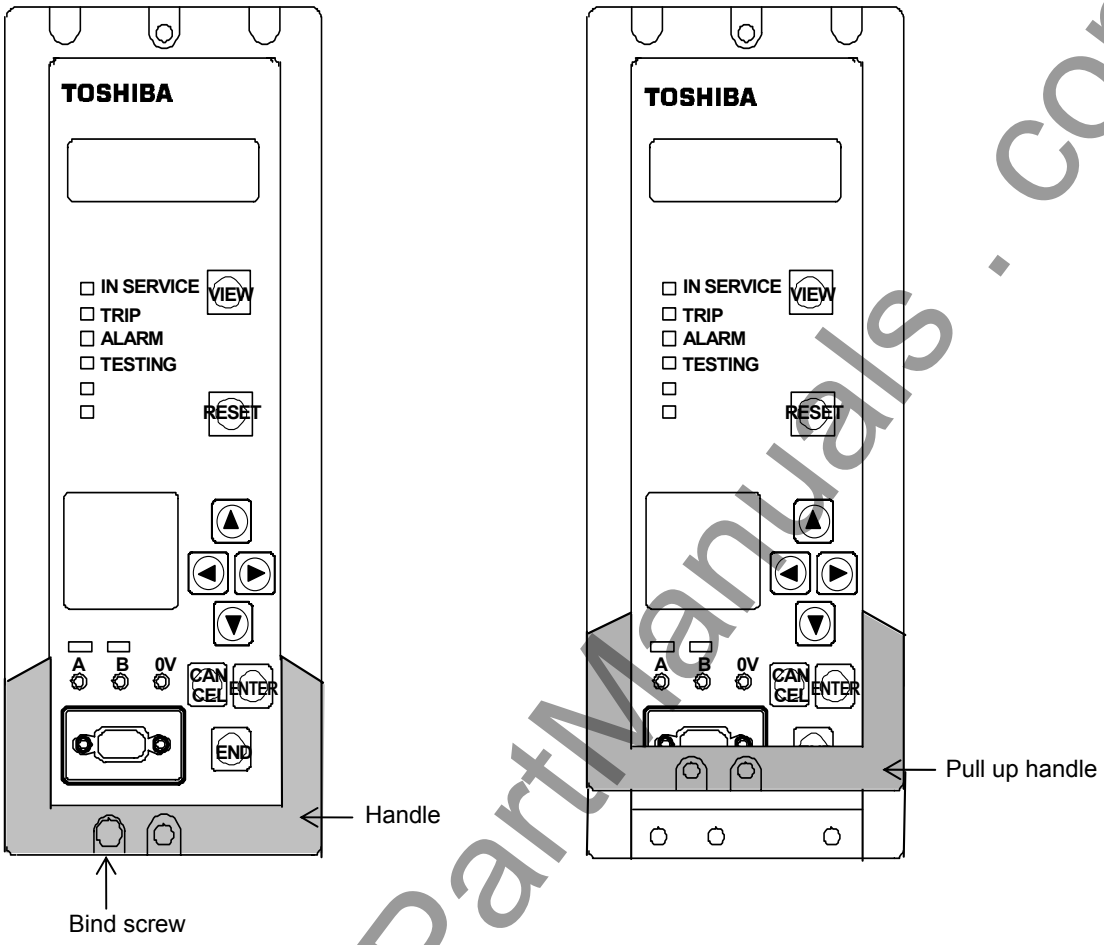


Figure 6.7.1 Handle of Relay Unit

6.7.4 Resumption of Service

After replacing the failed relay unit or repairing failed external circuits, take the following procedures to restore the relay to 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.
- Supply the AC inputs and reconnect the trip outputs.

6.7.5 Storage

The spare relay 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 the commissioning tests or maintenance tests.

- Check that all the external connections are correct.
- Check the settings of all measuring elements, timers, scheme switches, recordings and clock are correct.

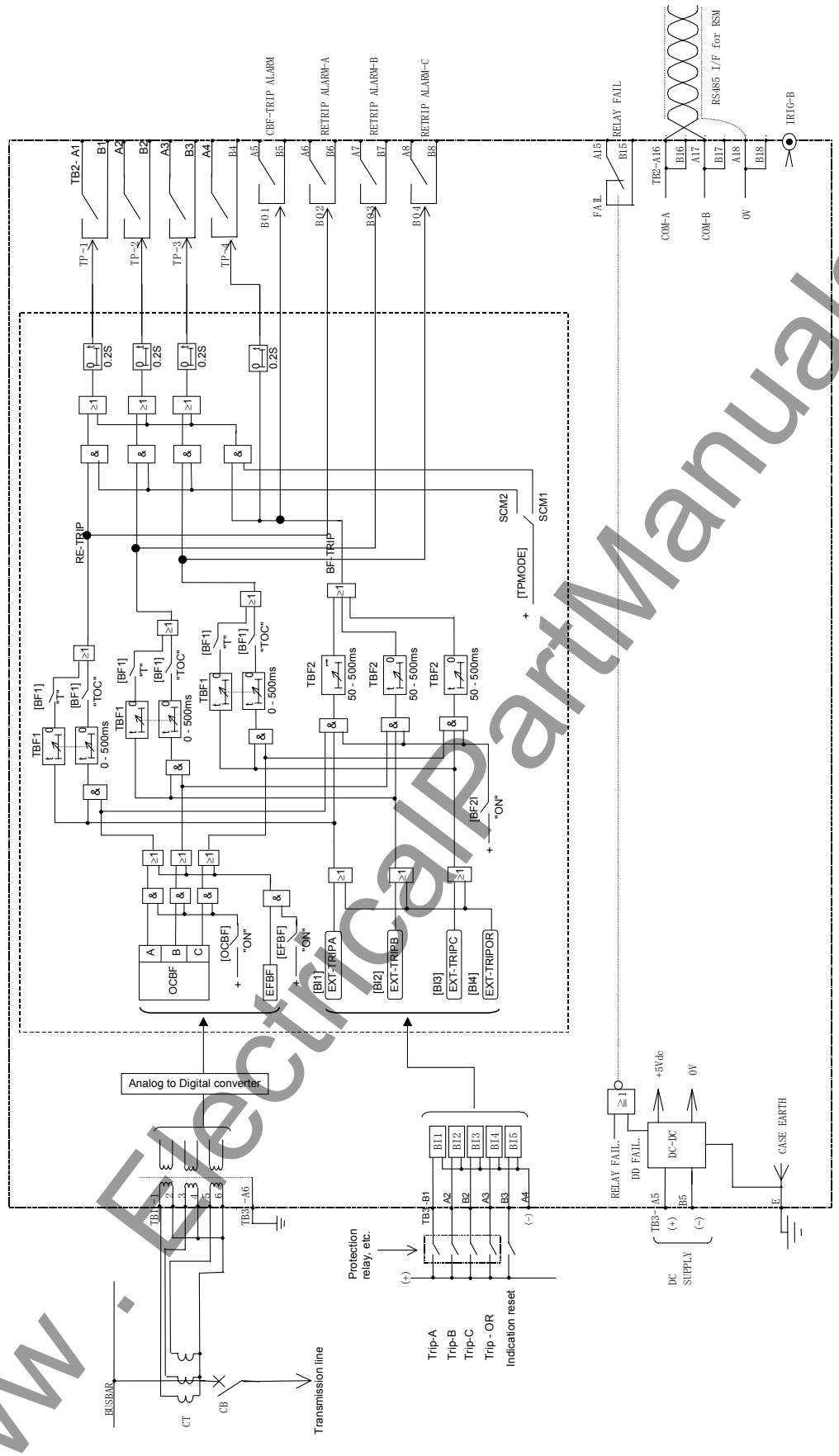
  In particular, when settings are changed temporarily for testing, be sure to restore them.
- Clear any unnecessary records on faults, events and disturbances which are recorded during the tests.

