INSTRUCTION MANUAL

FREQUENCY, VOLTAGE RELAY

GRF100 - ***B

TOSHIBA CORPORATION

(Ver. 4.0)

Safety Precautions

Before using this product, please read this chapter carefully.

This chapter describes the safety precautions recommended when using the GRF100. Before installing and using the equipment, this chapter must be thoroughly read and understood.

Explanation of symbols used

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

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

⚠ DANGER

- **Current transformer circuit**

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

⚠WARNING

- **Exposed terminals**

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

- **Residual voltage**

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

⚠CAUTION

- **Earth**

The earthing terminal of the equipment must be securely earthed.

CAUTION

- **Operating environment**

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

- **Ratings**

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

- **Printed circuit board**

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

- **External circuit**

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

- **Connection cable**

Carefully handle the connection cable without applying excessive force.

- **Modification**

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

- **Disposal**

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

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

1. Introduction

The GRF100 is a numerical frequency and voltage relay applied to frequency protection and undervoltage and/or overvoltage protection.

The GRF100 is a member of the G-series multifunction numerical relays which is built on common hardware modules and equipped with the following functions:

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

2. Application Notes

2.1 Application

GRF100 can be applied for underfrequency and/or overfrequency protection and undervoltage and/or overvoltage protection.

The relay provides a four-stage frequency protection and each stage includes the following protections.

- Underfrequency protection
- Overfrequency protection
- Frequency decay rate-of-change protection
- Frequency rise rate-of-change protection

Two frequency measuring elements and two frequency rate-of-change elements are provided for each stage. The frequency measuring elements can be set to operate either upon underfrequency or overfrequency individually. One of the frequency rate-of-change elements operates when the rate of change (df/dt) is negative and the other element operates when it is positive.

Each stage of each protection can either be delayed by a timer, or blocked by a setting or via a binary input.

All the frequency protections are blocked by the undervoltage elements.

GRF100 provides a four-stage voltage protection and each stage includes the following functions:

- Definite time undervoltage and overvoltage protection
- Inverse time undervoltage and overvoltage protection
- High-speed undervoltage protection

The undervoltage and overvoltage measuring elements are common to the four stages, though the scheme logic circuit is provided for each stage.

Each of the voltage protections can either be delayed by a timer, or blocked by a setting or via a binary input.

GRF100 provides the following metering and recording functions.

- Metering
- Fault recording
- Event recording
- Disturbance recording

GRF100 provides the following human interfaces for relay settings or viewing of stored data.

- Relay front panel: LCD, LED display and operation keys
- Local PC port: RS232
- Remote PC: RS485

The relay can be accessed from a local PC or a remote PC through the appropriate communication

port.

A local PC is connected to the relay via the RS232C port on the front fascia of the relay and a remote PC is also connected to the relay through the RS485 port at the rear of the relay.

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

GRF100 has two model series, Model 101 and Model 201. Model 101 provides a single phase-to-phase voltage input, and Model 201 provides three phase voltage inputs.

2.2 Frequency Protection

For a four-stage frequency protection, GRF100 incorporates dedicated frequency measuring elements and scheme logic for each stage. A-phase to B-phase voltage is used to detect frequency.

Appendix A shows a block diagram of the GRF100.

2.2.1 Underfrequency and Overfrequency Protection

Underfrequency protection is provided to maintain the balance between the power generation capability and the loads. It is also used to maintain the frequency within the normal range by load shedding.

Overfrequency protection is provided to protect synchronous machines from possible damage due to overfrequency conditions.

2.2.2 Frequency Rate-of-Change Protection

Frequency rate of change protection is applied to ensure that load shedding occurs very quickly when the frequency change is very rapid.

The frequency rate of change protection calculates the gradient of frequency change (df/dt).

GRF100 provides two rate-of-change elements, a frequency decay rate element and a frequency rise rate element.

2.2.3 Scheme Logic of Frequency Protection

Figure 2.2.1 shows the scheme logic of frequency protection in stage 1. The first frequency element F11, the second F12, frequency rise rate-of-change element DFR1 and frequency decay rate-of-change element DFD1 can all output a trip command independently under the condition that the system voltage is higher than the setting of the undervoltage element UVBLK (UVBLK = 1).

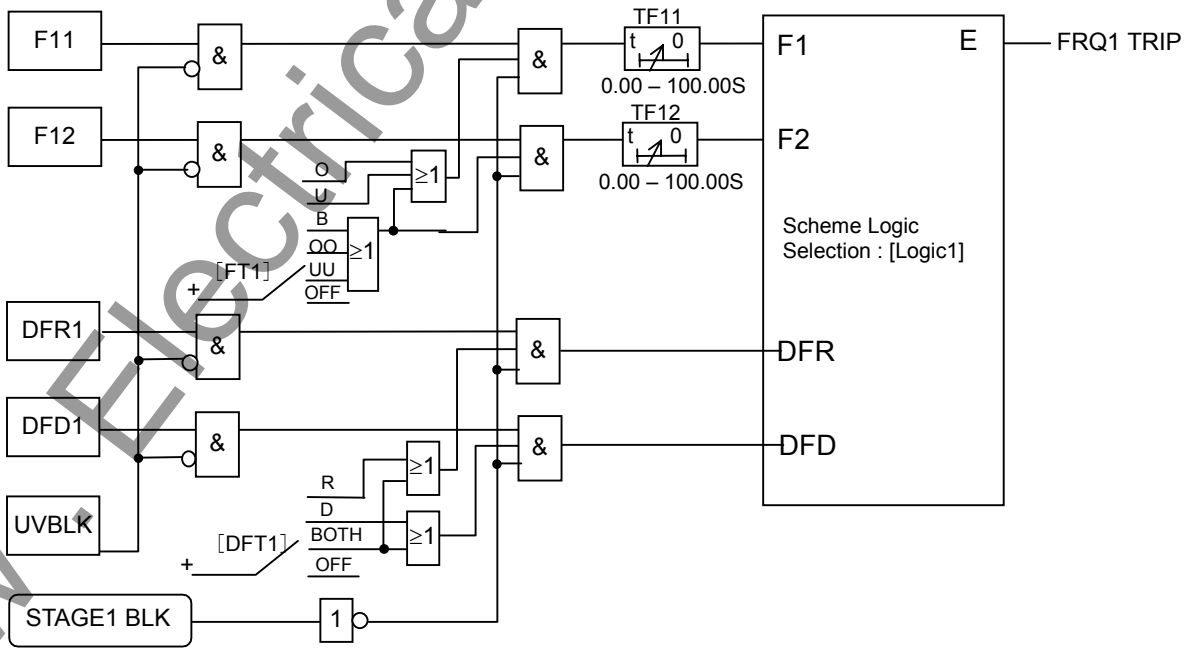


Figure 2.2.1 Scheme Logic of Frequency Protection

To apply for various frequency protections, the GRF100 has the following three scheme switches for each stage. For stage 1,

[FT1]: This switch selects the frequency protection to apply as well as provides the measuring elements F11 and F12 with an overfrequency or underfrequency characteristic.

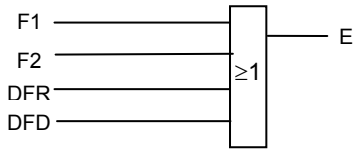
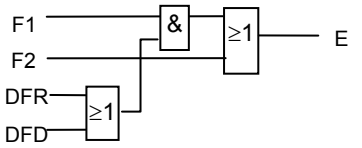
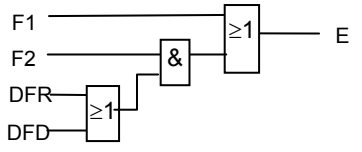
[FT1] setting	F11 / F12 characteristic		Protection selected
	F11	F12	
O	OF(*)	OF	Overfrequency protection only with F11 element
U	UF(**)	OF	Underfrequency protection only with F11 element
B	OF	UF	Overfrequency protection with F11 element and underfrequency protection with F12 element
OO	OF	OF	Overfrequency protection both with F11 and F12 elements
UU	UF	UF	Underfrequency protection both with F11 and F12 elements
Off	OF	OF	To block frequency protection

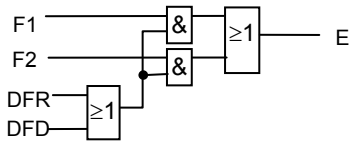
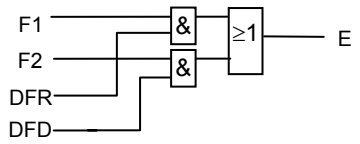
(*) OF: Overfrequency characteristic
(**)UF: Underfrequency characteristic

[DFT1]: This switch selects which frequency rate-of-change protection to apply. The following protections can be selected by the [DFT1] settings.

[DFT1] setting	Protection selected
R	Frequency rise rate-of-change protection only
D	Frequency decay rate-of-change protection only
BOTH	Both of frequency rise rate-of-change and decay rate-of-change protections
Off	To block frequency rate-of-change protection

[LOGIC1]: This switch is provided in the scheme logic selection circuit in Figure 2.2.1 and determines the trip command combination of frequency element output and frequency rate-of-change element output. The following table shows the [Logic1] setting and corresponding combinations.

[Logic1] Setting	Scheme Logic	Trip Command Logic (+:OR, x : AND)
L1		E = F1 + F2 + DFR + DFD
L2		E = F1 x (DFR + DFD) + F2
L3		E = F1 + F2 x (DFR + DFD)

L4		E = (F1 + F2) x (DFR + DFD)
L5		E = F1 x DFR + F2 x DFD

The scheme logics of stage 2 to 4 are similar to that of stage 1 except that the device names of the measuring elements, timers, scheme switches and binary input signals change and the mentioned above are applied to stages 2 to 4.

2.2.4 Setting

The setting elements necessary for the frequency protection and their setting ranges are shown in the table below.

Element	Range	Step	Default	Remarks
F□1 (*)	45.00 – 55.00 Hz	0.01 Hz	51.00 Hz	First frequency element setting
	(54.00 – 66.00 Hz	0.01 Hz	61.00 Hz)	
F□2	45.00 – 55.00 Hz	0.01 Hz	49.00 Hz	Second frequency element setting
	(54.00 – 66.00 Hz	0.01 Hz	59.00 Hz)	
DF□ (**)	0.1 – 9.9 Hz/s	0.1 Hz/s	0.5 Hz/s	Frequency rate-of-change (**)
UVBLK(***)	40 –100 V	1 V	40 V	Undervoltage block
TF□1	0.00 – 100.00 s	0.01 s	1.00 s	Timer setting of first frequency element
TF□2	0.00 – 100.00 s	0.01 s	1.00 s	Timer setting of second frequency element
FT□	Off / O / U / B / OO / UU		B	Frequency protection selection
DFT□	Off / R / D / Both		Both	Frequency rate-of-change protection selection
Logic□	L1 / L2 / L3 / L4 / L5		L1	Scheme logic selection

(*): Number 1 to 4 enter into □ for stages 1 to 4 respectively.
(**): DF□ is a common setting element name for DFR□ and DFD□.
(***): UVBLK is common to stage 1 to 4.

2.3 Voltage Protection

2.3.1 Undervoltage Protection

Undervoltage protection is mainly used to protect motors from possible damage caused by voltage drops.

The undervoltage protection has the following six measuring elements:

- Definite time phase-to-phase undervoltage element UVS
- Definite time phase-to-ground undervoltage element UVG (for model 201)
- Inverse time phase-to-phase undervoltage element UVIS
- Inverse time phase-to-ground undervoltage element UVIG (for model 201)
- High-speed phase-to-phase undervoltage element UVHSS
- High-speed phase-to-ground undervoltage element UVHSG (for model 201)

2.3.2 Overvoltage Protection

Overvoltage protection is mainly used to protect generators from abnormal voltage rises.

The overvoltage protection has the following four measuring elements:

- Definite time phase-to-phase overvoltage element OVS
- Definite time phase-to-ground overvoltage element OVG (for model 201)
- Inverse time phase-to-phase overvoltage element OVIS
- Inverse time phase-to-ground overvoltage element OVIG (for model 201)

2.3.3 Scheme Logic of Undervoltage and Overvoltage Protection

Figure 2.3.1 and 2.3.2 show the scheme logic of undervoltage and overvoltage protection in stage 1. The above five or ten elements described in Section 2.3.1 and 2.3.2 can each output a trip command independently.

To apply for various voltage protections, the GRF100 has the following scheme switches. For stage 1,

[OVT1]: This switch selects to use or not to use the overvoltage protection in Model 101 and the phase-to-phase and/or phase-to-ground definite time overvoltage protection in Model 201.

[UVT1]: This switch selects to use or not to use the undervoltage protection in Model 101 and the phase-to-phase and/or phase-to-ground definite time undervoltage protection in Model 201.

[OVIT1]: This switch selects to use or not to use the inverse time overvoltage protection in Model 101 and the phase-to-phase and/or phase-to-ground inverse time overvoltage protection in Model 201.

[UVIT1]: This switch selects to use or not to use the inverse time undervoltage protection in Model 101 and the phase-to-phase and/or phase-to-ground inverse time undervoltage protection in Model 201.

[UVHST1]: This switch selects to use or not to use the high-speed undervoltage protection in Model 101 and the phase-to-phase and/or phase-to-ground high-speed

undervoltage protection in Model 201.

The undervoltage and overvoltage measuring elements are common to the four stages. The scheme logic marked by the dotted line in Figure 2.3.1 and 2.3.2 are provided independently for each stage and stages 2 to 4 scheme logic is similar to the stage 1 except that the device names of the timers, scheme switches and binary input signals change.

In case of Model 201, settings of the scheme switches [OVT1] to [UVHST1] select the following protections:

Setting	Protection Selected
S	Phase-to-phase protection
G	Phase-to-earth protection
Both	Phase-to-phase and phase-to-earth protection
Off	Protection disabled

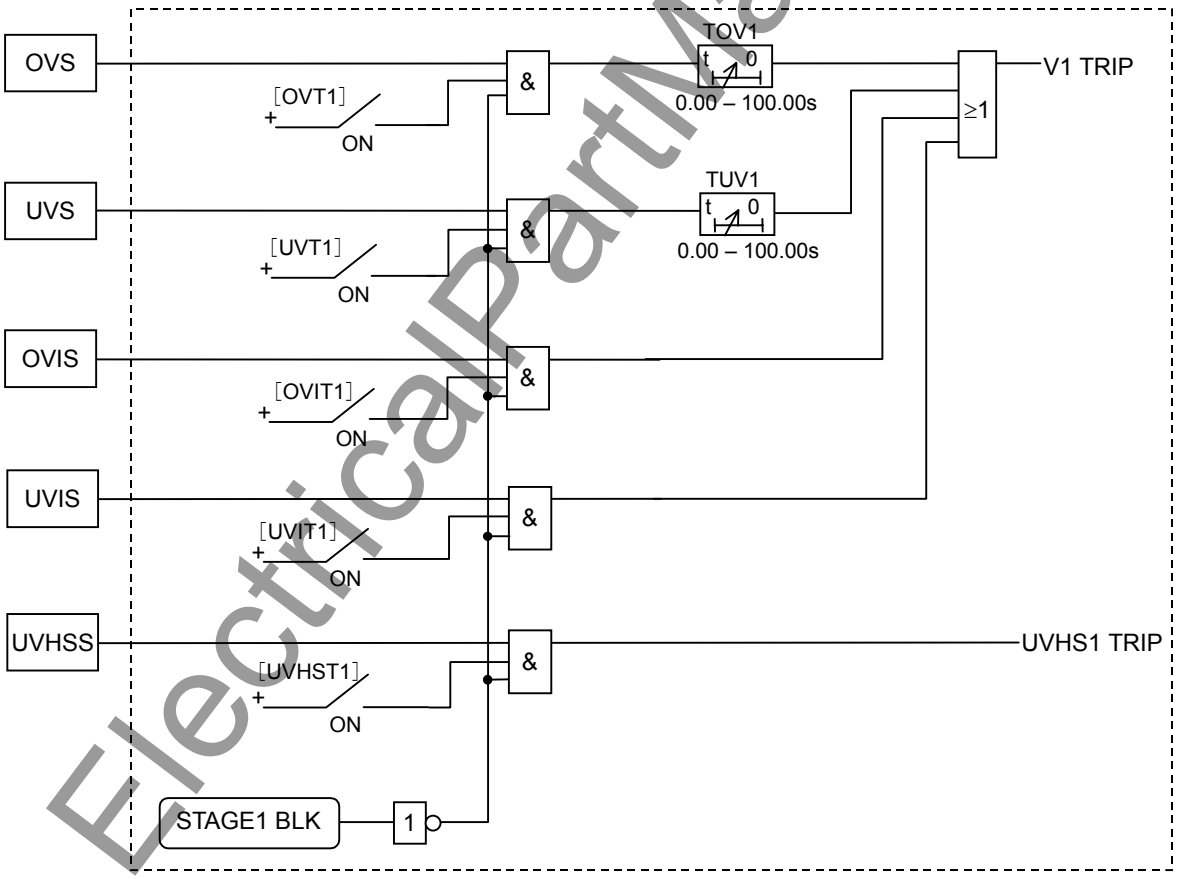


Figure 2.3.1 Scheme Logic of Undervoltage and Overvoltage Protection for Model 101

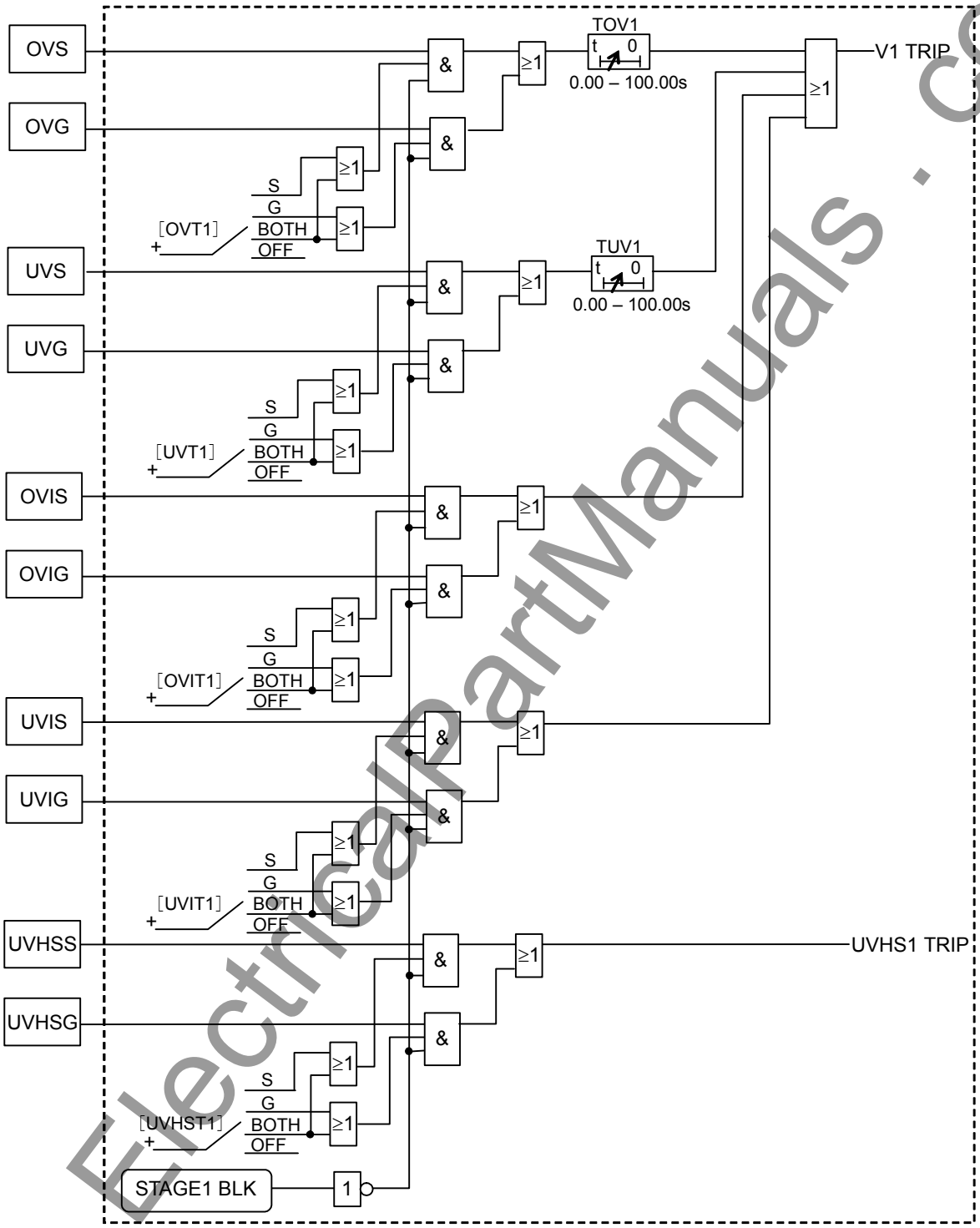


Figure 2.3.2 Scheme Logic of Undervoltage and Overvoltage Protection for Model 201

2.3.4 Setting

The setting elements necessary for the undervoltage and overvoltage protection and their setting ranges are shown in the table below.

