INSTRUCTION MANUAL

HIGH-IMPEDANCE DIFFERENTIAL RELAY

GRB150 - ***B

TOSHIBA CORPORATION

(Ver. 0.8)

Safety Precautions

Before using this product, please read this chapter carefully.

This chapter describes the safety precautions recommended when using the GRB150. 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.

- **Fiber optic**

When connecting this equipment via an optical fibre, do not look directly at the optical signal.

⚠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. 0.8)

1. Introduction

The GRB150 is a numerical high-impedance differential relay for busbar protection and restricted earth fault protection.

The GRB150 is a member of the G-series numerical single-function relays which are built on common hardware modules and equipped with the following functions:

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

2. Application Notes

2.1 Application

The GRB150 provides high-impedance differential protection scheme and is applied for the following protections:

- Restricted earth fault protection
- Single or one-and-a-half busbar protection
- T zone protection of one-and-a-half busbar arrangement
- Short line cable protection

The high-impedance differential protection detects a fault even if the CT is saturated by fault current.

The GRB150 provides the following metering and recording functions.

- Metering
- Fault records
- Event records
- Disturbance records

The GRB150 provides the following human interfaces for issuing alarms, setting relay parameters or viewing stored data.

- Relay front panel: LCD, LED display and operation keys
- Local PC
- Remote PC

The relay can be integrated with a local PC or a remote PC through a communication port.

A local PC can be connected via the RS232C port on the front panel of the relay. A remote PC can also be connected through the RS485 port on the rear panel of the relay.

IEC60870-5-103 protocol is provided for communication with substation control and automation systems.

The GRB150 has two models, model 101 and model 201. The model 101 is used for single-phase applications and for restricted earth fault protection. The model 201 is used for three-phase applications and for three-phase busbar, T zone and short line cable protection.

2.2 High-impedance Differential Protection

2.2.1 Principle of operation

The operating principle of high-impedance differential protection is depicted in Figure 2.2.1.

Under normal operating conditions or in the event of an external fault the primary currents entering and leaving the protected zone will summate to zero. The current transformers are connected in parallel hence if their ratios are the same the secondary currents will also sum to zero. According to the direction of the respective secondary current for each current transformer their driving voltages are in opposition and hence a low voltage is generated in the differential circuit such that under ideal conditions the voltage across the relay is zero.

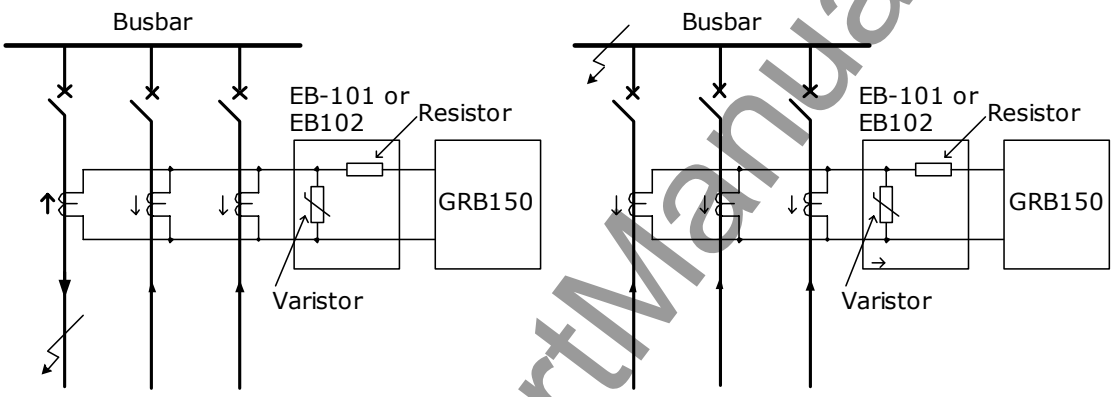


Figure 2.2.1 High-Impedance Differential Protection

In the case of an internal fault the current transformer secondary currents will be in the same direction and their sum will correspond to the total primary fault current. The corresponding driving voltages will be in the same direction and a high voltage will be developed in the differential circuit as it attempts to drive the secondary current through the burden presented by the high-impedance relay. Dependent upon its setting the voltage relay will operate.

Note that in Figure 2.2.1 an external unit, either type EB-101 for single-phase protection or EB-102 for three-phase protection has been shown. These include a varistor to limit the high voltage developed in the differential circuit during internal faults and a series resistor to fix the relay input impedance at 667ohms. Refer to Sections, 2.2.4 “Fault Setting or Primary Operating Current” and 2.2.5 “Peak Voltage Developed under Internal Fault Conditions”.

2.2.2 Through Fault Stability

The stability of a current differential system using a high-impedance relay and low reactance current transformers is determined by means of calculation. If the relay setting voltage is made equal to or greater than the maximum voltage that can appear across the relay circuit for a given value of through fault current the current differential system will be stable. In calculating the required setting voltage for the relay it is assumed that one current transformer will become fully saturated and that the remaining current transformers will maintain their ratio. An example to illustrate this point is shown in Figure 2.2.2 for a current differential system for a busbar with several feeders.

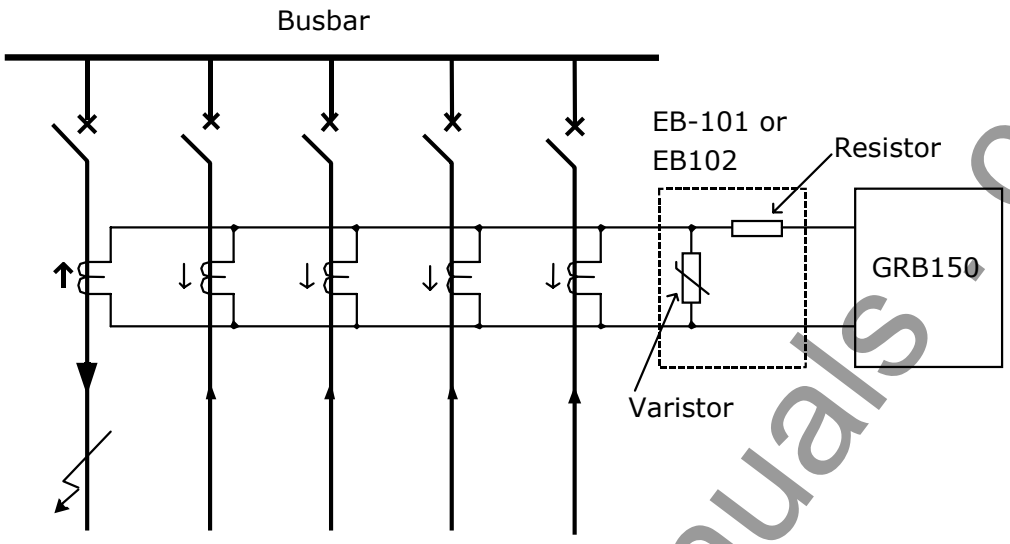


Figure 2.2.2 External Fault – Busbar with Several Feeders

In this example an external fault is fed through a single circuit with the fault current being supplied through all of the other circuits connected to the busbar. Since the total busbar current has to be transformed by the current transformer on the faulted feeder there is a high probability of this current transformer saturating whilst the current transformers on the other more lightly loaded circuits remain unsaturated. Under these conditions a secondary current will flow in the differential circuit that is equivalent to the primary fault current. The voltage drop caused by the secondary current that flows in the differential circuit therefore determines the voltage input at the relay.

In the equivalent circuit the shunt impedance for the fully saturated CT is negligible and the CT will not produce an output, this is shown as a short circuit across the excitation impedance in Figure 2.2.3.

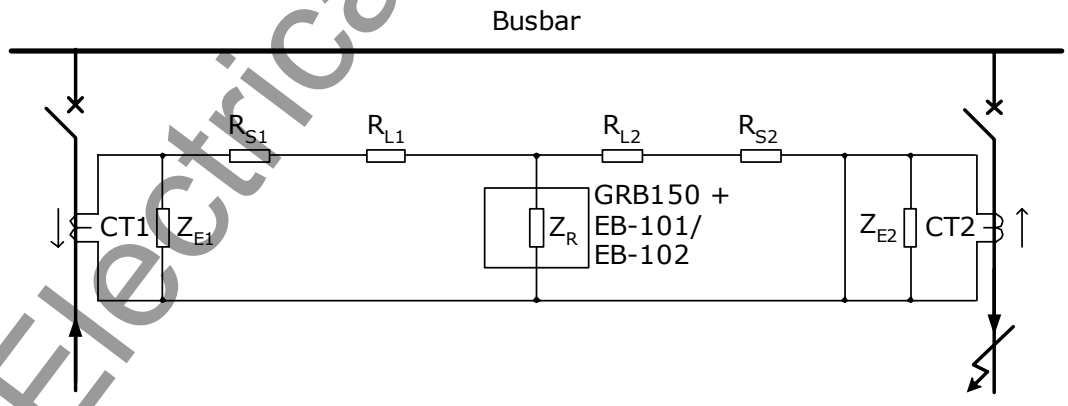


Figure 2.2.3 Equivalent Circuit of the Differential Circuit for an External Fault

The total voltage drop is therefore due to the secondary fault current through the secondary winding resistance of the saturated CT together with the wiring connecting it to the relay circuit terminals. Provided that the relay setting voltage exceeds the value of V_R in Equation (1) the scheme will remain stable.

$$V_R \geq K_1 (R_{S2} + R_{L2}) I_{Fmax}/N \quad (1)$$

where,

V_R : maximum voltage developed across the relay circuit

K_1 : safety factor – for the GRB150, K_1=1.2

R_S : resistance of current transformer secondary winding

R_L : resistance of secondary wiring for CT connecting lead loop – most onerous case

I_{Fmax} : maximum through fault current

N : CT ratio

Factor K_1 is associated with the design of the GRB150 relay and directly relates to its inherent capability to block the unidirectional transient component of the fault current. This is based on previous service experience and extensive laboratory tests.

In addition to K_1 an inherent safety factor exists because the basic assumption of complete saturation of one current transformer with no ratio error of the complementary one is an extreme case of unbalance. In practice it is unlikely to occur as when one current transformer begins to saturate its burden is transferred to the other current transformer(s) due to the fact that they are of the same construction and experience the same secondary voltage.

2.2.3 Current Transformer Requirements

- All current transformers used in the scheme shall have the same turns ratio
- All current transformers shall be of the low reactance type class X as specified in B.S.3938 in terms of turns ratio, knee point voltage, secondary winding resistance and secondary exciting current
- Bushing or toroidal current transformers with fully distributed windings and low leakage flux shall be used.
- The secondary winding resistance must be kept to a minimum
- It is preferable that the current transformers are of similar design
- Other devices must not be connected to the same CT core
- CT knee-point voltage, $V_k \geq 2 \times V_R$

For an internal fault it is essential that the current transformer(s) produce sufficient output to operate the relay. In order to achieve this, cater for any current transformer ratio errors and ensure a high speed of operation the current transformers should have a V_K of at least twice that of the relay setting voltage as stated above.

A setting example is provided in Appendix L.

2.2.4 Fault Setting or Primary Operating Current

During an internal fault, the fault current must provide the exciting current for all of the connected current transformers as well as the relay circuit current. To ensure positive operation, the current requirement of the relay and the magnetising current requirement of all of the connected current transformers at the relay setting voltage must be less than the minimum fault current that the relay is required to detect. Therefore the secondary effective setting is the sum of

the relay minimum operating current and the excitation losses in all parallel connected current transformers. The currents are not in-phase and hence the summation should be vectorial. However, an arithmetic addition is acceptable resulting in the calculated setting being slightly higher than the actual setting.

$$I_{min} = (n.I_e + I_r + I)N \qquad (2)$$

where,

I_{min} : minimum primary operating current

n : number of current transformers connected to the GRB150 relay

I_e : value of current transformer secondary exciting current at GRB150 setting voltage

I : relay current at setting voltage
where, $I = V_R / Z_R$ and Z_R is the GRB150 input impedance of 667 ohms with varistor unit EB-101 for single-phase protection or EB-102 for three-phase protection

I_r : varistor current at GRB150 setting voltage, this is obtained from the varistor V-I characteristic

N : CT ratio

If the value calculated for I_{min} is too low the sensitivity can be reduced by the use of a shunt resistor connected across the relay/varistor unit input.

A setting example is provided in Appendix L.

2.2.5 Peak Voltage Developed under Internal Fault Conditions

Under internal fault conditions a high voltage is developed in the differential circuit by the current transformer so a varistor, (non-linear resistor) is connected in parallel to the relay to limit the overvoltage. A varistor unit EB-101 is provided for single-phase protection and the EB-102 unit for three-phase protection.

Note: It is our standard practice to use the EB-101 and EB-102 varistor units when applying the GRB150. For those who prefer the more traditional approach of using externally mounted components in place of the EB-101 and EB-102 units the GRB150 can be applied with externally mounted suitably rated, linear and non-linear devices provided that the input impedance is maintained at 667 ohms.

2.2.6 CT Supervision

The DIFSV element provides CT supervision to detect any unbalance in the CT secondary circuit in the event of a fault in the wiring or the CT itself. The voltage setting of this element must be greater than any erroneous voltage that can be developed under normal service conditions. The two main sources of error are: -

- CT turns ratio error
- Differences in the respective lengths of the CT secondary connecting leads to the paralleling point of the differential circuit

The setting of the DIFSV element is best illustrated with an example which is given in Appendix L.

2.3 Scheme Logic

Figure 2.3.1 shows the scheme logic for the high-impedance differential protection type GRB150. The differential protection operates on a per phase basis, although output signals of the high-impedance differential element DIF can perform instantaneous three-phase tripping of the circuit breaker. The supervisory element DIFSV will detect any erroneous differential voltage appearing as a result of CT circuit failure. The tripping output signal of the DIF elements can be blocked when the DIFSV element output is maintained for the setting time of TVDSV. To block the tripping output with DIFSV operation, set scheme switch [VDCHK] to "ON" and set [SVCNT] to "ALM&BLK".

The output signal VD ERR of DIFSV element is used for alarm purposes.

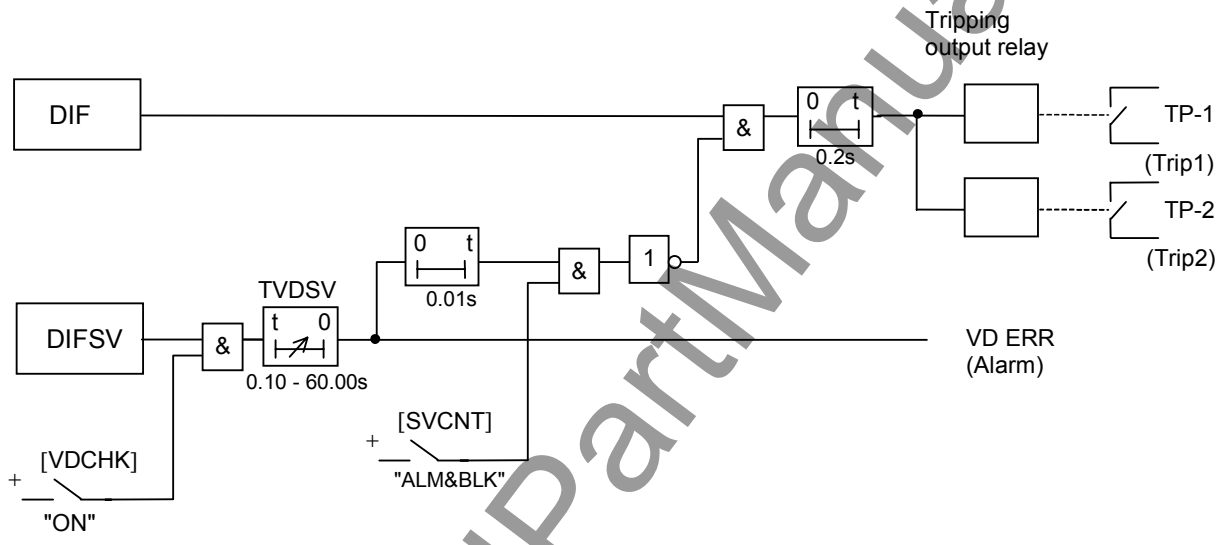


Figure 2.3.1 Scheme Logic of High-impedance Differential Protection

2.4 Setting

The following list shows the setting elements for the high-impedance differential protection and their setting ranges.

Element	Range	Step	Default
VDCHK	Off / On	-	On
SVCNT	ALM&BLK / ALM	-	ALM&BLK
DIF	10 - 600V	1V	100 V
DIFSV	5 - 100V	1V	50 V
TVDSV	0.10 - 60.00s	0.01	0.50 s

2.5 Tripping Output

As shown in Figure 2.3.1, two high-speed tripping output relays TP-1 (Trip 1) and TP-2 (Trip 2) are provided and each relay has one normally open contact.

The tripping output relays reset 200ms after the tripping signal disappears when the fault is cleared. The tripping circuit must be 'broken' using one of the circuit breaker auxiliary switch contacts prior to the tripping relay being reset to prevent the tripping relay from directly interrupting the tripping current of the circuit breaker.

3. Technical Description

3.1 Hardware Description

Case outlines of GRB150, EB-101 and EB-102 are shown in Appendix E.

The hardware structure of GRB150 is shown in Figure 3.1.1.

The GRB150 relay unit consists of the following hardware modules. These modules are fixed to the front panel 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 GRB150 is shown in Figure 3.1.2.

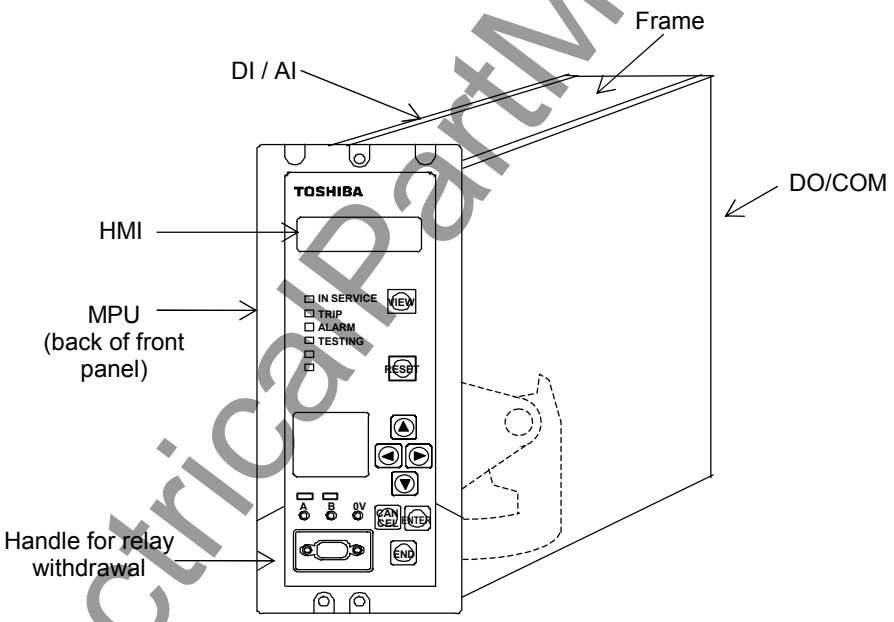


Figure 3.1.1 Hardware Structure without Case

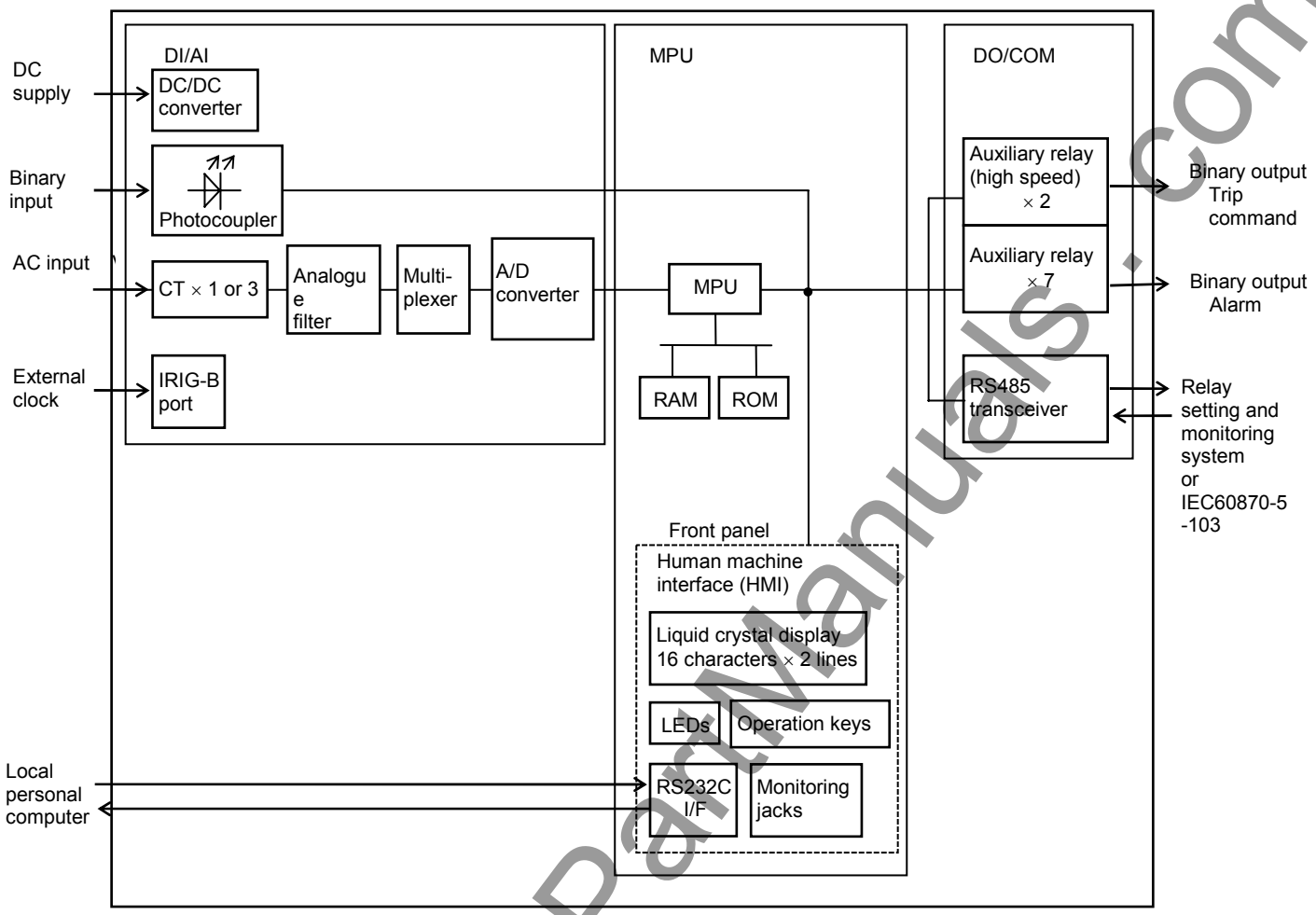


Figure 3.1.2 Hardware Block Diagram

DI/AI Module

The DI/AI module insulates internal circuits from external circuits through auxiliary transformers and transforms the magnitude of AC input signals to suit the electronic circuits. The AC input signals are single-phase or three-phase current which is the output from the varistor units EB-101 or EB-102.

There are 1 or 3 auxiliary CTs depending on the relay model. (For the correspondence between the relay model and terminal number AC input signals, see Table 3.2.1.)

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

The input voltage rating of DC/DC converter is 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) or 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 a processing unit (MPU), random access memory (RAM) and a read only memory (ROM) and executes all kinds of processing such as protection, measurement, recording and display.

The MPU implements two 60 MIPS (Million Instructions Per Second) RISC (Reduced Instruction Set Computer) type 32-bit microprocessors.

DO/COM Module

The DO/COM module incorporates two auxiliary relays (TP-1 and TP-2) dedicated to the circuit breaker tripping command, 7 auxiliary relays (BO1-BO6 and FAIL) for binary output signals and an RS485 transceiver.

TP-1 and TP-2 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 BO6 have one normally open contacts.

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

Human Machine Interface (HMI) Module

The operator can access the GRB150 via the human machine interface (HMI). As shown in Figure 3.1.3, the HMI panel has a liquid crystal display (LCD), light emitting diodes (LEDs), 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, setting data, and testing switches.

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 or final trip command is issued.
ALARM	Red	Lit when at least one failure is detected.
TESTING	Red	Lit when test condition is set.
(LED1)	Red	User-configurable
(LED2)	Red	User-configurable

LED1 and LED2 are user-configurable. Each is driven via a logic gate which can be programmed for OR gate or AND gate operation. Further, each LED has a programmable reset characteristic, settable for instantaneous drop-off, or for latching operation. A configurable LED can be programmed to indicate the OR combination of a maximum of 4 elements. For the setting, see Section 4.2.6.10.

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.

Once a trip command is issued, the TRIP LED remains lit even after the trip command disappears. Pressing the RESET key resets it. The other LEDs operate as long as a signal is

present. The RESET key is ineffective for these LEDs.

The operation keys are used to display the record, status and setting data on the LCD, input 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 a signal to be observed from the "Signal List" and setting it in the window. The signals can be transmitted to an oscilloscope via the monitoring jacks. (For the "Signal List", see Appendix B.)