  CAUTION:

  If dc power has not been supplied to the relay for two days or more, then it is recommended that all fault records, event records and disturbance records be cleared soon after restoring the power. This is because the back-up RAM may have discharged and may contain uncertain data.
- 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

Appendix B

Signal List

No.	Signal Name	Contents
0	Zero Level	"0" (Zero logic)
1	EXT. TRIP A	External trip A
2	EXT. TRIP B	External trip B
3	EXT. TRIP C	External trip C
4	EXT. TRIP OR	External trip OR
5	IND. RESET	Indication reset
6		
7		
8		
9		
10		
11	OCBF-A	A-phase overcurrent element output
12	OCBF-B	B-phase overcurrent element output
13	OCBF-C	C-phase overcurrent element output
14	EFBF	Residual overcurrent element output
15		
16		
17		
18		
19		
20		
21	RETRIP A	A-phase retrip
22	RETRIP B	B-phase retrip
23	RETRIP C	C-phase retrip
24	CBF-TRIP	Adjacent breakers trip
25	TRIP-1	TP-1 operation
26	TRIP-2	TP-2 operation
27	TRIP-3	TP-3 operation
28	TRIP-4	TP-4 operation
29	TRIP	TP-1 + TP-2 + TP-3 + TP-4
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41	TRIP-H	Trip signal (holded)
42		
43		
44		
45		
46		
47		
48		
49		
50	A.M.F. OFF	Monitoring off
51	FAULT RECORD INIT	Fault record trigger
52		
53	EXT. TRIP A	Fault record data
54	EXT. TRIP B	ditto
55	EXT. TRIP C	ditto
56		

Appendix C

Binary Output Default Setting List

Relay Model	BO No.	Terminal No.	Signal Name	Contents	Setting		
					Signal No.	Logic (OR:0, AND:1)	Timer (OFF:0, ON:1)
		TB2:					
GRC100	BO1	A5-B5	CBF-TRIP	Adjacent breaker trip	24	0	1
	BO2	A6-B6	RETRIP A	A-phase retrip	21	0	1
	BO3	A7-B7	RETRIP B	B-phase retrip	22	0	1
	BO4	A8-B8	RETRIP C	C-phase retrip	23	0	1