Element	Range	Step	Default	Remarks
OVS	5 – 190 V	1 V	132 V	Phase-to-phase overvoltage setting
OVG	5 – 100 V	1 V	76 V	Phase-to-ground overvoltage setting
TOV□(*)	0.00 – 100.00 s	0.01 s	1.00 s	OV trip delay timer setting
UVS	20 – 140 V	1 V	88 V	Phase-to-phase undervoltage setting
UVG	10 – 85 V	1 V	50 V	Phase-to-ground undervoltage setting
TUV□	0.00 – 100.00 s	0.01 s	1.00 s	UV trip delay timer setting
OVIS	5 – 190 V	1 V	132 V	Phase-to-phase inverse time overvoltage setting
TOVIS	0.05 - 100	0.01	13.50	Time multiplier of OVIS
OVIG	5 – 100 V	1 V	76 V	Phase-to-ground inverse time overvoltage setting
TOVIG	0.05 - 100	0.01	13.50	Time multiplier of OVIG
UVIS	20 – 140 V	1 V	88 V	Phase-to-phase inverse time undervoltage setting
TUVIS	0.05 - 100	0.01	13.50	Time multiplier of UVIS
UVIG	10 – 85 V	1 V	50 V	Phase-to-ground inverse time undervoltage setting
TUVIG	0.05 - 100	0.01	13.50	Time multiplier of UVIG
UVHSS	20 – 140 V	1 V	80 V	Phase-to-phase high-speed undervoltage setting
UVHSG	10 – 85 V	1 V	46 V	Phase-to-ground high-speed undervoltage setting
OVT□	Off / S / G / Both		Both	Definite time overvoltage protection for Model 201
	(Off / On		Off)	Definite time overvoltage protection for Model 101
UVT□	Off / S / G / Both		Both	Definite time undervoltage protection for Model 201
	(Off / On		Off)	Definite time undervoltage protection for Model 101
OVIT□	Off / S / G / Both		Both	Inverse time overvoltage protection for Model 201
	(Off / On		Off)	Inverse time overvoltage protection for Model 101
UVIT□	Off / S / G / Both		Both	Inverse time undervoltage protection for Model 201
	(Off / On		Off)	Inverse time undervoltage protection for Model 101
UVHST□	Off / S / G / Both		Both	High-speed undervoltage protection for Model 201
	(Off / On		Off)	High-speed undervoltage protection for Model 101

(*): Number 1 to 4 enter into □ for stage 1 to 4 respectively.

2.4 Tripping Output

The tripping logic is shown in Figure 2.4.1. The GRF100 has one tripping output relay for each protection stage (TP-1 to TP-4). The output relays have one normally open contact.

The auxiliary relay TP1 for the stage 1 protection is a high-speed operation relay.

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

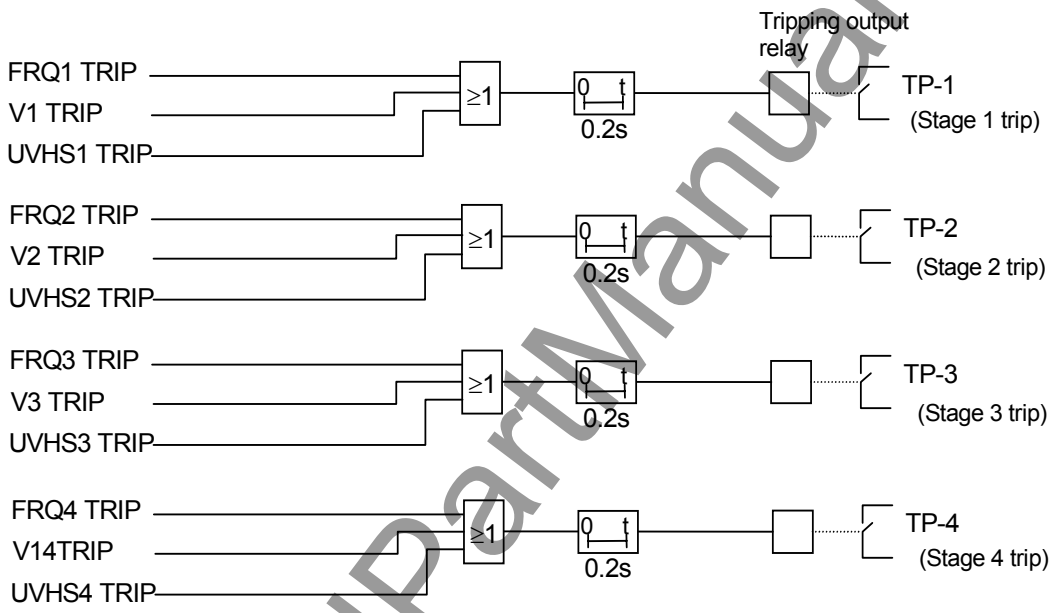


Figure 2.4.1 Tripping Logic

2.5 Characteristics of Measuring Elements

2.5.1 Frequency Elements

Underfrequency and overfrequency element

Underfrequency element UF operates when a power system frequency stays under the setting value.

Overfrequency element OF operates when a power system frequency stays over the setting value.

These elements measure the frequency and check the underfrequency or overfrequency every 5 ms. They operate when the underfrequency or overfrequency condition is detected 16 consecutive times.

Both UF and OF elements output is invalidated by undervoltage block element (UVBLK) operation during undervoltage condition.

Figure 2.5.1 shows characteristics of UF and OF elements.

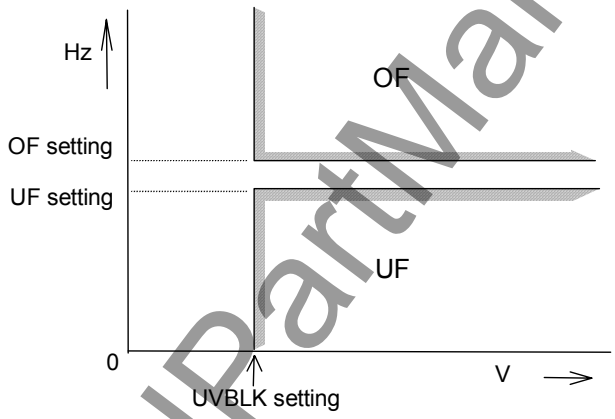


Figure 2.5.1 Underfrequency and Overfrequency Element

Frequency rate-of-change element

The frequency rate-of-change element calculates the gradient of frequency change (df/dt). GRF100 provides two rate-of-change elements, a frequency decay rate element and a frequency rise rate element. These elements measure the change in frequency (Δf) over a time interval (Δt=100ms), as shown Figure 2.5.2 and calculate the $\Delta f/\Delta t$ every 5 ms. They operate when the frequency change exceeds the setting value 40 consecutive times.

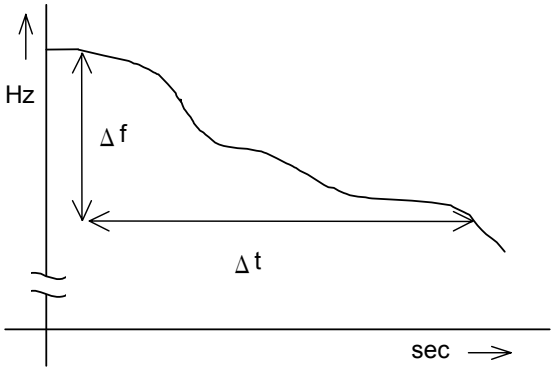


Figure 2.5.2 Frequency Rate-of-Change Element

2.5.2 Undervoltage and Overvoltage Elements

Phase-to-phase undervoltage elements UVS, UVHSS, UVIS and phase-to-ground undervoltage elements UVG, UVHSG and UVIG operate when a power system voltage stays under the setting values.

Phase-to-phase overvoltage elements OVS and OVIS and phase-to-ground overvoltage element OVG and OVIG operate when a power system voltage stays over the setting values.

These elements measure the voltage and check the undervoltage or overvoltage every 5 ms. They operate when the undervoltage or overvoltage condition is detected 2 consecutive times.

Figure 2.5.3 shows characteristics of undervoltage elements and overvoltage elements. The UVIS, UVIG, OVIS and OVIG have inverse time characteristics, and their characteristics are expressed by the following equations.

$$\text{UVIS and UVIG}: \quad t = \frac{1}{1 - (V/Vs)} \times TMS \ ,$$

$$\text{OVIS and OVIG}: \quad t = \frac{1}{(V/Vs) - 1} \times TMS \ ,$$

where,

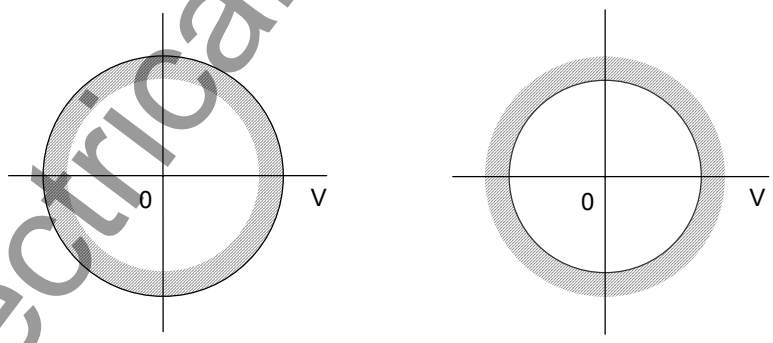
t = operating time

V = power system voltage

Vs = voltage setting

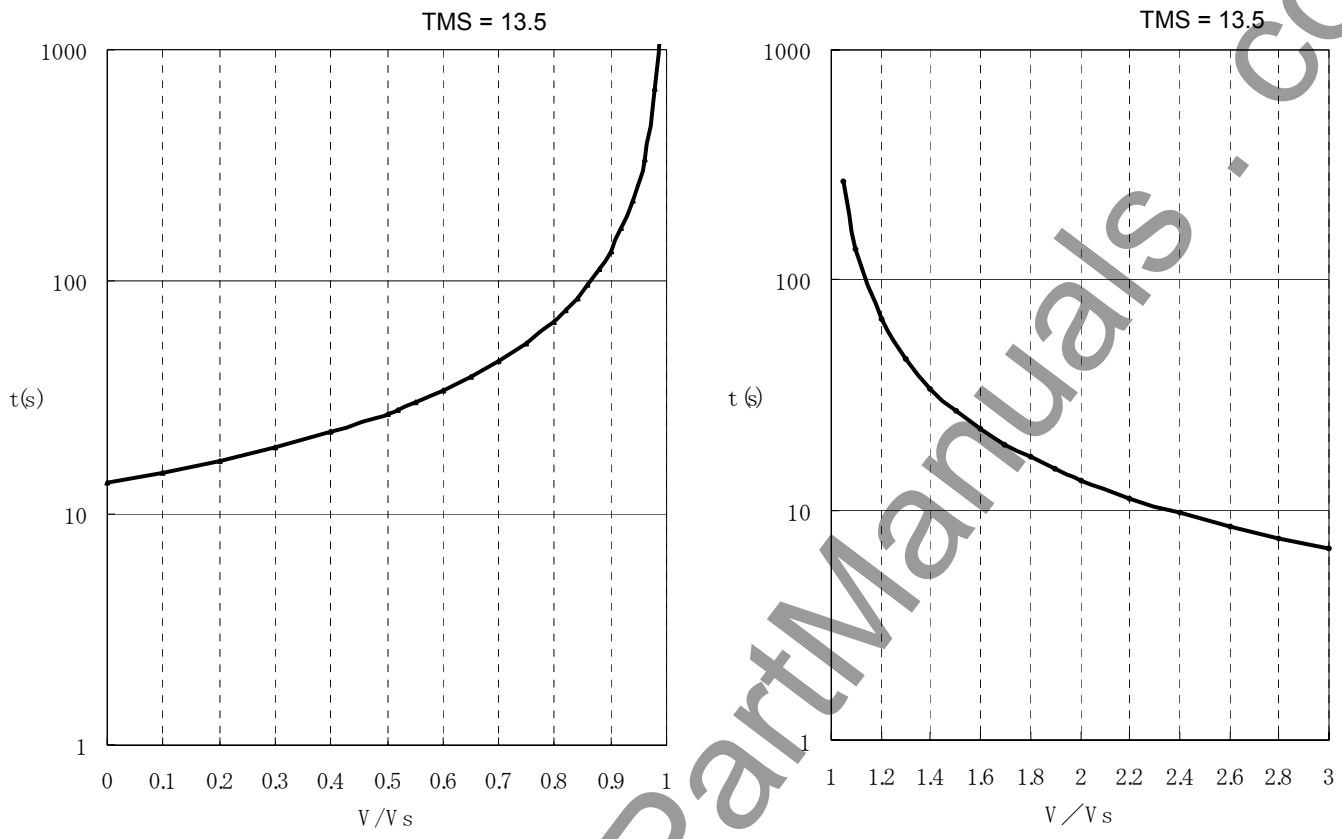
TMS = time multiplier setting

Figure 2.5.4 shows operating time characteristics of UVIS, UVIG, OVIS and OVIG.



(a) Undervoltage elements (b) Overvoltage elements

Figure 2.5.3 Undervoltage and Overvoltage Elements



(a) UVIS and UVIG

(b) OVIS and OVIG

Figure 2.5.4 Operating Time Characteristics

3. Technical Description

3.1 Hardware Description

3.1.1 Outline of Hardware Modules

Case outline of GRF100 is shown in Appendix F.

The hardware structure of GRF100 is shown in Figure 3.1.1.

The GRF100 relay unit consists of the following hardware modules. These modules are fixed and cannot be taken off individually. The human machine interface module is provided with the front panel.

- Binary input and analog 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 GRF100 is shown in Figure 3.1.2.

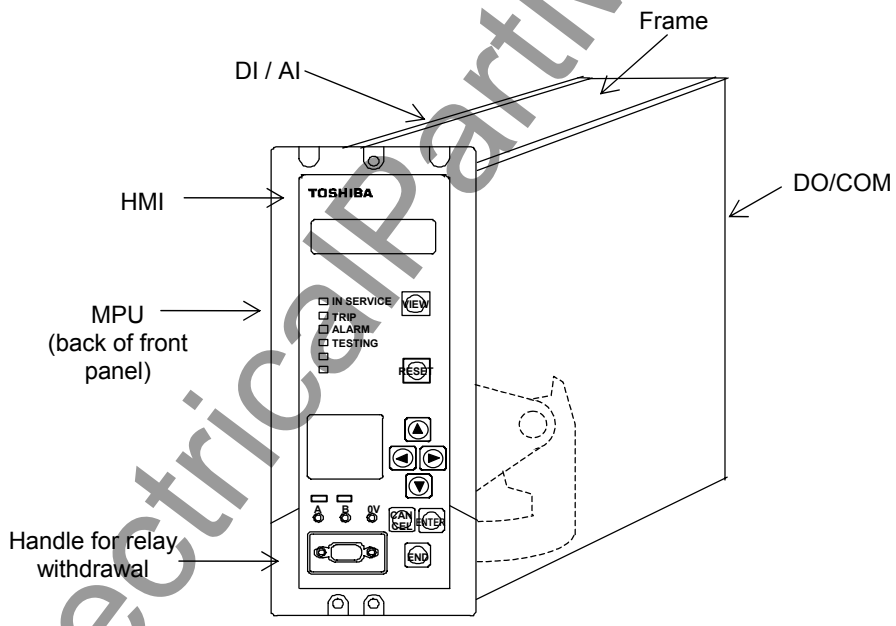


Figure 3.1.1 Hardware Structure without Case

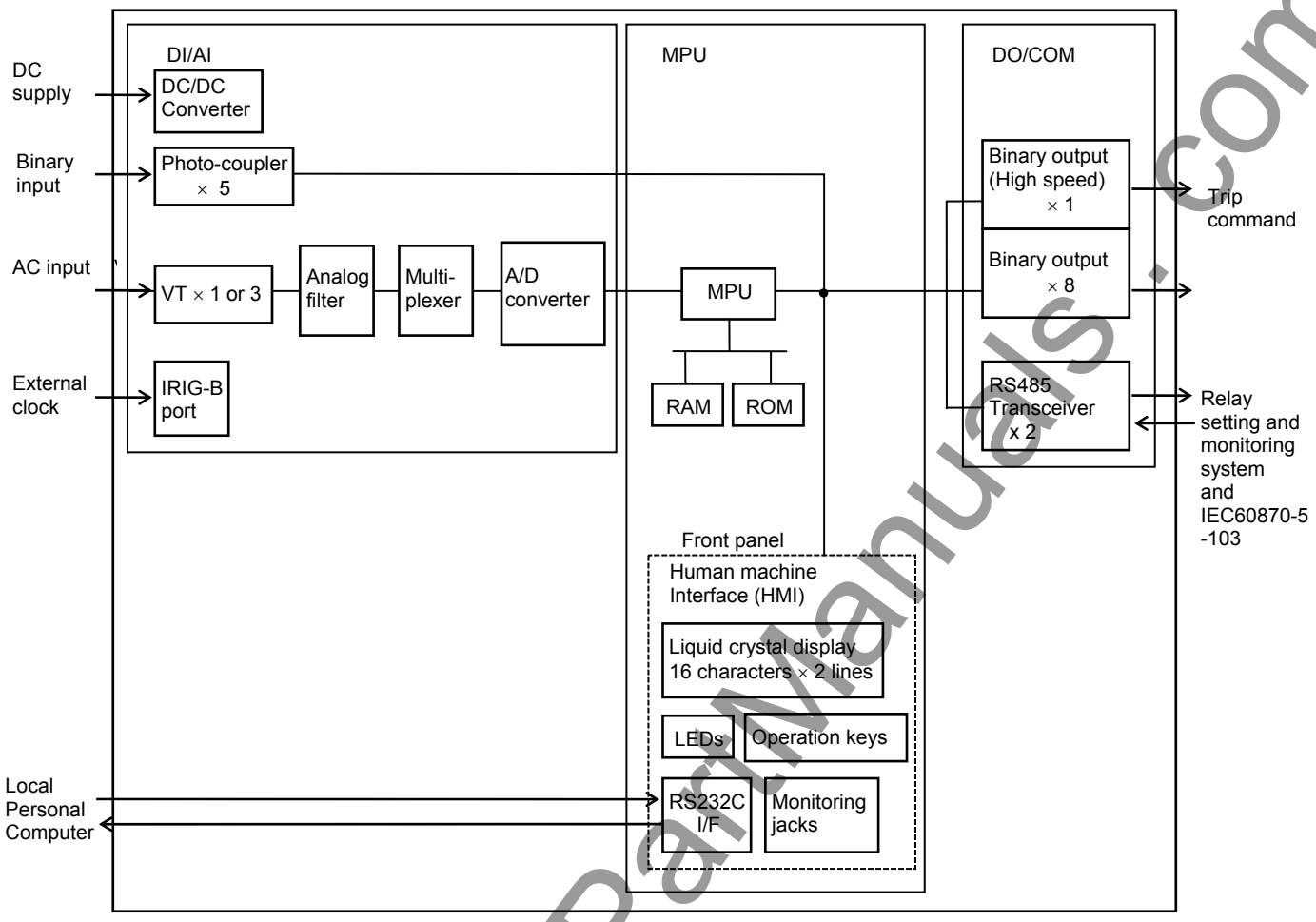


Figure 3.1.2 Hardware Block Diagram

DI/AI Module

The DI/AI module insulates between the internal and external circuits through an auxiliary transformer and transforms the magnitude of AC input signals to suit the electronic circuits. The AC input signals are phase-to-phase voltage or phase voltages.

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

This module incorporates a DC/DC converter, analog filter, multiplexer, analog to digital (A/D) converter and photo-coupler circuit for 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 analog filter performs low-pass filtering for the corresponding voltage signals.

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

This module is also provided with an IRIG-B port. This port collects the serial IRIG-B format data from the external clock for synchronization of the relay calendar clock. The IRIG-B port is insulated from the external circuit by a photo-coupler. A BNC connector is used as the input connector.

MPU Module

The MPU module consists of main processing unit (MPU) and executes all kinds of processing such as protection, measurement, recording and display.

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

DO/COM Module

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

The tripping command auxiliary relay for TP-1 is the high-speed operation type and has one normally open output contact.

The auxiliary relay FAIL has one normally closed contact, and operates when a relay failure or abnormality in the DC circuit is detected. BO1 to BO4 each have one normally open contact.

The RS485 transceiver is used for the link with communication system such as the relay setting and monitoring (RSM) or IEC60870-5-103. The external signal is isolated from the relay internal.

Human Machine Interface (HMI) Module

The operator can access the GRF100 via the human machine interface (HMI) module. As shown in Figure 3.1.3, the HMI panel has a liquid crystal display (LCD), light emitting diodes (LED), view and reset keys, operation keys, monitoring jacks and an RS232C connector on the front panel.

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

There are a total of 6 LED indicators and their signal labels and LED colors are defined as follows:

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

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.

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

The VIEW key starts the LCD indication and switches between windows. The RESET key clears the LCD indication and turns off the LCD back-light.

The operation keys are used to display the record, status and setting data on the LCD, input the settings or change the settings.

The monitoring jacks and two pairs of LEDs, A and B, on top of the jacks can be used while the test mode is selected in the LCD window. Signals can be displayed on LED A or LED B by selecting the signal to be observed from the "Signal List" and setting it in the window. The signals can be fed to an oscilloscope via the monitoring jacks. (For the "Signal List" or "Variable Timer List", see Appendix B or C.)