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.

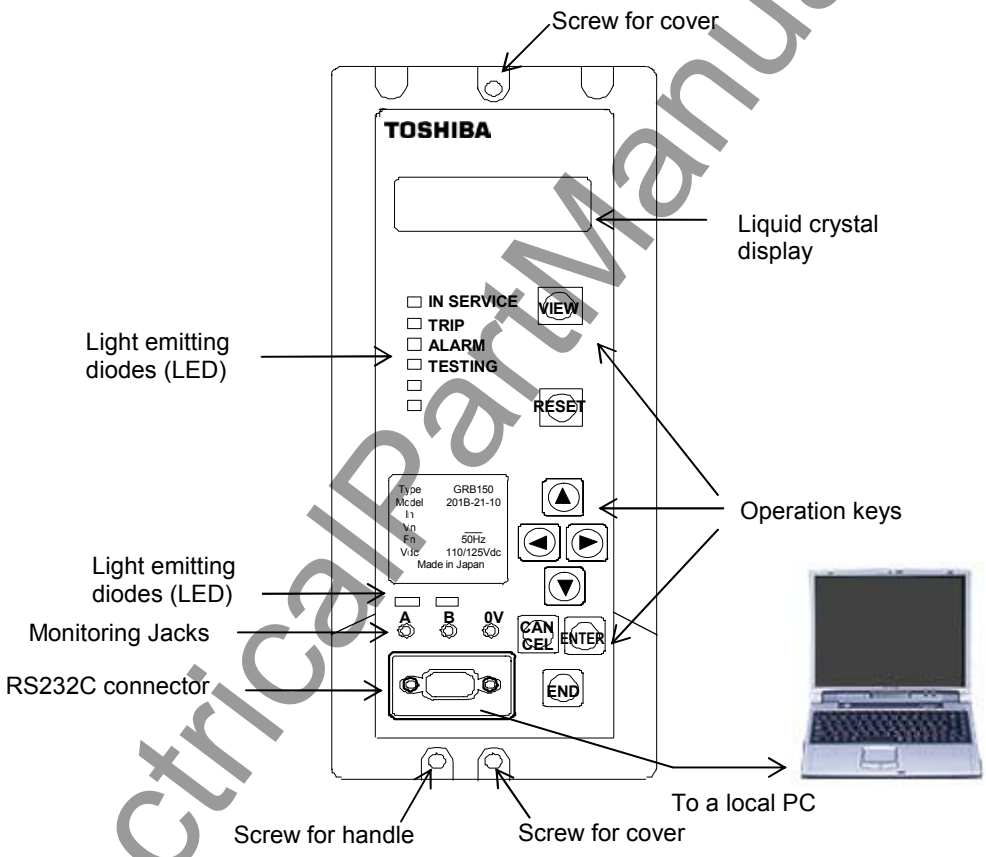
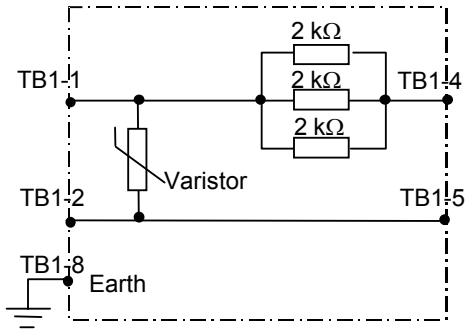


Figure 3.1.3 Front Panel

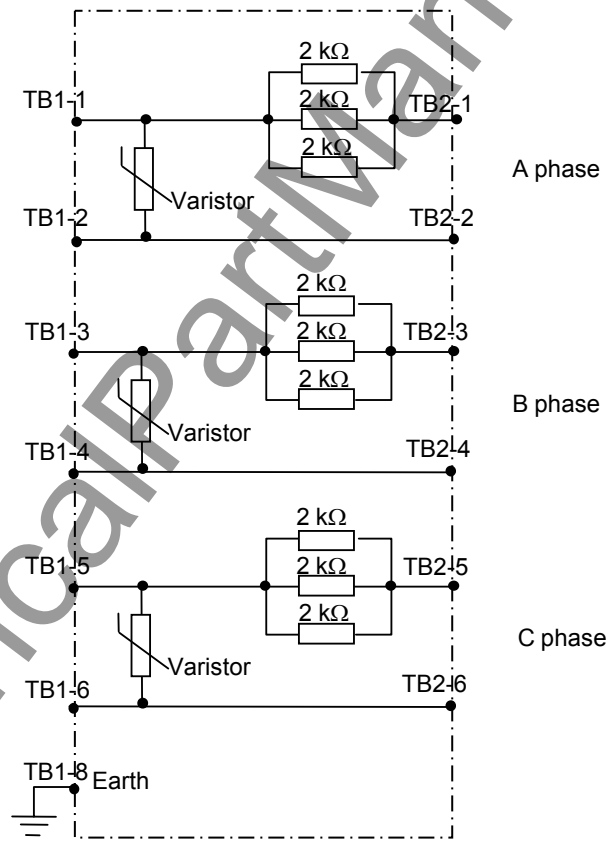
EB-101 and EB-102

Varistor unit EB101 or 102 is connected in parallel to the GRB150 to prevent an overvoltage generated at the differential circuit during a fault. Figure 3.1.4 shows an internal circuit of the varistor unit.

The EB-101 is coupled with the GRB150 model 101 for single-phase protection, and the EB-102 is coupled with the GRB150 model 201 for three-phase protection.



(a) EB-101



(b) EB-102

Figure 3.1.4 Internal Circuit of Varistor Unit

3.2 Input and Output Signals

3.2.1 Input Signals

AC input signals

Table 3.2.1 shows the AC input signals necessary for each of the GRB150 models and their respective input terminal numbers.

Table 3.2.1 AC Input Signals

Terminal No. of TB1	GRB150-101	GRB150-201
1-2	Current	A phase current
3-4	—	B phase current
5-6	—	C phase current

Binary input signals

Table 3.2.2 shows the binary input signal required by the GRB150, its driving contact conditions and functions enabled.

The binary input circuit of the GRB150 is provided with a logic level inversion function as shown in Figure 3.2.1. The 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).

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

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

Table 3.2.2 Binary Input Signal

Signal Name	Driving Contact Condition / Function Enabled	BISW
Indication reset	Closed to reset OPERATE LED indication. / Reset indication externally.	1

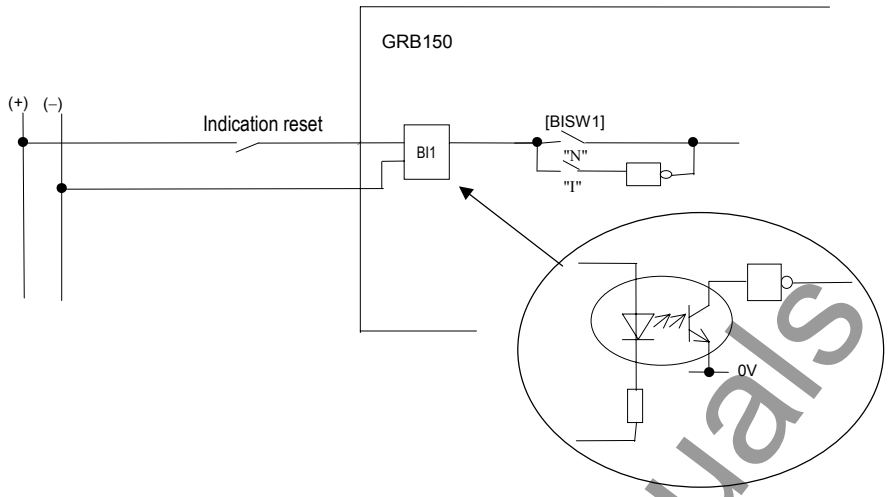


Figure 3.2.1 Logic Level Inversion

3.2.2 Binary Output Signals

The number of binary output signals and their output terminals are shown in Appendix F. All outputs, except tripping commands and a 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 BO6 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 C shows the factory default settings.

Further, each BO has a programmable reset characteristic, settable for instantaneous drop-off, for delayed drop-off, or for latching operation by the scheme switch [RESET].

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

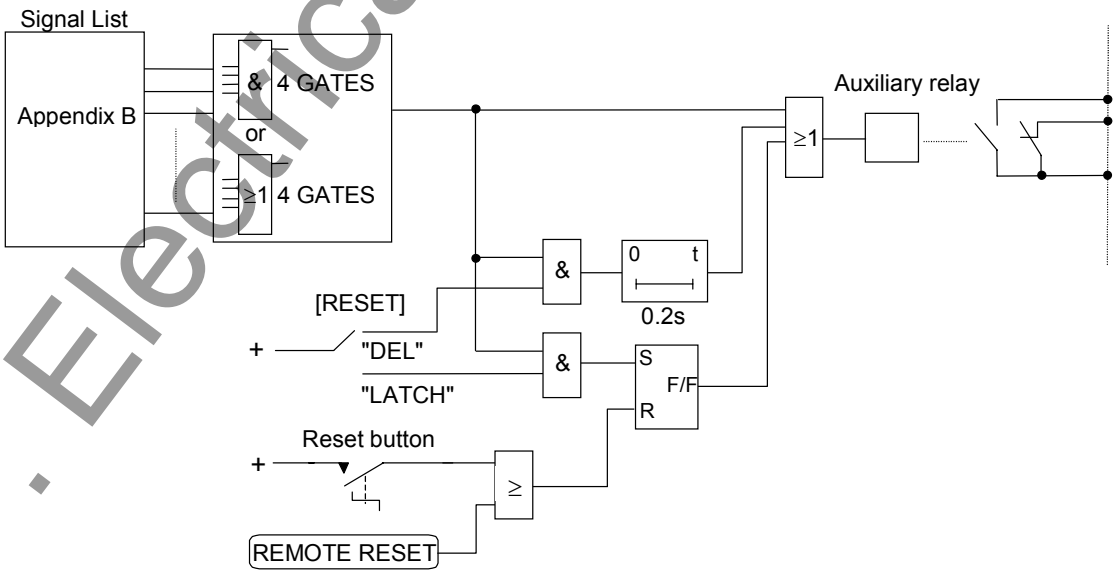


Figure 3.2.2 Configurable Output

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 without fail when it occurs. 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 GRB150 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 relay failure occurs, it should be able to easily identify the location of the failure.

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

3.3.2 Relay Monitoring

The relay is supervised with the following items.

Differential voltage monitoring

The supervisory element DIFSV is provided to check the health of CT circuits. The DIFSV element detects the erroneous differential voltage that appears under a CT circuit failure.

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 the discrepancy between the setting values stored in duplicate.

Watchdog timer

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

DC Supply Monitoring

The secondary voltage level of the built-in DC/DC converter is monitored and checks 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, "ALARM" LED indication, external alarm and event recording. Table 3.3.1 summarises the supervision items and alarms.

The alarms are retained until the failure is recovered.

The alarms can be disabled collectively by setting the scheme switch [AMF] (Automatic Monitoring Function) to OFF. The setting is used to block unnecessary alarms during commissioning, testing or maintenance.

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

Table 3.3.1 Supervision Items and Alarms

Supervision Item	[SVCNT] switch*	LCD Message	LED "IN SERVICE"	LED "ALARM"	Ext. alarm	Event record Message
Differential voltage monitoring	ALM & BLK	(1)	Off	On	(2)	Vd err
	ALM		On	On		
A/D accuracy check		(1)	Off	On	(3)	Relay fail
Memory monitoring						
Watchdog Timer		----	Off	On	(3)	----
DC supply monitoring		----	Off	(4)	(3)	----

*: For [SVCNT] (supervision control) switch, see Appendix G and for its scheme logic, see Appendix A.

(1) Diverse messages are provided as expressed with " Err:---" in the table in Section 6.7.2.

(2) The configurable signal "VD ERR" operates. (See Appendix B.)

(3) The binary output relay "FAIL" operates.

(4) Whether the LED is lit or not depends on the degree of the voltage drop.

3.3.4 Trip Blocking

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

- Differential voltage monitoring (selectable)
- A/D accuracy check
- Memory monitoring
- Watchdog Timer
- DC supply monitoring

When a failure is detected by the differential voltage monitoring, the scheme switch [SVCNT] setting can be used to determine if both tripping is blocked and an alarm is initiated, or, if only an alarm is initiated. (For the setting, see Section 4.2.6.7)

3.3.5 Setting

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

Element	Range	Step	Default	Remarks
[SVCNT]	ALM&BLK/ALM		ALM&BLK	Alarming and/or blocking selection

3.4 Recording Function

The GRB150 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 GRB150 and the following items are recorded for one fault:

Date and time of fault occurrence

Operating phase

Relevant events

Power system quantities

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

Date and time of fault occurrence

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

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

Operating phase (for Model 201)

The phase is indicated by differential element (DIF) operating phase(s).

Relevant events

Such events as for evolving faults are recorded with time-tags.

Power system quantities

The differential voltages in pre-faults and post-faults are recorded. The following power system quantities are not recorded during evolving faults.

- Magnitude of differential voltage (V_d) for model 101 or phase differential voltage (V_{da}, V_{db}, V_{dc}) for model 201

3.4.2 Event Recording

The events shown in Table 3.4.1 are recorded with a 1 ms resolution time-tag when the status changes. The user can select the recording items and their status change mode to initiate a recording.

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

Table 3.4.1 Event Record Items

Event	LCD Indication	
Trip command output or reset	Trip	On or Off
Relay failed or restored	Relay fail	On or Off
Differential voltage supervision alarm or reset	Vd err	On or Off
Indication reset input or reset	Ind. reset	On or Off
System setting changed	Sys. set change	
Relay setting changed	Rly. set change	
Group setting changed	Grp. set 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 a setting change of the 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 except for a change of setting(s).

- Not to record the event
- To record the event when status changes to "operate".
- To record the event when status changes to "reset".
- To record the event when status changes both to "operate" and "reset".

For “System setting changed”, “Relay setting changed” and “System setting changed”, one of the following modes is selectable.

- Not to record the event
- To record the event when status changes to "operate".

For the setting, see the Section 4.2.6.5.

3.4.3 Disturbance Recording

Disturbance recording is started when the supervisory element DIFSV operates or a tripping command is initiated. In Model 201, the records include three analogue signals (V_{da}, V_{db}, V_{dc} : phase differential voltage), seven binary signals listed below and the dates and times at which recording started.

- DIF-A
- DIF-B
- DIF-C
- DIFSV-A
- DIFSV-B
- DIFSV-C
- Trip

In Model 101, the records include an analogue signal (V_d : differential voltage), three binary signals (DIF, DIFSV, Trip) and the dates and times.

The LCD display only shows the dates and times of the disturbance records stored. Details can be displayed on a PC. For how to obtain disturbance records on the PC, see the "Instruction Manual PC Interface, RSM100".

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	41	20	12	9	7	5	5

3.5 Metering Function

The GRB150 performs continuous measurement of the analogue input quantities. The magnitudes of the phase differential voltage (V_{da}, V_{db}, V_{dc}) or differential voltage (V_d) are renewed every second and displayed on the LCD of the relay front panel or on the local or remote PC. The model 101 series measures a single phase quantity only.

4. User Interface

4.1 Outline of User Interface

The user can access the relay from the front panel.

Local communication with the relay is also possible using a personal computer (PC) via an RS232C port. Furthermore, remote communication is also possible using RSM (Relay Setting and Monitoring) or IEC60870-5-103 communication via RS485 port.

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 diodes (LED), operation keys, [VIEW] and [RESET] keys, monitoring jacks and an RS232C connector.

LCD

The LCD screen, with a 2-line, 16-character display and back-light, provides the user with information of the relay interior such as records, statuses and settings. The LCD screen is normally unlit, but pressing the [VIEW] key will display the digest screen and pressing any key other than [VIEW] and [RESET] will display the menu screen.

These screens are turned off by pressing the [RESET] key or the [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 trip command is issued.
ALARM	Red	Lit when a failure is detected.
TESTING	Red	Lit when test condition is set.
(LED1)	Red	User configurable
(LED2)	Red	User configurable

LED1 and LED2 are configurable. Refer to Section 3.1.

The TRIP LED lights up once the relay operates and remains lit even after the trip command goes off. The TRIP LED can be turned off by pressing the [RESET] key or by using an indication reset signal via a binary input contact on the rear panel of the relay. 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, statuses, and setting values on the LCD, as well as

to input or change setting values. The functions of each operation key are as follows:

① ▼, ▲, ◀, ▶: Used to move lines displayed on an LCD screen. Keys ◀ and ▶ are also used to enter numerical values.

② [CANCEL]: Used to cancel entries or return to the upper (previous) screen.

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

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

[VIEW] and [RESET] keys

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

Pressing [RESET] key turns off the display.

Monitoring jacks

The two monitoring jacks A and B and their respective LEDs can be used when the test mode is selected on the LCD screen. By selecting the signal to be observed from the "Signal List" (See Appendix B) and setting it on the screen, the signal can be displayed on LED A or LED B, or by using an oscilloscope via the monitoring jacks.

RS232C connector

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

4.1.2 Communication Ports

The following three 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 using this connector or via modems and a telephone line, setting operation and display functions can be performed on the personal computer.

RS485 port

The RS485 port is used for the RSM (Remote Setting and Monitoring system) via the protocol converter G1PR2 and IEC60870-5-103 communication via BCU/RTU (Bay Control Unit / Remote Terminal Unit) to connect between relays and to construct a network communication system. (See Figure 4.4.1 in Section 4.4.)

One or two (dual) RS485 ports (COM1 and COM2) are provided on the rear of the relay as shown in Figure 4.1.1 and Appendix F.

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 provided on the back of the relay and Figure 4.1.1 shows the location of this connector. The rated voltage level of the signal is from 2 to 8 V_{peak} (4 to 16 $V_{peak-to-peak}$).

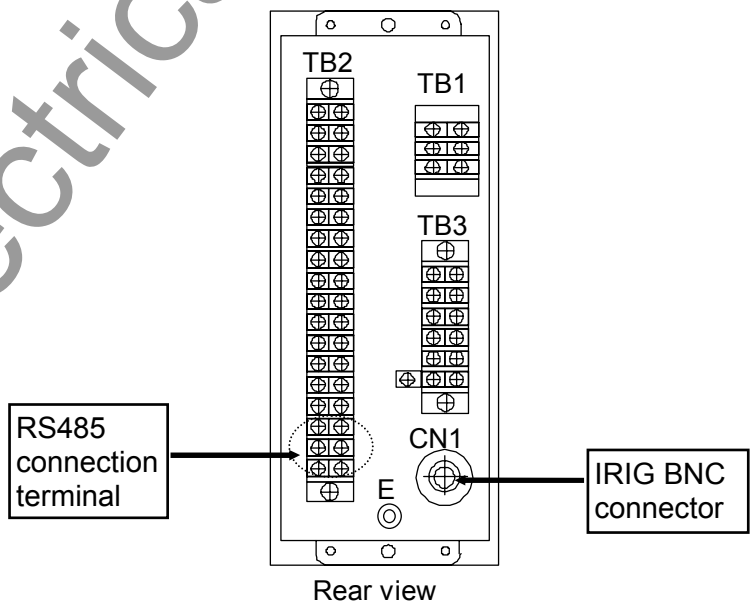


Figure 4.1.1 Locations of RS485 Port and IRIG Port

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 GRB150 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 screen below are the digest screens and can be displayed without entering the menu screens.

```
Vd     ***.*   V
```

```
DIF-ABC
Trip
```

```
Err :
```

To clear the latched indications (latched LEDs, LCD screen of Latest fault), press RESET key for 3 seconds or more.

For any display, the back-light is automatically turned off after five minutes.

Displays in tripping

If a fault occurs and a tripping command is output when the LCD is off, the red "TRIP" LED and other configurable LED if signals assigned to trigger by tripping

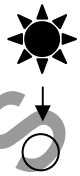
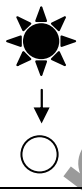
Press the VIEW key to scroll the LCD screen to read the rest of messages.

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

Notes:

1) When configurable LEDs (LED1 and LED2) are assigned to latch signals by trigger of tripping, press the RESET key more than 3s until the LCD screens relight. Confirm turning off the configurable LEDs. Refer to Table 4.2.1 Step 1.
2) Then, press the RESET key again on the "Latest fault" screen in short period, confirm turning off the "TRIP" LED. Refer to Table 4.2.1 Step 2.
3) When only the "TRIP" LED is go off by pressing the RESET key in short period, press the RESET key again to reset remained LEDs in the manner 1) on the "Latest fault" screen or other digest screens. LED1 and LED2 will remain lit in case the assigned signals are still active state.

Table 4.2.1 Turning off latch LED operation

	Operation	LED lighting status	
		"TRIP" LED	Configurable LED (LED1, LED2)
Step 1	Press the [RESET] key more than 3s on the "Latest fault" screen	 continue to lit	 turn off
Step 2	Then, press the [RESET] key in short period on the "Latest fault" screen	 turn off	

When any of the menu screens is displayed, the [VIEW] and [RESET] keys do not function.

To return from menu screen to the digest "Latest fault" screen, do the following:

- Return to the top screen of the menu by repeatedly pressing the [END] key.
- Press the [END] key to turn off the LCD.
- Press the [VIEW] key to display the digest "Latest fault" screen.

Displays in automatic supervision operation

If the automatic supervision function detects a failure while the LCD is off, the "Auto-supervision" screen is displayed automatically, showing the location of the failure, and the "ALARM" LED lights.

Press the [VIEW] key to display other digest screens in turn including the "Metering" and "Latest fault" screens.

Press the [RESET] key to turn off the LEDs and LCD display. However, if the failure continues, the "ALARM" LED remains lit.

After recovery from a failure, the "ALARM" LED and "Auto-supervision" display turn off automatically.

If a failure is detected while any of the screens is displayed, the current screen remains displayed and the "ALARM" LED lights.

Notes:

1) When configurable LEDs (LED1 and LED2) are assigned to latch signals by issuing an alarm, press the [RESET] key more than 3s until all LEDs reset except "IN SERVICE" LED.
2) When configurable LED is still lit by pressing [RESET] key in short period, press [RESET] key again to reset remained LED in the above manner.
3) LED1 and LED2 will remain lit in case the assigned signals are still active state.

While any of the menu screens is displayed, the VIEW and RESET keys do not function. To return to the digest "Auto-supervision" screen, do the following:

- Return to the top screen of the menu by repeatedly pressing the END key.
- Press the END key to turn off the LCD.
- Press the VIEW key to display the digest screen.
- Press the RESET key to turn off the LCD.

4.2.2 Relay Menu

Figure 4.2.1 shows the menu hierarchy in the GRB150. The menu has five sub-menus, "Record", "Status", "Set. (view)", "Set. (change)", and "Test". For details of the menu hierarchy, see Appendix D.

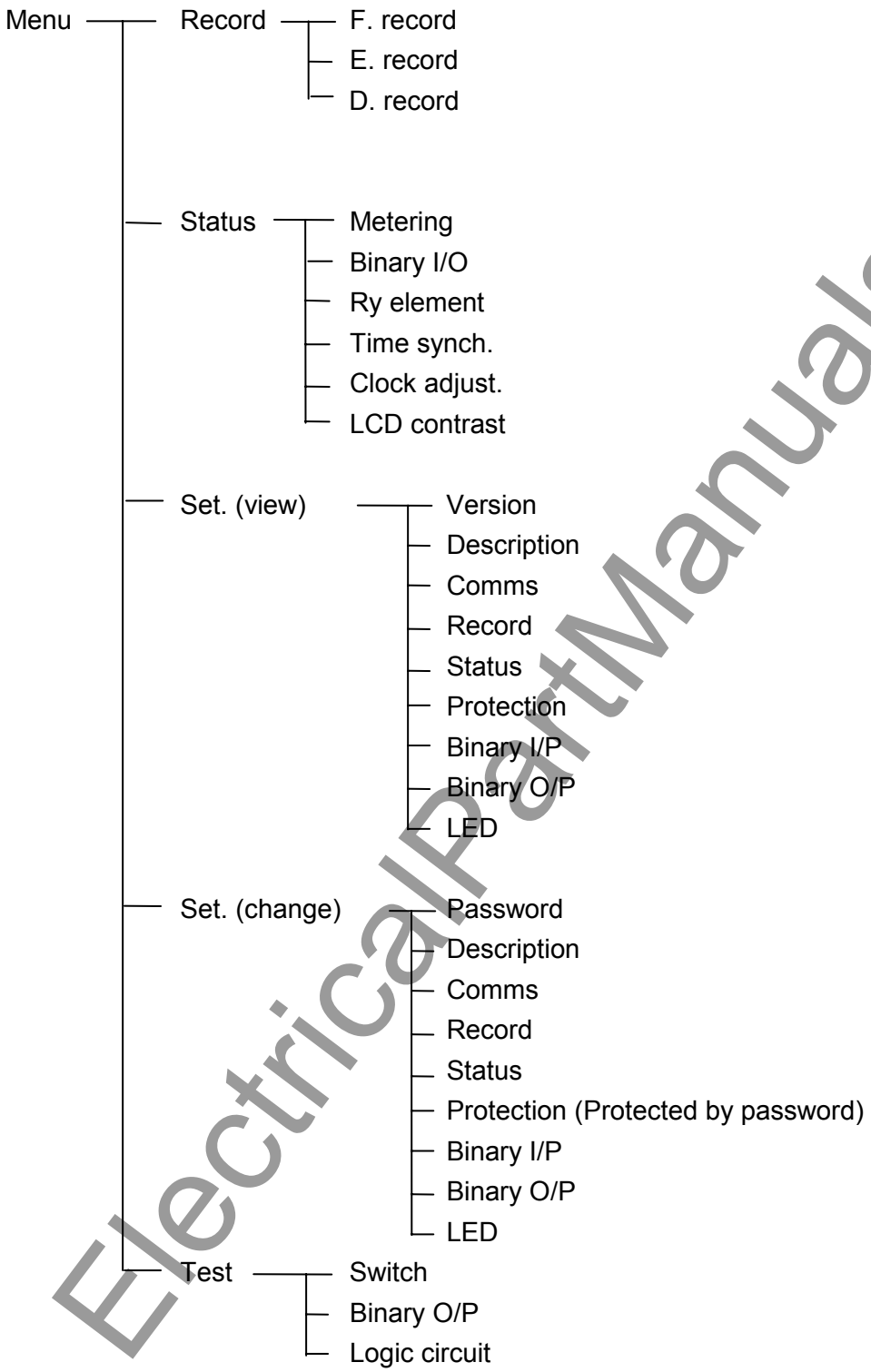


Figure 4.2.1 Relay Menu

Record

In the "Record" menu, the fault record, event record and disturbance record 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, RSM or IEC60870-5-103) and adjusts the clock and LCD contrast.