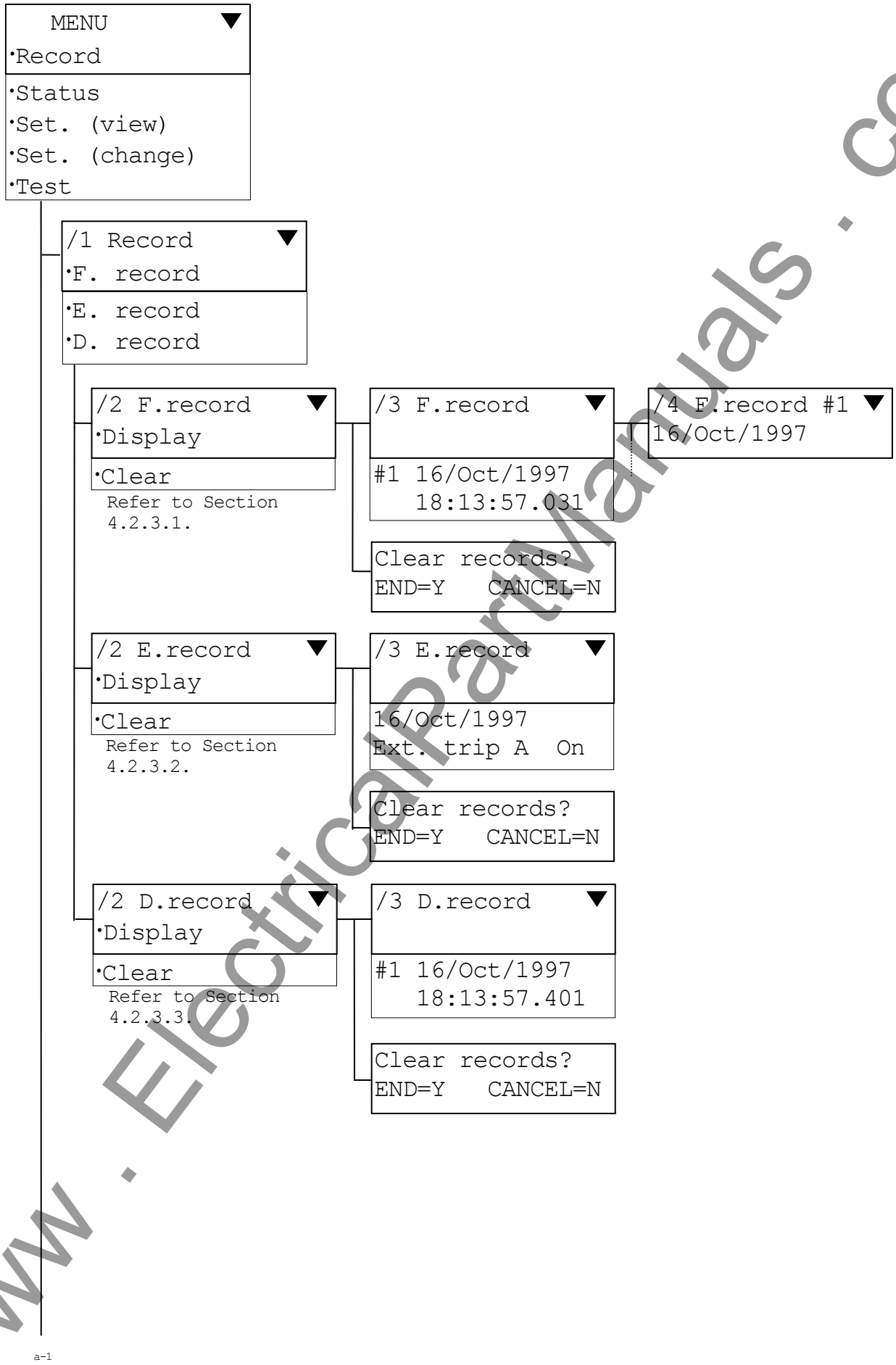
Appendix C

Variable Timer List

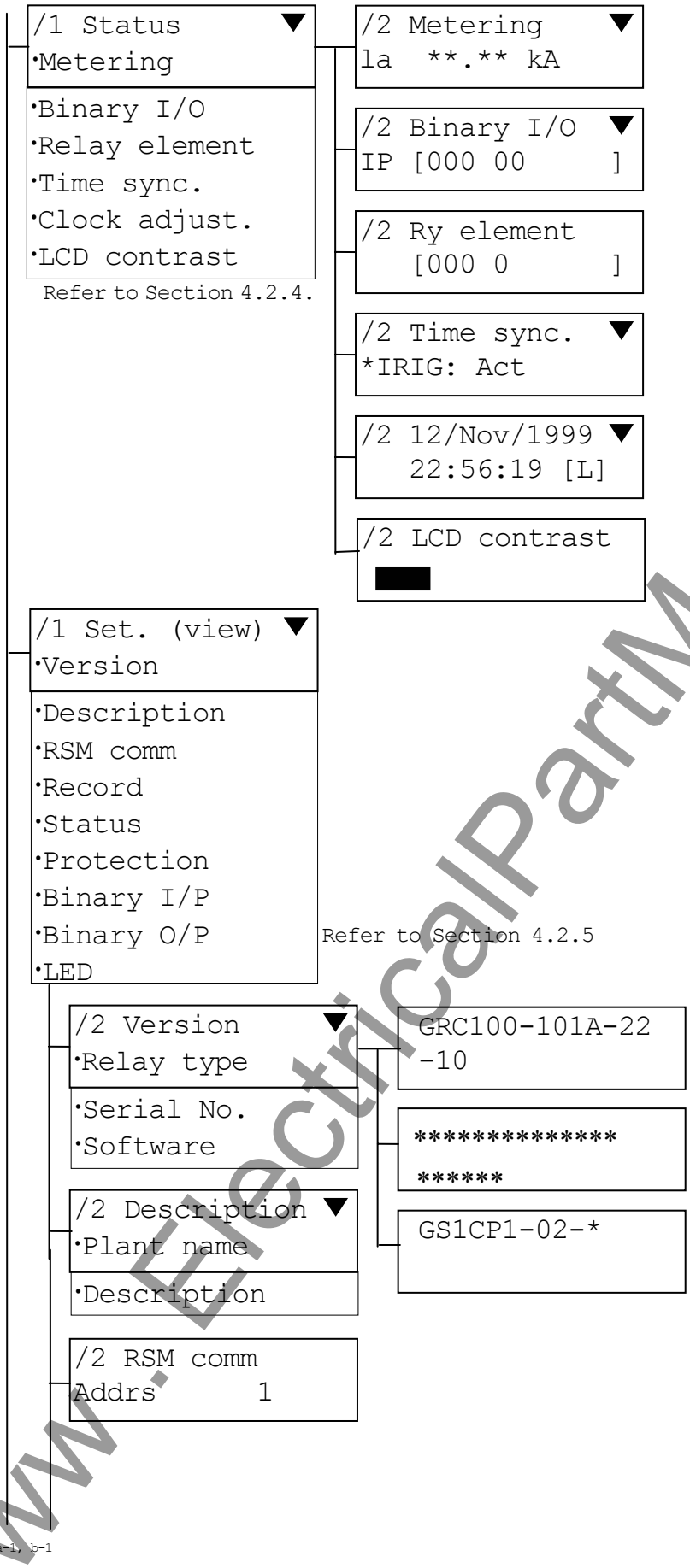
Timer	Timer No.	Contents
TBF1A	1	Original breaker retrip timer
TBF1B	2	ditto
TBF1C	3	ditto
TBF2A	4	Adjacent breakers trip timer
TBF2B	5	ditto
TBF2C	6	ditto