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

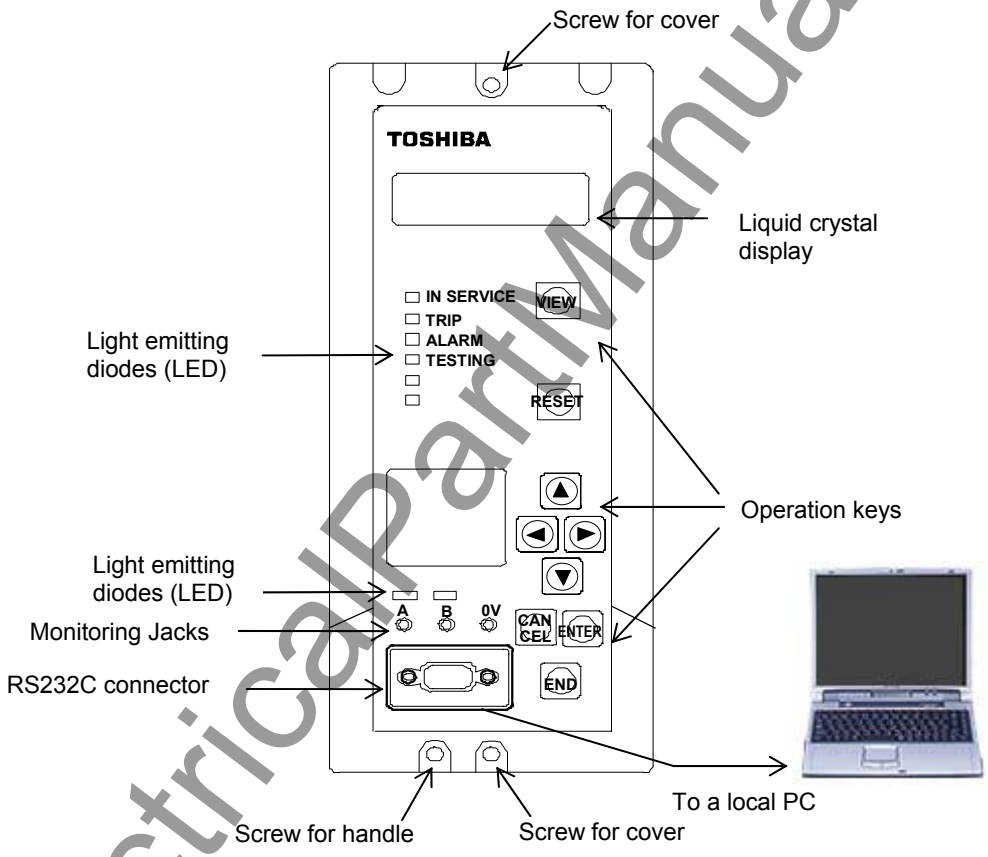


Figure 3.1.3 Front Panel

3.2 Input and Output Signals

3.2.1 Input Signals

AC input signals

Table 3.2.1 shows the AC input signals necessary for each of the GRF100 models and their respective input terminal numbers.

Table 3.2.1 AC Input Signals

Terminal No. of TB1	GRF100-101	GRF100-201
A1-B1	Phase to phase voltage	A-phase voltage
A2-B2	—	B-phase voltage
A3-B3	—	C-phase voltage

Binary input signals

Table 3.2.2 shows the binary input signals required by the GRF100, their driving contact conditions and functions enabled. See Appendix G for external connections

The binary input circuit of the GRF100 is provided with a logic level inversion function as shown in Figure 3.2.1. Each input circuit has a binary switch BISW which can be used to select either normal or inverted operation. This allows the inputs to be driven either by normally open or normally closed contacts. Where the driving contact meets the contact conditions indicated in Table 3.2.2 then the BISW can be set to “N” (normal). If not, then “I” (inverted) should be selected.

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

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

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

Table 3.2.2 Binary Input Signals

Signal Names	Driving Contact Condition / Function Enabled	BISW No.
Stage 1 block (STAGE1 BLK)	Closed to block stage 1 protection. / Block stage 1 protection.	1
Stage 2 block (STAGE2 BLK)	Closed to block stage 2 protection. / Block stage 2 protection.	2
Stage 3 block (STAGE3 BLK)	Closed to block stage 3 protection. / Block stage 3 protection.	3
Stage 4 block (STAGE4 BLK)	Closed to block stage 4 protection. / Block stage 4 protection.	4
Indication reset	Closed to reset TRIP LED indication. / Reset indication externally.	5

( ): Signal name used in the scheme logic.

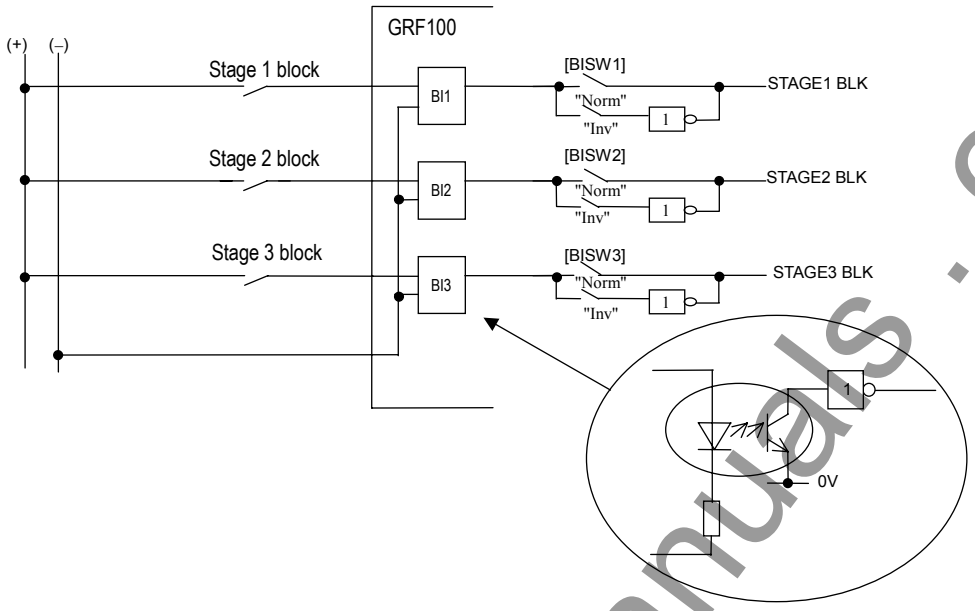


Figure 3.2.1 Logic Level Inversion

3.2.2 Binary Output Signals

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

The signals shown in the signal list in Appendix B can be assigned to the output relay BO1 to BO4 individually or in arbitrary combinations. Signals can be combined using either an AND circuit or OR circuit with 4 gates each as shown in Figure 3.2.2. The output circuit can be configured according to the setting menu. Appendix D 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.

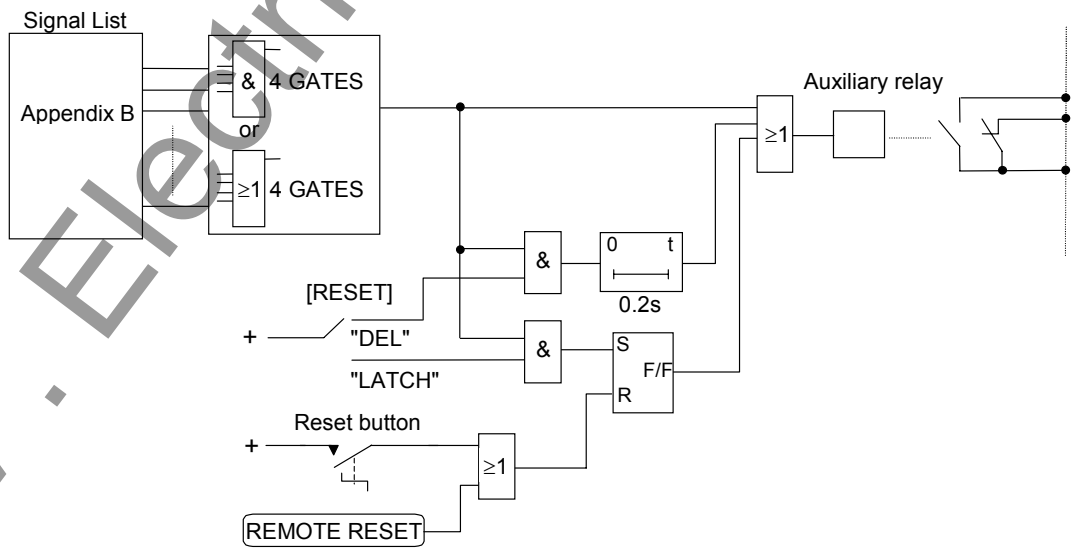


Figure 3.2.2 Configurable Output

3.3 Automatic Supervision

3.3.1 Basic Concept of Supervision

Though the protection system is in non-operating state under normal conditions, it is waiting for a power system fault to occur at any time and must operate for the fault without fail. Therefore, the automatic supervision function, which checks the health of the protection system during normal operation, plays an important role. A numerical relay based on microprocessor operations is suitable for implementing this automatic supervision function of the protection relay system. The GRF100 implements the automatic supervision function taking advantage of this feature based on the following concept:

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

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

3.3.2 Relay Monitoring

The relay is supervised with the following items.

AC input imbalance monitoring

This monitoring is provided only for model 201.

The AC voltage input is monitored to check that the following equations are satisfied and the health of the AC input circuits is checked.

- Zero sequence voltage monitoring

  $|V_a + V_b + V_c| / 3 \leq 0.1 \times$ (rated voltage)

- Negative sequence voltage monitoring

  $|V_a + a^2V_b + aV_c| / 3 \leq 0.1 \times$ (rated voltage)

  where, a = Phase shifter of 120°

The zero sequence monitoring and negative sequence monitoring allow high sensitivity detection of failures that have occurred in the AC input circuits.

The negative sequence voltage monitoring allows high sensitivity detection of failures in the voltage input circuit, and it is effective for detection particularly when cables have been connected with the incorrect phase sequence.

A/D accuracy checking

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

Memory monitoring

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

- Random access memory monitoring: Writes/reads prescribed data and checks the storage function.
- Program memory monitoring: Checks the checksum value of the written data.
- Setting value monitoring: Checks discrepancy between the setting values stored in duplicate.

Watchdog Timer

A hardware timer which is cleared periodically by the software is provided and is used to check that the software is running normally.

DC Supply Monitoring

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

3.3.3 Failure Alarms

When a failure is detected by the automatic supervision, it is followed with an LCD message, LED indication, external alarm and event recording. Table 3.3.1 summarizes the supervision items and alarms.

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

The alarms are retained until the failure is recovered.

The alarms can be disabled collectively by setting the scheme switch [AMF] to OFF. This setting is used to block unnecessary alarms during commissioning, test 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] Setting	LCD Message	LED "IN SERVICE"	LED "ALARM"	External Alarm	Event record Message
AC input imbalance monitoring (*)	ALM&BLK (**)	(1)	Off	On	(3)	Vo err or V2 err
	ALM (*)		On			
A/D accuracy check	----		Off			Relay fail
Memory monitoring						
Watchdog Timer		----		(2)		----
DC supply monitoring				On		
LCD supervision						

(1): Diverse messages are provided as expressed with "Err:---" in the table in Section 6.7.2.
(2): Whether the LED is lit or not depends on the degree of the voltage drop.
(3): The binary output relay "FAIL" operates.
(*): Depends on the switch [SVCNT] setting.
(**): This monitoring is provided only for Model 201.

3.3.4 Trip Blocking

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

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

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

3.3.5 Setting

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

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

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

3.4 Recording Function

The GRF100 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 GRF100 and the following items are recorded for one fault:

Date and time of fault occurrence

Tripping mode

Power system quantities

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

Date and time of fault occurrence

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

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

Tripping mode

This shows the protection scheme and stage that output the tripping command.

FRQ1 to FRQ4: Trip by frequency protection in stage 1 to 4

V1 to V4: Trip by definite time or inverse time voltage protection in stage 1 to 4

UV1 to UV4: Trip by high-speed undervoltage protection in stage 1 to 4

Power system quantities

Pre-fault and post-fault voltage and frequency data are recorded.

- Magnitude of phase-to-phase voltage (V for model 101, V_{ab}, V_{bc}, V_{ca} for model 201)
- Magnitude and phase angle of phase voltage (V_a, V_b, V_c only for model 201)
- Magnitude and phase angle of symmetrical component voltage (V_1, V_2, V_0 only for model 201)
- Frequency
- Frequency rate-of-change

Phase angles above are expressed taking the positive sequence voltage as a reference.

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 recording.

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

Table 3.4.1 Event Record Items

Event	LCD Indication	
Stage 1 trip command output or reset	Trip 1	On or Off
Stage 2 trip command output or reset	Trip 2	On or Off
Stage 3 trip command output or reset	Trip 3	On or Off
Stage 4 trip command output or reset	Trip 4	On or Off
Stage 1 blocking external command input or reset	Trip 1 BLK	On or Off
Stage 2 blocking external command input or reset	Trip 2 BLK	On or Off
Stage 3 blocking external command input or reset	Trip 3 BLK	On or Off
Stage 4 blocking external command input or reset	Trip 4 BLK	On or Off
Indication reset input or reset	Ind. reset	On or Off
Relay failed or restored	Relay fail	On or Off
AC input circuit failed or restored (detected by zero sequence voltage monitoring)	V0 err	On or Off
AC input circuit failed or restored (detected by negative sequence voltage monitoring)	V2 err	On or Off
System setting changed (*)	Sys. change	
Relay setting changed (*)	Rly. change	
Group setting changed (*)	Grp. change	

Note: A change of setting is classified into three events. The event "System setting changed" corresponds to all the setting changes except setting changes in the sub-menu "Protection". (See section 4.2.6 for changing the settings). The event "Relay setting changed" corresponds to setting change of measuring elements and timers in the sub-menu "Protection". The event "Group setting changed" corresponds to other setting changes in the sub-menu "Protection".

Setting

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

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

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

3.4.3 Disturbance Recording

Disturbance recording is started when voltage starter element operates, a tripping command is

output or frequency element operates. The records include one analog signal (V) for Model 101 (V) or three analog signals (V_a, V_b, V_c) for Model 201, 30 binary signals listed below and the dates and times at which recording started.

- F11	- F21	- F31	- F41	- OVS	- OVIS	- TRIP 1	- UVHSS
- F12	- F22	- F32	- F42	- OVG	- OVIG	- TRIP 2	- UVHSG
- DF-R1	- DF-R2	- DF-R3	- DF-R4	- UVS	- UVIS	- TRIP 3	
- DF-D1	- DF-D2	- DF-D3	- DF-D4	- UVG	- UVIG	- TRIP 4	

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

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

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

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

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

Recording time	0.1s	0.5s	1.0s	1.5s	2.0s	2.5s	3.0s
50Hz	40	22	10	9	7	6	5
60Hz	30	15	10	8	6	5	4

Settings

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

Element	Range	Step	Default	Remarks
OVP-S	5 – 190 V	1 V	132 V	Phase-to-phase overvoltage starter
OVP-G (*)	5 – 100 V	1 V	76 V	Phase-to-ground overvoltage starter
UVP-S	20 – 140 V	1 V	88 V	Phase-to-phase undervoltage starter
UVP-G (*)	10 – 85 V	1 V	50 V	Phase-to-ground undervoltage starter

(*) : Only for Model 201

Starting the disturbance recording by the operation of starter elements listed above, by the trip command or by the operation of frequency elements is selected by setting the following scheme switches.

Element	Range	Step	Default	Remarks
[OVP-S]	ON/OFF		ON	Start by OVP-S operation
[OVP-G] (*)	ON/OFF		ON	Start by OVP-G operation
[UVP-S]	ON/OFF		ON	Start by UVP-S operation
[UVP-G] (*)	ON/OFF		ON	Start by UVP-G operation
[TRIP]	ON/OFF		ON	Start by trip command
[FRQ]	ON/OFF		ON	Start by frequency element operation

(*) : Only for Model 201

3.5 Metering Function

The GRF100 performs continuous measurement of the analog input quantities. The measurement data shown below is updated every second and displayed on the LCD of the relay front panel or on the local or remote PC.

- Magnitude of phase-to-phase voltage (V for model 101, V_{ab}, V_{bc}, V_{ca} for model 201)
- Magnitude and phase angle of phase voltage (V_a, V_b, V_c only for model 201)
- Magnitude and phase angle of symmetrical component voltage (V_1, V_2, V_0 only for model 201)
- Frequency
- Frequency (maximum, minimum)
- Frequency rate-of-change
- Frequency rate-of-change (maximum rate of rise, maximum rate of decay)

The phase angles above are expressed taking the positive sequence voltage as a reference. Leading phase angles are expressed as positive.

The maximum and minimum data on frequency and the maximum data on frequency rate-of-change can be reset by pressing the RESET key. A new data is displayed based on the measurements after resetting.

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

4. User Interface

4.1 Outline of User Interface

The user can access the relay from the front panel.

Local communication with the relay is also possible using a personal computer (PC) via an RS232C port. Furthermore, remote communication is also possible using RSM (Relay Setting and Monitoring) and 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 (LEDs), operation keys, [VIEW] and [RESET] keys, monitoring jack and RS232C connector.

LCD

The LCD screen, provided with a 2-line, 16-character back-light, provides the user with information of the relay data 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 [END] key. If any display is left for 5 minutes or longer without operation, the back-light will go off.

LED

There are 6 LED displays. The signal labels and LED colors are defined as follows:

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

LED1 and LED2 are configurable. Refer to Section 3.1.1.

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

Operation keys

The operation keys are used to display records, status, and set values on the LCD, to input or change set values. The function of each operation key is as follows:

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

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

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

④ ENTER: Used to store or establish entries.

VIEW and RESET keys

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

Pressing the RESET key turns off the display.

Monitoring jacks

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

RS-232C connector

The RS232C connector is a 9-way D-type connector for a 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, setting operation and display functions can be performed.

RS485 port

The RS485 port is used for the RSM (Relay 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.)

Two (dual) RS485 ports (COM1 and COM2) are provided on the rear of the GRF100-***B relay as shown in Figure 4.1.1 and Appendix G.

IRIG-B port

The IRIG-B port is mounted on the DI/AI module. This port collects serial IRIG-B format data from the external clock to synchronize the relay calendar clock. The IRIG-B port is isolated from the external circuit by using a 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.

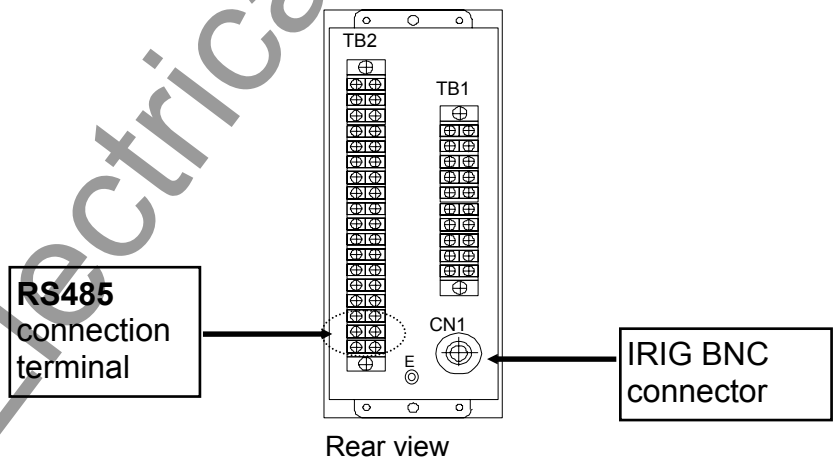


Figure 4.1.1 Locations of RS485 Port and IRIG B Port

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 GRF100 is operating normally, the green "IN SERVICE" LED is lit and the LCD is off.

Press the [VIEW] key when the LCD is off to display the digest screens "Metering", "Latest fault" and "Auto-supervision" screens in turn. The last two screens are displayed only when there is some data. These are the digest screens and can be displayed without entering the menu screens.

[Metering]

```
V        * * * . *   k V
```

(Model 101)

```
V a      * * * . * k V
         * * * . * °
```

(Model 201)

```
V b      * * * . * k V
         * * * . * °
```

(Model 201)

```
V c      * * * . * k V
         * * * . * °
```

(Model 201)

```
f        * * . * * Hz
```

```
f / t    – * * . * * Hz / s
```

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

[Latest fault]

```
FRQ1 , V1 , FRQ2 , V2
FRQ3 , V3 , FRQ4 , V4
```

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

[Auto-supervision]

```
Err :
```

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

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

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

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

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

Notes:

1) When configurable LEDs (LED1 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 GRF100. The menu has five sub-menus, "Record", "Status", "Set.(view)", "Set.(change)", and "Test". For details of the menu hierarchy, see Appendix E.