Set. (view)

The "Set. (view)" menu displays the relay version, description, relay address and baud rate in RSM or IEC60870-5-103 communication, the current settings of record, status, protection, binary inputs, configurable binary outputs and the configurable LEDs.

Set. (change)

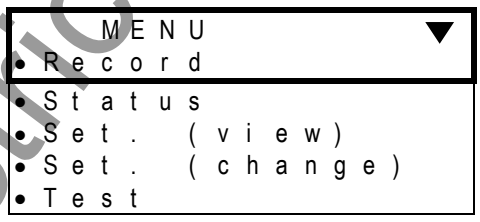
The "Set. (change)" menu is used to change the settings of password, description, relay address and baud rate in RSM or IEC60870-5-103 communication, record, status, protection, binary inputs, configurable binary outputs and configurable LEDs.

Since this is an important menu and is used to change settings related to relay tripping, it has a password security protection.

Test

The "Test" menu is used to set testing switches, to forcibly operate binary output relays 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.

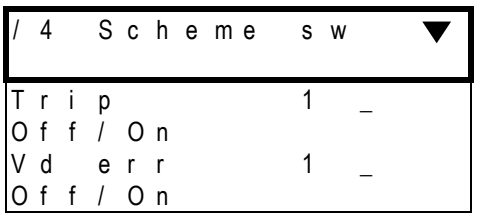


To display the "MENU" screen when the digest screen is displayed, press the [RESET] key to turn off the LCD, then press any key other than the [VIEW] and [RESET] keys.

Press the [END] key when the top screen is displayed to turn off the LCD.

An example of the sub-menu screen is shown below. The top line shows the hierarchical layer. The last item is not displayed for all the screens. "/4" displayed on the far left means that the screen is in the fourth hierarchical layer, while "▲" or "▼" displayed on the far right shows that upper or lower lines exist.

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



To return to the higher screen or move from the right side screen to the left side screen in Appendix D, 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.

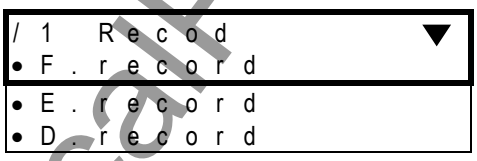
4.2.3 Displaying Records

The sub-menu of "Record" is used to display fault records, event records and disturbance records.

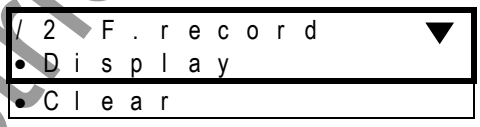
4.2.3.1 Displaying Fault Records

To display fault records, do the following:

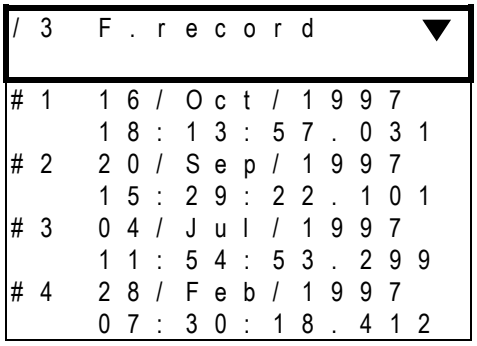
- Open the top "MENU" screen by pressing any keys other than the [VIEW] and [RESET] keys.
- Select "Record" to display the "Record" sub-menu.



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



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



- 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.

```
/ 3  F . r e c o r d  # 1 ▼
1 6 / O c t / 1 9 9 7
1 8 : 1 3 : 5 7 . 0 3 1
D I F - A B C
T r i p
P r e f a u l t  v a l u e s
V d a  * * * . *  V
V d b  * * * . *  V
V d c  * * * . *  V
F a u l t  v a l u e s
V d a  * * * . *  V
V d b  * * * . *  V
V d c  * * * . *  V
```

The lines which are not displayed in the window can be displayed by pressing the ▲ and ▼ keys.

To clear 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.

```
C l e a r  r e c o r d ?
E N D = Y    C A N C E L = 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 digest screens is not displayed.

4.2.3.2 Displaying Event Records

To display event records, do the following:

- Open the top "MENU" screen by pressing any keys other than the [VIEW] and [RESET] keys.
- Select "Record" to display the "Record" sub-menu.
- Select "E. record" to display the "Event record" screen.

```
/ 2  E . r e c o r d  ▼
• D i s p l a y
• C l e a r
```

- Select "Display" to display the events with date from the top in new-to-old sequence.

```
/ 3  E . r e c o r d  ▼
1 6 / O c t / 1 9 9 7
T r i p  O n
1 6 / O c t / 1 9 9 7
V d  e r r  O n
1 6 / O c t / 1 9 9 7
R l y .  c h a n g e
```

The time is displayed by pressing the ▶ key.

```
/ 3   E . r e c o r d          ▼

1 8 : 1 3 : 5 8 . 2 5 5
T r i p                    O n
1 8 : 1 3 : 5 8 . 0 2 8
V d   e r r                O n
1 8 : 1 3 : 5 8 . 5 2 8
R l y .   c h a n g e
```

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 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.

```
C l e a r   r e c o r d ?
E N D = Y     C A N C E L = 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 the 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.

```
/ 2   D . r e c o r d          ▼
• D i s p l a y
• C l e a r
```

- Select "Display" to display the date and time of the disturbance records from the top in new-to-old sequence.

```
/ 3   D . r e c o r d          ▼

# 1   1 6 / O c t / 1 9 9 7
      1 8 : 1 3 : 5 7 . 4 0 1
# 2   2 0 / S e p / 1 9 9 7
      1 5 : 2 9 : 2 2 . 3 8 8
# 3   0 4 / J u l / 1 9 9 7
      1 1 : 5 4 : 5 3 . 4 4 4
# 4   2 8 / F e b / 1 9 9 7
      0 7 : 3 0 : 1 8 . 8 7 6
```

The lines which are not displayed in the window can be displayed by pressing the ▲ and ▼

keys.

To clear 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 Information

From the sub-menu of "Status", the following status condition can be displayed on the LCD and is updated every second:

Metering data of the protected line

Status of binary inputs and outputs

Status of relay elements

Status of time synchronisation source

The user can also adjust the time of the internal clock and the LCD contrast in this sub-menu.

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              ▼
Vd    ***.*  V
```

(Model 101)

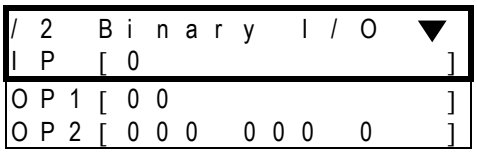
```
/ 2 Metering              ▼
Vda   ***.*  V
Vdb   ***.*  V
Vdc   ***.*  V
```

(Model 201)

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 inputs and outputs status.



The display format is shown below.

	[■	■	■	■	■	■	■	■]
Input (IP)	BI1	—	—	—	—	—	—	—
Output (OP1)	TP-1	TP-2	—	—	—	—	—	—
Output (OP2)	BO1	BO2	BO3	BO4	BO5	BO6	FAIL	—

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

Lines 2 and 3 show the binary output statuses. TP-1 and TP-2 of line 2 correspond to the tripping command outputs. FAIL of line 3 corresponds to the relay failure output. Other outputs expressed with BO1 to BO6 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 energised when the status is "1".

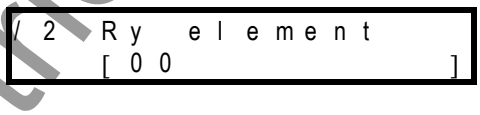
To display all the lines, press the ▲ and ▼ keys.

4.2.4.3 Displaying the Status of Relay Elements

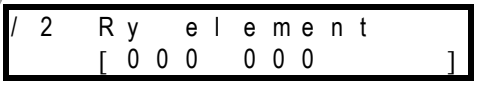
To display the status of measuring elements on the LCD, do the following:

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

Model 101:



Model 201:



The display format is as shown below.

Model 101:

	[■	■	■	■	■	■	■	■]
DIF, DIFSV	DIF	DIFSV						

Model 201:

	[■	■	■	■	■	■	■	■]
DIF, DIFSV	A	B	C	A	B	C		
	DIF			DIFSV				

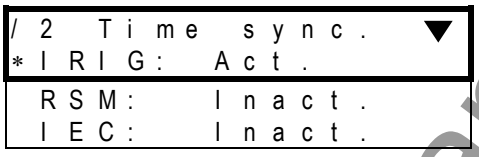
This shows the operation status of differential elements and the supervisory element.

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 GRB150 can be synchronised with external clocks such as the IRIG-B time standard signal clock or RSM (relay setting and monitoring system) clock or IEC60870-5-103. 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.



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 “Loc” is indicated on the top line, showing that the clock is running locally. When “IRI”(IRIG), “RSM” or “IEC” 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.

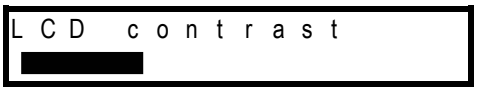
If a date which does not exist in the calendar is set and [END] key is pressed, "**** Error ****"

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 set in the sub-menu "Set. (change)".

The following items are displayed:

Relay version

Description

Relay address and baud rate in the RSM (relay setting and monitoring system) or IEC60870-5-103 communication

Recording setting

Status setting

Protection setting

Binary input setting

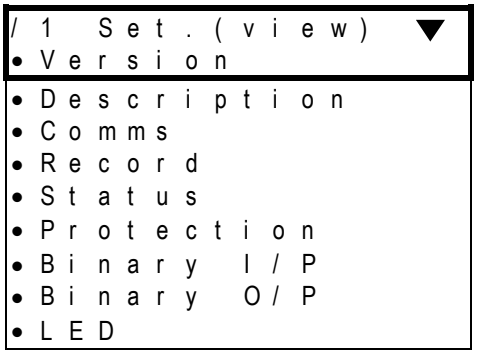
Binary output setting

LED setting

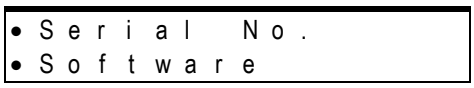
4.2.5.1 Relay Version

To view the relay version, do the following.

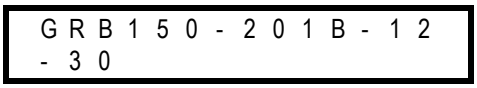
- Select the "Set.(view)" on the main menu.



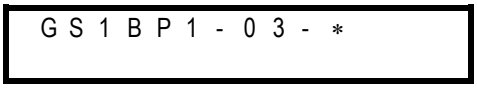
- Select "Version" to display the relay version screen.



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

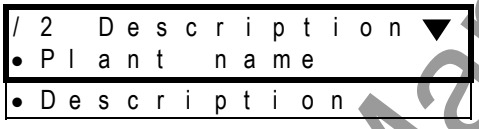


- Select "Serial number" to display the relay manufacturing number.
- Select "Software" to display the relay software type form.



4.2.5.2 Description

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



- Select "Plant name" to display the plant name.
- Select "Description" to display the special items.

4.2.5.3 Settings

The "Comms", "Record", "Status", "Protection", "Binary I/O", "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 and baud rate in the RSM or IEC60870-5-103 communication

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 to enter as follows:

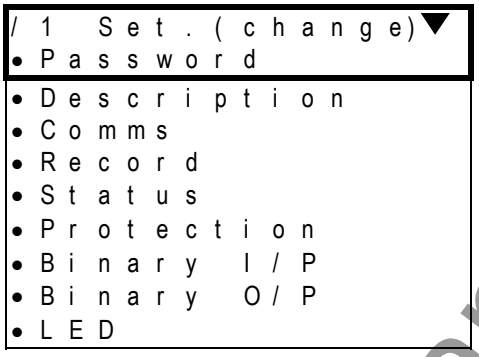
- A selective item
- A text string

- Numerical values

A selected item

If a screen below is displayed, perform the settings as follows.

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

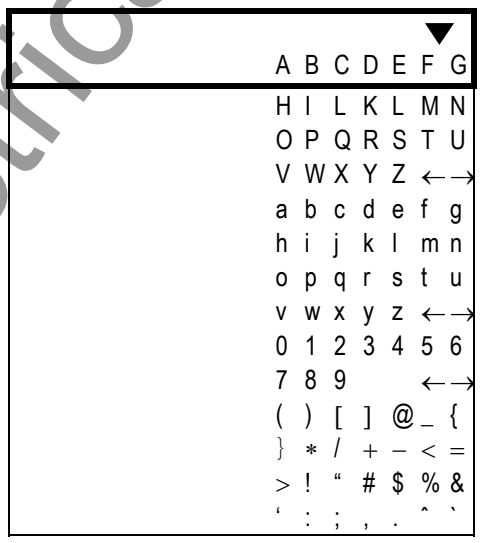


- Move the cursor to a setting item.
- Press the ENTER key.

A text string

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

To select a character, use keys ▼, ▲, ◀ and ▶ to move the 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 within the brackets.



- 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.

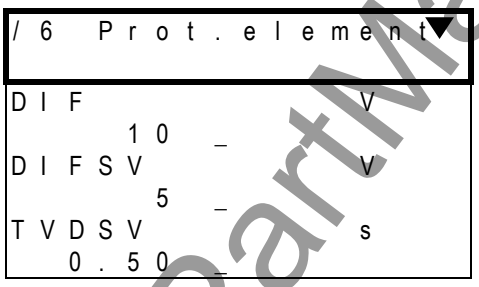
To correct the entered character, do either of the following:

- 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 step.

Numerical values

When a screen shown below is displayed, perform the settings 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 the upper or lower lines within the screen by pressing the ▲ and ▼ keys. If a setting (change) is not required, skip the line with the ▲ and ▼ keys.



- 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 confirm the entry.
- After completing the setting on the screen, press the [END] key to return to the upper screen.

To correct the entered numerical value, do the following.

- If it is before pressing the [ENTER] key, press the [CANCEL] key and enter the new numerical value.
- If it is after pressing the [ENTER] key, move the cursor to the correcting line by pressing the ▲ and ▼ keys and enter the new numerical value.

Note: If the [CANCEL] key is pressed after any of the entry is confirmed by pressing the [ENTER] key, all the entries made so far on the screen concerned are canceled and screen returns to the upper one.

To complete the setting

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 the 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.

```
Input          [ _      ]
0 1 2 3 4 5 6 7 8 9 ←
```

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

```
Retype         [ _      ]
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 password!"

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

```
Password       [ _      ]
0 1 2 3 4 5 6 7 8 9 ←
```

Canceling or changing the password

To cancel the password protection, set "0000" as a password. 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.

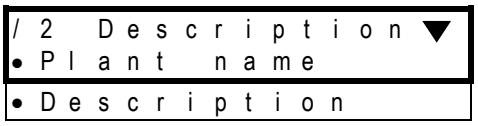
If you forget the password

Press [CANCEL] and [RESET] keys together for one second on the top "MENU" screen. The screen goes off, and the password protection of the GRB150 is canceled. Set the password again.

4.2.6.3 Description

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

- 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.

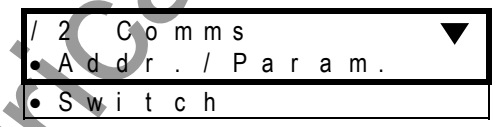
The plant name and special items entered are viewed with the "Set. (view)" sub-menu and attached to disturbance records when they are displayed on a local or a remote PC.

4.2.6.4 Communication

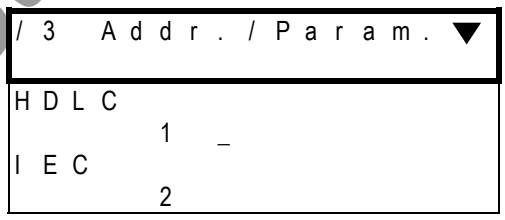
If the relay is linked with RSM (relay setting and monitoring system) or IEC60870-5-103 communication, the relay address must be set. Do this as follows:

Note: The settings related to IEC60870-5-103 communication are available for the relay with dual RS485 port.

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



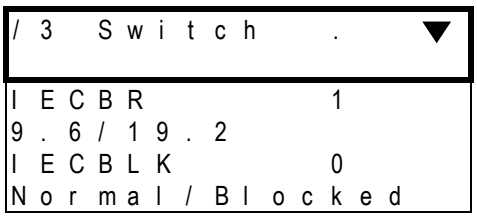
- Select "Addr./Param." on the "Comms" screen to enter the relay address number.



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

CAUTION Do not overlap the relay address number.

- Select "Switch" on the "Comms" screen to select the protocol and transmission speed (baud rate), etc., of the RSM and IEC60870-5-103.



- Select the number and press the ENTER key.

<IECBR>

This line is to select the baud rate when the IEC60870-5-103 system is applied.

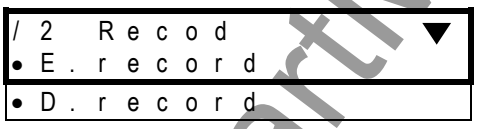
<IECBLK>

Select 1 (=Blocked) to block the monitor direction in the IEC60870-5-103 communication.

4.2.6.5 Setting the Recording

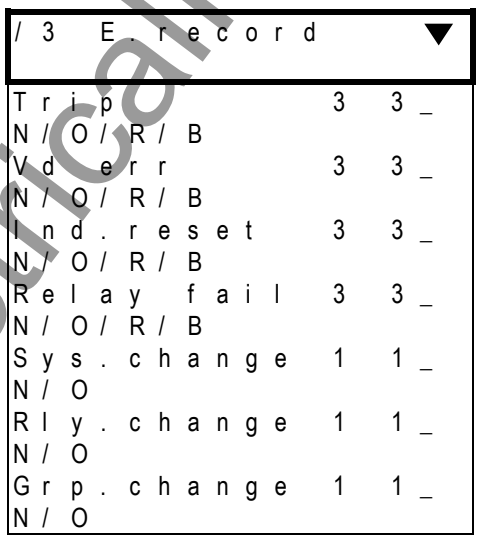
To set the recording function as described in Section 4.2.3, do the following:

- 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 "Event record" screen.



- 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.

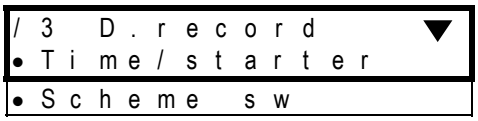
  Enter 1 (= O) to record the event when the status changes to "operate".

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

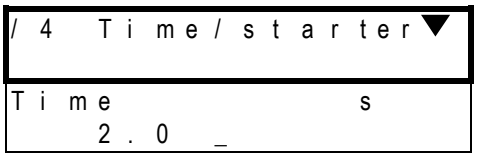
  Enter 3 (= B) to record the event when the status changes both to "operate" and "reset".

Setting the disturbance recording

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



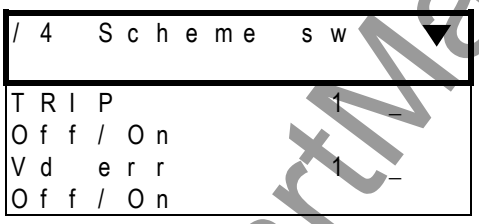
- Select "Time/starter" to display the "Record time" screen.



- Enter the recording time setting.

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

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

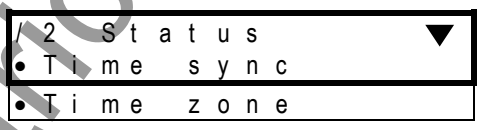


- Enter 1 to use as a starter.
- If the selected switch is not used as a starter, enter 0.

4.2.6.6 Status

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

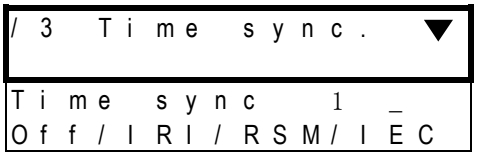
Select "Status" on the "Set. (change)" sub-menu to display the "Status setting" screen.



Setting the time synchronisation

The calendar clock can run locally or be synchronised with the external IRIG-B time standard signal, RSM clock, or by an IEC60870-5-103. This is selected by setting as follows.

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

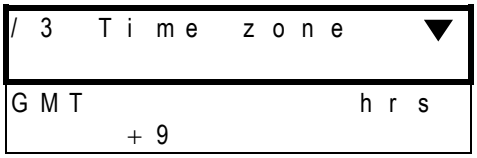
Enter 3 (=IEC) to be synchronised with IEC60870-5-103.

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

Setting the time zone

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

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

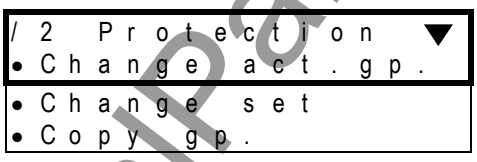


- Enter the difference between GMT and local time from –12 to +12 and press the ENTER key.

4.2.6.7 Protection

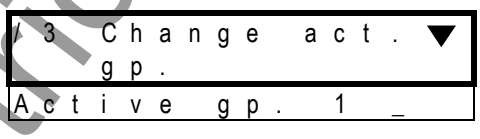
The GRB150 can have 4 setting groups for protection in order to accommodate changes in the operation of the power system, one setting group is assigned active. To set protection, do the following:

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



Changing the active group

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



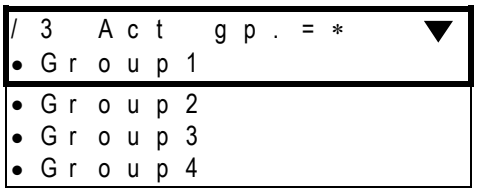
- Enter the group number and press the ENTER key.

Changing the settings

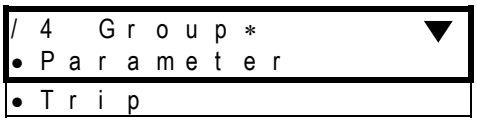
All the setting items have default values that are set when the product was shipped except names and descriptions specified by the user. For the default values, see Appendix C and G.

To change the settings, do the following:

- Select "Change set." to display the "Change setting" screen.



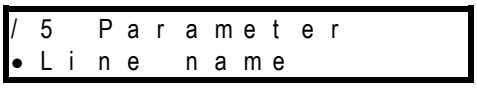
- Select the group number to change the settings and press the [ENTER] key.



Setting the parameter

Enter the line name as follows:

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

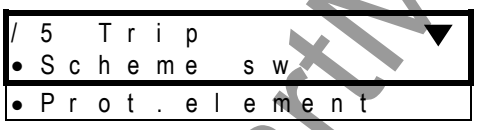


- Select "Line name" to display the "Line name" screen.
- Enter the line name as a text string and press the [END] key.

Setting the trip function

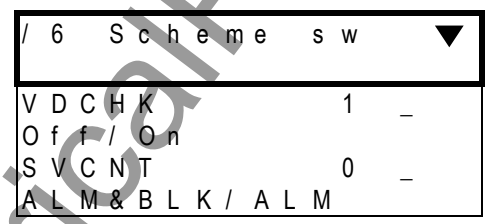
To set the scheme switches and protection elements, do the following.

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



Setting the scheme switch

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



<VDCHK>

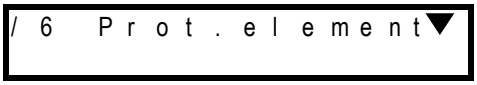
- Enter 1 to perform the differential voltage supervision or enter 0 if you do not need to perform it, and press the [ENTER] key.

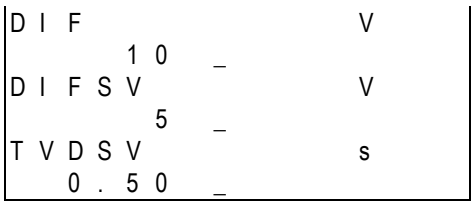
<SVCNT>

- Enter 0 (= ALM&BLK) to output an alarm and to block the trip function by the differential voltage 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 "Protection element" screen.