Appendix E

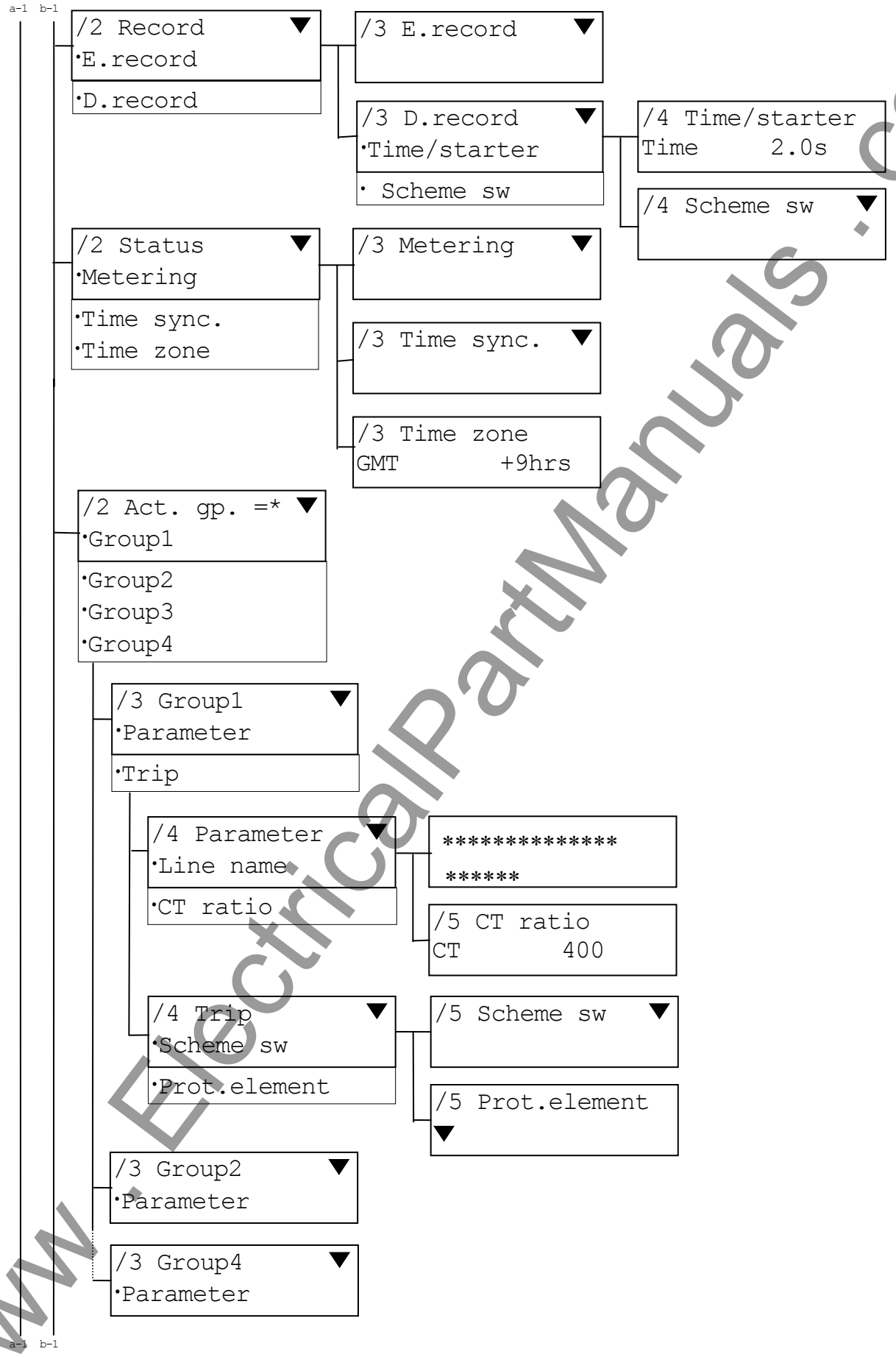
Details of Relay Menu

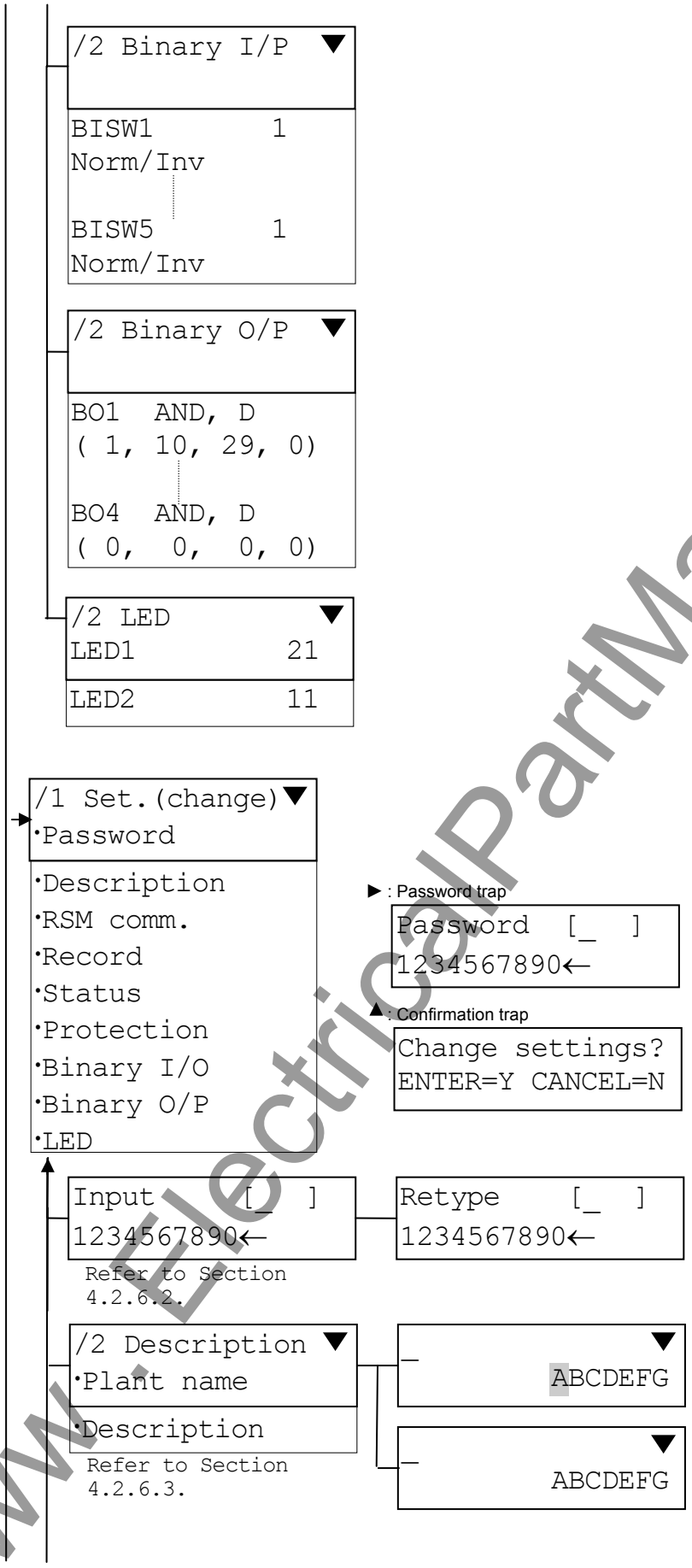


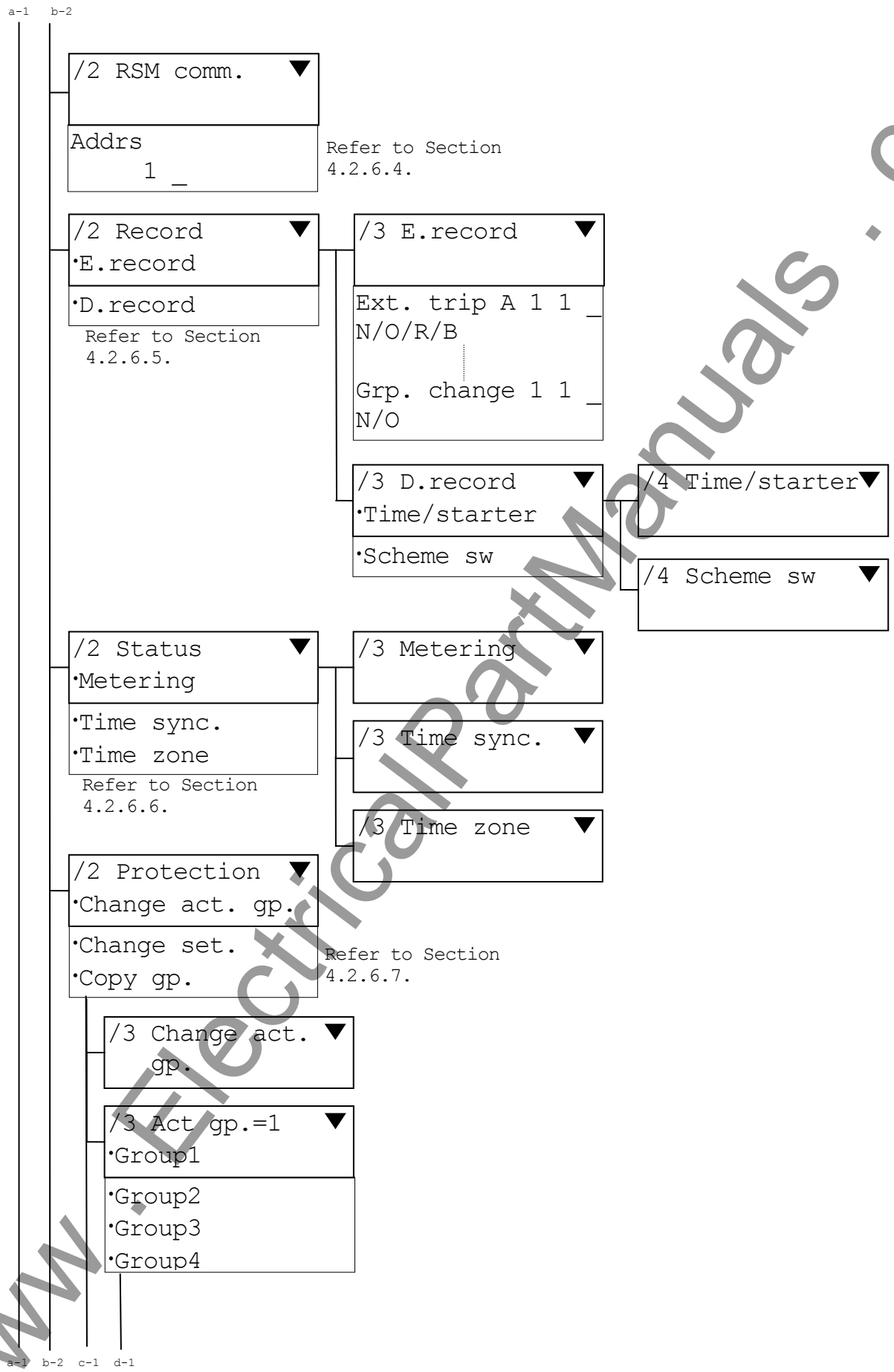
a-1

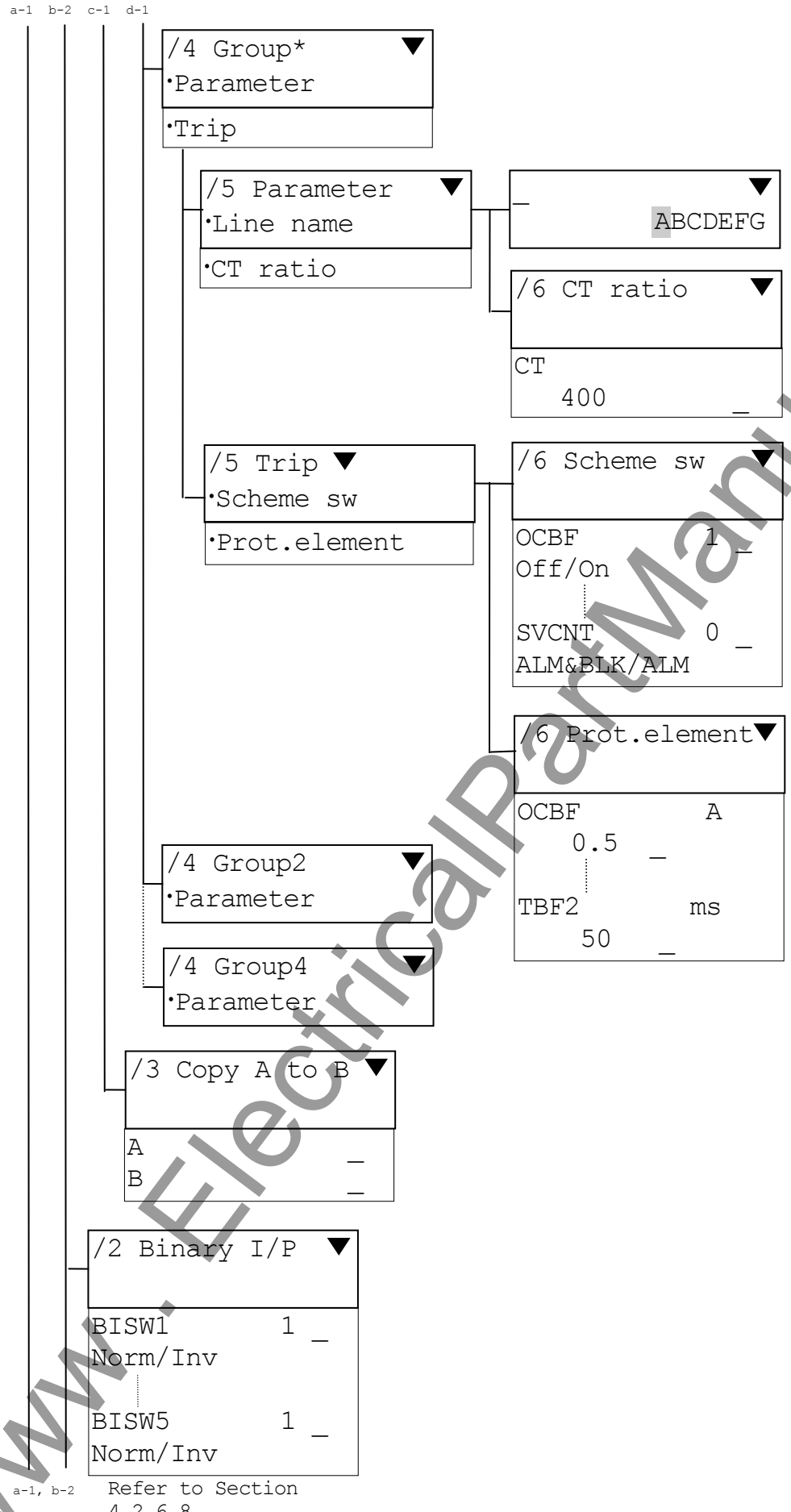


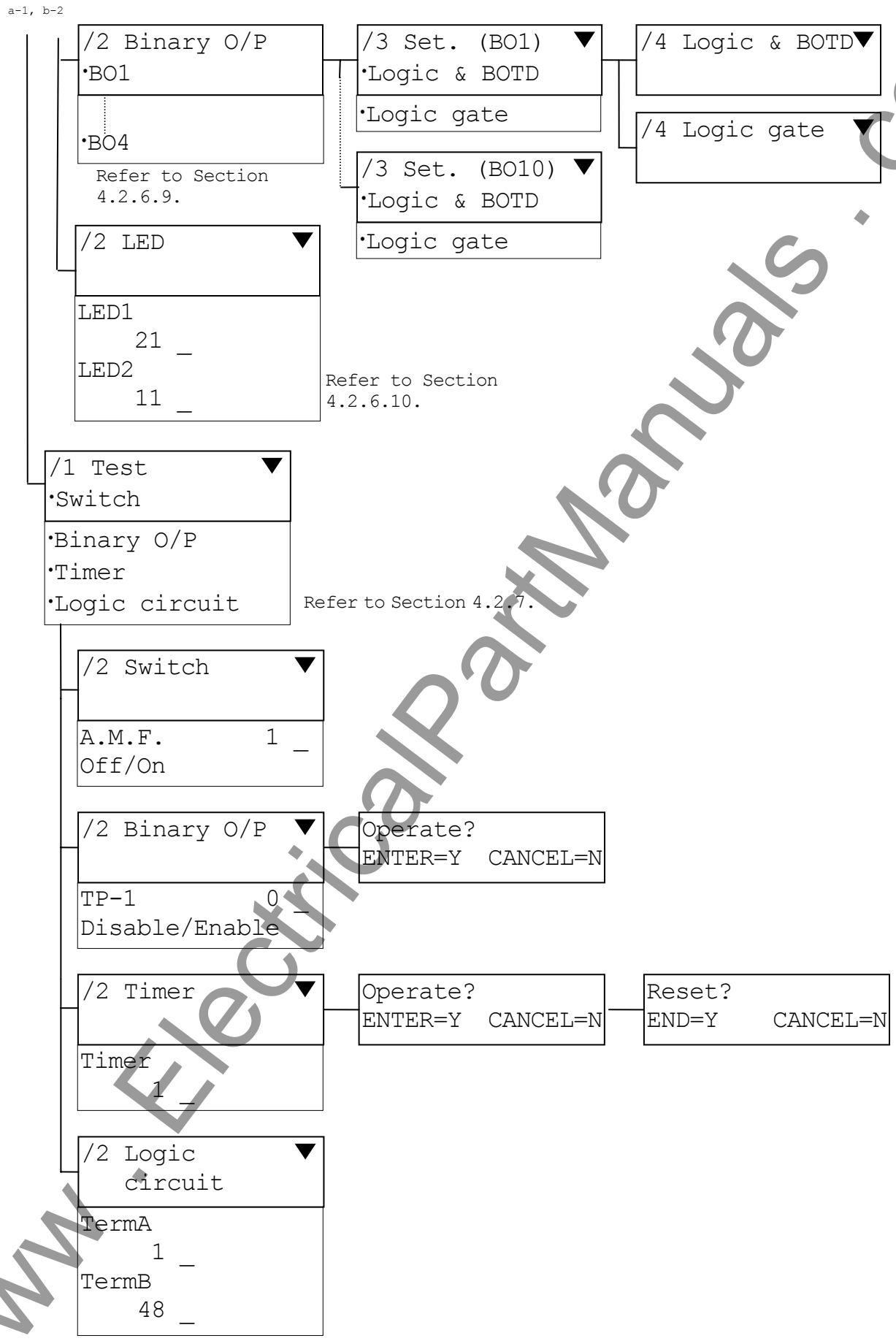
a-1, b-1