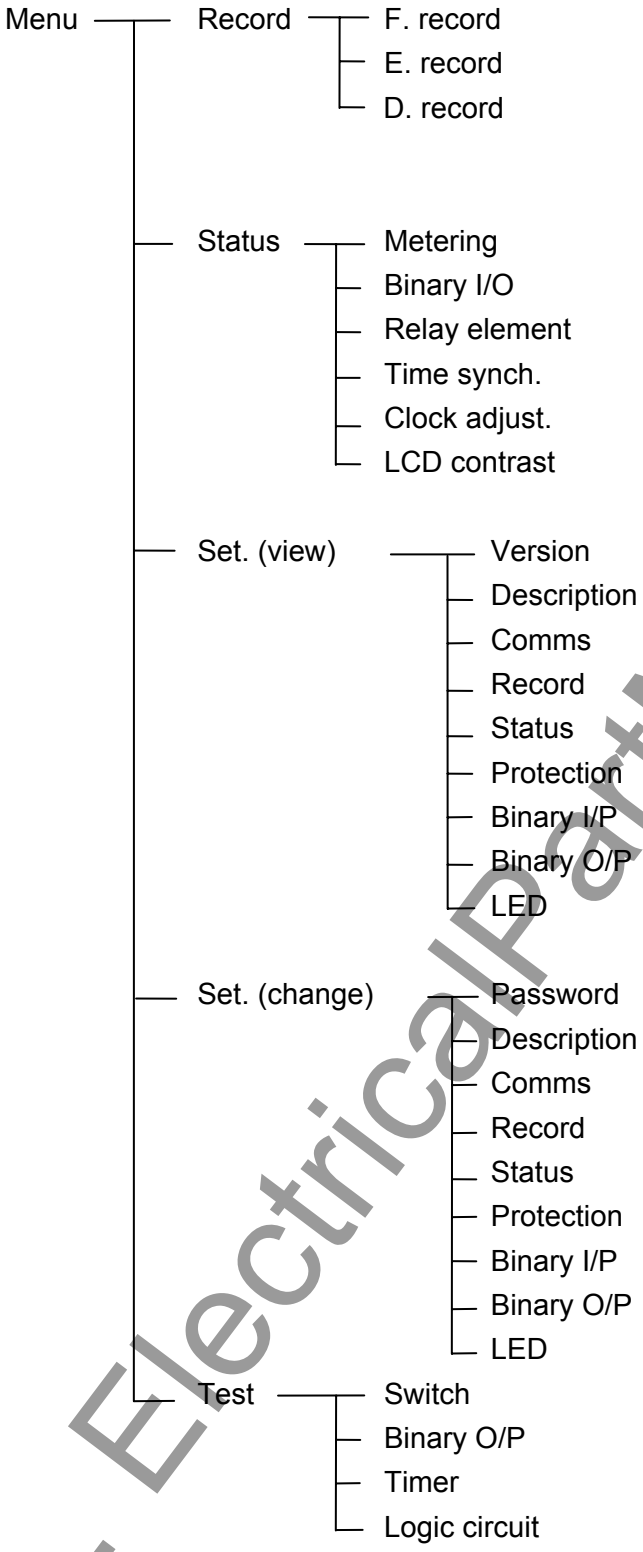


Figure 4.2.1 Relay Menu

Record

In the "Record" menu, the fault record, event record and disturbance 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)

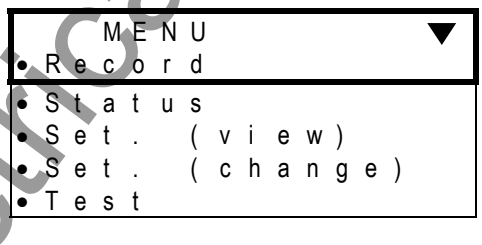
The "Set. (change)" menu is used to change the settings of password, description, relay address and baud rate in RSM or IEC60870-5-103 communication, record, status, protection, binary inputs, configurable binary outputs and configurable LEDs.

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

Test

The "Test" menu is used to set testing switches, to forcibly operate binary output relays, to measure the variable timer time and to observe the binary signals in the logic circuit.

When the LCD is off, press any key other than the [VIEW] and [RESET] keys to display the top "MENU" screen and then proceed to the relay menus.



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 the ▼ and ▲ keys.

```
/ 4  Scheme sw          ▼
Trip              1  _
Off / On
FRQ               1  _
Off / On
```

To return to the higher screen or move from the right side screen to the left side screen in Appendix E, press the [END] key.

The [CANCEL] key can also be used to return to the higher screen but it must be used carefully because it may cancel entries made so far.

To move between screens of the same depth, first return to the higher screen and then move to the lower screen.

4.2.3 Displaying Records

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

4.2.3.1 Displaying Fault Records

To display fault records, do the following:

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

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

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

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

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

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

- Move the cursor to the fault record line to be displayed using the ▲ and ▼ keys and press the [ENTER] key to display the details of the fault record.

```
/4  F.record  #1 ▼
16/Oct/1997
18:13:57.031
FRQ1
Prefault values
Va          ***.* kV
            ***.* °
Vb          ***.* kV
            ***.* °
Vc          ***.* kV
            ***.* °
Vab         ***.* kV
            ***.* °
Vbc         ***.* kV
            ***.* °
Vca         ***.* kV
            ***.* °
V1          ***.* kV
               0.0 °
V2          ***.* kV
            ***.* °
V0          ***.* kV
            ***.* °
f           **.** Hz
f/t      -***.** Hz/s
Fault values
Va          ***.* kV
            ***.* °
Vb          ***.* kV
            ***.* °
Vc          ***.* kV
            ***.* °
Vab         ***.* kV
            ***.* °
Vbc         ***.* kV
            ***.* °
Vca         ***.* kV
            ***.* °
V1          ***.* kV
               0.0 °
V2          ***.* kV
            ***.* °
V0          ***.* kV
            ***.* °
f           **.** Hz
f/t      -***.** Hz/s
```

Date

Time

Tripping mode

Power system quantities

Note : In the case of model 101, only single phase-to-phase voltage is displayed for the voltage quantities.

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

To clear all the fault records, do the following:

- Open the "Record" sub-menu.
- Select "F. record" to display the "Fault record" screen.

- Select "Clear" to display the following confirmation screen.

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

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

If all fault records have been cleared, the "Latest fault" screen of the 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.record      ▼
• Display
• Clear
```

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

```
/3 E.record      ▼
16/Oct/1997
Trip1            Off
16/Oct/1997
Trip1            On
16/Sep/1997
Rly. change
```

The time is displayed by pressing the ▶ key.

```
/3 E.record      ▼
18:13:58.255
Trip1            Off
18:13:58.028
Trip1            On
18:13:58.528
Rly. change
```

Press the ◀ key to return the screen with the date.

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

To clear all the event records, do the following:

- Open the "Record" sub-menu.
- Select "E. record" to display the "Event record" screen.
- Select "Clear" to display the following confirmation screen.

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

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

4.2.3.3 Displaying Disturbance Records

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

(*) For the display on the PC screen, refer to 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 all the disturbance records, do the following:

- Open the "Record" sub-menu.
- Select "D. record" to display the "Disturbance record" screen.
- Select "Clear" to display the following confirmation screen.

```
C l e a r   r e c o r d s ?
E N D = Y     C A N C E L = 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 measuring elements output

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                  ▼
Va          ***.* kV
            ***.* °
Vb          ***.* kV
            ***.* °
Vc          ***.* kV
            ***.* °
Vab         ***.* kV
            ***.* °
Vbc         ***.* kV
            ***.* °
Vca         ***.* kV
            ***.* °
V1          ***.* kV
              0.0 °
V2          ***.* kV
            ***.* °
V0          ***.* kV
            ***.* °
f           **.** Hz
fmax        **.** Hz
fmin        **.** Hz
f/t        -**.** Hz/s
f/tm        **.** Hz/s
f/tm       -**.** Hz/s
```

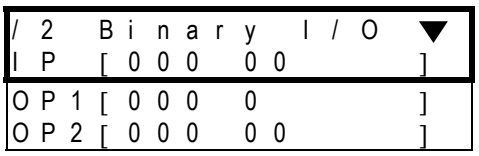
Note : In the case of model 101, only single phase-to-phase voltage is displayed for the voltage quantities.
To change the voltage value from the primary side to the secondary side or vice versa, see section 4.2.6.6.

- Press the RESET key to reset the fmax, fmin, f/tm, f/tm(-).

4.2.4.2 Displaying the Status of Binary Inputs and Outputs

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

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



The display format is shown below.

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

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

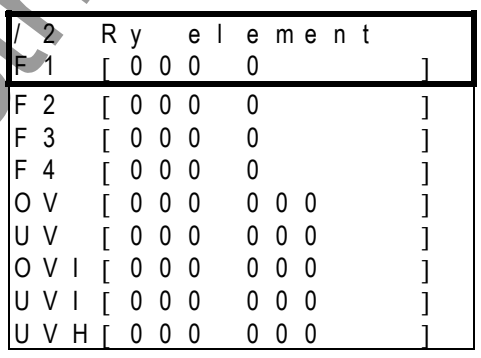
Lines 2 to 3 show the binary output status. TP-1 to TP-4 of line 2 correspond to the tripping command outputs. FAIL of line 3 corresponds to the relay failure output. Other outputs expressed with BO1 to BO4 are configurable. The status of these outputs is expressed with logical level "1" or "0" at the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

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

4.2.4.3 Displaying the Status of Measuring Elements

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

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



The display format is as shown below.

	[■	■	■	■	■	■	■	■]
F1	F11	F12	DF-R1	DF-D1	—	—	—	—
F2	F21	F22	DF-R2	DF-D2	—	—	—	—
F3	F31	F32	DF-R3	DF-D3	—	—	—	—
F4	F41	F42	DF-R4	DF-D4	—	—	—	—
OV	AB	BC	CA	A	B	C	—	—
		OVS			OVG			
UV	AB	BC	CA	A	B	C	—	—
		UVS			UVG			
OVI	AB	BC	CA	A	B	C	—	—
		OVIS			OVIG			
UVI	AB	BC	CA	A	B	C	—	—
		UVIS			UVIG			
UVH	AB	BC	CA	A	B	C	—	—
		UVHS			UVHG			

Line 1 to 4 show the operation status of each stage frequency elements and frequency rate-of-change elements. The frequency elements F11 to F42 take either overfrequency or underfrequency characteristic depending on the scheme switch FT□ setting. For the relation between the setting and the characteristic, see Section 2.2.4.

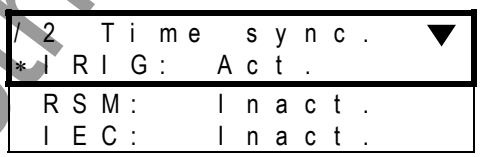
Line 5 to 9 show the operation status of the overvoltage and undervoltage elements. Model 101 introduces a single phase-to-phase voltage, so provides only the far left column .

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 Synchronization Source

The internal clock of the GRF100 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 synchronization sources.



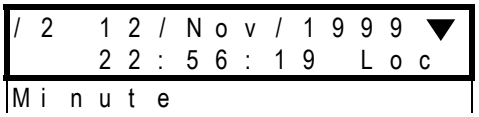
The asterisk on the far left shows that the internal clock is synchronized with the marked source clock. If the marked source clock is inactive, the internal clock runs locally.

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

4.2.4.5 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.



```
        5 6   _
Hour
        2 2   _
Day
        1 2   _
Month
        1 1   _
Year
    1 9 9 9   _
```

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.

```
/ 2  L C D  c o n t r a s t
■■■■
```

- 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 relay version or the settings made using 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

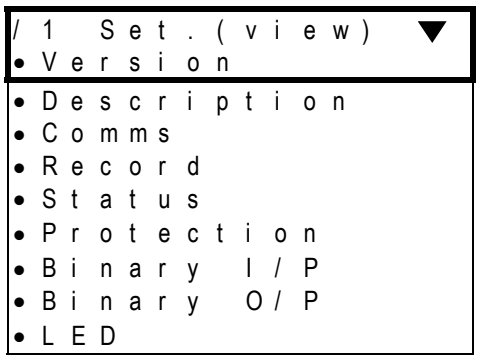
Binary output setting

LED setting

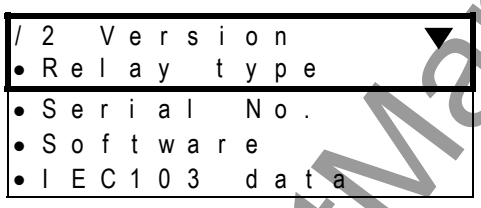
4.2.5.1 Relay Version

To view the relay version, do the following.

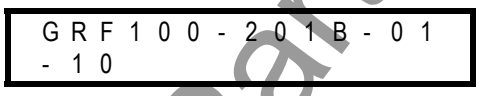
- Select the "Set.(view)" on the main menu.



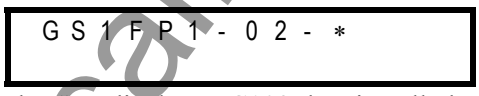
- Select "Version" to display the relay version screen.



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



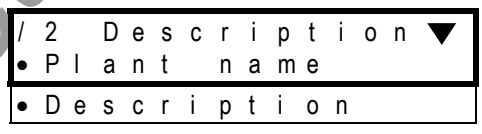
- Select "Serial number" to display the relay manufacturing number.
- Select "Software" to display the relay software type form.



- Select "IEC103 data" to display IEC103 data installed on the relay.

4.2.5.2 Description

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



- Select "Plant name" to display the plant name or line 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

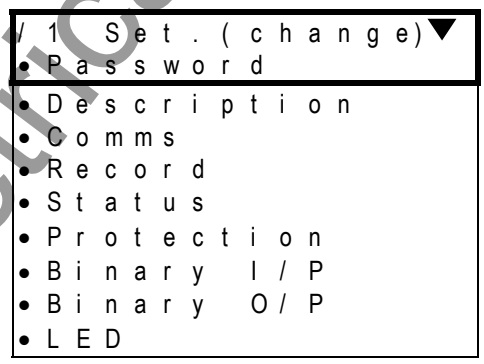
There are three setting methods as follows:

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

To enter a selected item

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

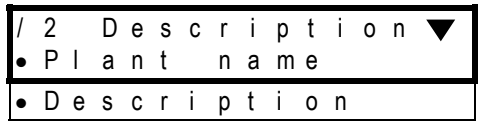
The cursor can be moved to upper or lower lines within the screen by pressing the ▲ and ▼ keys.
If a setting (change) is not required, skip the line with the ▲ and ▼ keys.



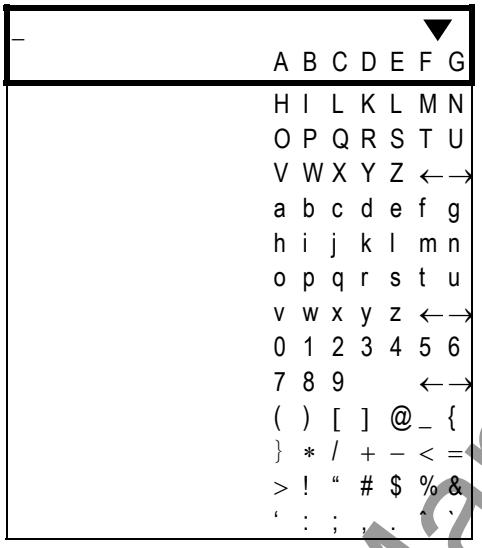
- Move the cursor to a setting item.
- Press the [ENTER] key.

To enter a text string

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



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



- Set the cursor position 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.

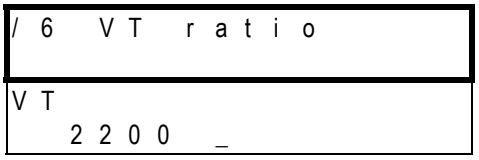
To correct the entered character, do either of the followings:

- 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 complete entry again.

To enter numerical values

When the screen shown below is displayed, perform setting as follows:

The number to the left of the cursor shows the current setting or default setting set at shipment. The cursor can be moved to 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 raised or lowered 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 correct line by pressing the ▲ and ▼ keys and enter the new numerical value.

Note: If the CANCEL key is pressed after any of the entry's 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 stored in the memory but not yet used for operation. 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, enter "0000" in the two brackets on the "Password" screen. The "Set.(change)" screen is then displayed without having to enter a password.

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

If you forgot the password

Press CANCEL and RESET together for one second on the top "MENU" screen. The screen goes off, and the password protection of the GRF100 is canceled. Set the password again.

4.2.6.3 Description

To enter the plant name and other data, do the following.

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

```
/ 2  Description ▼
• Plant name
• Description
```

- 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

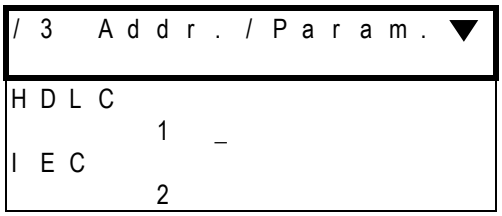
If the relay is linked with RSM (relay setting and monitoring system) and/or IEC60870-5-103 communication, the relay address must be set. Do this as follows:

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 "Ccomms" screen.

```
/ 2  Comms ▼
• Addr. / Param.
• Switch
```

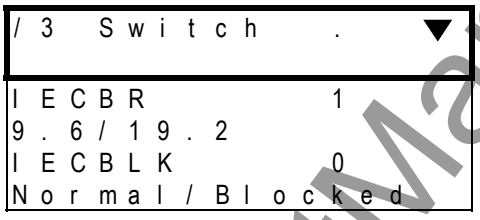
- Select "Addr./Param." on the "Comms" screen to enter the relay address number.



- 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 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.

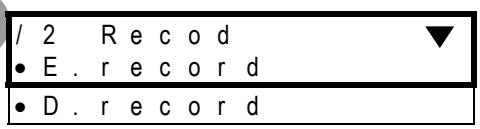
<IECBLK>

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

4.2.6.5 Setting the Recording

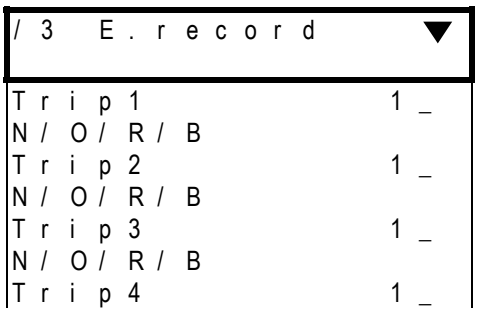
To set the recording function as described in Section 4.2.3, do the following:

- 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 "E. record" screen.