<DIF>

- Enter the numerical value and press the [ENTER] key.

<DIFSV>

- Enter the numerical value and press the [ENTER] key.

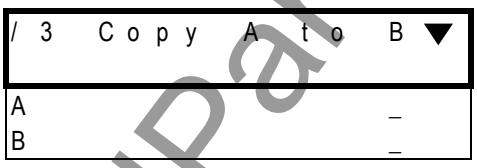
<TVDSV>

- 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.

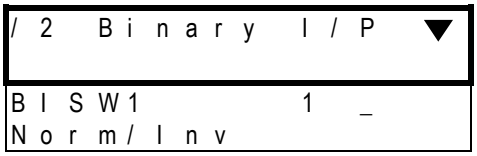


- Enter the group number to be copied in line A and press the [ENTER] key.
- Enter the group number to be overwritten by the copy in line B and press the [ENTER] key.

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 requirement 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 GRB150 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 Instantaneous or delayed or latched reset timing to these signals.

Appendix C shows the factory default settings.

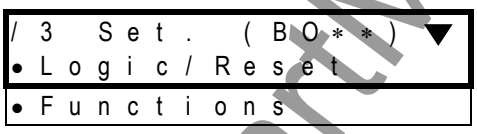
To configure the binary output signals, do the following:

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.

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



Setting the logic gate type and reset type

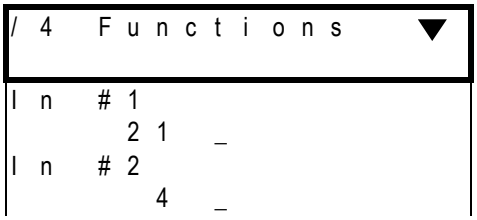
- Select "Logic/Reset" to display the "Logic/Reset" screen.

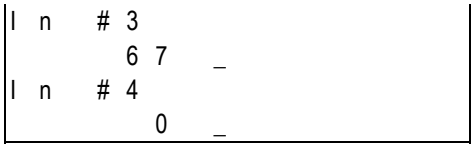
- Enter 0 (= OR) or 1 (= AND) to use an OR gate or AND gate and press the ENTER key.
- Enter 0 (= Instantaneous) or 1 (= Delayed) or 2 (=Latched) to select the reset timing and press the ENTER key.
- Press the END key to return to the "Set. (BO**)" screen.

Note: To release the latch state, push the [RESET] key for more than 3 seconds.

Assigning signals

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





- Assign signals to gates (In #1 to #4) by entering the number corresponding to each signal referring to Appendix B. Do not assign the signal numbers 120 to 125 (signal names: "BO1 OP" to "BO6 OP").

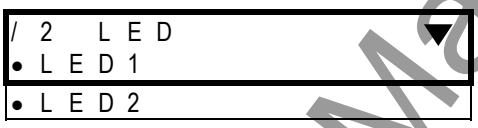
Note: If signals are not assigned to all the gates #1 to #4, enter 0 for the unassigned gate(s).

Repeat this process for the outputs to be configured.

4.2.6.10 LEDs

Two LEDs of the GRB150 are user-configurable. A configurable LED can be programmed to indicate the OR/AND combination of a maximum of 4 elements. 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.

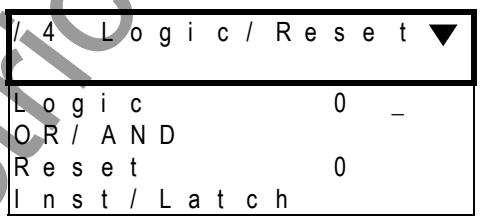


Note: The setting is required for all the LEDs. If any of the LEDs are not used, enter 0 to logic gates #1 to #4 in assigning signals.

- Select the LED number and press the ENTER key to display the "LED∗" screen.

Setting the logic gate type and reset type

- Select "Logic/Reset" to display the "Logic/Reset" screen.

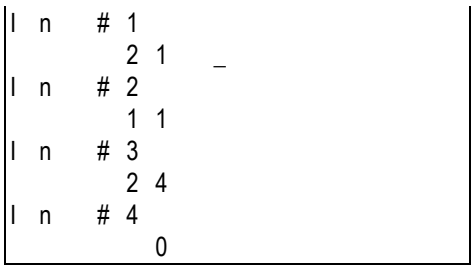


- Enter 0 (= OR) or 1 (= AND) to use an OR gate or AND gate and press the ENTER key.
- Enter 0 (= Instantaneous) or 1(=Latched) to select the reset timing and press the ENTER key.
- Press the END key to return to the "LED∗" screen.

Note: To release the latch state, push the [RESET] key for more than 3 seconds.

Assigning signals

- Select "Functions" on the "LED∗" screen to display the "Functions" 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).

- Press the END key to return to the "LED∗" screen.

Repeat this process for all the LEDs to be configured.

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.

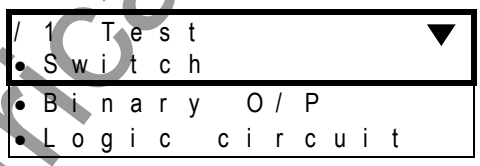
4.2.7.1 Scheme switch

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

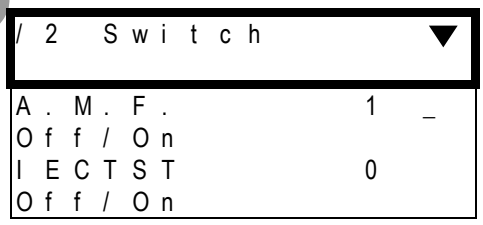
Disabling the A.M.F. inhibits trip blocking even in the event of a failure in the items being monitored by this function. It also prevents failures from being displayed on the "ALARM" LED and LCD described in Section 4.2.1. No events related to A.M.F. are recorded, either.

Disabling the 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.
- Enter 1(=On) for IECTST to transmit 'test mode' to the control system by IEC60870-5-103 communication when testing the local relay, and press the ENTER key.
- Press the END key to return to the "Test" screen.

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.

```
/ 2  Binary  O/P  ▼
TP-1              0  _
Disable/Enable
TP-2              0  _
Disable/Enable
BO1               0  _
Disable/Enable
BO2               0  _
Disable/Enable
BO3               0  _
Disable/Enable
BO4               0  _
Disable/Enable
BO5               0  _
Disable/Enable
BO6               0  _
Disable/Enable
FAIL              0  _
Disable/Enable
```

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

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

- Keep pressing the [ENTER] key to operate the assigned output relay(s).
- Release pressing the [ENTER] key to reset the operation.
- Press the [CANCEL] key to return to the upper "Binary O/P" screen.

4.2.7.3 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 differential voltage are available in addition to the items available on the LCD screen.

- Display of differential voltage waveform: Oscillograph, vector display
- Harmonic 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 the telecommunication network using a remote PC.

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

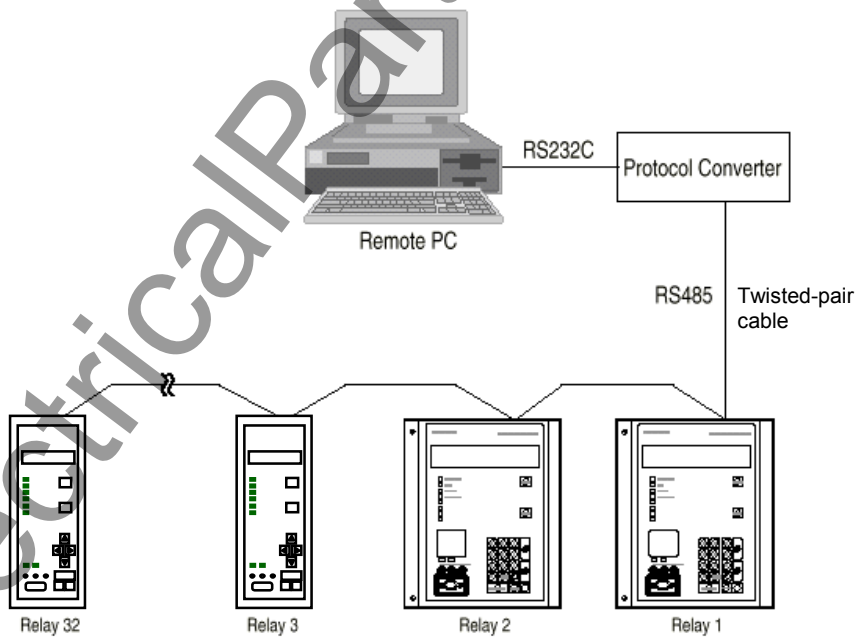


Figure 4.4.1 Relay Setting and Monitoring System

4.5 IEC 60870-5-103 Interface

The GRB150 can support the IEC60870-5-103 communication protocol. This protocol is mainly used when the relay communicates with a control system and is used to transfer the following measurand, status data and general command from the relay to the control system.

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

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

The protocol can be used through the RS485 port on the relay rear panel and can be also used through the optional fibre optical interface. The relay connection is similar to Figure 4.4.1.

The relay supports two baud-rates 9.6kbps and 19.2kbps.

The data transfer from the relay can be blocked by the setting.

For the settings, see the Section 4.2.6.4.

4.6 Clock Function

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

- Event records
- Disturbance records
- Fault records

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

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

When the relays are connected to the RSM system as shown in Figure 4.4.1, the calendar clock of each relay is 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 synchronised 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 damage 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 E 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 F.

6. Commissioning and Maintenance

6.1 Outline of Commissioning Tests

The GRB150 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 a 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
Human interface

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

- When testing the relay, house it in the case and test it.
- While the power is on, do not draw out/insert the relay unit.
- Before turning on the power, check the followings.
  - 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 voltage source
1 DC power supply
1 AC voltmeter
1 DC voltmeter
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 G Relay Setting Sheet

Visual inspection

After unpacking the product, check for any damage to the relay case. If there is any damage, the internal module might also have been affected. Contact the vendor.

Relay ratings

Check that the items described on the nameplate on the front of the relay conform to the user's specification. The items are: relay type and model, AC voltage, current and frequency ratings, and auxiliary DC supply voltage rating.

Local PC

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

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

6.4 Hardware Tests

The tests can be performed without external wiring, but a DC power supply and AC voltage source are required.

6.4.1 User Interfaces

This test ensures that the LCD, LEDs and keys function correctly.

LCD display

- Apply the rated DC voltage and check that the LCD is off.

  Note: If there is a failure, the LCD will display the "Err: " screen when the DC voltage is applied.

- Press the [RESET] key 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 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.

▼, ▲, ◀ and ▶ 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.

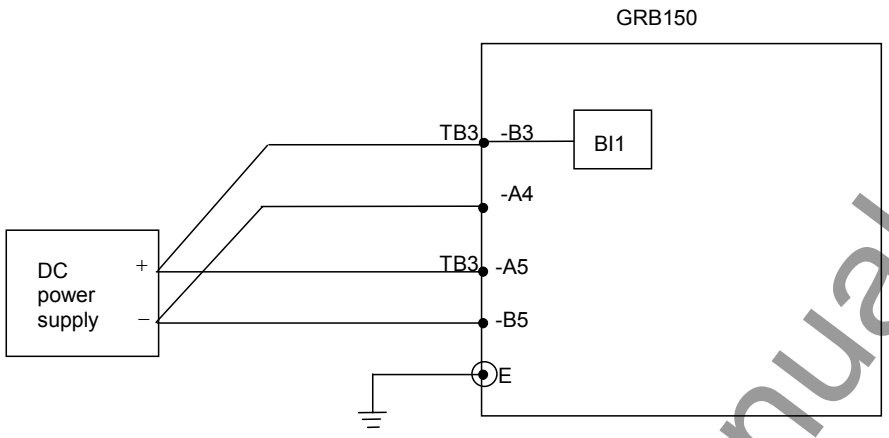


Figure 6.4.1 Testing Binary Input Circuit

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

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

- Apply rated DC voltage to terminal B3 of terminal block TB3.

  Check that the status display corresponding to the input signal changes from 0 to 1. (For the binary input status display, see Section 4.2.4.2.)

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 F.

- Select "Binary O/P" on the "Test" screen to display the "Binary O/P" screen. The LCD will display 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
B O 1                0  _
D i s a b l e / E n a b l e
B O 2                0  _
D i s a b l e / E n a b l e
B O 3                0  _
```

- Enter 1 at any B/O(s) tested 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.

```
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 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 voltages 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 voltage source is required.

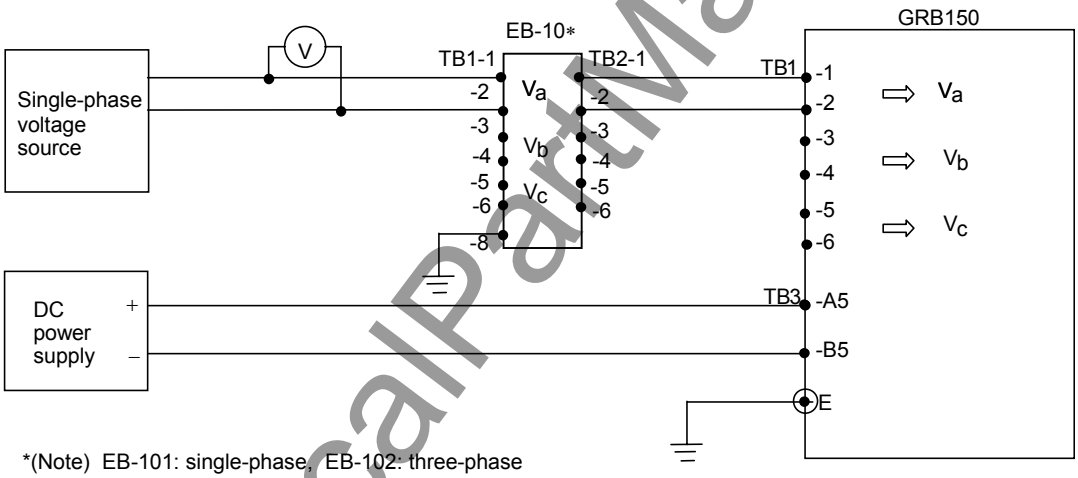


Figure 6.4.2 Testing AC Input Circuit

- Check the metering data on the "Metering" screen.

  "Setting (view)" sub-menu → "Status" setting screen → "Metering" screen

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

  "Status" sub-menu → "Metering" screen

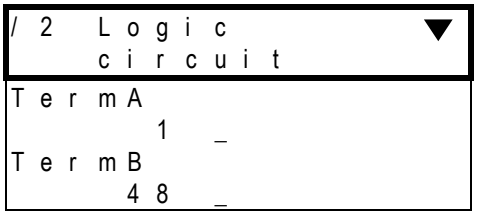
- Apply AC voltages and check that the displayed values are within ±5% of the input values.

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.

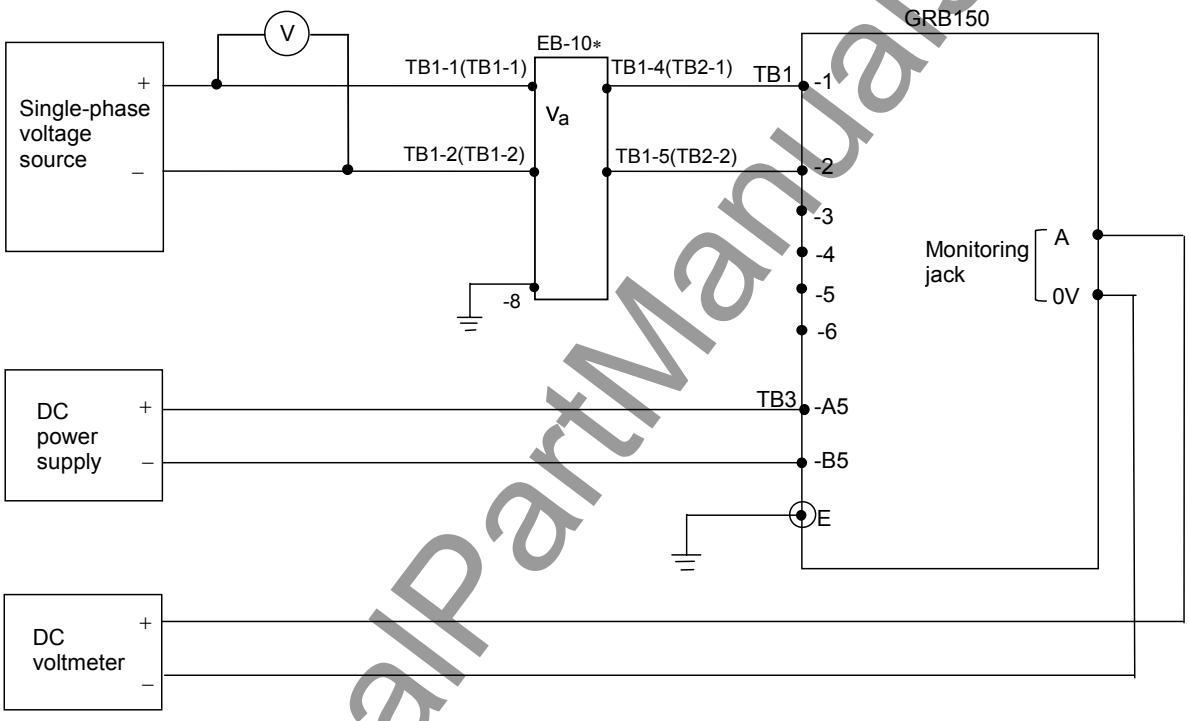
6.5.1.1 Differential element DIF

The differential element is checked for the following:

- Operating voltage value
- Operating time

Operating voltage value

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



*(Note) EB-101: single-phase, EB-102: three-phase. The terminal No. shown in the parentheses are in the case of EB-102.

Figure 6.5.1 Operating Voltage Value Test Circuit

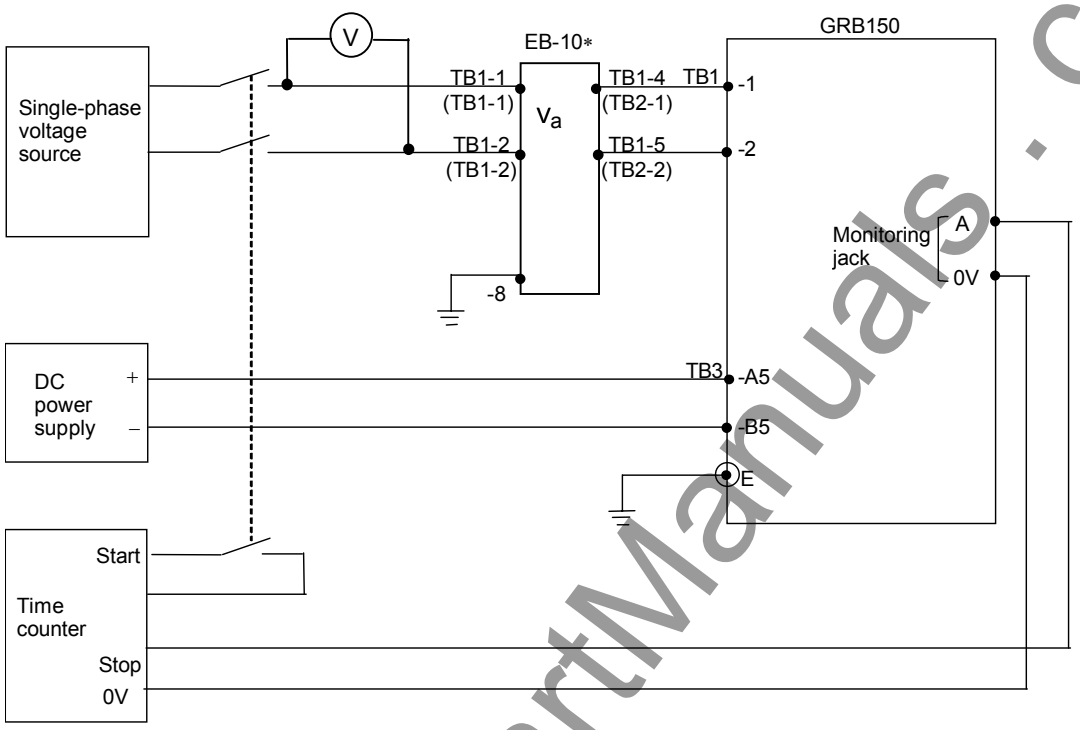
The output signal numbers of the DIF elements are as follows:

Element	Signal number	Remarks
DIF-A (DIF)	11	
DIF-B	12	
DIF-C	13	

- Select "Logic circuit" on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter signal number 11 to observe the DIF-A operation at monitoring jack A and press the [ENTER] key.
- Apply a test voltage and change the magnitude of the voltage applied and measure the value at which the element operates.
  Check that the measured value is within 10% of the setting value.

Operating time

The testing circuit is shown in Figure 6.5.2.



*(Note) EB-101: single-phase, EB-102: three-phase. The terminal No. shown in the parentheses are in the case of EB-102.

Figure 6.5.2 Operating Time Test

- Set the test current to 2 times the DIF setting value.
- Apply the test voltage and measure the operating time.
- Check that the operating time is 20 ms or less.

6.5.1.2 Supervisory element DIFSV

The supervisory element is checked for the operating voltage value.

Operating voltage value

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

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

Element	Signal number	Remarks
DIFSV-A	14	
DIFSV-B	15	
DIFSV-C	16	

- Select "Logic circuit" on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter signal number 14 to observe the DIFSV-A operation at monitoring jack A and press

the [ENTER] key.

- Apply a test voltage and change the magnitude of the voltage applied and measure the value at which the element operates.
  Check that the measured value is within 10% of the setting value.

6.5.2 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 and 2.

Differential tripping

The tripping should be checked for the voltage which is two times or larger than the minimum operating voltage DIF. Operating time is measured by the operating time of the tripping command output relay. It is usually 20ms.

Check that the indications and recordings are correct.

6.5.3 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 event is an external event 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 with the RSM100 software. Check that the descriptions on the PC are correct. For details on how to obtain disturbance records on the PC, see the RSM100 Manual.

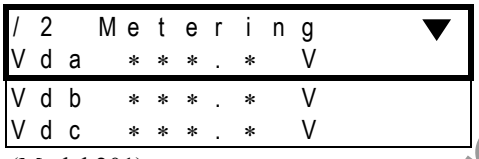
6.6 Conjunctive Tests

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 transformer with the metering displays on the LCD screen.

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

(Model 101)



(Model 201)

- Check that the differential voltage Vd or Vda, Vdb and Vdc are sufficiently smaller than the DIF and DIFSV setting values.

6.6.2 Tripping Circuit Test

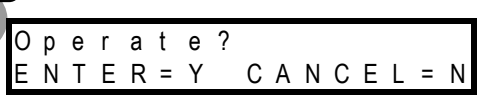
The tripping circuit including the circuit breaker is checked by forcibly operating the output relay and monitoring the circuit breaker to confirm that it is tripped. Forcible operation of the output relay is performed on the "Binary O/P " screen of the "Test" sub-menu as described in Section 6.4.3.

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 and -2 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.



- Keep pressing the [ENTER] key to operate the output relay TP-1 and check that the No.1 breaker is tripped.
- Stop pressing the [ENTER] key to reset the operation.
- Repeat the above for TP-2.

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.

If any messages are shown on the LCD, the failure item can be indicated by referring to Table 6.7.1.

This table shows the relationship between messages displayed on the LCD and estimated failure location. The location marked with (1) has a higher probability than the location marked with (2).

Table 6.7.1 LCD Message and Failure Location

Message	Failure location		
	Relay Unit	EB-101 or -102	AC cable
Err: Sum	×		
Err: MEM	×		
Err: RAM	×		
Err: BRAM	×		
Err: ROM	×		
Err: A/D	×		
Err: SP	×		
Err: DI	×		
Err: DO	×		
Err: LCD	×		
Err: Vd	× (1)	× (2)	× (2)

If no message is shown on the LCD, this means that the failure location is either in the DC power supply circuit or in the microprocessors.

When 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.
- Relay unit is securely inserted in position.
- Correct DC power voltage with correct polarity is applied and connected to the correct terminals.
- Correct AC inputs are applied and connected to the correct terminals.
- Test procedures comply with those stated in the manual.

6.7.3 Replacing a Failed Relay Unit

If a failure is identified 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 No. and relay version (software type form) as the removed relay.

The Model No. 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 approximately 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.