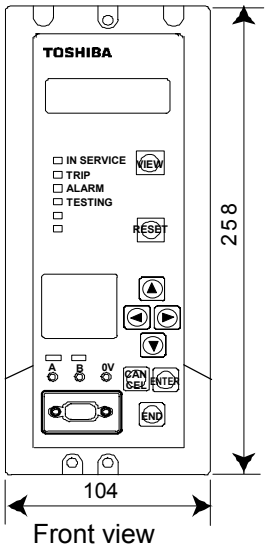




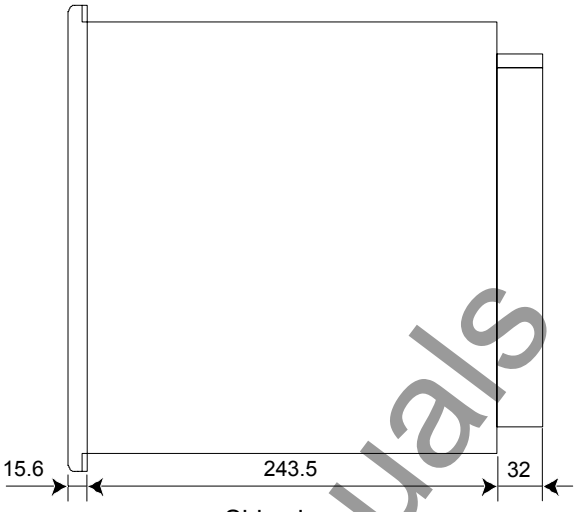


Appendix F

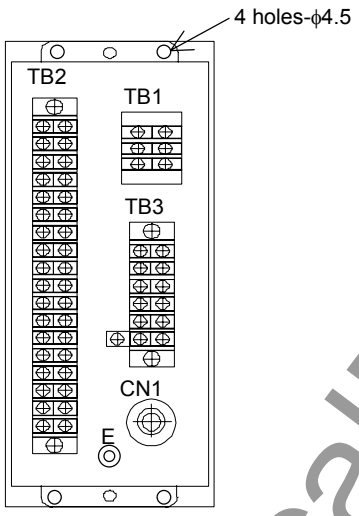
Case Outline



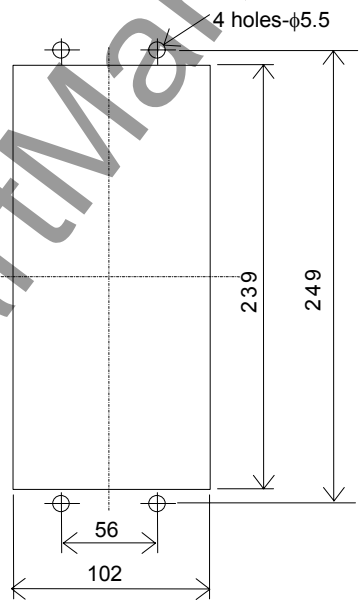
Front view



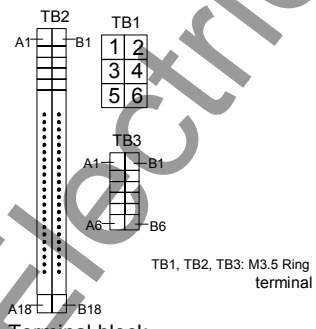
Side view