```
N / O / R / B
Trip1  BLK        1 _
N / O / R / B
Trip2  BLK        1 _
N / O / R / B
Trip3  BLK        1 _
N / O / R / B
Trip4  BLK        1 _
N / O / R / B
Ind.  reset       1 _
N / O / R / B
Relay  fail       1 _
N / O / R / B
V0  err           1 _
N / O / R / B
V2  err           1 _
N / O / R / B
Sys.change        1 _
N / O
Rly.change        1 _
N / O
Grp.change        1 _
N / O
```

Note : In the case of model 101, the V0 and V2 are not displayed.

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

  Enter 0 (= N) not to record the event.

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

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

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

Setting the disturbance recording

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

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

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

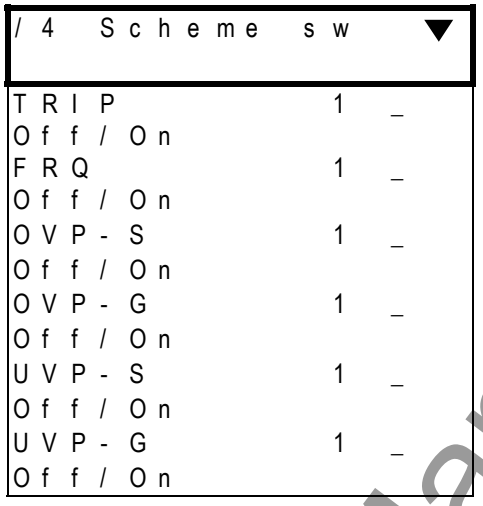
```
/ 4  Time/starter ▼

Time                s
     1.0  _
OVP-S               V
     132  _
OVP-G               V
      76  _
UVP-S               V
      88  _
UVP-G               V
      50  _
```

Note : In the case of model 101, the OVP-G and UVP-G are not displayed.

- Enter the recording time and starter element settings.

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

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



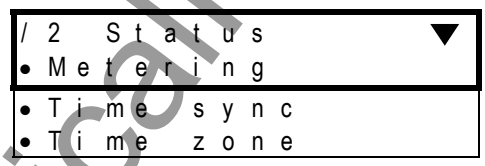
Note : In the case of model 101, the OVP-G and UVP-G are not displayed.

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

4.2.6.6 Status

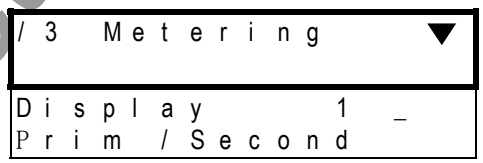
To set the status display described in Section 4.2.4, do the following:

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



Setting the metering

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

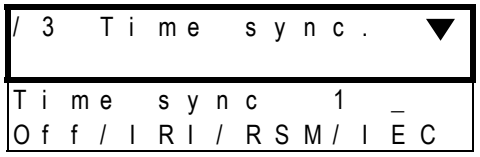


- Enter 0 or 1 to display the primary or secondary value respectively.

Setting the time synchronization

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

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



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

  Enter 0 (=off) not to be synchronised with any external signals.

  Enter 1 (=IRIG) to be synchronised with the external IRIG-B time standard signal.

  Enter 2 (=RSM) to be synchronised with the RSM clock.

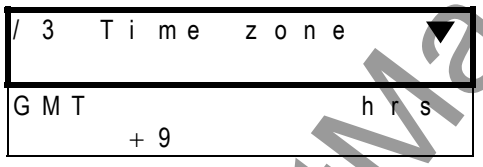
  Enter 3 (=IEC) to be synchronised with IEC60870-5-103.

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.

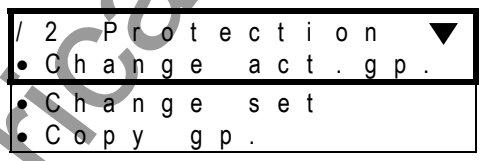


- Enter the difference between GMT and local time and press the [ENTER] key.

4.2.6.7 Protection

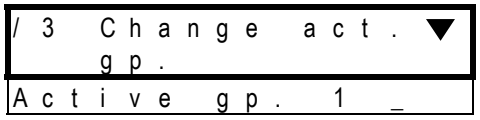
The GRF100 can have 4 setting groups for protection in order to accommodate changes in the operation of the power system, one setting group is assigned active. To set the protection, do the following:

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



Changing the active group

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



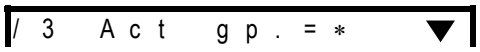
- Enter the group number and press the [ENTER] key.

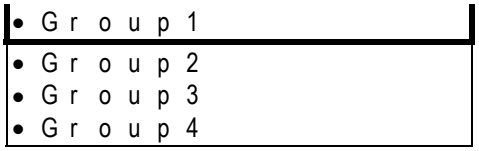
Changing the settings

Almost all the setting items have default values that are set when the product was shipped. For the default values, see Appendix D and H.

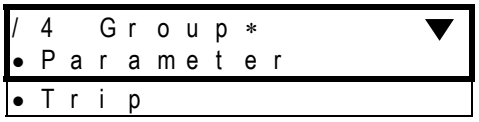
To change the settings, do the following:

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





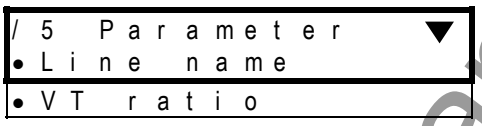
- Select the group number to change the settings and display the "Group ∗" screen.



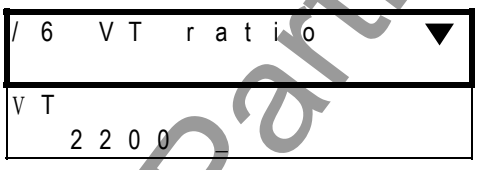
Setting the parameter

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.
- Select "VT ratio" to display the "VT ratio" screen.

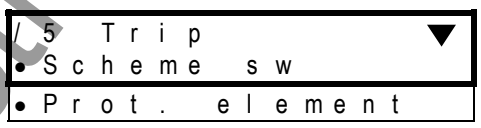


- Enter the VT ratio and press the ENTER key.

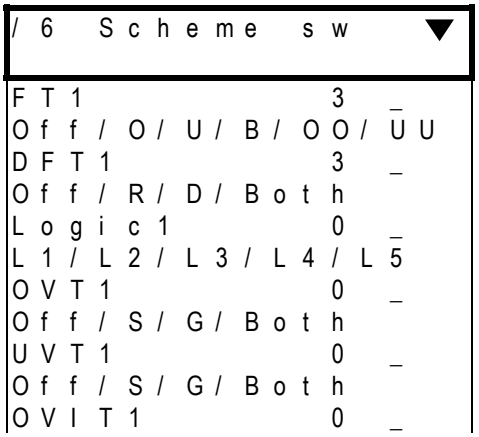
Setting the protection function

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

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



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



```
Off/S/G/Both
UVIT1                0   _
Off/S/G/Both
UVHST1               0   _
Off/S/G/Both
FT2                  3   _
   :
   :
SVCNT                0   _
ALM&BLK/ALM
```

Note : In the case of model 101, the settings of OVT to UVHST are off/on and SVCNT is not displayed.

To set the scheme switches for the stage 1, do the followings:

[FT1]

[FT1] selects the frequency protection.

- Enter 0 or 1 or 2 or 3 or 4 or 5 and press the ENTER key.

  Enter 0 (=Off) not to use the frequency protection.

  Enter 1 (=O) to use the F11 element for overfrequency protection. The F12 element is not used.

  Enter 2 (=U) to use the F11 element for underfrequency protection. The F12 element is not used

  Enter 3 (=B) to use the F11 element for overfrequency protection and the F12 element for underfrequency protection.

  Enter 4 (=OO) to use the F11 and F12 elements for overfrequency protection.

  Enter 5 (=UU) to use the F11 and F12 elements for underfrequency protection.

[DFT1]

[DFT1] selects the frequency rate-of-change protection.

- Enter 0 or 1 or 2 or 3 and press the ENTER key.

  Enter 0 (= Off) not to use the frequency rise rate nor frequency decay rate protection.

  Enter 1 (= R) to use only the frequency rise rate protection.

  Enter 2 (= D) to use only the frequency decay rate protection.

  Enter 3 (= Both) to use both the frequency rise rate and frequency decay rate protections.

[Logic 1]

[Logic 1] selects the tripping combination of the frequency protection and the frequency rate-of-change protection.

- Enter 0 (=L1) or 1 (=L2) or 2 (=L3) or 3 (=L4) or 4 (=L5) and press the ENTER key. Refer to Table 2.2.1 for setting.

[OVT1]

- Enter 0 or 1 or 2 or 3 and press the ENTER key.

Enter 0 (= Off) not to use the definite time overvoltage protection.

Enter 1 (= ON) to use the definite time overvoltage protection for model 101.

Enter 1 (=S) to use the phase-to-phase definite time overvoltage protection for model 201.

Enter 2 (=G) to use the phase-to-earth definite time overvoltage protection for model 201.

Enter 3 (=Both) to use both the phase-to-phase and phase-to-earth definite time overvoltage protection for model 201.

[UVT1]

- Enter 0 or 1 and press the ENTER key.

Enter 0 (= Off) not to use the definite time undervoltage protection.

Enter 1 (= ON) to use the definite time undervoltage protection for model 101.

Enter 1 (=S) to use the phase-to-phase definite time undervoltage protection for model 201.

Enter 2 (=G) to use the phase-to-earth definite time undervoltage protection for model 201.

Enter 3 (=Both) to use both the phase-to-phase and phase-to-earth definite time undervoltage protection for model 201.

[OVIT1]

- Enter 0 or 1 and press the ENTER key.

Enter 0 (= Off) not to use the inverse time overvoltage protection.

Enter 1 (= ON) to use the inverse time overvoltage protection for model 101.

Enter 1 (=S) to use the phase-to-phase inverse time overvoltage protection for model 201.

Enter 2 (=G) to use the phase-to-earth inverse time overvoltage protection for model 201.

Enter 3 (=Both) to use both the phase-to-phase and phase-to-earth inverse time overvoltage protection for model 201.

[UVIT1]

- Enter 0 or 1 and press the ENTER key.

Enter 0 (= Off) not to use the inverse time undervoltage protection.

Enter 1 (= ON) to use the inverse time undervoltage protection for model 101.

Enter 1 (=S) to use the phase-to-phase inverse time undervoltage protection for model 201.

Enter 2 (=G) to use the phase-to-earth inverse time undervoltage protection for model 201.

Enter 3 (=Both) to use both the phase-to-phase and phase-to-earth inverse time undervoltage protection for model 201.

[UVHST1]

- Enter 0 or 1 and press the ENTER key.

Enter 0 (= Off) not to use the high-speed undervoltage protection.

Enter 1 (= ON) to use the high-speed undervoltage protection for model 101.

Enter 1 (=S) to use the phase-to-phase high-speed undervoltage protection for model 201.

Enter 2 (=G) to use the phase-to-earth high-speed undervoltage protection for model 201.

Enter 3 (=Both) to use both the phase-to-phase and phase-to-earth high-speed undervoltage protection for model 201.

To set the scheme for stages 2 to 4, do the same above.

[SVCNT]

The "SVCNT" is provided for model 201.

- Enter 0 or 1 and press the [ENTER] key.

  Enter 0 (= ALM&BLK) to issue an alarm and to block a tripping when the failure is detected by the AC input imbalance monitoring.

  Enter 1 (= ALM) to issue an alarm when the failure is detected by the AC input imbalance monitoring.

- After settings, press the [END] key to return to the "Trip" screen.

Setting the protection element

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

```
/ 6   P r o t . e l e m e n t▼

F 1 1                    H z
  5 1 . 0 0          _
T F 1 1                  s
    1 . 0 0          _
F 1 2                    H z
  4 9 . 0 0          _
T F 1 2                  s
    1 . 0 0          _
D F 1                H z / s
    0 . 5            _
F 2 1                    H z
    :
    :
D F 4                H z / s
    0 . 5            _
U V B L K                V
      4 0            _
O V S                    V
      1 3 2          _
O V G                    V
      7 6            _
T O V 1                  s
    :
U V S                    V
      8 8            _
U V G                    V
      5 0            _
T U V 1                  s
    :
O V I S                  V
```

```
      132      _
TOVIS
    13.5       _
OVIG                    V
      76       _
TOVIG
    13.5       _
UVIS                    V
      88       _
TUVIS
    13.5       _
UVIG                    V
      50       _
TUVIG
    13.5       _
UVHSS                   V
      80       _
UVHSG                   V
      46       _
```

Note : In the case of model 101, the OVG, UVG, OVIG, TOVIG, UVIG, TUVIG and UVHSG are not displayed.

- 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.

```
/3  Copy A to B ▼

A                       _
B                       _
```

- 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.

```
/2  Binary I/P  ▼

BISW1              1    _
Norm/Inv
BISW2              1    _
Norm/Inv
BISW3              1    _
Norm/Inv
BISW4              1    _
```

```
Norm/Inv
BISW5          1  _
Norm/Inv
```

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

4.2.6.9 Binary Output

All the binary outputs of the GRF100 except the tripping command, and relay failure signal are user-configurable. It is possible to assign one signal or up to four6 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 D 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.

```
/ 2  Binary  O/P  ▼
• BO1
• BO2
• BO3
• BO4
```

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

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

```
/ 3  Set.  (BO**)  ▼
• Logic & BOTD
• Logic gate
```

Setting the logic gate type and timer

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

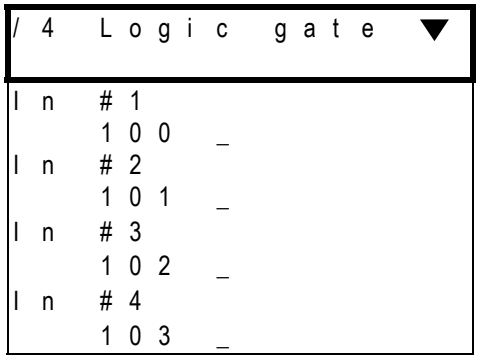
```
/ 4  Logic/Reset  ▼

Logic          0  _
OR/AND
Reset          0
Inst/Del/Latch
```

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



- Assign signals to gates (In #1 to #4) by entering the number corresponding to each signal referring to Appendix B. Do not assign the signal numbers 220 to 223 (signal names: "BO1 OP" to "BO4 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 GRF100 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.

```
/ 5  Functions          ▼

In  # 1
      2 1  _
In  # 2
      1 1
In  # 3
      2 4
In  # 4
        0
```

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

4.2.7.1 Scheme Switch

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

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

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

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

```
/ 1  Test               ▼
• Switch
• Binary  O/P
• Timer
• Logic  circuit
```

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

```
/ 2  Switch             ▼

A. M. F.            1   _
Off / On
IECTST              0
Off / On
```

- 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"[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
TP-3              0  _
Disable/Enable
TP-4              0  _
Disable/Enable
BO1               0  _
Disable/Enable
BO2               0  _
Disable/Enable
BO3               0  _
Disable/Enable
BO4               0  _
Disable/Enable
FAIL              0  _
Disable/Enable
```

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

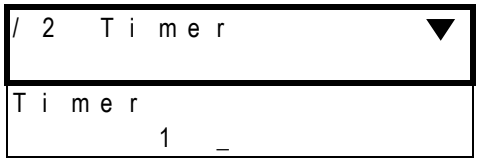
```
Operate?
ENTER=Y  CANCEL=N
```

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

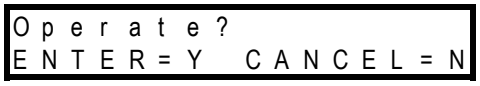
4.2.7.3 Timer

The pick-up or drop-off delay time of the variable timer used in the scheme logic can be measured with monitoring jacks A and B. Monitoring jacks A and B are used to observe the input signal and output signal to the timer, respectively.

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



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



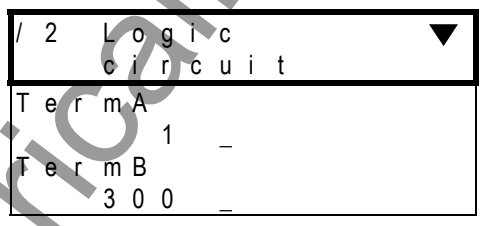
- Press the ENTER key to operate the timer. The "TESTING" LED turns on, and the timer is initiated and the following display appears. The input and output signals of the timer can be observed at monitoring jacks A and B, respectively. The LEDs above monitoring jacks A or B are also lit if the input or output signal exists.

- Press the END key to reset the input signal to the timer. The "TESTING" LED turns off.
- Press the CANCEL key to test the other timers. Repeat the above testing.

4.2.7.4 Logic Circuit

It is possible to observe the binary signal level on the signals listed in Appendix B with monitoring jacks A and B.

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



- Enter a signal number to be observed at monitoring jack A and press the ENTER key.
- Enter the other signal number to be observed at monitoring jack B and press the ENTER key.

After completing the setting, the signals can be observed by the binary logic level at monitoring jacks A and B or by the LEDs above the jacks.

On screens other than the above screen, observation with the monitoring jacks is disabled.

4.3 Personal Computer Interface

The relay can be operated from a personal computer using an RS232C port on the front panel. On the personal computer, the following analysis and display of the fault voltages are available in addition to the items available on the LCD screen.

- Display of voltage waveform: Oscillograph, vector display
- Harmonic analysis: On arbitrary time span
- Frequency analysis: On arbitrary time span

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

4.4 Relay Setting and Monitoring System

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

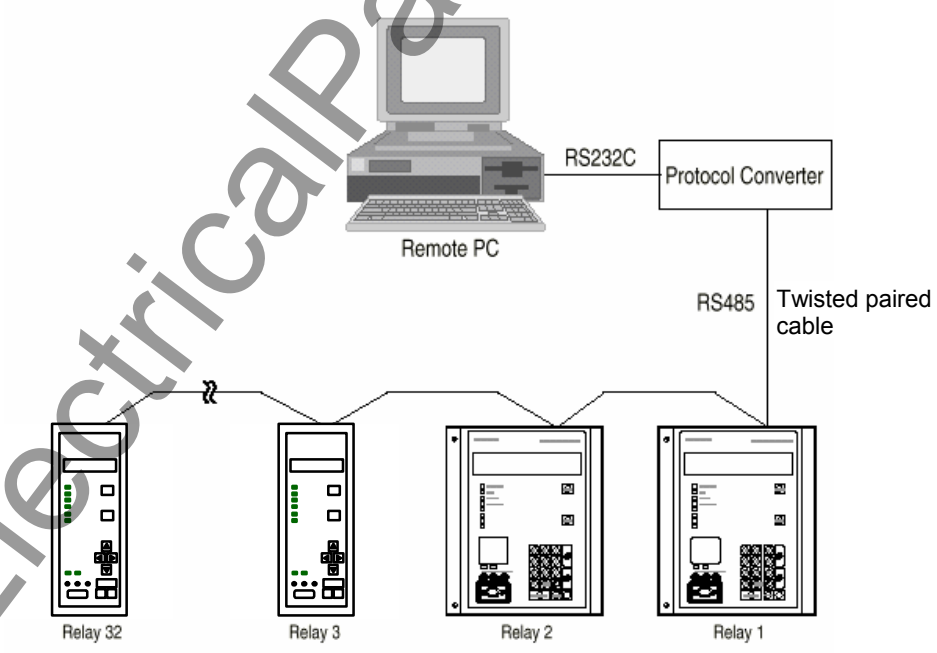


Figure 4.4.1 Relay Setting and Monitoring System

4.5 IEC 60870-5-103 Interface

The GRF100 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: voltage, frequency
- Status data: events, fault indications, etc.

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

Check that the following accessories are attached.

- 3 pins for the monitoring jack, packed in a plastic bag.

Always store the relays in a clean, dry environment.

5.2 Relay Mounting

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

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

5.3 Electrostatic Discharge

⚠CAUTION

Do not take out the relay unit outside the relay case since electronic components on the modules are very sensitive to electrostatic discharge. If it is absolutely essential to take the modules out of the case, do not touch the electronic components and terminals with your bare hands. Additionally, always put the module in a conductive anti-static bag when storing it.

5.4 Handling Precautions

A person's normal movements can easily generate electrostatic potentials of several thousand volts. Discharge of these voltages into semiconductor devices when handling electronic circuits can cause serious damage, which often may not be immediately apparent but the reliability of the circuit will have been reduced.

The electronic circuits are completely safe from electrostatic discharge when housed in the case. Do not expose them to risk of damage by withdrawing relay unit unnecessarily.

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

⚠CAUTION

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

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

It is strongly recommended that detailed investigations on electronic circuitry should be carried out in a Special Handling Area such as described in the aforementioned IEC 60747.

5.5 External Connections

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

6. Commissioning and Maintenance

6.1 Outline of Commissioning Tests

The GRF100 is fully numerical and the hardware is continuously monitored.

Commissioning tests can be kept to a minimum and need only include hardware tests and the conjunctive tests. The function tests are at the user's discretion.

In these tests, user interfaces on the front panel of the relay or local PC can be fully utilised.

Test personnel must be familiar with general relay testing practices and safety precautions to avoid personal injuries or equipment damage.

Hardware tests

These tests are performed for the following hardware to ensure that there is no hardware defect. Defects of hardware circuits other than the following can be detected by monitoring which circuits functions when the DC power is supplied.

User interfaces
Binary input circuits and output circuits
AC input circuits

Function tests

These tests are performed for the following functions that are fully software-based.

Measuring elements
Metering and recording
Human interface

Conjunctive tests

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

6.2 Cautions

6.2.1 Safety Precautions

⚠CAUTION

- The relay rack is provided with an earth terminal.
  Before starting the work, always make sure the relay rack is earthed.
- When connecting the cable to the back of the relay, firmly fix it to the terminal block and attach the cover provided on top of it.
- Before checking the interior of the relay, be sure to turn off the power.

Failure to observe any of the precautions above may cause electric shock or malfunction.

6.2.2 Cautions on Tests

⚠CAUTION

- While the power is on, do not drawout/insert the relay unit.
- Before turning on the power, check the following:
  - Make sure the polarity and voltage of the power supply are correct.
  - Make sure the VT circuit is not short-circuited.
- 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 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 Three-phase voltage source or single-phase voltage source
1 Variable-frequency source
1 DC power supply
1 DC voltmeter
1 AC voltmeter
1 Frequency meter
1 Time counter, precision timer
1 PC (not essential)

Relay settings

Before starting the tests, it must be specified whether the tests will use the user's settings or the default settings.

For the default settings, see the following appendixes:

Appendix D	Binary Output Default Setting List
Appendix H	Relay Setting Sheet

Visual inspection

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

Relay ratings

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

Local PC

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

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

6.4 Hardware Tests

The tests can be performed without external wiring, but a DC power supply and an 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.

Other operation keys

- Press any key when the LCD is off and check that the LCD displays the "MENU" screen. Press the [END] key to turn off the LCD.
- Repeat this for all keys.

6.4.2 Binary Input Circuit

The testing circuit is shown in Figure 6.4.1.

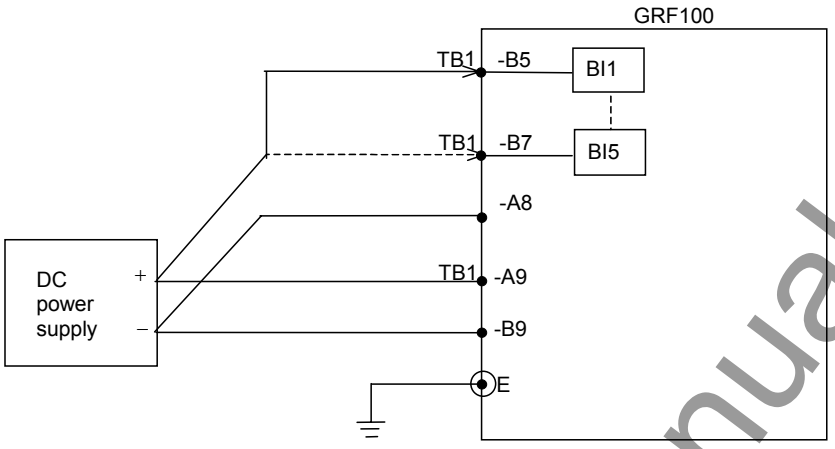


Figure 6.4.1 Testing Binary Input Circuit

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

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

- Apply rated DC voltage to terminal B5, A6, ..., B7 of terminal block TB1.