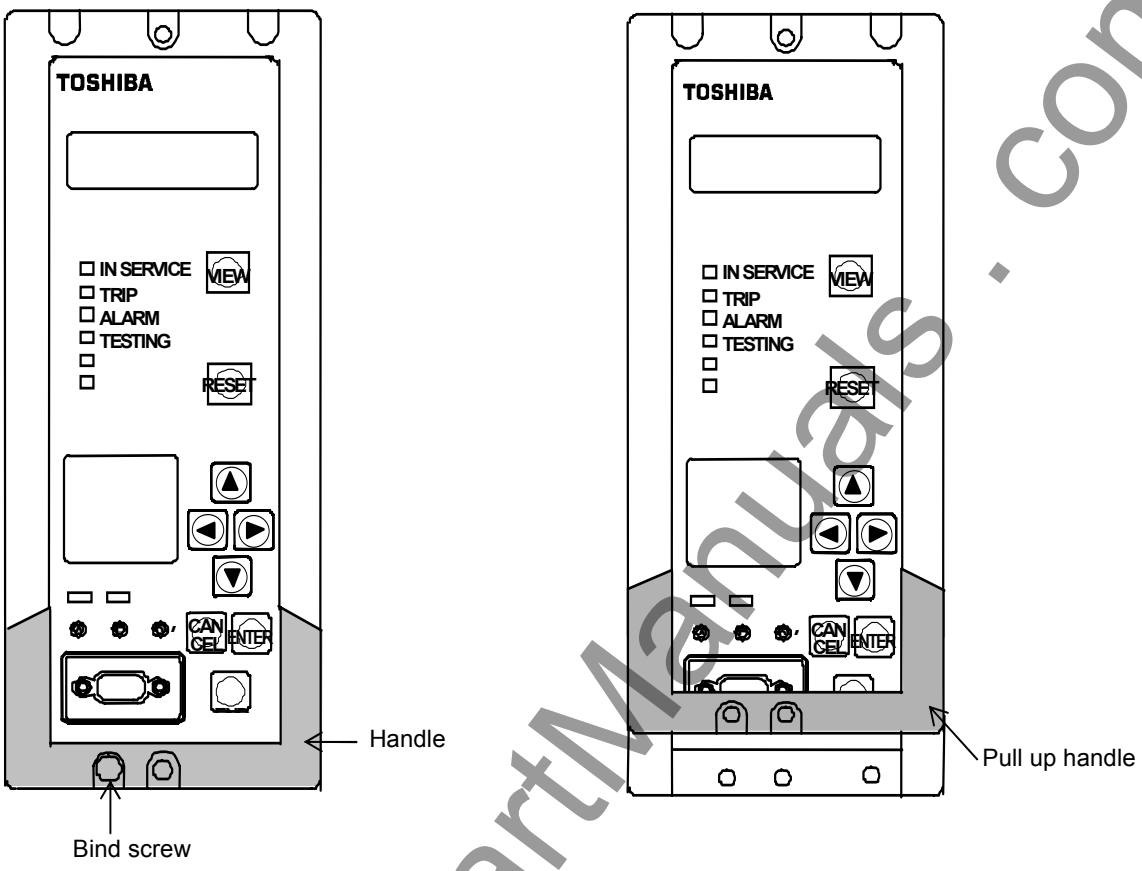


Figure 6.7.1 Handle of Relay Unit

6.7.4 Resumption of Service

After replacing the failed relay unit or repairing failed external circuits, take the following procedures to put the relay into 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 between –25°C and +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 external connections are correct.
- Check the settings of all measuring elements, timers, scheme switches, recordings and clock are correct.

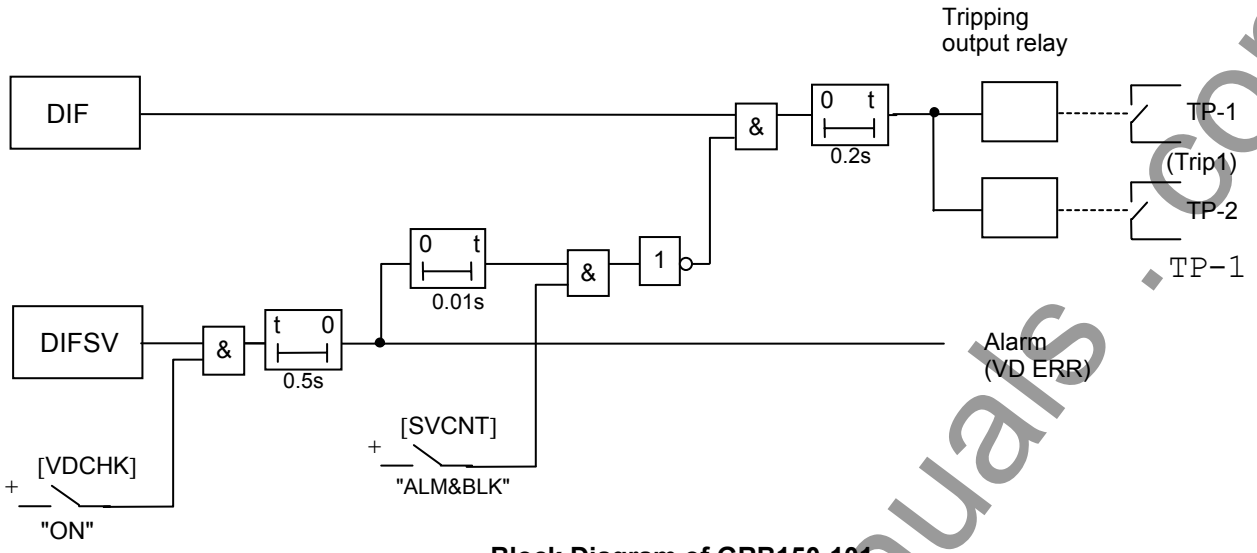
  In particular, when settings are changed temporarily for testing, be sure to restore them.
- Clear any unnecessary records on faults, events and disturbances which are recorded during the tests.

  CAUTION:

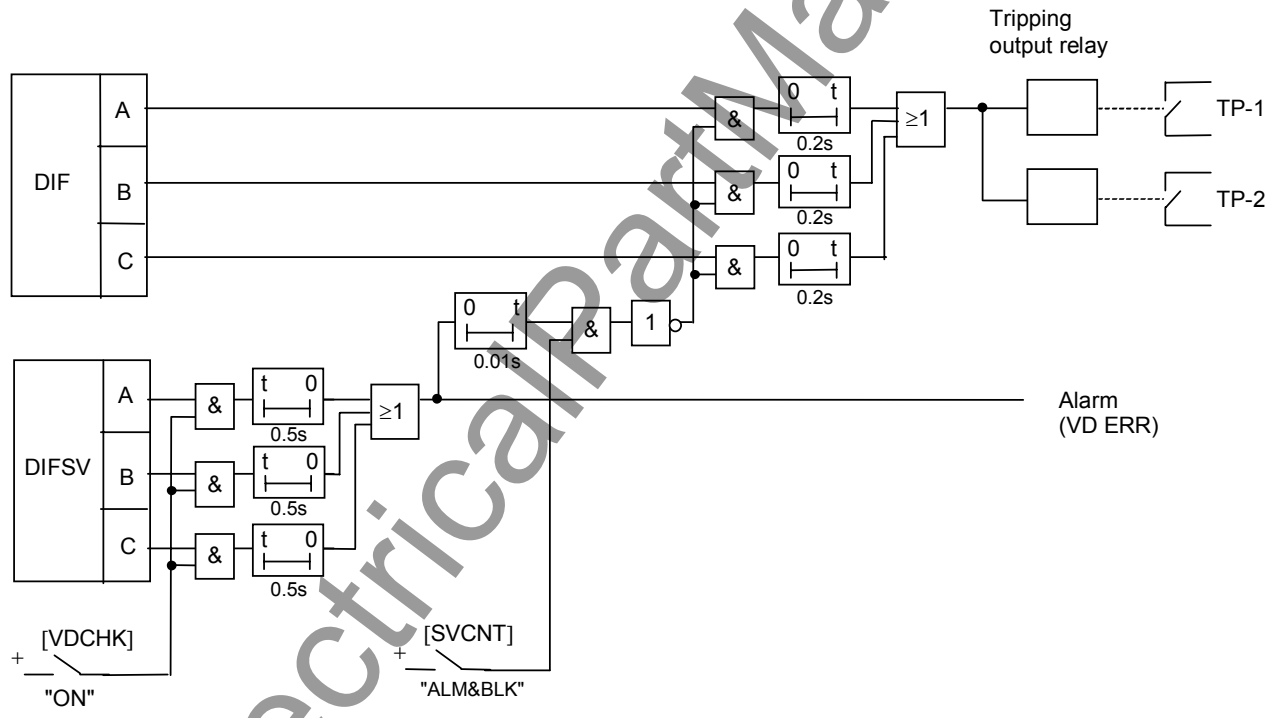
  If dc power has not been supplied to the relay for two days or more, then it is recommended that all fault records, event records and disturbance records be cleared soon after restoring the power. This is because the back-up RAM may have discharged and may contain uncertain data.
- Press the [VIEW] key 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 of GRB150-101



Block Diagram of GRB150-201

DIF: Differential element
DIFSV: Supervisory element of DIF
VDCHK: Vd check
SVCNT: Supervision control switch
VD ERR: Voltage differential error

Appendix B

Signal List

SIGNAL LIST

No.	SIGNAL NAME	CONTENTS	No.	SIGNAL NAME	CONTENTS	No.	SIGNAL NAME	CONTENTS
0	Zero Level	"0" (Zero logic)						
1	IND.RESET	BI (INDICATION RESET)	81			161		
2			82			162	GEN PICKUP	GENERAL START/PICK-UP
3			83			163		
4			84			164	DI ERR	DI CONTACT ERROR
5			85			165		
6			86			166	FAULT RECORD DONE	FAULT RECORD DONE
7			87			167		
8			88			168		
9			89			169		
10			90			170		
11	DIF-A	DIFFERENTIAL RELAY	91			171		
12	B	ditto	92			172		
13	C	ditto	93			173		
14	DIFSV-A	DIFFERENTIAL RELAY FOR SV	94			174		
15	B	ditto	95			175		
16	C	ditto	96			176		
17			97			177		
18			98			178		
19			99			179		
20			100			180		
21	TRIP-A	TRIP SIGNAL	101	RELAY FAIL	RELAY FAIL	181		
22	TRIP-B	ditto	102	RELAY BLOCK	RELAY BLOCK	182		
23	TRIP-C	ditto	103	TESTING	TEST SWITCH ACTIVATED	183		
24	VD ERR-A	VOLTAGE DIFFERENTIAL ERR	104	RELAY FAIL-A	RELAY FAIL-A	184		
25	VD ERR-B	ditto	105			185		
26	VD ERR-C	ditto	106			186		
27	VD ERR-OR	ditto	107			187	PROT COM RCV	PROTECTION COMMAND RECEIVE
28	TRIP	TRIP SIGNAL	108			188	TPLED RST RCV	TRIP LED RESET RECEIVE
29			109			189		
30			110			190		
31			111			191	PRGLED/DO RST RCV	PROGRAMMABLE LED/DO RESET
32			112			192		
33			113			193	SET.GROUP1	ACTIVE GRP CHANGED COMMAND
34			114			194	SET.GROUP2	ditto
35			115			195	SET.GROUP3	ditto
36			116			196	SET.GROUP4	ditto
37			117			197		
38			118			198		
39			119			199		
40			120	BO1 OP	Binary output1	200		
41	TRIP-H	TRIP SIGNAL HOLD	121	BO2 OP	Binary output2			
42			122	BO3 OP	Binary output3			
43			123	BO4 OP	Binary output4			
44			124	BO5 OP	Binary output5			
45			125	BO6 OP	Binary output6			
46			126					
47			127					
48			128					
49			129					
50			130					
51	Δ. M.F OFF	SV BLOCK	131	IECBLK	MONITORING DIRECTION BLOCK			
52	FALUT RECORD INITIATION	TRIG OF FAULT RECORD	132	IECTST	TEC103 TESTMODE			
53	IND.DAT TRIG	ditto	133	GROUP1 ACTIVE	GROUP1 ACTIVE			
54	DIF-AT	FALLT RECORD DATA	134	GROUP2 ACTIVE	GROUP2 ACTIVE			
55	DIF-BT	ditto	135	GROUP3 ACTIVE	GROUP3 ACTIVE			
56	DIF-CT	ditto	136	GROUP4 ACTIVE	GROUP4 ACTIVE			
57			137					
58			138					
59			139					
60			140					
61			141	LOCAL OP ACT.	LOCAL OPERATION ACTIVE			
62			142	REMOTE OP ACT.	REMOTE OPERATION ACTIVE			
63			143	NORMAL LED ON	IN SERVICE LED ON			
64			144	ALARM LED ON	ALARM LED ON			
65			145	TRIP LED ON	TRIP LED ON			
66			146	TEST LED ON	TEST LED ON			
67			147					
68			148					
69			149	LED RESET	TRIP LED RESET			
70			150					
71			151					
72			152					
73			153					
74			154					
75			155	PROT COM ON	PROTECTION COMMAND ON			
76			156	PRG. LED1 ON	PROGRAMMABLE LED1 ON			
77			157	PRG. LED2 ON	PROGRAMMABLE LED2 ON			
78			158					
79			159					
80			160					

Appendix C

Binary Output Default Setting List

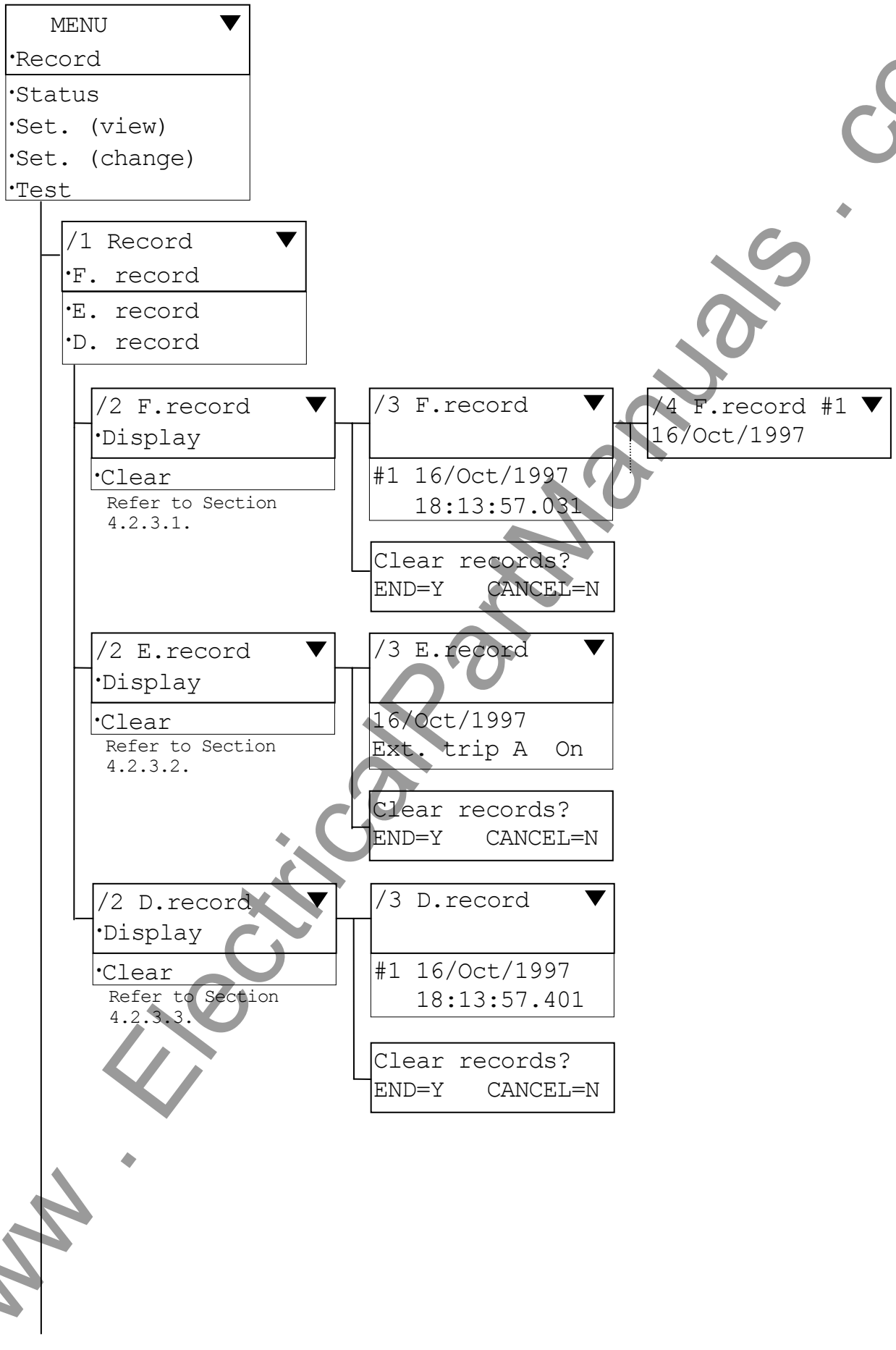
Binary Output Default Setting List

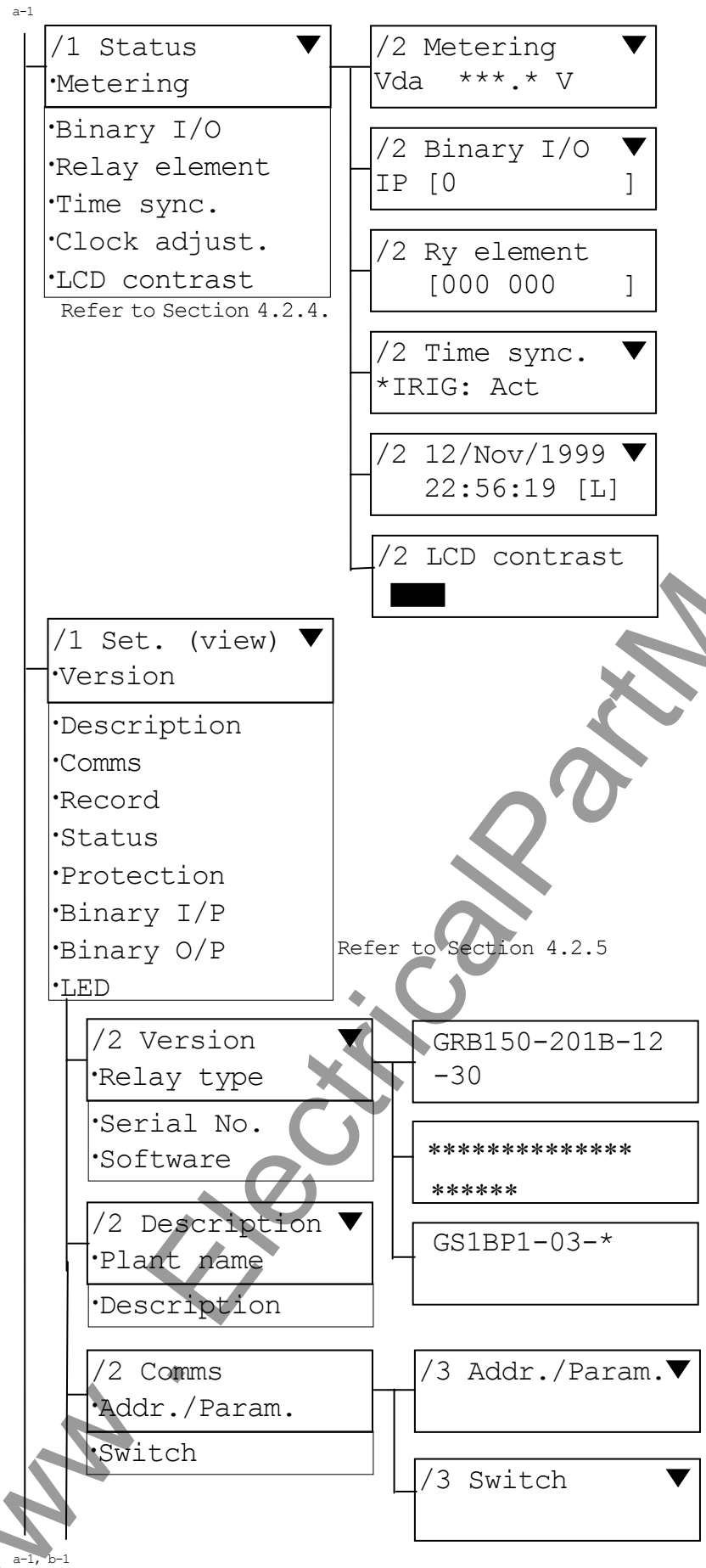
Model	BO No.	Signal Name	Contents	Setting					
				Signal No.(See Appendix B)				LOGIC (OR:0, AND:1)	Reset (Inst:0, Del:1, Latch:2)
				In #1	In #2	In #3	In #4		
101									
	BO1	VD ERR	Voltage Differential error	24	0	0	0	0	1
	BO2	VD ERR	Voltage Differential error	24	0	0	0	0	1
	BO3	VD ERR	Voltage Differential error	24	0	0	0	0	1
	BO4	TRIP	Trip signal	21	0	0	0	0	1
	BO5	TRIP	Trip signal	21	0	0	0	0	1
	BO6	TRIP	Trip signal	21	0	0	0	0	1
201									
	BO1	VD ERR-A	Voltage Differential error	24	0	0	0	0	1
	BO2	VD ERR-B	Voltage Differential error	25	0	0	0	0	1
	BO3	VD ERR-C	Voltage Differential error	26	0	0	0	0	1
	BO4	TRIP-A	Trip signal	21	0	0	0	0	1
	BO5	TRIP-B	Trip signal	22	0	0	0	0	1
	BO6	TRIP-C	Trip signal	23	0	0	0	0	1

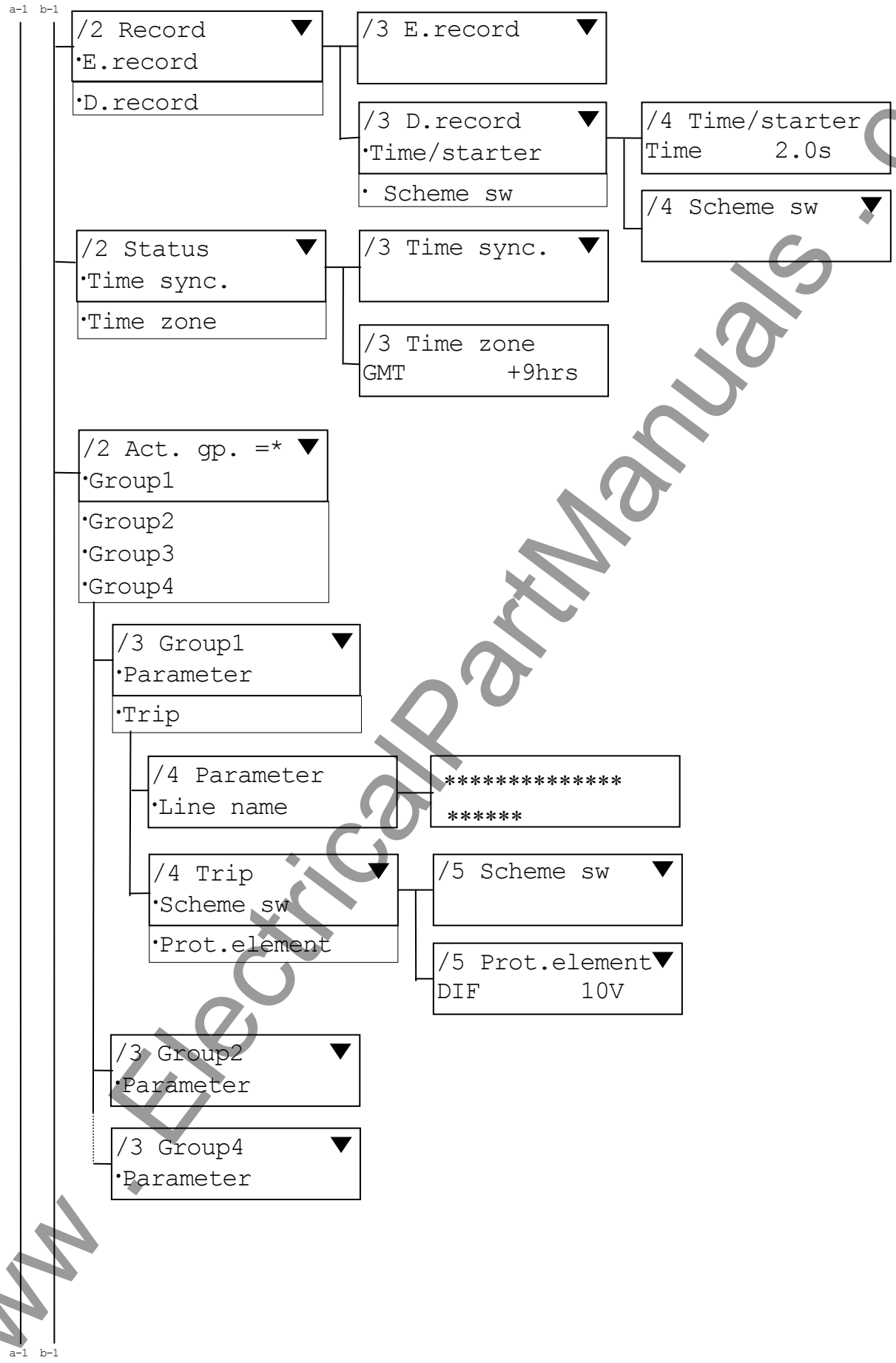
For configuration, see Figure 3.2.2.