Rear view



Panel cut-out

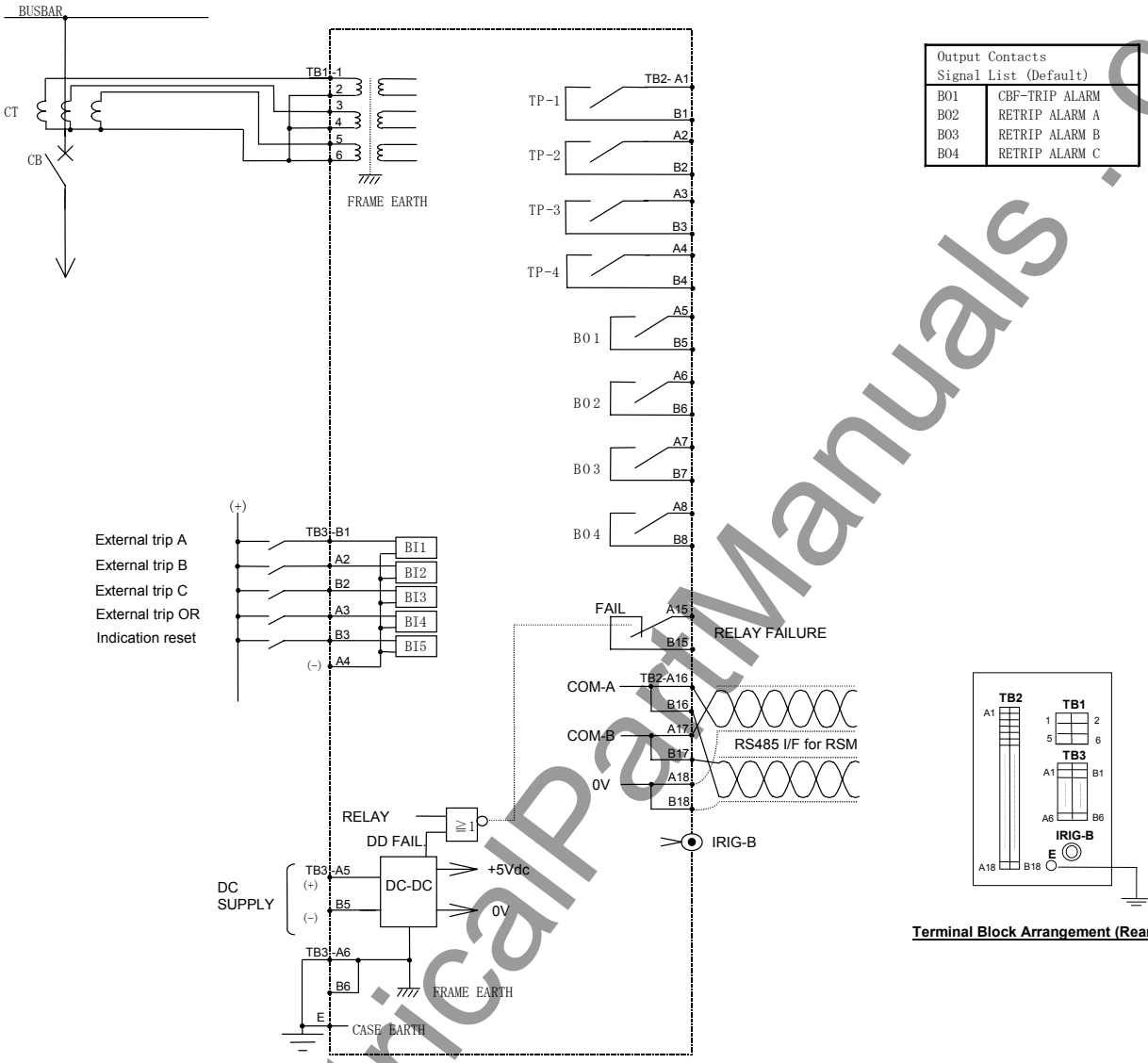


Terminal block

Case Outline of GRC100

Appendix G

External Connection



Output Contacts Signal List (Default)	
B01	CBF-TRIP ALARM
B02	RETRIP ALARM A
B03	RETRIP ALARM B
B04	RETRIP ALARM C