  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.)

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

6.4.3 Binary Output Circuit

This test can be performed by using the "Test" sub-menu and forcibly operating the relay drivers and output relays. Operation of the output contacts is monitored at the output terminal. The output contact and corresponding terminal number are shown in Appendix G.

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

```
/ 2  B i n r y  O / P    ▼

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

- Enter 1 (= Enable) and press the [ENTER] key.

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

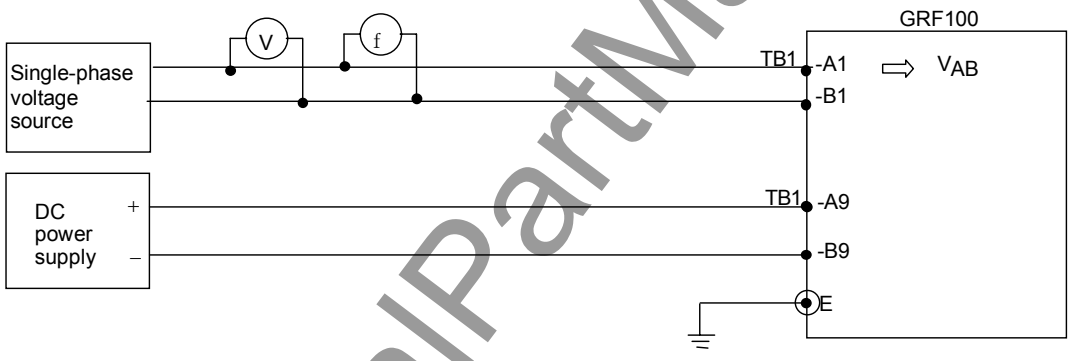
```
Operate?
ENTER=Y  CANCEL=N
```

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

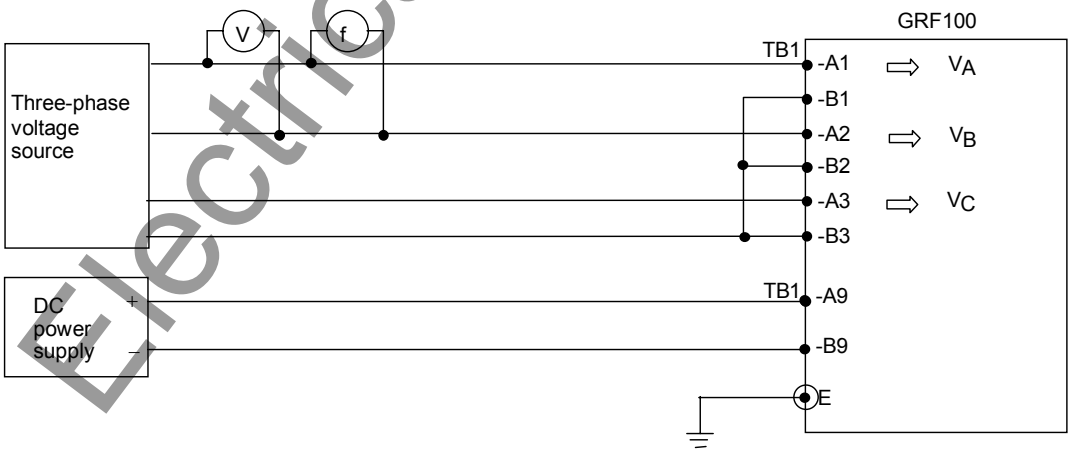
6.4.4 AC Input Circuits

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

The testing circuit is shown in Figure 6.4.2.



(a) Testing Circuit for Model 101



(b) Testing Circuit for Model 201

Figure 6.4.2 Testing AC Input Circuit

- Check that the metering data set to be expressed as secondary values (Display =1) on the "Metering" screen.

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

If the setting is primary (Display = 0), change the setting on the "Set.(change)" sub-menu.

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

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

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

  "Status" sub-menu → "Metering" screen

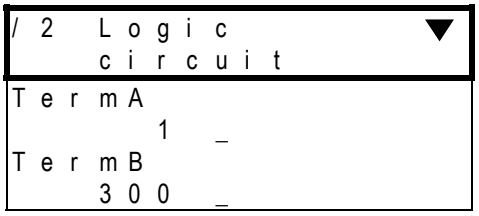
- Apply AC voltages and check that the displayed values are within ±5% of the input voltages and ±0.005Hz of the frequency.

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".

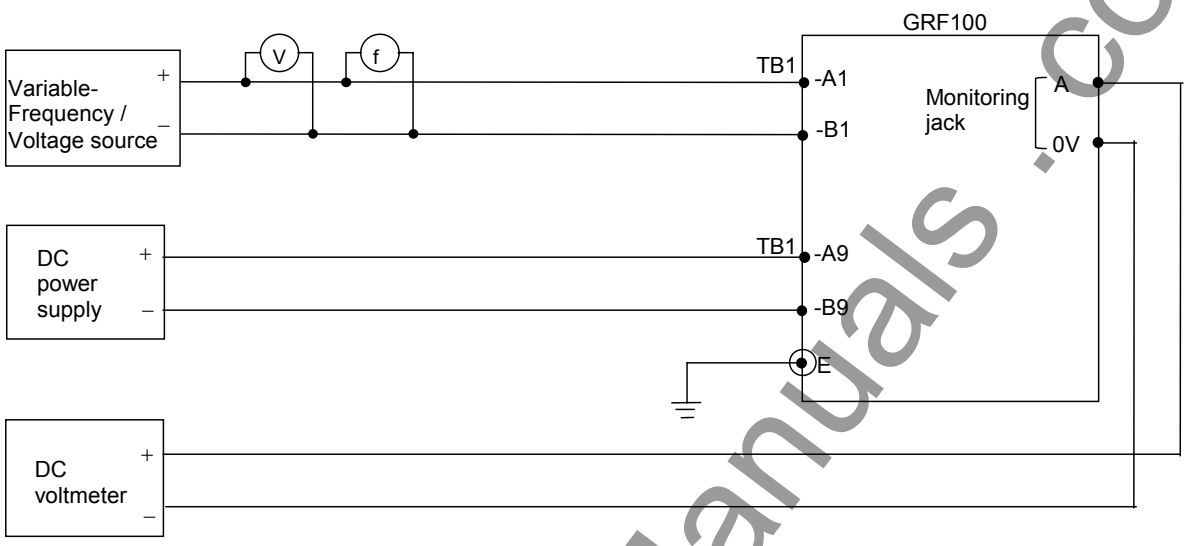
CAUTION

- 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.

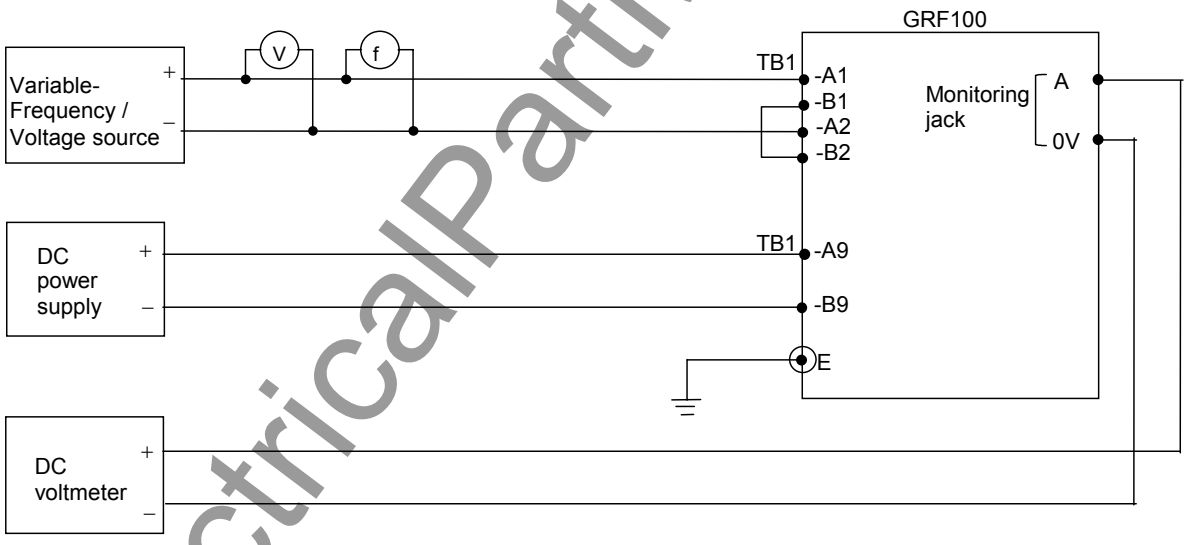
In case of a three-phase element, it is enough to test a representative phase.

6.5.1.1 Frequency Elements

The testing circuit is shown in Figure 6.5.1.



(a) Testing Circuit for Model 101



(b) Testing Circuit for Model 201

Figure 6.5.1 Operating Value Test Circuit

Frequency elements and their output signal number are listed below.

Measuring element	Signal number
F11, F21, F31, F41	11, 15, 19, 23
F12, F22, F32, F42	12, 16, 20, 24

Overfrequency or underfrequency elements F11 to F42

Note: Each element characteristic, overfrequency or underfrequency, is determined by the scheme switch [FT1] to [FT4] settings. Check the scheme switch setting and characteristic of each element before testing (see Section 2.2.3).

- Select "Logic circuit" on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number for the Term A line to observe the above element output at monitoring jack A and press the [ENTER] key.
- Apply a rated voltage and frequency as shown in Figure 6.5.1.

In case of overfrequency characteristic,

- Increase the frequency and measure the value at which the element operates. Check that the measured value is within ± 0.005Hz of the setting.

In case of underfrequency characteristics,

- Decrease the frequency and measure the value at which the element operates. Check that the measured value is within ± 0.005Hz of the setting.

Undervoltage block test

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

6.5.1.2 Overvoltage and Undervoltage Elements

The testing circuit is shown in Figure 6.5.1.

Overvoltage and undervoltage elements and their output signal number are listed below.

Measuring element for Model 101	Signal number
OVS	31
UVS	37
OVIS	43
UVIS	49
UVHSS	55

Measuring element for Model 201	Signal number
OVS-AB, -BC, -CA	31, 32, 33
OVG-A, -B, -C	34, 35, 36
UVS-AB, -BC, -CA	37, 38, 39
UVG-A, -B, -C	40, 41, 42
OVIS-AB, -BC, -CA	43, 44, 45
OVIG-A, -B, -C	46, 47, 48
UVIS-AB, -BC, -CA	49, 50, 51
UVIG-A, -B, -C	52, 53, 54
UVHSS-AB, -BC, -CA	55, 56, 57
UVHSG-A, -B, -C	58, 59, 60

Operating Value Test

Overvoltage element OVS, OVG, OVIS, OVIG

- Select "Logic circuit" on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number for the Term A line to observe the above element output at monitoring jack A and press the [ENTER] key.
- Apply a rated voltage as shown in Figure 6.5.1.
- Increase the voltage and measure the value at which the element operates. Check that the measured value is within ± 5% of the setting.

Undervoltage element UVS, UVG, UVIS, UVIG, UVHSS, UVHSG

- Select "Logic circuit" on the "Test" sub-menu screen to display the "Logic circuit" screen.
- Enter a signal number for the Term A line to observe the above element output at monitoring jack A and press the [ENTER] key.
- Apply a rated voltage and frequency as shown Figure 6.5.1.
- Decrease the voltage and measure the value at which the element operates. Check that the measured value is within ± 5% of the setting.

Operating Time Test

Inverse time overvoltage and undervoltage element OVIS, OVIG, UVIS, UVIG

- Change the voltage from the rated voltage to the test voltage quickly and measure the operating time.
- Calculate the theoretical operating time using the characteristic equations shown in Section 2.5.2. Check the measured operating time.

6.5.2 Timer

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

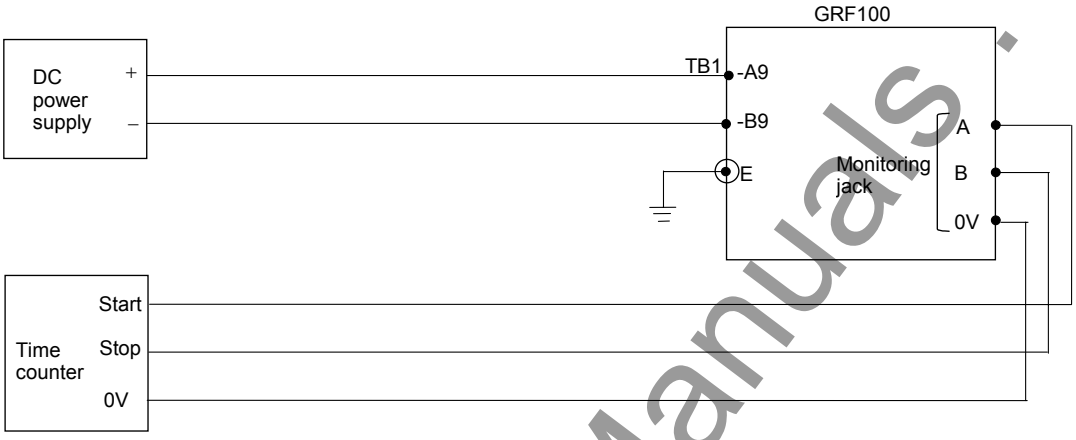


Figure 6.5.2 Testing Variable Timer

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

```
/ 2  T i m e r                ▼
T i m e r
          1 _
```

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

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

- Press the [ENTER] key to operate the timer. The "TESTING" LED turns on, and the timer is initiated and the following display appears. The input and output signals of the timer can be observed at monitoring jacks A and B, respectively. The LEDs above monitoring jacks A or B are also lit if the input or output signal exists.