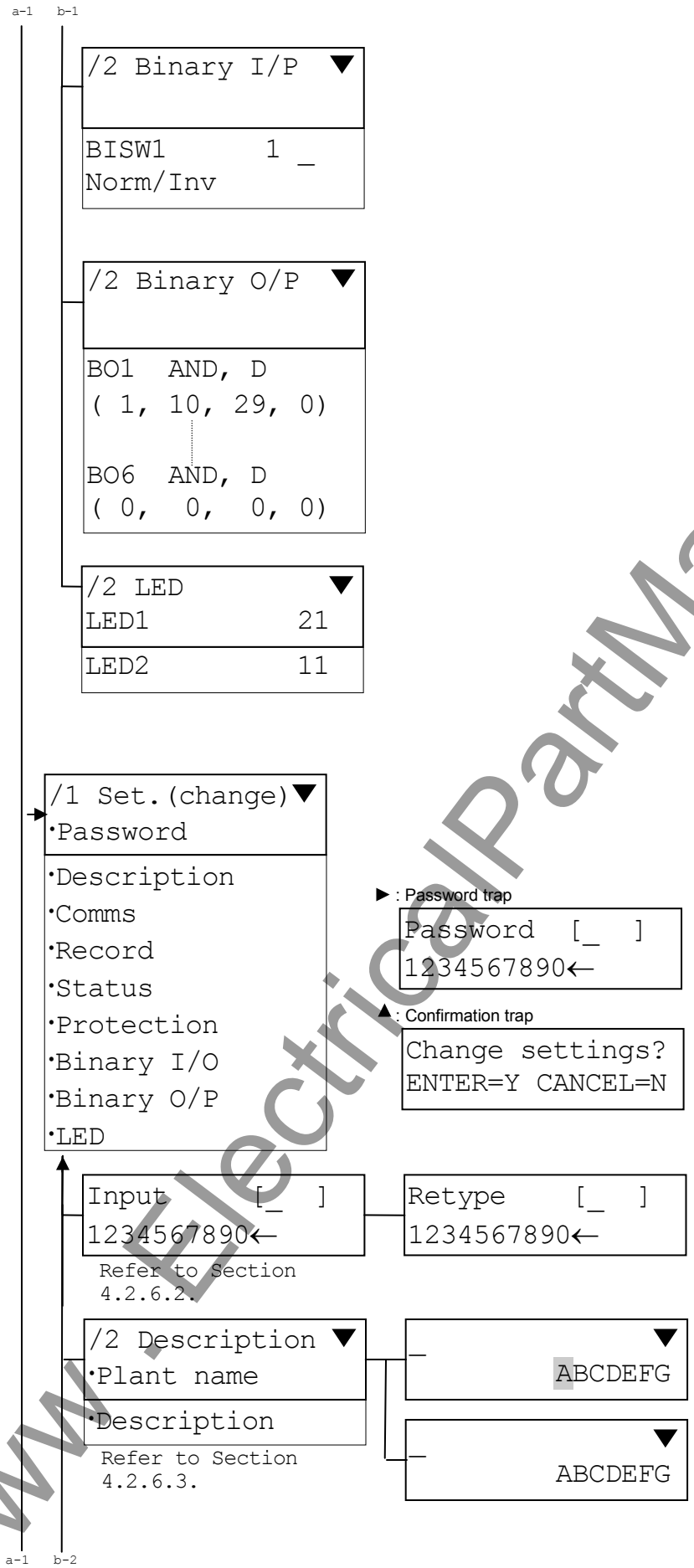
Appendix D

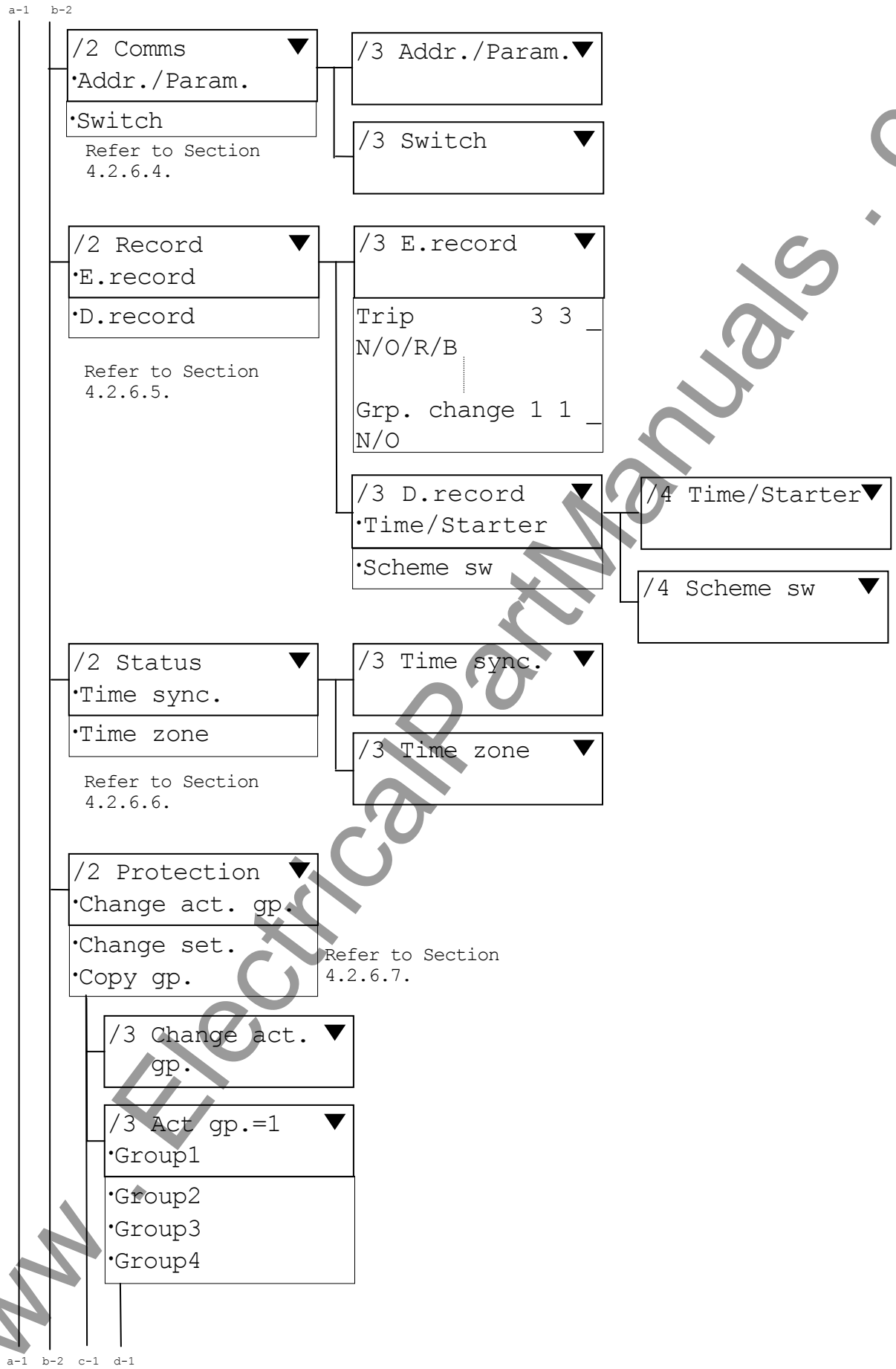
Details of Relay Menu and LCD & Button Operation Instruction

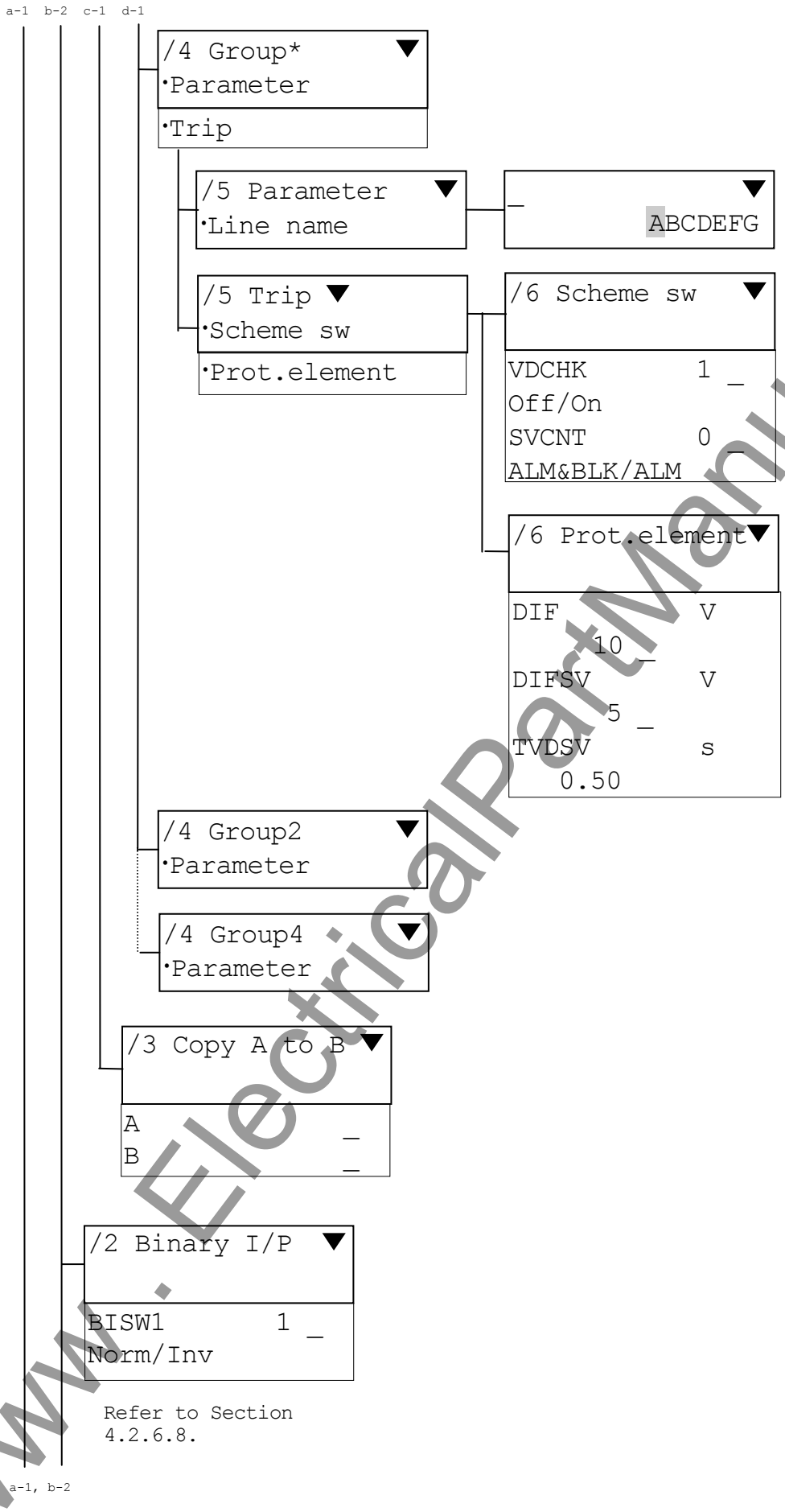


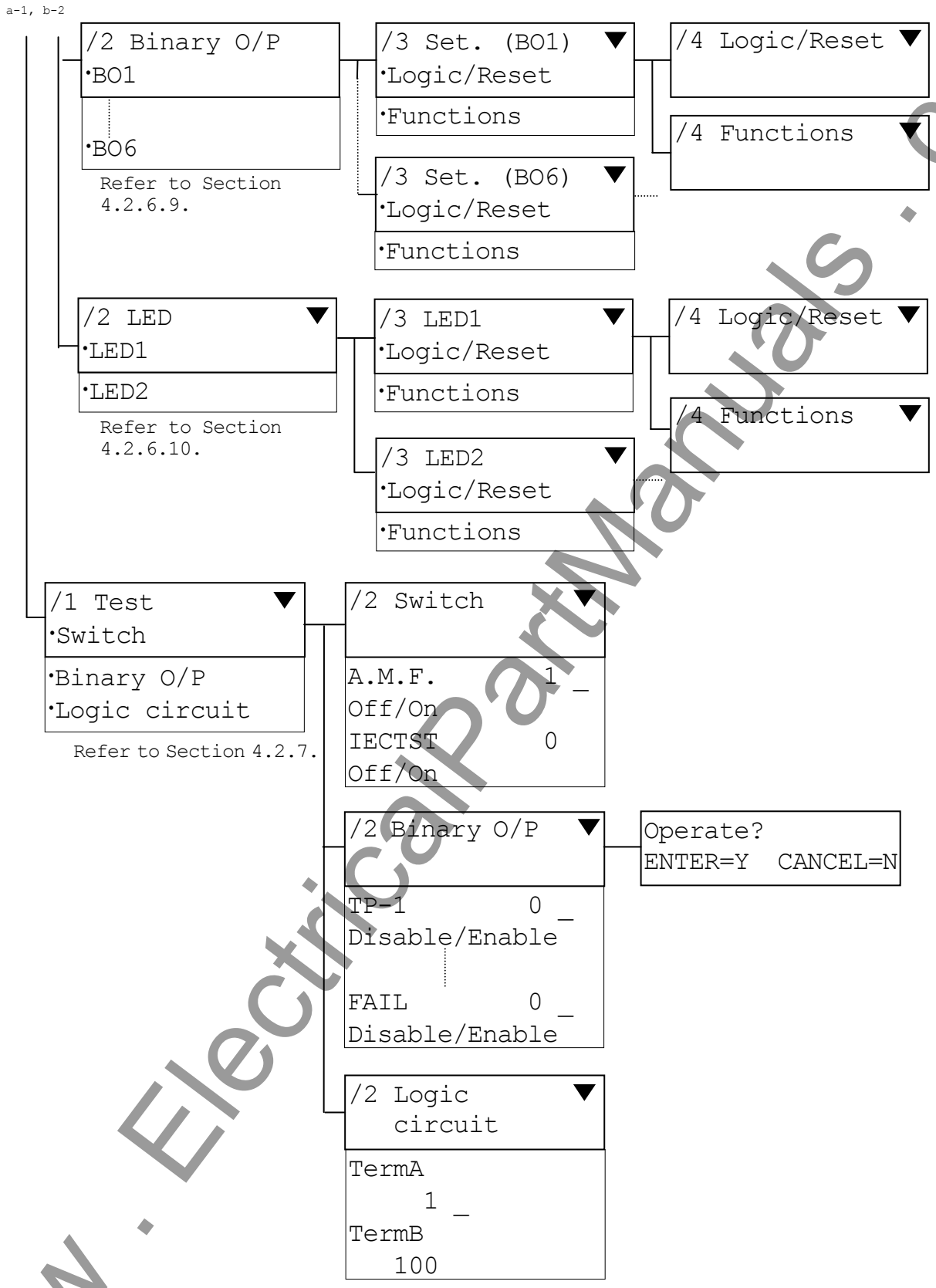




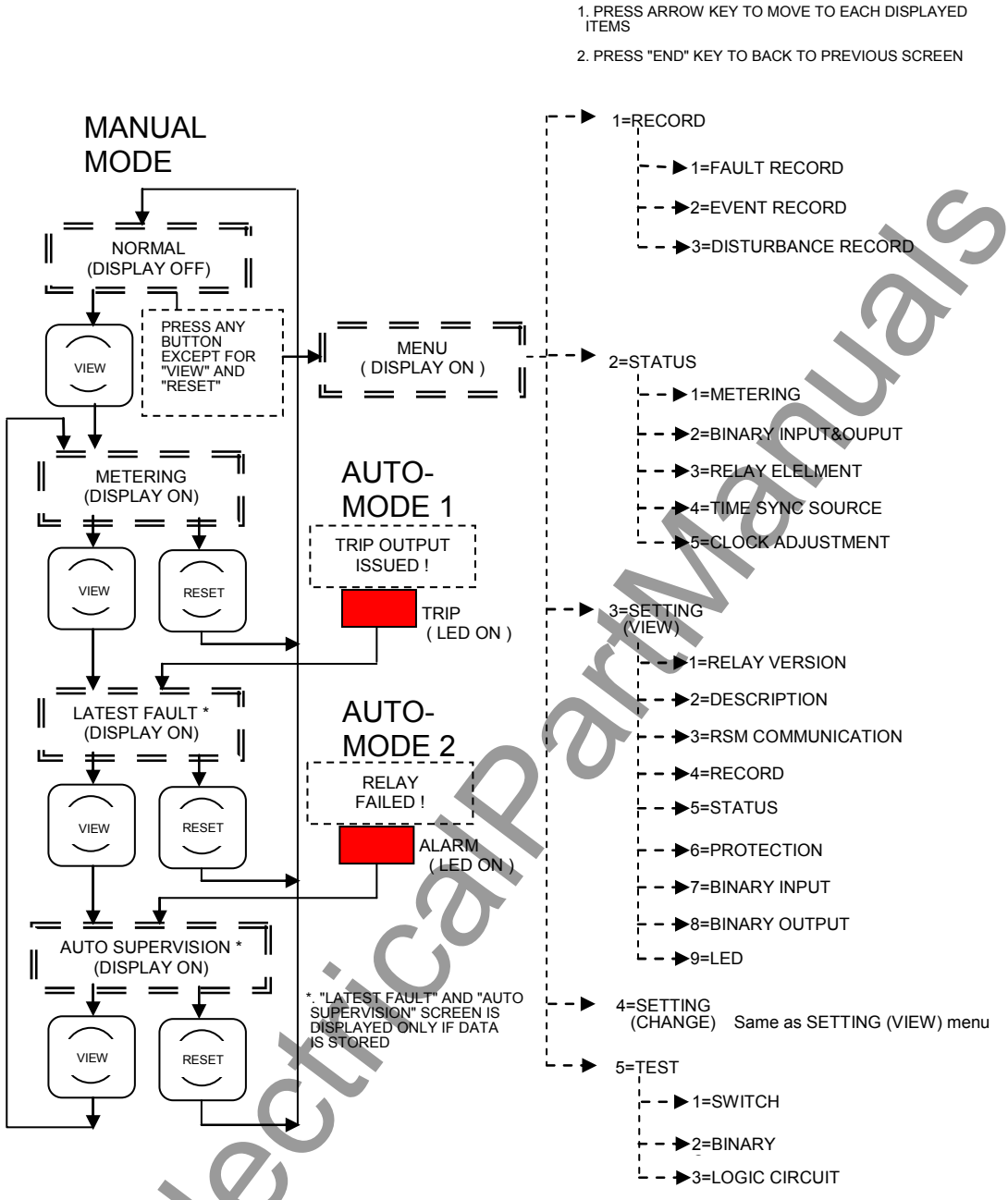








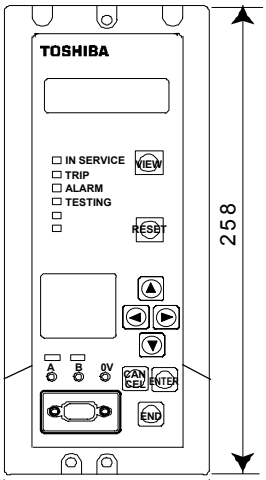
LCD AND BUTTON OPERATION INSTRUCTION



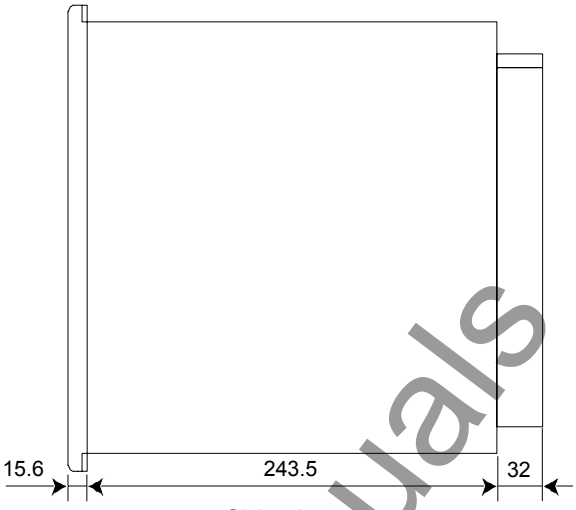
Appendix E

Outline of GRB150 and EB-101, -102

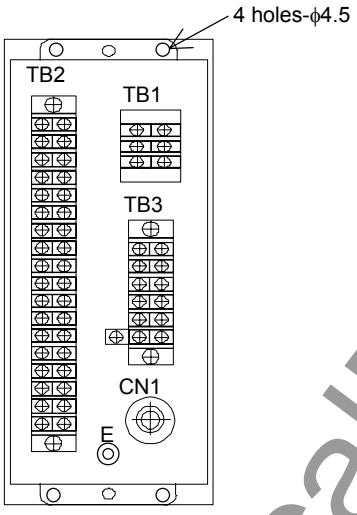
- Case Type of GRB150: Flush Mount Type
- EB-101 and EB-102