Terminal Block Arrangement (Rear view)

External connection

Appendix H

Relay Setting Sheet

1. Relay Identification
2. Busbar parameters
3. Contacts setting
4. Relay setting sheet

1. Relay Identification **Date:**

Relay type	Serial Number
Frequency	AC current
DC supply voltage	
Password	
Active setting group	

2. Busbar parameters

CT ratio

3. Contacts setting

(1) TB2 Terminal A5-B5

Terminal A6-B6

Terminal A7-B7

Terminal A8-B8

4. Relay setting sheet

No.	Name	Range		Units	Contents	Default Setting (5A rating / 1A rating)	Setting
		5A rating	1A rating				
1	Act.gp.	1 - 4		—	Active setting group	1	
2	Line name	Specified by user		—	Line name	Specified by user	
3	CT	1 - 20000		—	CT ratio	400	
4	OCBF	Off(0) / On(1)		—	OCBF trip use or not	On(1)	
5	EFBF	Off(0) / On(1)		—	EFBF trip use or not	Off(0)	
6	TPMD	SCM1(0) / SCM2(1)		—	Trip mode	SCM2(1)	
7	BF1	Off(0)/ T(1) / TOC(2)		—	CBF re-trip	TOC(2)	
8	BF2	Off(0) / On(1)		—	CBF related trip	On(1)	
9	SVCNT	ALM&BLK(0) / ALM(1)		—	Supervisor control	ALM&BLK(0)	
9	OCBF	0.5 - 10.0	0.1 - 2.0	A	Minimum operating current of OCBF	4.0 / 0.8	
10	EFBF	0.5 - 10.0	0.1 - 2.0	A	Minimum operating current of EFBF	4.0 / 0.8	
11	TBF1	0 - 500 (1ms step)		ms	CBF timer for re-trip	150	
12	TBF2	50 - 500 (1ms step)		ms	CBF timer for related trip	200	
13	BISW1	Norm(0) / Inv(1)		—	Binary input	Norm(0)	
14	BISW2	Norm(0) / Inv(1)		—	ditto	Norm(0)	
15	BISW3	Norm(0) / Inv(1)		—	ditto	Norm(0)	
16	BISW4	Norm(0) / Inv(1)		—	ditto	Norm(0)	
17	BISW5	Norm(0) / Inv(1)		—	ditto	Norm(0)	
18	LED1	0 - 60		—	Configrable LEDs	0	
19	LED2	0 - 60		—	ditto	0	
20	Plant name	Specified by user		—	Plant name	Specified by user	
21	Description	ditto		—	Memorandum for user	Specified by user	
22	Addrs	1 - 32		—	Relay ID No. for RSM	1	
23	EXT.trip A	N(0) / O(1) / R(2) / B(3)		—	Event record trigger	B(3)	
24	EXT.trip B	N(0) / O(1) / R(2) / B(3)		—	ditto	B(3)	
25	EXT.trip C	N(0) / O(1) / R(2) / B(3)		—	ditto	B(3)	
26	Ext.tripOR	N(0) / O(1) / R(2) / B(3)		—	ditto	B(3)	
27	Retrip	N(0) / O(1) / R(2) / B(3)		—	ditto	B(3)	
28	Trip	N(0) / O(1) / R(2) / B(3)		—	ditto	B(3)	
29	Ind.reset	N(0) / O(1) / R(2) / B(3)		—	ditto	B(3)	
30	Relay fail	N(0) / O(1) / R(2) / B(3)		—	ditto	B(3)	
31	CT err	N(0) / O(1) / R(2) / B(3)		—	ditto	B(3)	
32	Sys.change	N(0) / O(1)		—	ditto	O(1)	
33	Rly.change	N(0) / O(1)		—	ditto	O(1)	
34	Grp.change	N(0) / O(1)		—	ditto	O(1)	
35	Time	0.1 - 3.0		s	Disturbance record	1.0	
36	OCP	0.5 - 250.0	0.1 - 50.0	A	Relay element for disturbance trigger	5.0 / 1.0	
37	EF	0.5 - 10.0	0.1 - 2.0	A	Relay element for disturbance trigger	5.0 / 1.0	
38	TRIP	Off(0) / On(1)		—	Disturbance record trigger use or not	On(1)	
39	OCP	Off(0) / On(1)		—	ditto	On(1)	
40	EF	Off(0) / On(1)		—	ditto	Off(0)	
41	Display	Prim.(0) / Second.(1)		—	Metering	Prim.(0)	
42	Time sync	Off(0) / IRIG(1) / RSM(2)		—	Time synchronization	Off(0)	
43	GMT	-12 - +12		hrs	Time zone	0	

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 Overcurrent elements OCBF and EFBF 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 test

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 Overcurrent elements OCBF and EFBF test

Element	Current setting	Measured current
OCBF		
EFBF		

5. Protection scheme test

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 GRC100 to be repaired.

TOSHIBA CORPORATION FUCHU WORKS
1,Toshiba-cho, Fuchu-shi, Tokyo, Japan
For: Power System Control Department
Quality Assurance Group

Type: GRC100 Model: _____
(Example: Type: GRC100 Model: 101A-12-10)

Product No.: _____
Serial No.: _____
Date: _____

1. Reason for returning the relay
   - ☐ mal-function
   - ☐ does not operate
   - ☐ increased error
   - ☐ investigation
   - ☐ others

     _____
     _____
     _____
     _____

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

   Please provide relevant information regarding the incident on floppy disk, or fill in the attached fault record sheet and relay setting sheet.

Fault Record

Date/Month/Year Time / / / : : .