```
R e s e t ?
E N D = Y       C A N C E L = N
```

- Press the [END] key to reset the input signal to the timer. The "TESTING" LED turns off.
- Press the [CANCEL] key to test the other timers. Repeat the above testing.

6.5.3 Protection Scheme

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

Tripping is observed with the tripping command output relays TP-1 to 4.
Check that the indications and recordings are correct.

6.5.4 Metering and Recording

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

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

Recording events are listed in Table 3.4.1. The top 8 events are external events and others are internal events. Event recording on the external 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 "E. records" screen is correct.

Note: The choice of whether to record or not can be set for each event. Change the status of the binary input signal after confirming that the related event is set to record. (The default setting enables all the events to be recorded.)

Some of the internal events 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 "D. records" screen and check that the descriptions are correct.

Details can be displayed on the PC. Check that the descriptions on the PC are correct. For details on how to obtain disturbance records on the PC, see the RSM100 Manual.

6.6 Conjunctive Tests

6.6.1 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.

- Set the breaker to be closed.
- Select "Binary O/P" on the "Test" sub-menu screen to display the "Binary O/P" screen.

TP-1 to TP-4 are output relays with one normally open contact.

- Enter 1 for TP-1 and press the [ENTER] key.
- Press the [END] key. Then the LCD displays the screen shown below.

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

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

6.7 Maintenance

6.7.1 Regular Testing

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

Therefore, regular testing is minimized to checking the unsupervised circuits. The test procedures are the same as described in Sections 6.4.1, 6.4.2 and 6.4.3.

6.7.2 Failure Tracing and Repair

Failures will be detected by automatic supervision or regular testing.

When a failure is detected by supervision, a remote alarm is issued with the binary output 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 failed unit or failed external circuit can be estimated by referring to Table 6.7.1.

This table shows the relation ship between messages displayed on the LCD and estimated failure location. Locations marked with (1) have a higher probability than locations marked with (2).

Table 6.7.1 LCD Message and Failure Location

Message	Failure location	Remarks
Err: Sum	Flash memory	
Err: MEM	ROM or RAM	
Err: RAM	RAM	
Err: BRAM	Backup RAM	
Err: ROM	EEPROM	
Err: A/D	A/D converter	
Err: SP	Sampling signal circuit	
Err: DI	Binary input circuit	
Err: DO	Binary output drive circuit	
Err: LCD	LCD circuit	
Err.CH	Analog input channel circuit	
Err: V0	Analog input circuit (1) AC cable (2)	For Model 201
Err: V2	Analog input circuit (1) AC cable (2)	For Model 201

If no message is shown on the LCD, it means that the failure location is either in the DC power supply circuit or in the microprocessors. If the "ALARM" LED is off, the failure is in the DC power supply circuit. If the LED is lit, the failure is in the microprocessors. Replace the relay unit in both cases after checking if the correct DC voltage is applied to the relay.

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

Note: When a failure or an abnormality is detected during the regular test, confirm the following first:
- Test circuit connections are correct.
- Relay unit is securely inserted in position.
- Correct DC power voltage is applied.
- Correct AC inputs are applied.
- Test procedures comply with those stated in the manual.

6.7.3 Replacing Failed Relay Unit

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

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

Check that the replacement relay unit has an identical Model 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.
- Disconnect all AC voltage inputs.
- Unscrew the relay front cover.
- Unscrew the binding screw on the handle.
- To remove the relay unit from its case, pull up the handle and pull the handle towards you. (See Figure 6.7.1.)
- Insert the (spare) relay unit in the reverse procedure.

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

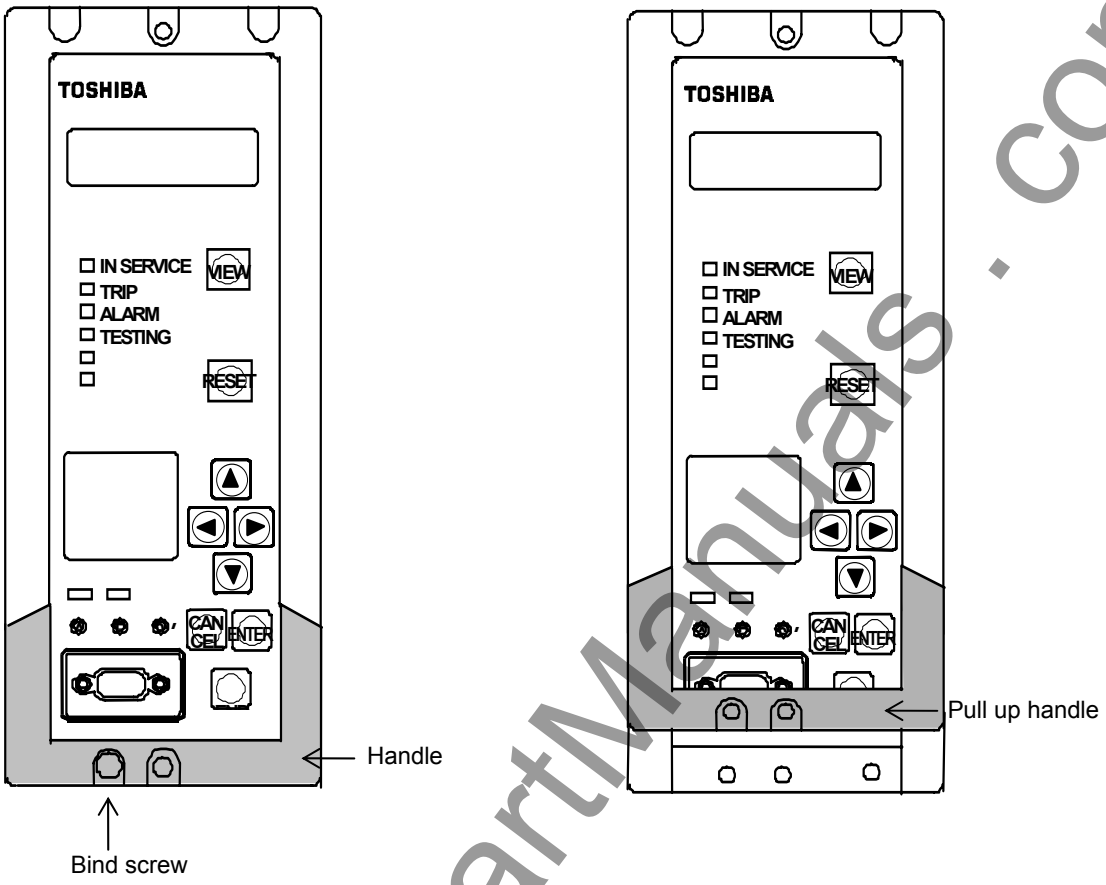


Figure 6.7.1 Handle of Relay Unit

6.7.4 Resumption of Service

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

- Switch on the DC power supply and confirm that the "IN SERVICE" green LED is lit and the "ALARM" red LED is not lit.
- Supply the AC inputs and reconnect the trip outputs.

6.7.5 Storage

The spare relay should be stored in a dry and clean room. Based on IEC Standard 60255-6 the storage temperature should be –25°C to +70°C, but a 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.

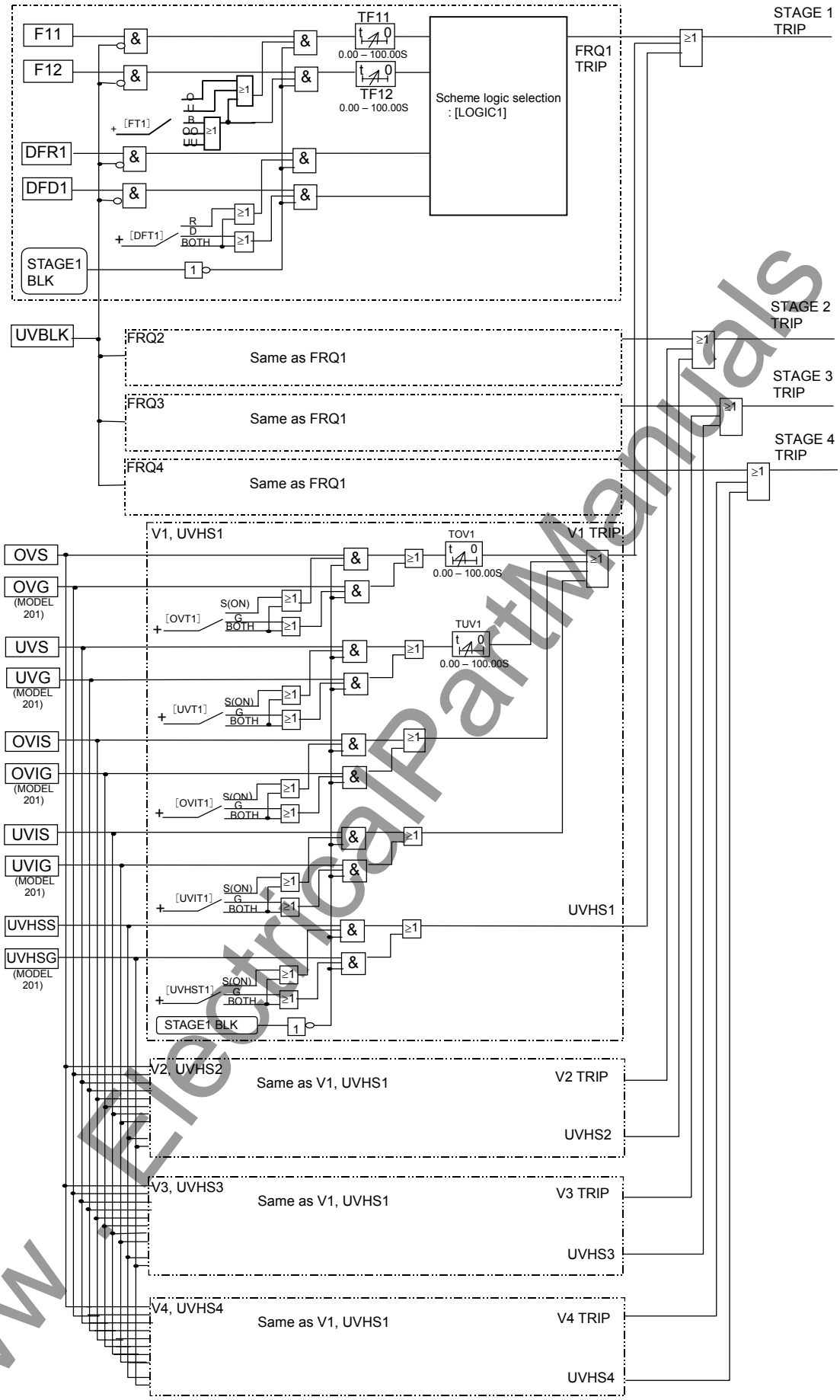
  In particular, when settings are changed temporarily for testing, be sure to restore them.
- Clear any unnecessary records on faults, events and disturbances which are recorded during the tests.

  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



Appendix B

Signal List

Signal List

No.	SIGNAL NAME	CONTENTS	No.	SIGNAL NAME	CONTENTS
0	Zero Level	"0" (Zero logic)	70		
1	STAGE1 BLK	BI (STAGE1 BLOCK)	71	OVSOR	OV RELAY FOR SHORT CIRCUIT FAULT
2	STAGE2 BLK	BI (STAGE2 BLOCK)	72	OVGOR	OV RELAY FOR EARTH FAULT
3	STAGE3 BLK	BI (STAGE3 BLOCK)	73	UVSOR	UV RELAY FOR SHORT CIRCUIT FAULT
4	STAGE4 BLK	BI (STAGE4 BLOCK)	74	UVGOR	UV RELAY FOR EARTH FAULT
5	IND.RESET	BI (INDICATION RESET)	75	OVISOR	OV RELAY FOR SHORT CIRCUIT FAULT
6			76	OVIGOR	OV RELAY FOR EARTH FAULT
7			77	UVISOR	UV RELAY FOR SHORT CIRCUIT FAULT
8			78	UVIGOR	UV RELAY FOR EARTH FAULT
9			79	UVHSSOR	HIGH SPEED UV RELAY FOR SHORT CIRCUIT FAULT
10			80	UVHSGOR	HIGH SPEED UV RELAY FOR EARTH FAULT
11	F11	FREQUENCY 1 RELAY OF STAGE1	81		
12	F12	FREQUENCY 2 RELAY OF STAGE1	90		
13	DF-R1	FREQUENCY RATE OF CHANGE RELAY OF STAGE1(RISE)	91	F11 TRIP	FREQUENCY RELAY 1 TRIP OF STAGE 1
14	DF-D1	FREQUENCY RATE OF CHANGE RELAY OF STAGE1(DECAY)	92	F12 TRIP	FREQUENCY RELAY 2 TRIP OF STAGE 1
15	F21	FREQUENCY 1 RELAY OF STAGE2	93	DF-R1	DF-R1 TRIP OF STAGE 1
16	F22	FREQUENCY 2 RELAY OF STAGE2	94	DF-D1	DF-D1 TRIP OF STAGE 1
17	DF-R2	FREQUENCY RATE OF CHANGE RELAY OF STAGE2(RISE)	95	FRQ1	F1, DF1 TRIP OF STAGE 1
18	DF-D2	FREQUENCY RATE OF CHANGE RELAY OF STAGE2(DECAY)	96	F21 TRIP	FREQUENCY RELAY 1 TRIP OF STAGE 2
19	F31	FREQUENCY 1 RELAY OF STAGE3	97	F22 TRIP	FREQUENCY RELAY 2 TRIP OF STAGE 2