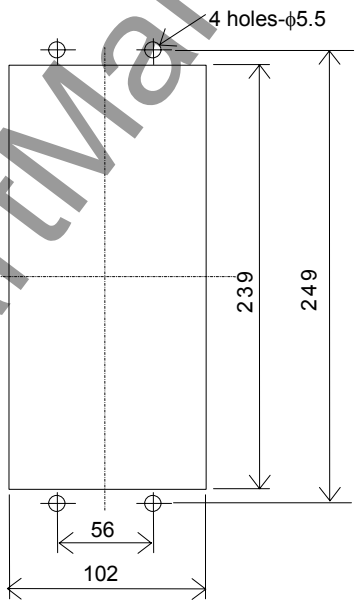
Front view



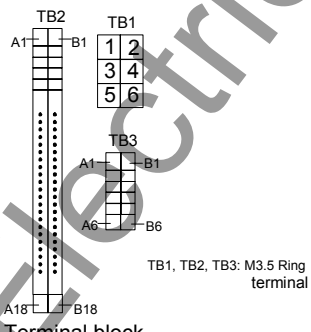
Side view



Rear view

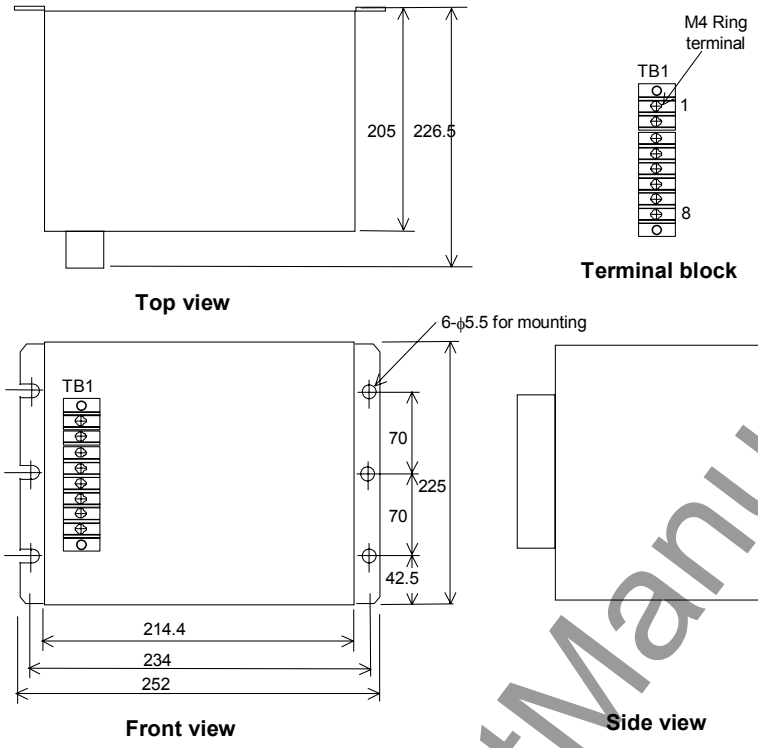


Panel cut-out

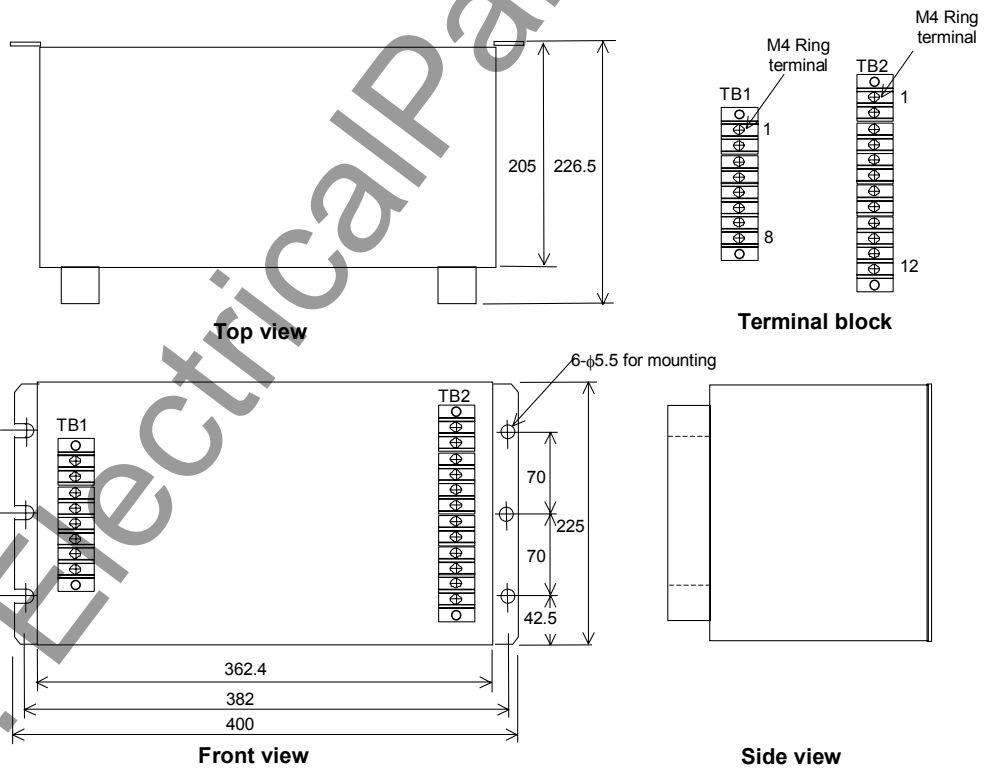


Terminal block

Case Outline of GRB150 : Flush Mount Type



(a) EB-101



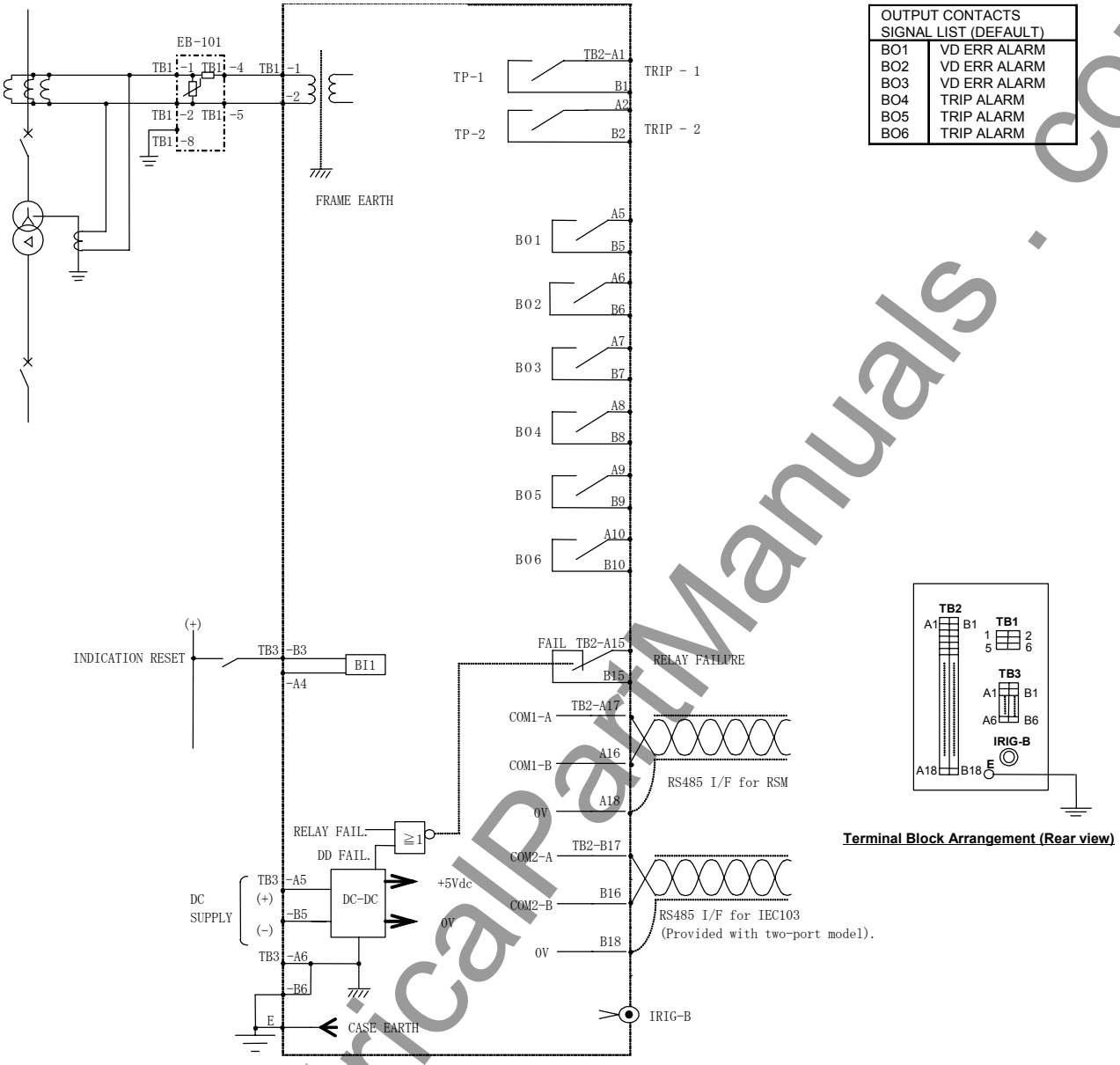
(b) EB-102

Note: When mounting varistor units longitudinally, the TB1 should be located in the down side.

Outline of varistor unit

Appendix F

External Connection

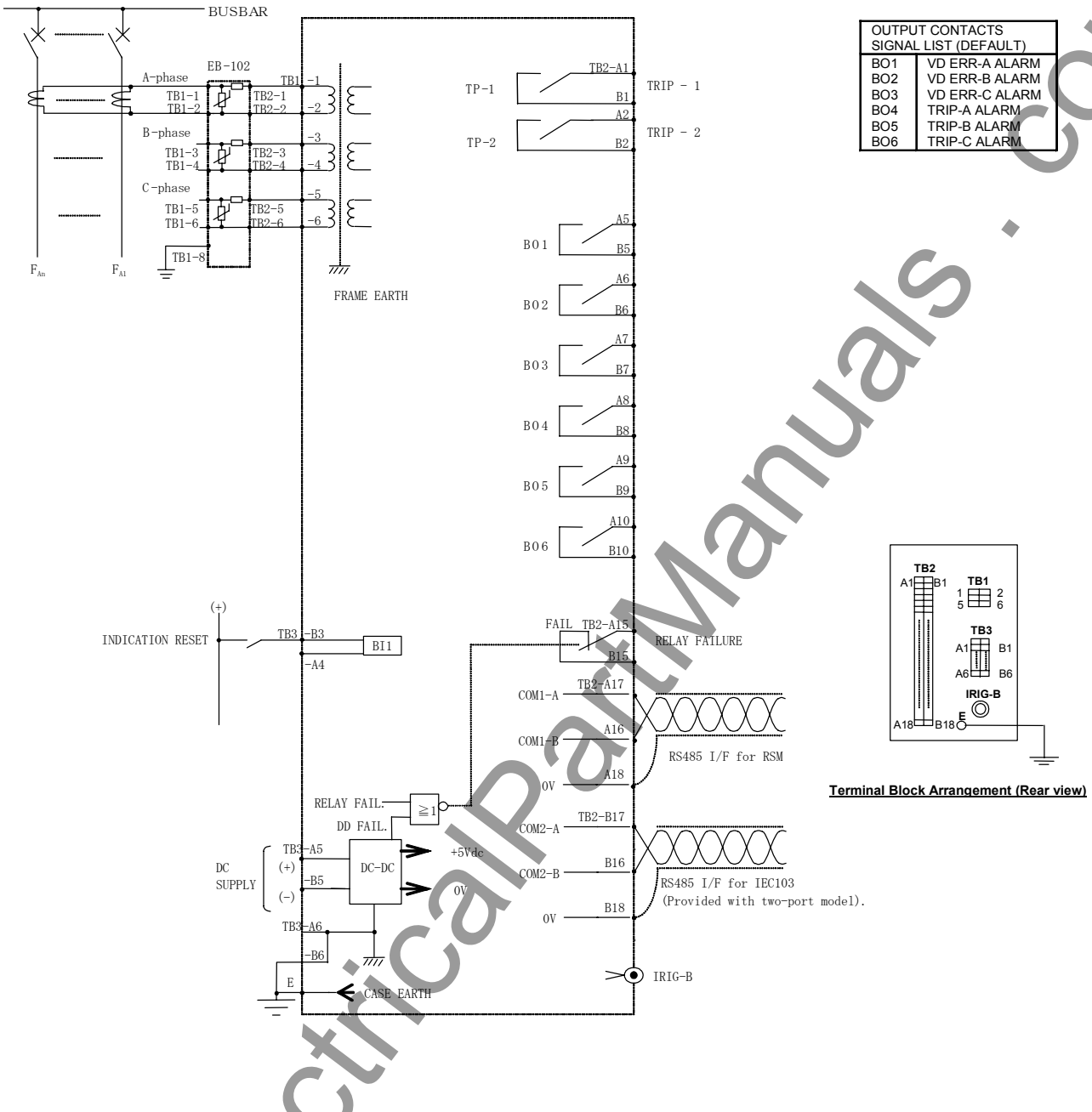


OUTPUT CONTACTS SIGNAL LIST (DEFAULT)	
BO1	VD ERR ALARM
BO2	VD ERR ALARM
BO3	VD ERR ALARM
BO4	TRIP ALARM
BO5	TRIP ALARM
BO6	TRIP ALARM

Terminal Block Arrangement (Rear view)

Note: In AC circuit wiring, the wires of the relay side should be separated from these of the CT side to avoid the influence of noise.

External connection of Model 101



Terminal Block Arrangement (Rear view)

Note: In AC circuit wiring, the wires of the relay side should be separated from these of the CT side to avoid the influence of noise.

External connection of Model 201

Appendix G

Relay Setting Sheet

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

Relay Setting Sheets

1. Relay Identification

Date:

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

2. Busbar parameters

CT ratio

3. Contacts setting

(1)

BO1	
BO2	
BO3	
BO4	
BO5	
BO6	

4. Relay setting sheet

№	Name		Range	Units	Contents	Default Setting of Relay series 101	Default Setting of Relay series 201	Setting
1	Act.gp.		1 - 4	—	Active setting group	1		
2	Line name		Specified by user	—	Line name	Specified by user		
3	VDCHK		Off(0) / On(1)	—	Vd check use or not	On(1)		
4	SVCNT		ALM&BLK(0) / ALM(1)	—	Supervision control	ALM&BLK(0)		
5	DIF		10 - 600	V	Differential relay	100		
6	DIFSV		5 - 100	V	Differential relay for supervision	50		
7	TVDSV		0.10 - 60.00	s	VD err timer	0.50		
8	BISW1		Norm(0) / Inv(1)	—	Binary input	Norm(0)		
9	LED1	Logic	OR(0)/AND(1)	—	LED1 Logic Gate Type	OR(0)		
10		Reset	Inst(0)/Latch(1)	—	LED1 Reset operation	Inst(0)		
11		In #1	0 - 200	—	LED Functions	0		
12		In #2	0 - 200	—	ditto	0		
13		In #3	0 - 200	—	ditto	0		
14		In #4	0 - 200	—	ditto	0		
15	LED2	Logic	OR(0)/AND(1)	—	LED2 Logic Gate Type	OR(0)		
16		Reset	Inst(0)/Latch(1)	—	LED2 Reset operation	Inst(0)		
17		In #1	0 - 200	—	LED Functions	0		
18		In #2	0 - 200	—	ditto	0		
19		In #3	0 - 200	—	ditto	0		
20		In #4	0 - 200	—	ditto	0		
21	Plant name		Specified by user	—	Plant name	Specified by user		
22	Description		ditto	—	Memorandum for user	Specified by user		
23	HDLC		1 - 32	—	Relay ID No. for RSM	1		
24	IEC		0 - 254	—	Relay ID No. for IEC	2		
25	IECBR		9.6(0) / 19.2(1)	—	Switch for communications	19.2(1)		
26	IECBLK		Normal(0) / Blocked(1)	—	Switch for communications	Normal(0)		
24	Trip		N(0) / O(1) / R(2) / B(3)	—	Event record trigger	B(3)		
25	Vd err		N(0) / O(1) / R(2) / B(3)	—	ditto	B(3)		
26	Ind.reset		N(0) / O(1) / R(2) / B(3)	—	ditto	B(3)		
27	Relay fail		N(0) / O(1) / R(2) / B(3)	—	ditto	B(3)		
28	Sys.change		N(0) / O(1)	—	ditto	O(1)		
29	Rly.change		N(0) / O(1)	—	ditto	O(1)		
30	Grp.change		N(0) / O(1)	—	ditto	O(1)		
31	Time		0.1 - 3.0	s	Disturbance record	1.0		
32	TRIP		Off(0) / On(1)	—	Disturbance record trigger use or not	On(1)		
33	Vd err		Off(0) / On(1)	—	ditto	On(1)		
34	Time sync		Off(0) / IRI(1) / RSM(2) / IEC(3)	—	Time synchronization	Off(0)		
35	GMT		-12 - +12	hrs	Time zone	0		

Appendix H

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 Differential element DIF test
   - 4.2 Supervisory element DIFSV 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 Differential element DIF test

(1) Minimum operating value test

Tap setting	Measured voltage

(2) Operating time test

Tap setting	Test voltage	Measured time

4.2 Supervisory element DIFSV test

(1) Minimum operating value test

Tap setting	Measured voltage

5. Protection scheme test

6. Metering and recording check

7. Conjunctive test

Scheme	Results
On load Tripping circuit	

Appendix I

Return Repair Form

RETURN / REPAIR FORM

Please fill in this form and return it to Toshiba Corporation with the GRB150 to be repaired.

TOSHIBA CORPORATION Fuchu Operations – Industrial and Power Systems & Services

1, Toshiba-cho, Fuchu-shi, Tokyo, Japan

For: Power Systems Protection & Control Department

Quality Assurance Section

Type: GRB150 Model: _____ Sub No. _____

(Example: Type: GRB150 Model: 201B-12-30)

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

V_{da}: V

V_{db}: V

V_{dc}: V

Fault values
Prefault values
V_{da}: V
V_{db}: V
V_{dc}: V

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 GRB150, including the documents:

Customer

Name: _____

Company Name: _____

Address: _____

_____

_____

Telephone No.: _____

Facsimile No.: _____

Signature: _____

Appendix J

Technical Data

TECHNICAL DATA

Ratings

AC current (In):	1A (fixed)
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 voltage input for varistor unit EB-101 or EB-102:

300V continuous

1kVrms for 0.4s

Binary input signal

Operating voltage:	Typical 74Vdc, minimum 70Vdc at 100Vdc/125Vdc rating Typical 138Vdc, minimum 125Vdc at 200Vdc/250Vdc rating

Burden

DC power supply:	less than 10W (quiescent)
	less than 15W (operation)

High impedance differential protection

Differential protection:	10 to 600V in 1V steps
Supervisory:	5 to 100V in 1V steps
Input impedance:	667Ω with varistor unit EB-101 or EB-102

Operating time of differential protection

Operating time:	1 cycle

Accuracy of differential element

Differential protection:	±10%
Supervisory:	±10%

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
	10A, 220Vdc for 0.2s (L/R ≥ 5ms)
Break:	0.1A, 220Vdc (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	IEC60068-2-78	56 days at 40°C and 93% relative humidity.
Enclosure Protection	IEC60529	IP51 (Rear: IP20)
Mechanical Environment		
Vibration	IEC60255-21-1	Response - Class 1 Endurance - Class 1
Shock and Bump	IEC60255-21-2	Shock Response Class 1 Shock Withstand Class 1 Bump Class 1
Seismic	IEC60255-21-3	Class 1
High Voltage Environment		
Dielectric Withstand	IEC60255-5	2kVrms for 1 minute between all terminals and earth. 2kVrms for 1 minute between independent circuits. 1kVrms for 1 minute across normally open contacts.
High Voltage Impulse	IEC60255-5	Three positive and three negative impulses of 5kV(peak), 1.2/50μs, 0.5J between all terminals and between all terminals and earth.
Electromagnetic Environment		
High Frequency Disturbance	IEC60255-22-1 Class 3	1MHz 2.5kV applied to all ports in common mode. 1MHz 1.0kV applied to all ports in differential mode.
Electrostatic Discharge	IEC60255-22-2 Class 3 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 K

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

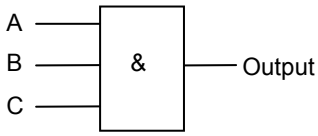
Marked with ⬭ : Binary signal input from or output to the external equipment

Marked with [ ] : Scheme switch

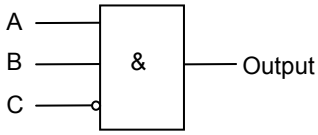
Marked with " " : Scheme switch position

Unmarked : Internal scheme logic signal

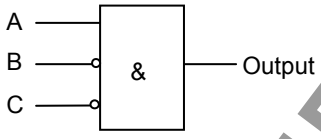
AND gates



A	B	C	Output
1	1	1	1
Other cases			0

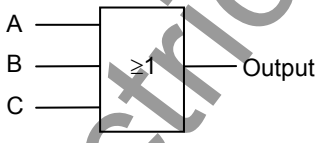


A	B	C	Output
1	1	0	1
Other cases			0

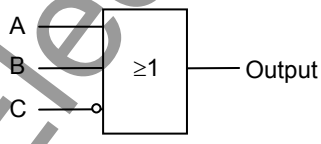


A	B	C	Output
1	0	0	1
Other cases			0

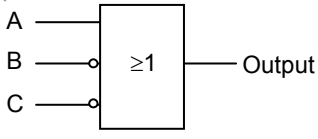
OR gates



A	B	C	Output
0	0	0	0
Other cases			1

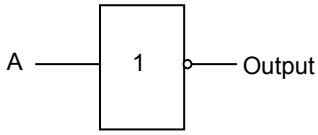


A	B	C	Output
0	0	1	0
Other cases			1



A	B	C	Output
0	1	1	0
Other cases			1

Signal inversion



A	Output
0	1
1	0

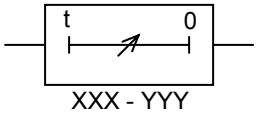
Timer

Delayed pick-up timer with fixed setting

XXX: Set time

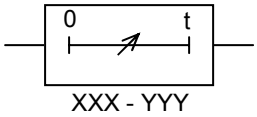
Delayed drop-off timer with fixed setting

XXX: Set time



Delayed pick-up timer with variable setting

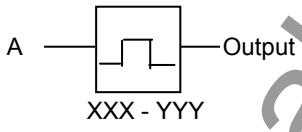
XXX - YYY: Setting range

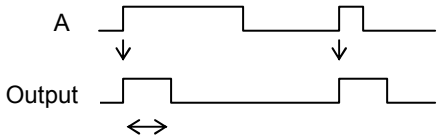


Delayed drop-off timer with variable setting

XXX - YYY: Setting range

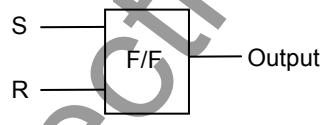
One-shot timer





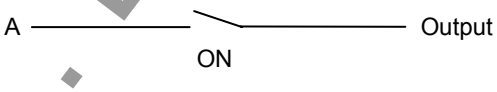
XXX - YYY: Setting range

Flip-flop

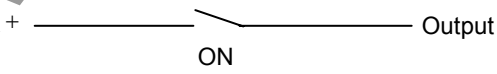


S	R	Output
0	0	No change
1	0	1
0	1	0
1	1	0

Scheme switch



A	Switch	Output
1	ON	1
Other cases		0



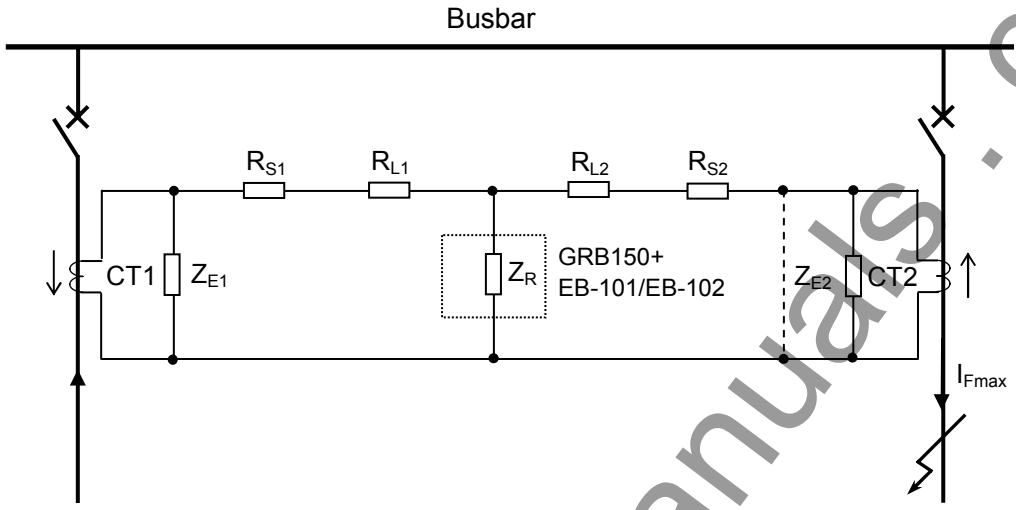
Switch	Output
ON	1
OFF	0

Appendix L

Setting Calculation

1. Setting of DIF

Model circuit:



Constants:

1) Resistance of CT secondary winding ..... R_{S2} = 1.5 ohms
2) Resistance of secondary wiring for CT connecting lead loop – most onerous case ..... R_{L2} = 1.0 ohm
3) Maximum through fault current ..... I_{Fmax} = 50kA
4) CT ratio ..... N = 800
5) Number of CTs connected to GRB150..... n = 14
6) CT secondary excitation current at GRB150 setting voltage ..... I_e = 3mA
7) GRB150 input impedance..... Z_R = 667 ohms
8) CT knee-point voltage ..... V_k= 1000V
9) Minimum internal fault current ..... I_{Fmin} = 1000A

Setting calculations :

1) Calculate voltage setting value.

$V_R \geq 1.2 (R_{S2} + R_{L2}) \times I_{Fmax} / N$

$\geq 1.2 \times (1.5 \text{ ohms} + 1.0 \text{ ohm}) \times 50000 / 800$

$\geq 188V$

2) Calculate minimum operating current value for internal fault.

$I_{min} = (n I_e + I_r + I) N$

$= (n I_e + I_r + V_R / Z_R) N$

$= (14 \times 0.003 \text{ A} + 188 / 667 \text{ ohms}) \times 800$

= 259A

I_r is neglected because it is less than 0.1 mA referring to voltage-current characteristic of the varistor shown below.

Setting checks:

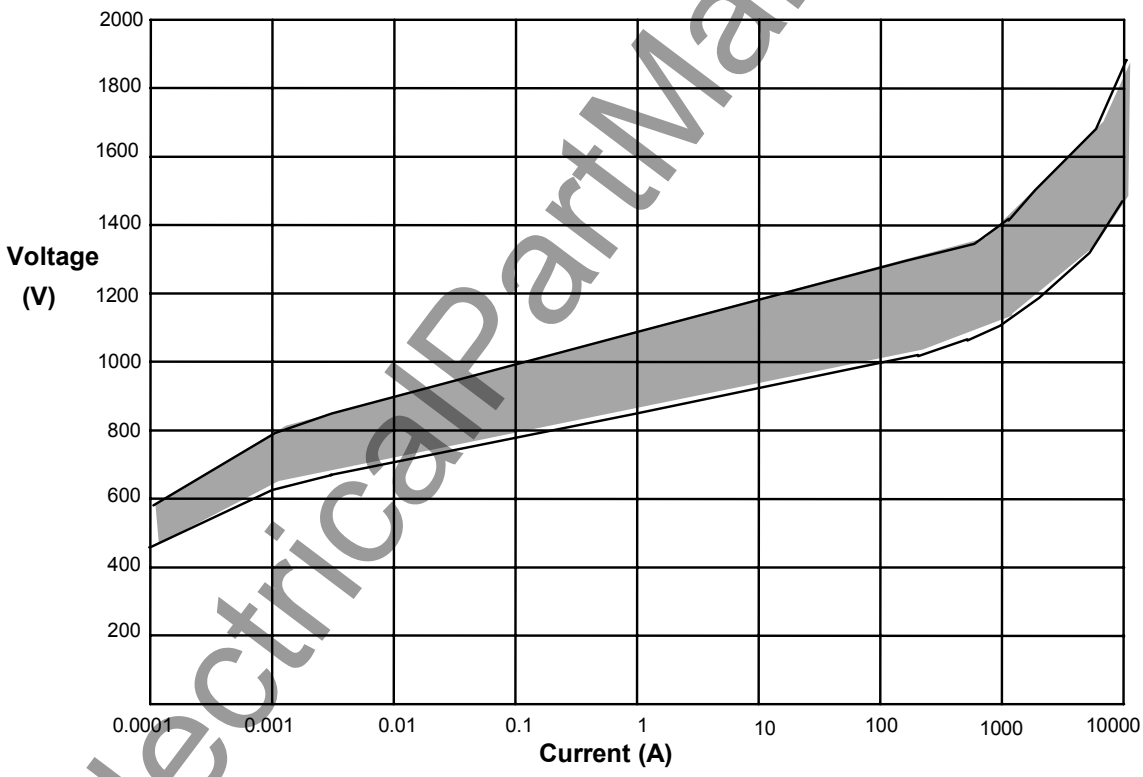
1) Check that the setting voltage value V_R is smaller than half of the CT knee-point voltage V_k .