(Example: 04/ Nov./ 1997 15:09:58.442)

Faulty phase:

Prefault values

I_a: A
I_b: A
I_c: A

Fault values

Prefault values

I_a: A
I_b: A
I_c: A

3. What was the message on the LCD display at the time of the incident?

4. Describe the details of the incident:

5. Date incident occurred

   Day/Month/Year: / / /

   (Example: 10/July/1998)

6. Give any comments about the GRC100, including the documents:

Customer

Name: _____

Company Name: _____

Address: _____

_____

_____

Telephone No.: _____

Facsimile No.: _____

Signature: _____

Appendix K

Technical Data

TECHNICAL DATA

Ratings

AC current (In):	1A or 5A
Frequency:	50Hz or 60Hz
DC power supply:	110Vdc/125Vdc 220Vdc/250Vdc 48Vdc (Nominal range: –20% and +20% of rated voltage)
AC ripple on DC supply, IEC60255-11:	Maximum 12%
DC supply interruption, IEC60255-11	
Permissive duration of DC supply voltage interruption to maintain normal operation:	
	less than 50ms at 110Vdc
Restart time:	less than 10s

Overload rating

AC current input:	4 times rated continuous
	100 times rated for 1 second

Binary input signal

Minimum operating voltage:	70Vdc at 110Vdc/125Vdc rating
	100Vdc at 220Vdc/250Vdc rating

Burden

AC current circuit:	0.2VA per phase (at rated 5A)
	0.1VA per phase (at rated 1A)
DC power supply:	less than 10W (quiescent)
	less than 15W (operation)

Breaker failure protection

Phase overcurrent element:	0.1 to 2.0A in 0.1A steps (1A relay)
	0.5 to 10.0A in 0.1A steps (5A relay)
Zero sequence overcurrent element:	0.1 to 2.0A in 0.1A steps (1A relay)
	0.5 to 10.0A in 0.1A steps (5A relay)
Timer for retrip:	0 to 500ms in 1ms steps
Timer for adjacent breaker trip:	50 to 500ms in 1ms steps

Operating time and resetting time of overcurrent element

Operating time:	less than 20ms at 50Hz, less than 17ms at 60Hz
Resetting time:	less than 15ms at 50Hz, less than 13ms at 60Hz

Accuracy of overcurrent element

Overcurrent element:	±5%

Communication port

Front communication port (local PC)

Connection:	Point to point
Cable type:	Multi-core (straight)
Cable length:	15m (max.)
Connector:	RS232C 9-way D-type female

Rear communication port (remote PC)

Signal level:	RS485
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 1 min.

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
	20A, 290Vdc for 0.2s (L/R ≥ 5ms)
Break:	0.1A, 290Vdc (L/R=40ms)

Mechanical design

Weight:	5kg
Case color:	Munsell No. 10YR8/0.5
Installation:	Flush mounting

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	IEC60068-2-3	4 days at 40°C and 93% relative humidity.
Enclosure Protection	IEC60529	IP51
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 IEC60255-22-2 Class 4	6kV contact discharge. 15kV 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

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

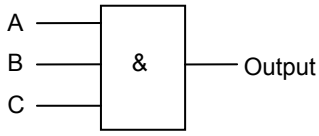
Marked with ⬭ : Binary signal input from or output to the external equipment

Marked with [ ] : Scheme switch

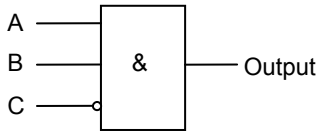
Marked with " " : Scheme switch position

Unmarked : Internal scheme logic signal

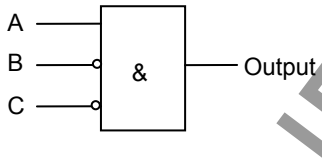
AND gates



A	B	C	Output
1	1	1	1
Other cases			0

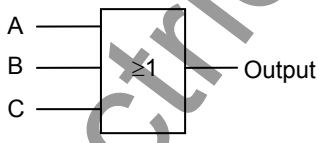


A	B	C	Output
1	1	0	1
Other cases			0

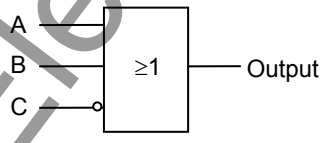


A	B	C	Output
1	0	0	1
Other cases			0

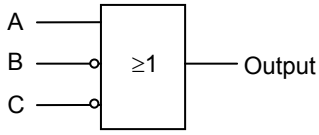
OR gates



A	B	C	Output
0	0	0	0
Other cases			1

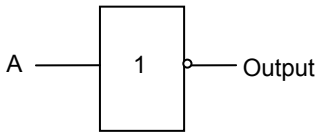


A	B	C	Output
0	0	1	0
Other cases			1



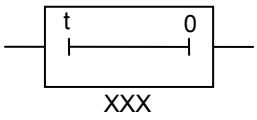
A	B	C	Output
0	1	1	0
Other cases			1

Signal inversion



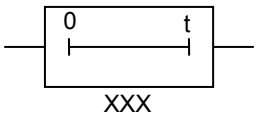
A	Output
0	1
1	0

Timer



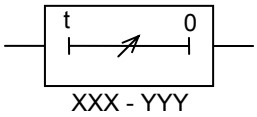
Delayed pick-up timer with fixed setting

XXX: Set time



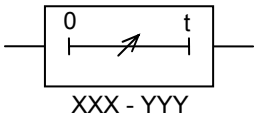
Delayed drop-off timer with fixed setting

XXX: Set time



Delayed pick-up timer with variable setting

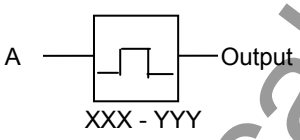
XXX - YYY: Setting range

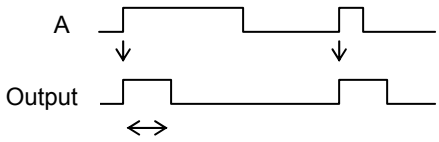


Delayed drop-off timer with variable setting

XXX - YYY: Setting range

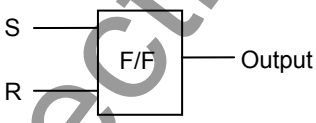
One-shot timer





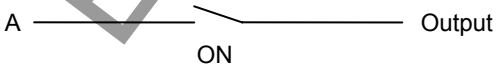
XXX - YYY: Setting range

Flip-flop

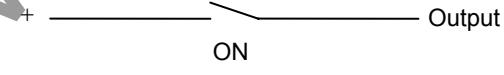


S	R	Output
0	0	No change
1	0	1
0	1	0
1	1	0

Scheme switch



A	Switch	Output
1	ON	1
Other cases		0



Switch	Output
ON	1
OFF	0

Version-up Records

Version No.	Date	Revised Section	Contents
0.0	Feb. 15, 2001	--	First issue
0.1	Apr. 26, 2001	2.2 3.1.1 3.4.1, 3.4.3 4.2.4. 4.2.6 6.5.1 Appendices	Added the description of EFBF element. Modified the description. Modified the description. Added and changed samples of LCD screen. Changed samples of LCD screen. Added the description of EFBF element. Added Appendix A and modified Appendix B, C, E, G, H, I, K.
1.1	Feb. 27, 2002	3.1.1 3.2.2 3.3.3, 3.3.5 3.4.3 4.2.5 4.2.6 6.5.2 6.7.2 Appendices	Modified the Figure 3.1.3. Modified the description. Modified the description. Modified the table of Settings. Added samples of LCD screen. Added and changed samples of LCD screen. Added Section 6.5.2 Timer. Modified Table 6.7.1. Modified Appendix A, E, K.
1.2	Sep. 5, 2002	3.3.3 6.2.2 7 Appendix K	Modified the description. Modified the description in Caution. Added Caution. Modified the description.
1.3	Jan. 31, 2003	3.1, 4.1, 4.2, 4.4 Appendix I	Modified the description. (RSM: remote setting and monitoring → relay setting and monitoring) Modified the description.
1.4	Aug. 23, 2003	2.2	Added the description about the reset value of CBF element and tripping time.

TOSHIBA CORPORATION