   1000 / 2 = 500 V > 188V

2) Check that the minimum internal fault current I_{Fmin} is larger than the minimum operating current value I_{min}.

   1000A > 259A

Note: The current sensitivity I_{min} can be reduced by connecting a shunt resistor across the relay/varistor unit input. To reduce it from 259A to 400A for example, connect a resistor of 1067 ohms[= 188V × 800/(400A-259A)].



2. Setting of DIFSV

The setting of DIFSV is determined from the maximum erroneous voltage which is generated due to the following two factors under normal service conditions.

- CT turns ratio errors
- Error due to differences in the respective lengths of the CT secondary connecting leads to the paralleling point of the differential circuit

Erroneous voltage V_{er1} due to CT turns ratio errors:

The maximum erroneous voltage V_{er1} is given by the following equation:

$$V_{er1} = Z_R \times I_{Lmax} \times CT_{er}$$

where,

Z_R: relay impedance

I_{Lmax}: maximum load current (= rated current, for example)

CT_{er}: maximum CT turns ratio error (= 0.25 %, for example)

Then,

$$V_{er1} = 667 \text{ ohms} \times 5 \text{ A} \times 0.0025$$
$$\fallingdotseq 8 \text{ V}$$

When the busbar is configured with parallel feeders, the maximum load current of the feeder may increase by up to 1.8 times rated current when one of the feeders is opened.

Then,

$$V_{er1} = 667 \text{ ohms} \times 1.8 \times 5 \text{ A} \times 0.0025$$
$$\fallingdotseq 15 \text{ V}$$

Erroneous voltage V_{er2} due to differences in the respective lengths of the CT secondary connecting leads to the paralleling point of the differential circuit:

The maximum erroneous voltage V_{er2} must not exceed $(R_S + R_L) \times I_{Lmax}$ for the most onerous case,

$$V_{er2} < (R_S + R_L) \times I_{Lmax}$$
$$< (1.5 \text{ ohms} + 1.0 \text{ ohm}) \times 5\text{A}$$
$$< 12.5 \text{ V}$$

In a busbar configured with parallel feeders, the load current may increase transiently by up to 1.8 times when one of the parallel feeders is opened. Then assuming that the feeders are fully loaded under normal conditions,

$$V_{er2} < (1.5 \text{ ohms} + 1.0 \text{ ohm}) \times 1.8 \times 5\text{A}$$
$$< 22.5 \text{ V}$$

DIFSV should be set to satisfy the following equation:

$$\text{DIFSV} > V_{er1} + V_{er2} = 15 \text{ V} + 12.5 \text{ V} = 27.5 \text{ V} \quad \text{for single feeder busbar}$$
$$= 15 \text{ V} + 22.5 \text{ V} = 37.5 \text{ V} \quad \text{for parallel feeder busbar}$$

Then,

$$\text{DIFSV} = 30 \text{ V} \quad \text{for single feeder busbar}$$
$$= 40 \text{ V} \quad \text{for parallel feeder busbar}$$

Appendix M

IEC60870-5-103: Interoperability and Troubleshooting

IEC60870-5-103 Configurator

IEC103 configurator software is included in a same CD as RSM100, and can be installed easily as follows:

Installation of IEC103 Configurator

Insert the CD-ROM (RSM100) into a CDROM drive to install this software on a PC.

Double click the "Setup.exe" of the folder "\IEC103Conf" under the root directory, and operate it according to the message.

When installation has been completed, the IEC103 Configurator will be registered in the start menu.

Starting IEC103 Configurator

Click [Start]→[Programs]→[IEC103 Configurator]→[IECConf] to the IEC103 Configurator software.

Note: The instruction manual of IEC103 Configurator can be viewed by clicking [Help]→[Manual] on IEC103 Configurator.

IEC60870-5-103: Interoperability

1. Physical Layer

1.1 Electrical interface: EIA RS-485

Number of loads, 32 for one protection equipment

1.2 Optical interface

Glass fibre (option)

ST type connector (option)

1.3 Transmission speed

User setting: 9600 or 19200 bit/s

2. Application Layer

COMMON ADDRESS of ASDU

One COMMON ADDRESS OF ASDU (identical with station address)

3. List of Information

The following items can be customized with the original software tool "IEC103 configurator". (For details, refer to "IEC103 configurator" manual No.6F2S0839.)

- Items for "Time-tagged message": Type ID(1/2), INF, FUN, Transmission condition(Signal number), COT
- Items for "Time-tagged measurands": INF, FUN, Transmission condition(Signal number), COT, Type of measurand quantities
- Items for "General command": INF, FUN, Control condition(Signal number)
- Items for "Measurands": Type ID(3/9), INF, FUN, Number of measurand, Type of

measurand quantities

- Common setting
  - Transmission cycle of Measurand frame
  - FUN of System function
  - Test mode, etc.

Note: To be effective the setting data written via the RS232C, turn off the DC supply of the relay and turn on again.

3. 1 IEC60870-5-103 Interface

3.1.1 Spontaneous events

The events created by the relay will be sent using Function type (FUN) / Information numbers (INF) to the IEC60870-5-103 master station.

3.1.2 General interrogation

The GI request can be used to read the status of the relay, the Function types and Information numbers that will be returned during the GI cycle are shown in the table below.

For details, refer to the standard IEC60870-5-103 section 7.4.3.

3.1.3 Cyclic measurements

The relay will produce measured values using Type ID=3 or 9 on a cyclical basis, this can be read from the relay using a Class 2 poll. The rate at which the relay produces new measured values can be customized.

3.1.4 Commands

The supported commands can be customized. The relay will respond to non-supported commands with a cause of transmission (COT) of negative acknowledgement of a command.

For details, refer to the standard IEC60870-5-103 section 7.4.4.

3.1.5 Test mode

In test mode, both spontaneous messages and polled measured values, intended for processing in the control system, are designated by means of the CAUSE OF TRANSMISSION 'test mode'. This means that CAUSE OF TRANSMISSION = 7 'test mode' is used for messages normally transmitted with COT=1 (spontaneous) or COT=2 (cyclic).

For details, refer to the standard IEC60870-5-103 section 7.4.5.

3.1.6 Blocking of monitor direction

If the blocking of the monitor direction is activated in the protection equipment, all indications and measurands are no longer transmitted.

For details, refer to the standard IEC60870-5-103 section 7.4.6.

3.2 List of Information

The followings are the default settings.

List of Information

INF	Description	Contents	IEC103 Configurator Default setting						
			GI	Type ID	COT	FUN	DPI		
							Signal No.	OFF	ON
Standard Information numbers in monitor direction									
System Function									
0	End of General Interrogation	Transmission completion of GI items.	--	8	10	255	--	--	--
0	Time Synchronization	Time Synchronization ACK.	--	6	8	255	--	--	--
2	Reset FCB	Reset FCB(toggle bit) ACK	--	5	3	217	--	--	--
3	Reset CU	Reset CU ACK	--	5	4	217	--	--	--
4	Start/Restart	Relay start/restart	--	5	5	217	--	--	--
5	Power On	Relay power on.	Not supported				--	--	--
Status Indications									
16	Auto-recloser active	If it is possible to use auto-recloser, this item is set active, if impossible, inactive.	Not supported						
17	Teleprotection active	If protection using telecommunication is available, this item is set to active. If not, set to inactive.	Not supported						
18	Protection active	If the protection is available, this item is set to active. If not, set to inactive.	GI	1	1, 7, 9, 12, 20, 21	217	155	1	2
19	LED reset	Reset of latched LEDs	--	1	1, 7, 11, 12, 20, 21	217	149	--	2
20	Monitor direction blocked	Block the 103 transmission from a relay to control system. IECBLK: "Blocked" settimg.	GI	1	9, 11	217	131	1	2
21	Test mode	Transmission of testmode situation froma relay to control system. IECTST "ON" setting.	GI	1	9, 11	217	132	1	2
22	Local parameter Setting	When a setting change has done at the local, the event is sent to control system.	Not supported						
23	Characteristic1	Setting group 1 active	GI	1	1, 7, 9, 11, 12, 20, 21	176	133	1	2
24	Characteristic2	Setting group 2 active	GI	1	1, 7, 9, 11, 12, 20, 21	176	134	1	2
25	Characteristic3	Setting group 3 active	GI	1	1, 7, 9, 11, 12, 20, 21	176	135	1	2
26	Characteristic4	Setting group 4 active	GI	1	1, 7, 9, 11, 12, 20, 21	176	136	1	2
27	Auxiliary input1	Binary input 1	No set						
28	Auxiliary input2	Binary input 2	No set						
29	Auxiliary input3	Binary input 3	No set						
30	Auxiliary input4	Binary input 4	No set						
Supervision Indications									
32	Measurand supervision I	Zero sequence current supervision	Not supported						
33	Measurand supervision V	Zero sequence voltage supervision	Not supported						
35	Phase sequence supervision	Negative sequence voltage supevision	Not supported						
36	Trip circuit supervision	Output circuit supervision	Not supported						
37	I>>backup operation		Not supported						
38	VT fuse failure	VT failure	Not supported						
39	Teleprotection disturbed	CF(Communication system Fail) supervision	Not supported						
46	Group warning	Only alarming	GI	1	1, 7, 9	176	104	1	2
47	Group alarm	Trip blocking and alarming	GI	1	1, 7, 9	176	102	1	2
Earth Fault Indications									
48	Earth Fault L1	A phase earth fault	No						
49	Earth Fault L2	B phase earth fault	No						
50	Earth Fault L3	C phase earth fault	No						
51	Earth Fault Fwd	Earth fault forward	Not supported						
52	Earth Fault Rev	Earth fault reverse	Not supported						

INF	Description	Contents	IEC103 Configurator Default setting						
			GI	Type ID	COT	FUN	DPI		
							Signal NO.	OFF	ON
Fault Indications									
64	Start/pick-up L1	A phase, A-B phase or C-A phase element pick-up	No set						
65	Start/pick-up L2	B phase, A-B phase or B-C phase element pick-up	No set						
66	Start/pick-up L3	C phase, B-C phase or C-A phase element pick-up	No set						
67	Start/pick-up N	Earth fault element pick-up	No set						
68	General trip	Any trip	--	2	1, 7	217	162	--	2
69	Trip L1	A phase, A-B phase or C-A phase trip	No set						
70	Trip L2	B phase, A-B phase or B-C phase trip	No set						
71	Trip L3	C phase, B-C phase or C-A phase trip	No set						
72	Trip I>>(back-up)	Back up trip	Not supported						
73	Fault location X In ohms	Fault location	Not supported						
74	Fault forward/line	Forward fault	Not supported						
75	Fault reverse/Busbar	Reverse fault	Not supported						
76	Teleprotection Signal transmitted	Carrier signal sending	Not supported						
77	Teleprotection Signal received	Carrier signal receiving	Not supported						
78	Zone1	Zone 1 trip	Not supported						
79	Zone2	Zone 2 trip	Not supported						
80	Zone3	Zone 3 trip	Not supported						
81	Zone4	Zone 4 trip	Not supported						
82	Zone5	Zone 5 trip	Not supported						
83	Zone6	Zone 6 trip	Not supported						
84	General Start/Pick-up	Any elements pick-up	No set						
85	Breaker Failure	CBF trip or CBF retrip	Not supported						
86	Trip measuring system L1		Not supported						
87	Trip measuring system L2		Not supported						
88	Trip measuring system L3		Not supported						
89	Trip measuring system E		Not supported						
90	Trip I>	Inverse time OC trip	Not supported						
91	Trip I>>	Definite time OC trip	Not supported						
92	Trip IN>	Inverse time earth fault OC trip	Not supported						
93	Trip IN>>	Definite time earth fault OC trip	Not supported						
Autoreclose indications									
128	CB 'ON' by Autoreclose	CB close command output	Not supported						
129	CB 'ON' by long-time Autoreclose		Not supported						
130	Autoreclose Blocked	Autoreclose block	Not supported						

INF	Description	Contents	IEC103 configurator Default setting				
			GI	Type ID	COT	FUN	Max. No.
Measurands							
144	Measurand I	<meaurand I>	No				0
145	Measurand I,V	<meaurand I>	No				0
146	Measurand I,V,P,Q	<meaurand I>	No				0
147	Measurand IN,VEN	<meaurand I>	No				0
148	Measurand IL1,2,3, VL1,2,3, P,Q,f	Vda, Vdb, Vdc measurand <meaurand II>	--	9	2, 7	217	9
Generic Function							
240	Read Headings		Not supported				
241	Read attributes of all entries of a group		Not supported				
243	Read directory of entry		Not supported				
244	Real attribute of entry		Not supported				
245	End of GGI		Not supported				
249	Write entry with confirm		Not supported				
250	Write entry with execute		Not supported				
251	Write entry aborted		Not supported				

Details of MEA settings in IEC103 configurator

INF	MEA	Tbl	Offset	Data type	Limit		Coeff
					Lower	Upper	
148	(empty)						
	(empty)						
	(empty)						
	Vda	1	0	short	0	4096	1.8998
	Vdb	1	2	short	0	4096	1.8998
	Vdc	1	4	short	0	4096	1.8998
	(empty)						
	(empty)						
	(empty)						

INF	Description	Contents	Default setting			
			Control direction	Type ID	COT	FUN
Selection of standard information numbers in control direction						
System functions						
0	Initiation of general interrogation		--	7	9	217
0	Time synchronization		--	6	8	217
General commands						
16	Auto-recloser on/off		Not supported			
17	Teleprotection on/off		Not supported			
18	Protection on/off	(*1)	ON/OFF	20	20	217
19	LED reset	Reset indication of latched LEDs.	ON	20	20	217
23	Activate characteristic 1	Setting Group 1	ON	20	20	217
24	Activate characteristic 2	Setting Group 2	ON	20	20	217
25	Activate characteristic 3	Setting Group 3	ON	20	20	217
26	Activate characteristic 4	Setting Group 4	ON	20	20	217
Generic functions						
240	Read headings of all defined groups		Not supported			
241	Read values or attributes of all entries of one group		Not supported			
243	Read directory of a single entry		Not supported			
244	Read values or attributes of a single entry		Not supported			
245	General Interrogation of generic data		Not supported			
248	Write entry		Not supported			
249	Write entry with confirmation		Not supported			
250	Write entry with execution		Not supported			

(∗1) Note: While the relay receives the "Protection off" command, " IN SERVICE LED" is off.

Details of Command settings in IEC103 configurator

INF	DCO			
	Sig off	Sig on	Rev	Valid time
18	187	187		✓ 0
19	0	188		200
23	0	193		1000
24	0	194		1000
25	0	195		1000
26	0	196		1000

✓: signal reverse

	Description	Contents	GRB150 supported	Comment
Basic application functions				
	Test mode		Yes	
	Blocking of monitor direction		Yes	
	Disturbance data		No	
	Generic services		No	
	Private data		Yes	
Miscellaneous				
	Measurand		Max. MVAL = rated value times	
	Current L1	Ia	No	
	Current L2	Ib	No	
	Current L3	Ic	No	
	Voltage L1-E	Vda	Configurable	
	Voltage L2-E	Vdb	Configurable	
	Voltage L3-E	Vdc	Configurable	
	Active power P	P	No	
	Reactive power Q	Q	No	
	Frequency f	f	No	
	Voltage L1 - L2	Vab	Configurable	

Details of Common settings in IEC103 configurator

- Setting file's remark: GRB150_1.00
- Remote operation valid time [ms]: 4000
- Local operation valid time [ms]: 4000
- Measurand period [s]: 2
- Function type of System functions: 217
- Signal No. of Test mode: 132
- Signal No. for Real time and Fault number: 162

[Legend]

GI: General Interrogation (refer to IEC60870-5-103 section 7.4.3)

Type ID: Type Identification (refer to IEC60870-5-103 section 7.2.1)

1 : time-tagged message
2 : time-tagged message with relative time
3 : measurands I
4 : time-tagged measurands with relative time
5 : identification
6 : time synchronization
8 : general interrogation termination
9 : measurands II
10: generic data
11: generic identification
20: general command
23: list of recorded disturbances
26: ready for transmission for disturbance data
27: ready for transmission of a channel
28: ready for transmission of tags
29: transmission of tags
30: transmission of disturbance values
31: end of transmission

COT: Cause of Transmission (refer to IEC60870-5-103 section 7.2.3)

1: spontaneous
2: cyclic
3: reset frame count bit (FCB)
4: reset communication unit (CU)
5: start / restart
6: power on
7: test mode
8: time synchronization
9: general interrogation
10: termination of general interrogation
11: local operation
12: remote operation
20: positive acknowledgement of command
21: negative acknowledgement of command
31: transmission of disturbance data
40: positive acknowledgement of generic write command
41: negative acknowledgement of generic write command
42: valid data response to generic read command
43: invalid data response to generic read command
44: generic write confirmation

FUN: Function type (refer to IEC60870-5-103 section 7.2.5.1)

DPI: Double-point Information (refer to IEC60870-5-103 section 7.2.6.5)

DCO: Double Command (refer to IEC60870-5-103 section 7.2.6.4)

IEC103 setting data is recommended to be saved as follows:

(1) Naming for IEC103setting data

The file extension of IEC103 setting data is ".csv". The version name is recommended to be provided with a revision number in order to be changed in future as follows:

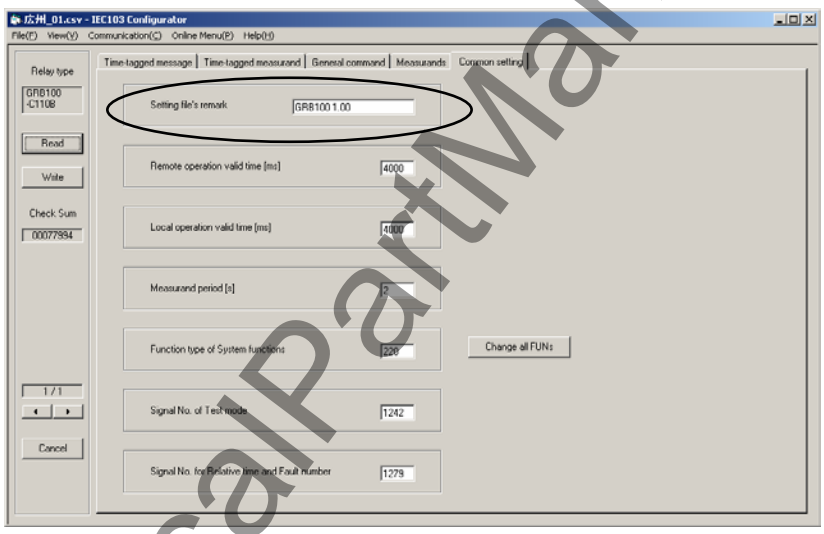
First draft: ******_01.csv

Second draft: ******_02.csv

Third draft: ******_03.csv

↑——— Revision number

The name "******" is recommended to be able to discriminate the relay type such as GRZ100 or GRL100, etc. The setting files remark field of IEC103 is able to enter up to 12 one-byte characters. It is utilized for control of IEC103 setting data.



(2) Saving theIEC103 setting data

The IEC103 setting data is recommended to be saved in external media such as FD (floppy disk) or CD-R, not to remain in the folder.

Troubleshooting

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Phenomena</th><th rowspan="2">Supposed causes</th><th colspan="2">Check / Confirmation</th></tr>
<tr><th>Object</th><th>Procedure</th></tr>
<tr><td rowspan="10">1</td><td rowspan="10">Communication trouble （IEC103 communication is not available.）</td><td>Address setting is incorrect.</td><td>BCU
RY</td><td>Match address setting between BCU and relay.
Avoid duplication of address with other relay.</td></tr>
<tr><td>Transmission baud rate setting is incorrect.</td><td>BCU
RY</td><td>Match transmission baud rate setting between BCU and relay.</td></tr>
<tr><td>Start bit, stop bit and parity settings of data that BCU transmits to relay is incorrect.</td><td>BCU</td><td>Go over the following settings by BCU. Relay setting is fixed as following settings.
- Start bit: 1bit
- Stop bit: 1bit
- Parity setting: even</td></tr>
<tr><td>The PRTCL1 setting is incorrect. (The model with PRTCL1 setting.)</td><td>RY</td><td>Change the PRTCL1 setting. Relation between PRTCL1 setting and available transmission protocol is referred to the following table.
<table>
<tr><td>RS485 port at the back of the relay</td><td>PRTCL1 =HDLC</td><td>PRTCL1 =IEC</td></tr>
<tr><td>COM1 (CH1)</td><td>HDLC</td><td>IEC</td></tr>
<tr><td>COM2 (CH2)</td><td>IEC</td><td>–</td></tr>
</table></td></tr>
<tr><td>RS485 or optical cable interconnection is incorrect.</td><td>Cable</td><td>- Check the connection port.(CH1/CH2)
- Check the interconnection of RS485 A/B/COM
- Check the send and received interconnection of optical cable.</td></tr>
<tr><td>The setting of converter is incorrect. (RS485/optic conversion is executed with the transmission channel, etc.)</td><td>Converter</td><td>In the event of using G1IF2, change the DIPSW setting in reference to INSTRUCTION MANUAL (6F2S0794).</td></tr>
<tr><td>The relationship between logical “0/1” of the signal and Sig.on/off is incorrect. (In the event of using optical cable)</td><td>BCU</td><td>Check the following;
Logical0 : Sig.on
Logical1:Sig.off</td></tr>
<tr><td>Terminal resistor is not offered. (Especially when RS485 cable is long.)</td><td>cable</td><td>Impose terminal resistor (150[ohms]) to both ends of RS 485 cable.</td></tr>
<tr><td>Relay cannot receive the requirement frame from BCU.
(The timing coordination of sending and receiving switch control is irregular in half-duplex communication.)</td><td>BCU</td><td>Check to secure the margin more than 15ms between receiving the reply frame from the relay and transmitting the next requirement frame on BCU.</td></tr>
<tr><td>The requirement frame from BCU and the reply frame from relay contend.
(The sending and receiving timing coordination is irregular in half-duplex communication.)</td><td>BCU</td><td>Check to set the time-out of reply frame from the relay.
Time-out setting: more than 100ms (acceptable value of response time 50ms plus margin)</td></tr>
</table>

No.	Phenomena	Supposed causes	Check / Confirmation	
			Object	Procedure
2	HMI does not display IEC103 event on the SAS side.	The relevant event sending condition is not valid.	RY	Change the event sending condition (signal number) of IEC103 configurator if there is a setting error. When the setting is correct, check the signal condition by programmable LED, etc.
		The relevant event Information Number (INF) and/or Function Type (FUN) may be different between the relay and SAS.	RY SAS	Match the relevant event Information Number (INF) or Function Type (FUN) between the relay and SAS.
		The relay is not initialised after writing IEC103 configurator setting.	RY	Check the sum value of IEC103 setting data from the LCD screen. When differing from the sum value on IEC103 configurator, initialise the relay.
		It changes to the block mode.	RY	Change the IECBR settling to Normal.
3	Time can be synchronised with IEC103 communication.	BCU does not transmit the frame of time synchronisation.	BCU	Transmit the frame of time synchronisation.
		The settling of time synchronisation source is set to other than IEC.	RY	Change the settling of time synchronisation source to IEC.

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

Appendix N

Ordering

Ordering

GRB150 – [ ] B – [ ] 0 – [ ] 0 – [ ]

Type:	
High-impedance Differential Relay	GRB150
Model:	
- Single-phase protection (with EB-101)	101
- Three-phase protection (with EB-102)	201
Ratings:	
1A, 50Hz, 110V/125Vdc	1
1A, 60Hz, 110V/125Vdc	2
1A, 50Hz, 220V/250Vdc	5
1A, 60Hz, 220V/250Vdc	6
1A, 50Hz, 48V/54V/60Vdc	A
1A, 60Hz, 48V/54V/60Vdc	B
Communications:	
Dual RS485	3
LED label:	
Standard	None
Option: User configurable LED label	J

Note

EB-101: Varistor unit for single phase
EB-201: Varistor unit for three phase

Version-up Records

Version No.	Date	Revised Section	Contents
0.0	Jan. 19, 2004	--	First issue
0.1	Apr. 28, 2004	6.4, 6.5 Appendices	Modified Figures 6.4.1, 6.4.2 and 6.5.1 Modified the Appendix M and added the Appendix N.
0.2	May 20, 2004	Appendix B	Changed the name of No.131.
0.3	Aug. 24, 2004	3.2.1 4.5 6.7.2 Appendices	Modified the description of Binary input signals. Modified the description. Modified the description of Note. Modified the Appendix J and M.
0.4	Feb. 25, 2005	Appendices	Modified the Appendix D and M.
0.5	Jan. 31, 2006	Appendices	Modified the Appendix I, J and N.
0.6	Apr. 06, 2006	3.2.1 4.1.2 Appendices	Modified the description. Modified the description. Appendix F, J and N.
0.7	Jan. 15. 2007	2.2.3 4.4, 4.5 Appendices	Modified the description about secondary winding resistance. Modified the description. Added the item 'LCD and Button operation Instruction' in Appendix D, and modified Appendix M.
0.8	Aug.01, 2007	4.2.1 Appendices	Modified the description. Modified Appendix D, M and N.

TOSHIBA CORPORATION