20	F32	FREQUENCY 2 RELAY OF STAGE3	98	DF-R2	DF-R2 TRIP OF STAGE 2
21	DF-R3	FREQUENCY RATE OF CHANGE RELAY OF STAGE3(RISE)	99	DF-D2	DF-D2 TRIP OF STAGE 2
22	DF-D3	FREQUENCY RATE OF CHANGE RELAY OF STAGE3(DECAY)	100	FRQ2	F2, DF2 TRIP OF STAGE 2
23	F41	FREQUENCY 1 RELAY OF STAGE4	101	F31 TRIP	FREQUENCY RELAY 1 TRIP OF STAGE 3
24	F42	FREQUENCY 2 RELAY OF STAGE4	102	F32 TRIP	FREQUENCY RELAY 2 TRIP OF STAGE 3
25	DF-R4	FREQUENCY RATE OF CHANGE RELAY OF STAGE4(RISE)	103	DF-R3	DF-R3 TRIP OF STAGE 3
26	DF-D4	FREQUENCY RATE OF CHANGE RELAY OF STAGE4(DECAY)	104	DF-D3	DF-D3 TRIP OF STAGE 3
27			105	FRQ3	F3, DF3 TRIP OF STAGE 3
28			106	F41 TRIP	FREQUENCY RELAY 1 TRIP OF STAGE 4
29			107	F42 TRIP	FREQUENCY RELAY 2 TRIP OF STAGE 4
30			108	DF-R4	DF-R4 TRIP OF STAGE 4
31	OVS-AB (OVS)(*)	OV RELAY FOR SHORT CIRCUIT FAULT	109	DF-D4	DF-D4 TRIP OF STAGE 4
32	-BC	ditto	110	FRQ4	F4, DF4 TRIP OF STAGE 4
33	-CA	ditto	111	OV1 TRIP	OV RELAY TRIP OF STAGE1
34	OVG-A	OV RELAY FOR EARTH FAULT	112	UV1 TRIP	UV RELAY TRIP OF STAGE1
35	-B	ditto	113	OVI1 TRIP	OVI RELAY TRIP OF STAGE1
36	-C	ditto	114	UVI1 TRIP	UVI RELAY TRIP OF STAGE1
37	UVS-AB (UVS)(*)	UV RELAY FOR SHORT CIRCUIT FAULT	115	V1 TRIP	VOLTAGE RELAY TRIP OF STAGE1
38	-BC	ditto	116	OV2 TRIP	OV RELAY TRIP OF STAGE2
39	-CA	ditto	117	UV2 TRIP	UV RELAY TRIP OF STAGE2
40	UVG-A	UV RELAY FOR EARTH FAULT	118	OVI2 TRIP	OVI RELAY TRIP OF STAGE2
41	-B	ditto	119	UVI2 TRIP	UVI RELAY TRIP OF STAGE2
42	-C	ditto	120	V2 TRIP	VOLTAGE RELAY TRIP OF STAGE2
43	OVIS-AB (OVIS)(*)	OVI RELAY FOR SHORT CIRCUIT FAULT	121	OV3 TRIP	OV RELAY TRIP OF STAGE3
44	-BC	ditto	122	UV3 TRIP	UV RELAY TRIP OF STAGE3
45	-CA	ditto	123	OVI3 TRIP	OVI RELAY TRIP OF STAGE3
46	OVIG-A	OVI RELAY FOR EARTH FAULT	124	UVI3 TRIP	UVI RELAY TRIP OF STAGE3
47	-B	ditto	125	V3 TRIP	VOLTAGE RELAY TRIP OF STAGE3
48	-C	ditto	126	OV4 TRIP	OV RELAY TRIP OF STAGE4
49	UVIS-AB (UVIS)(*)	UVI RELAY FOR SHORT CIRCUIT FAULT	127	UV4 TRIP	UV RELAY TRIP OF STAGE4
50	-BC	ditto	128	OVI4 TRIP	OVI RELAY TRIP OF STAGE4
51	-CA	ditto	129	UVI4 TRIP	UVI RELAY TRIP OF STAGE4
52	UVIG-A	UVI RELAY FOR EARTH FAULT	130	V4 TRIP	VOLTAGE RELAY TRIP OF STAGE4
53	-B	ditto	131	UVHS1 TRIP	UVHS RELAY TRIP OF STAGE1
54	-C	ditto	132	UVHS2 TRIP	UVHS RELAY TRIP OF STAGE2
55	UVHSS-AB (UVHSS)	HIGH SPEED UV RELAY FOR SHORT CIRCUIT FAULT	133	UVHS3 TRIP	UVHS RELAY TRIP OF STAGE3
56	-BC	ditto	134	UVHS3 TRIP	UVHS RELAY TRIP OF STAGE4
57	-CA	ditto	135	STAGE1 TRIP	STAGE1 TRIP SIGNAL
58	UVHSG-A	HIGH SPEED UV RELAY FOR EARTH FAULT	136	STEGE2 TRIP	STAGE2 TRIP SIGNAL
59	-B	ditto	137	STAGE3 TRIP	STAGE3 TRIP SIGNAL
60	-C	ditto	138	STAGE4 TRIP	STAGE4 TRIP SIGNAL
61			139	TRIP-OR	TRIP SIGNAL
62			150		
63			151	TRIP-H	TRIP SIGNAL HOLD
64			152		
65			160		
66			161	A.M.F. OFF	SV BLOCK
67			162	FAULT RECORD IN	TRIG OF FAULT RECORD
68			163	FRQ TRIG	TRIG OF DISTURBACNCE RECORD
69			164		

Signal List

No.	SIGNAL NAME	CONTENTS	No.	SIGNAL NAME	CONTENTS
165			235	GROUP3 ACTIVE	GROUP3 ACTIVE
166			236	GROUP4 ACTIVE	GROUP4 ACTIVE
167			237		
168			238		
169			239		
170			240		
171			241	LOCAL OP ACT.	LOCAL OPERATION ACTIVE
172			242	REMOTE OP ACT.	REMOTE OPERATION ACTIVE
173			243	NORMAL LED ON	IN SERVICE LED ON
174			244	ALARM LED ON	ALARM LED ON
175			245	TRIP LED ON	TRIP LED ON
176			246	TEST LED ON	TEST LED ON
177			247		
178			248		
179			249	LED RESET	TRIP LED RESET
180			250		
181			251		
182			252		
183			253		
184			254		
185			255	PROT COM ON	PROTECTION COMMAND ON
186			256	PRG.LED1 ON	PROGRAMMABLE LED1 ON
187			257	PRG.LED2 ON	PROGRAMMABLE LED2 ON
188			258		
189			259		
190			260		
191			261		
192			262	GEN PICKUP	GENERAL START/PICK-UP
193			263	GEN TRIP	GENERAL TRIP
194			264	DI ERR	DI CONTACT ERROR
195			265		
196			266	FAULT RECORD D	FAULT RECORD DONE
197			267		
198			268		
199			269		
200			270		
201	RELAY FAIL	RELAY FAIL	271		
202	RELAY BLOCK	RELAY BLOCK	272		
203	TESTING	TEST SWITCH ACTIVATED	273		
204			274		
205	V0 err	VO ERR	275		
206	V2 err	V2 ERR	276		
207			277		
208			278		
209			279		
210			280		
211			281		
212			282		
213			283		
214			284		
215			285		
216			286		
217			287	PROT COM RECV	PROTECTION COMMAND RECIEVE
218			288	TPLED RST RCV	TRIP LED RESET RECIEVE
219			289		
220	BO1 OP	Binary output 1	290		
221	BO2 OP	Binary output 2	291	PRGLED/DO RST R	PROGRAMMABLE LED/DO RESET
222	BO3 OP	Binary output 3	292		
223	BO4 OP	Binary output 4	293	SET.GROUP1	ACTIVE GROUP CHANGED COMMAND
224			294	SET.GROUP2	ditto
225			295	SET.GROUP3	ditto
226			296	SET.GROUP4	ditto
227			297		
228			298		
229			299		
230			300		
231	M.D.BLOCK	MONITORING DIRECTION BLOCK			
232	IECTST	IEC103 TEST			
233	GROUP1 ACTIVE	GROUP1 ACTIVE			
234	GROUP2 ACTIVE	GROUP2 ACTIVE			

Appendix C

Variable Timer List

Variable Timer List

Timer	Timer No.	Contents
TF11	1	F11 element trip delay timer
TF12	2	F12 element trip delay timer
TF21	3	F21 element trip delay timer
TF22	4	F22 element trip delay timer
TF31	5	F31 element trip delay timer
TF32	6	F32 element trip delay timer
TF41	7	F41 element trip delay timer
TF42	8	F42 element trip delay timer
TOV1	9	OV trip stage 1 delay timer
TOV2	10	OV trip stage 2 delay timer
TOV3	11	OV trip stage 3 delay timer
TOV4	12	OV trip stage 4 delay timer
TUV1	13	UV trip stage 1 delay timer
TUV2	14	UV trip stage 2 delay timer
TUV3	15	UV trip stage 3 delay timer
TUV4	16	UV trip stage 4 delay timer

Appendix D

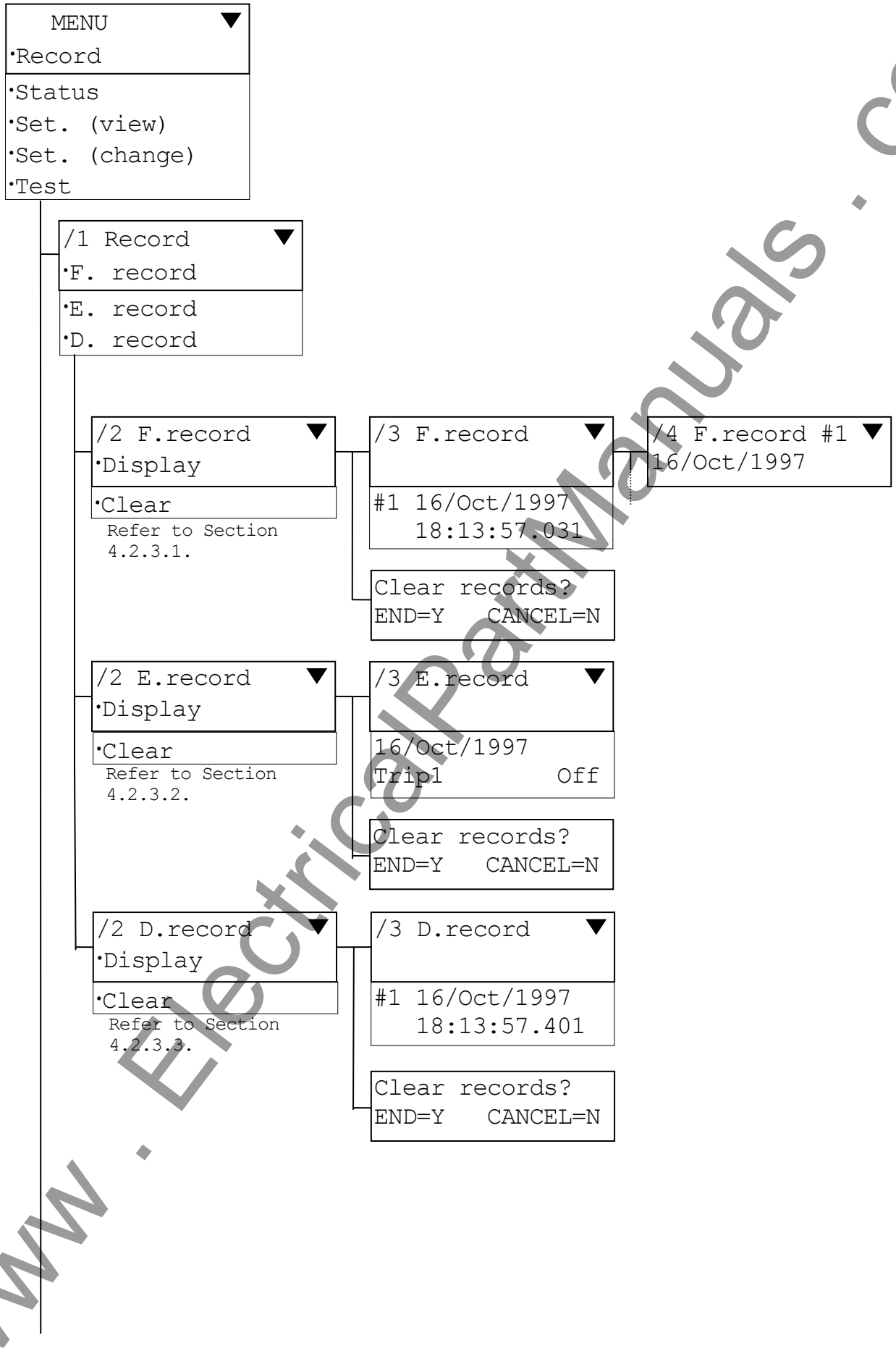
Binary Output Default Setting List

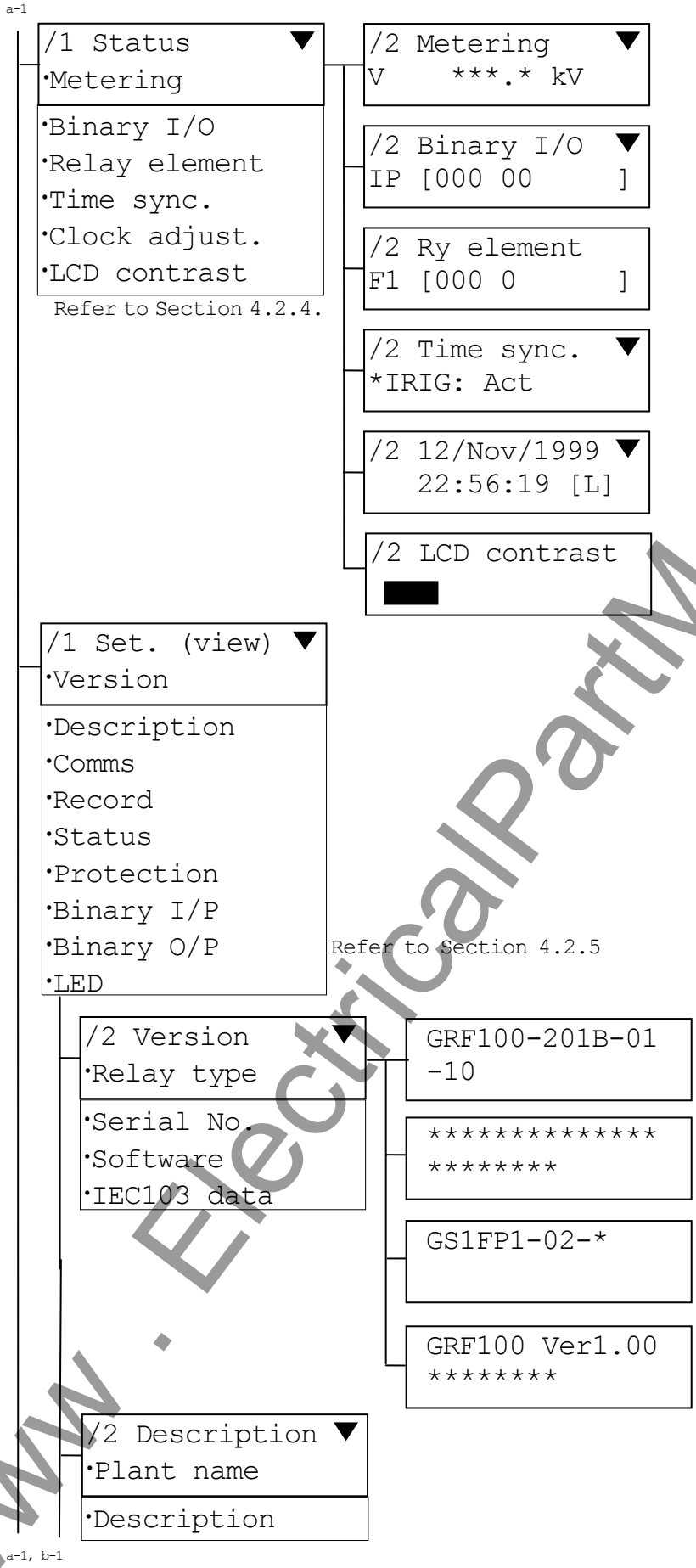
Binary Output Default Setting List

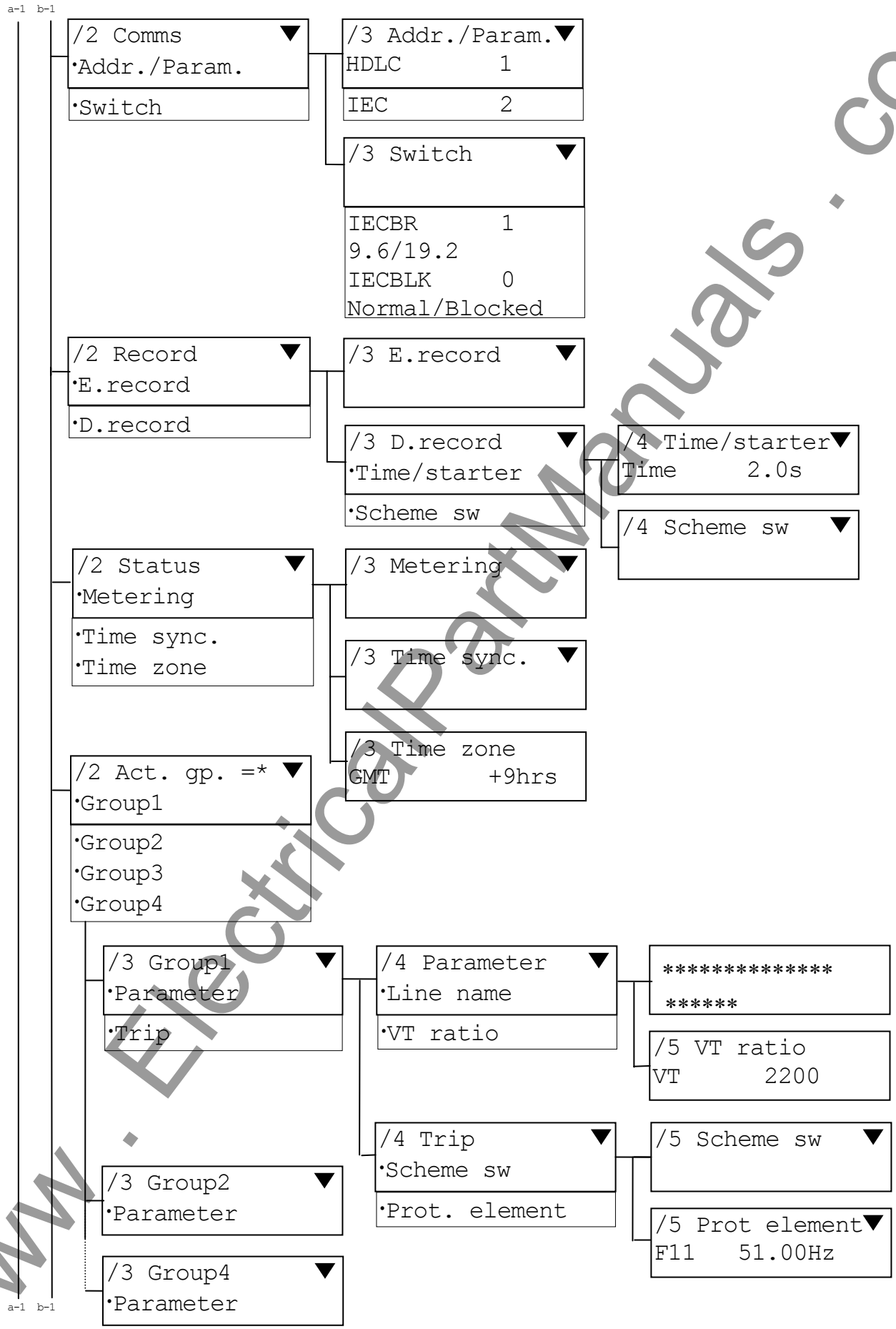
№	Setting range					Model					Setting				
	BO	Logic	Reset	Functions		101, 201									
						Logic	BOTD	Functions			Logic	BOTD	Functions		
1	BO1	OR(0) / AND(1)	Inst(0)/Del(1)/Latch(2)	In #1	0-300	OR	Del	In #1	135	STAGE1 TRIP			In #1		
				In #2	0-300			In #2	0				In #2		
				In #3	0-300			In #3	0				In #3		
				In #4	0-300			In #4	0				In #4		
2	BO2	OR(0) / AND(1)	Inst(0)/Del(1)/Latch(2)	In #1	0-300	OR	Del	In #1	136	STAGE2 TRIP			In #1		
				In #2	0-300			In #2	0				In #2		
				In #3	0-300			In #3	0				In #3		
				In #4	0-300			In #4	0				In #4		
3	BO3	OR(0) / AND(1)	Inst(0)/Del(1)/Latch(2)	In #1	0-300	OR	Del	In #1	137	STAGE3 TRIP			In #1		
				In #2	0-300			In #2	0				In #2		
				In #3	0-300			In #3	0				In #3		
				In #4	0-300			In #4	0				In #4		
4	BO4	OR(0) / AND(1)	Inst(0)/Del(1)/Latch(2)	In #1	0-300	OR	Del	In #1	138	STAGE4 TRIP			In #1		
				In #2	0-300			In #2	0				In #2		
				In #3	0-300			In #3	0				In #3		
				In #4	0-300			In #4	0				In #4		

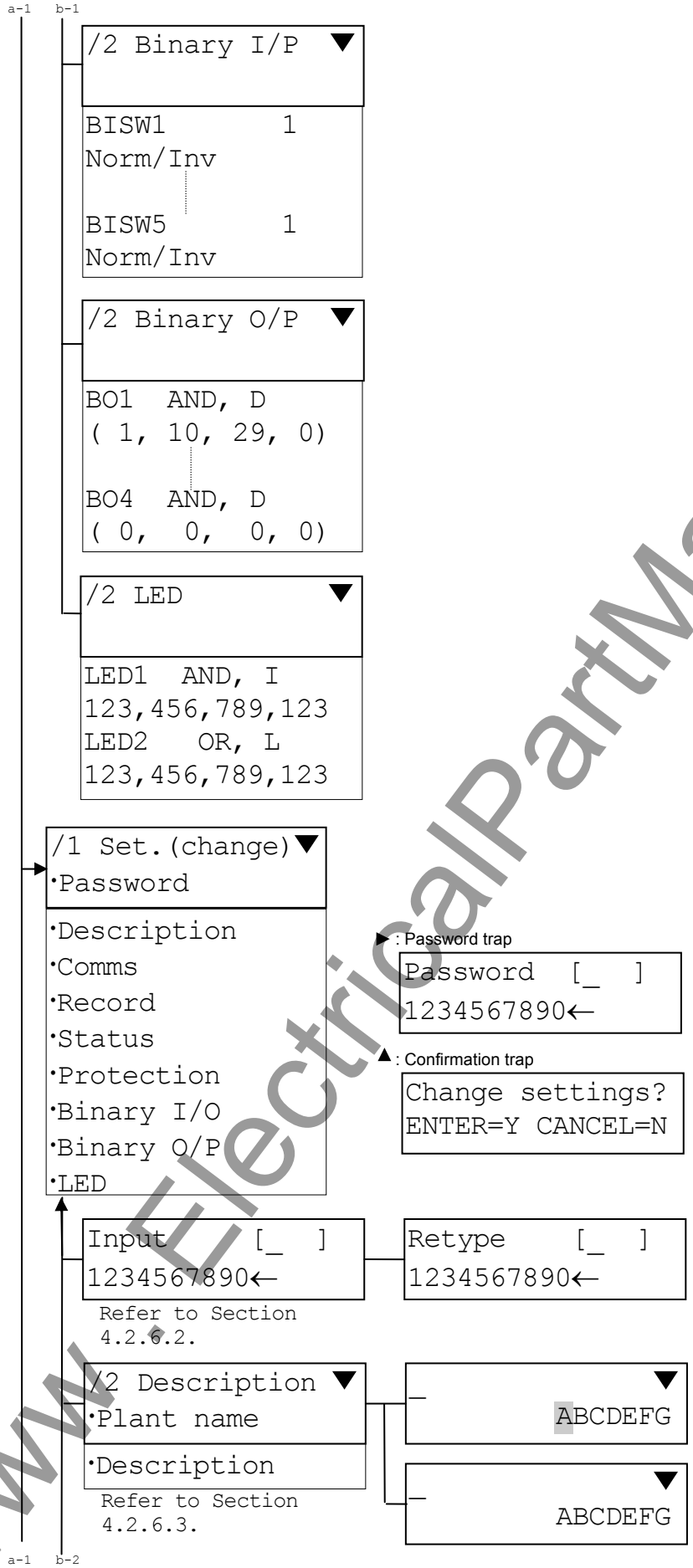
Appendix E

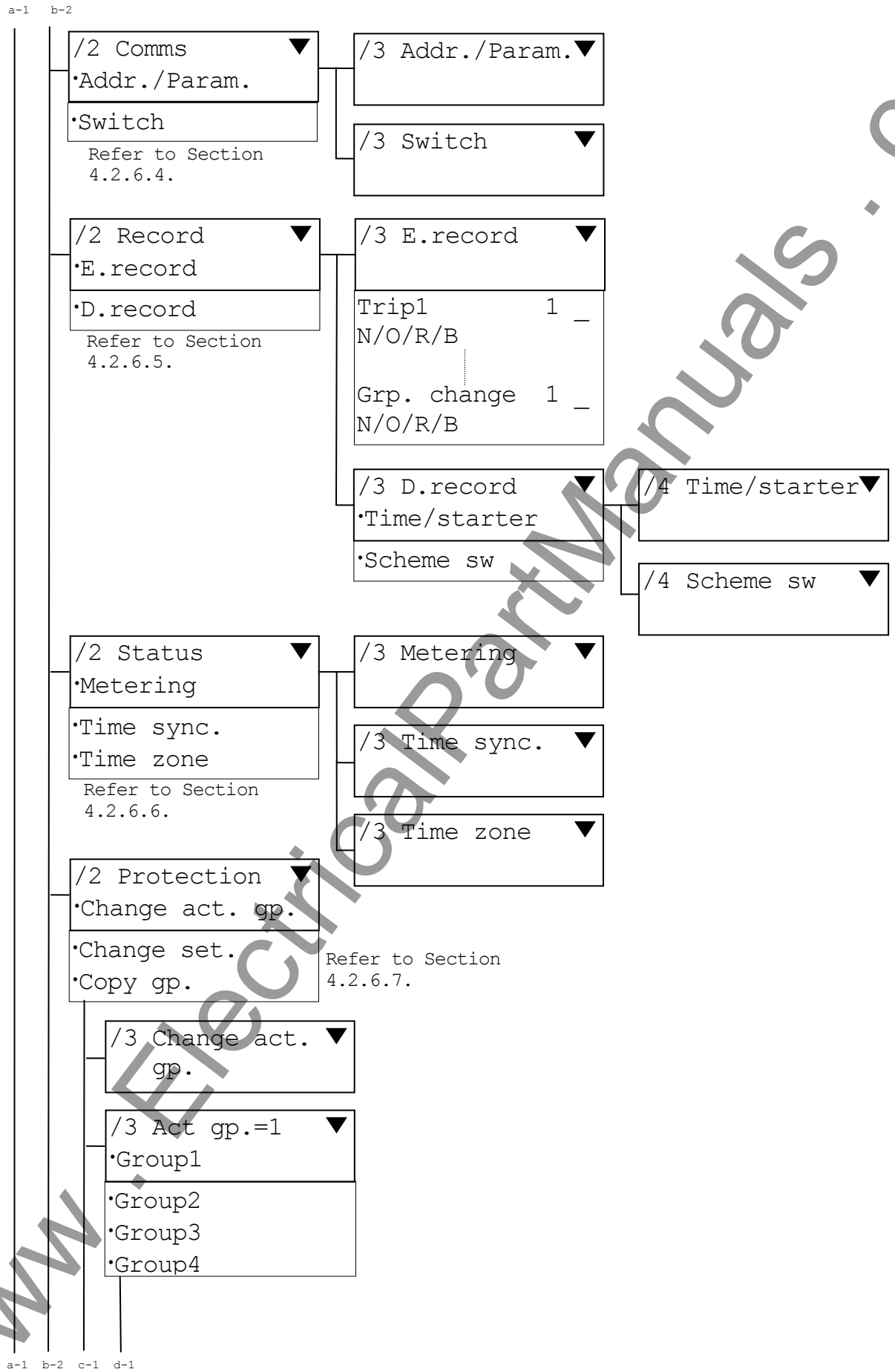
Details of Relay Menu and LCD & Button Operation

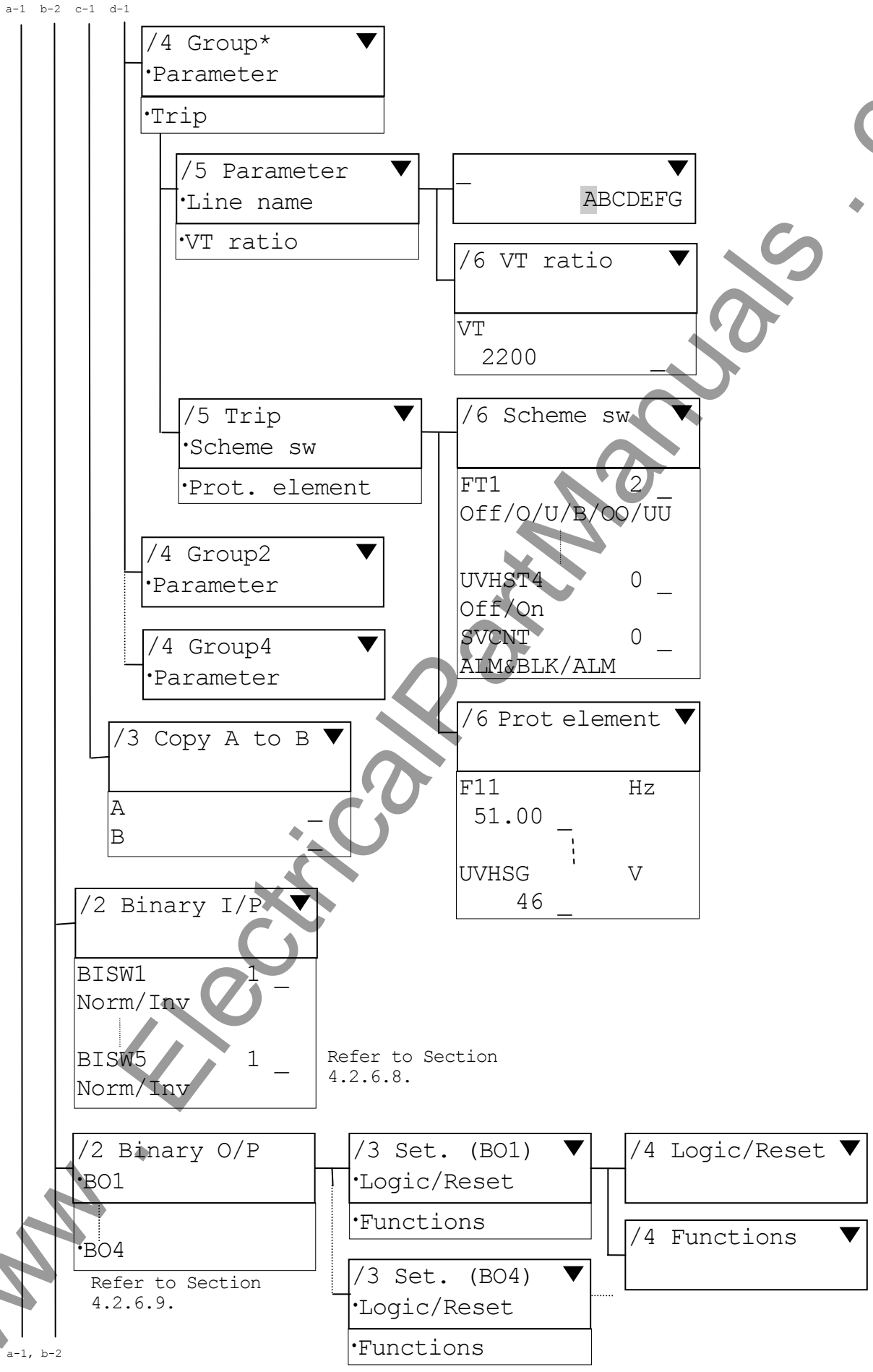


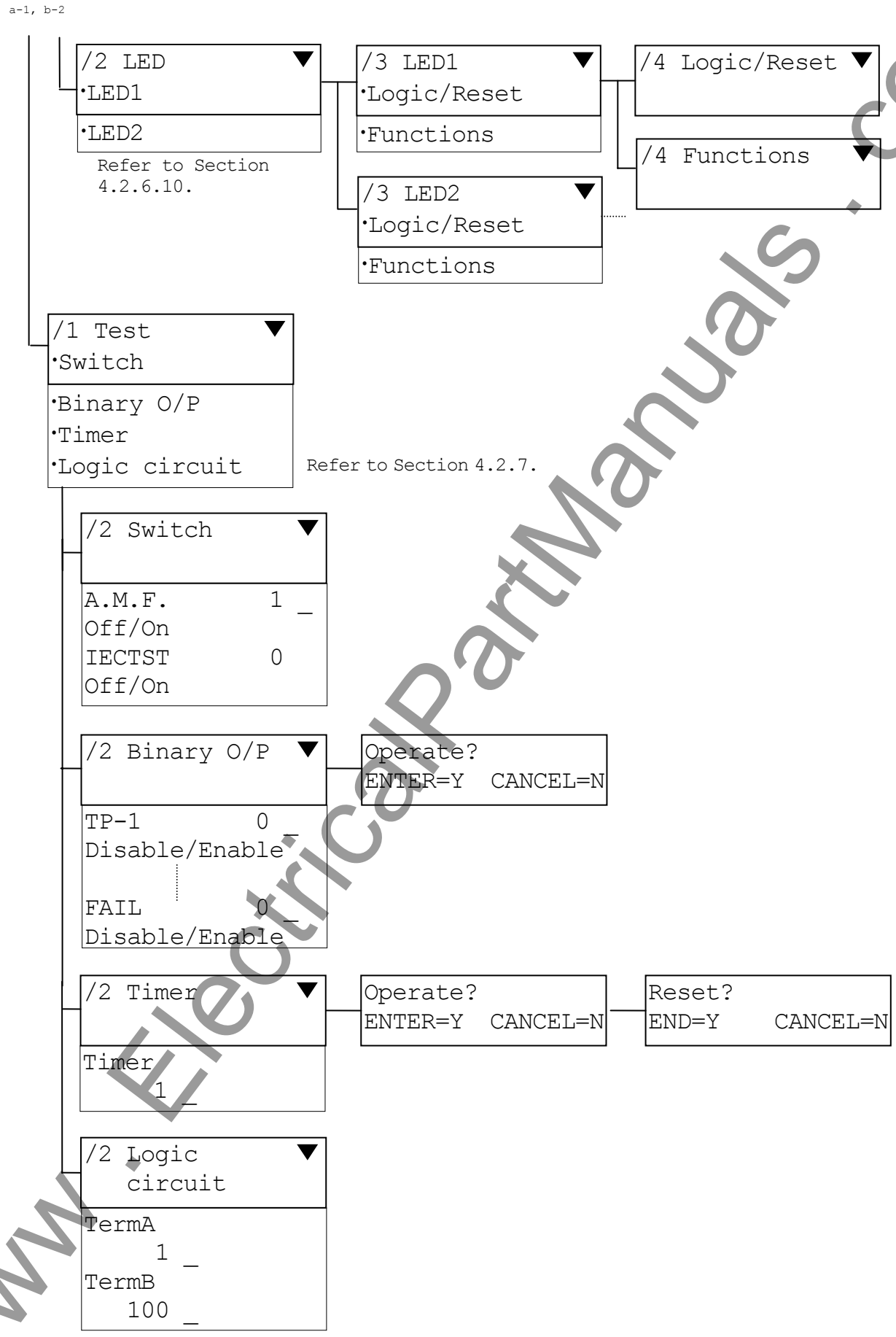




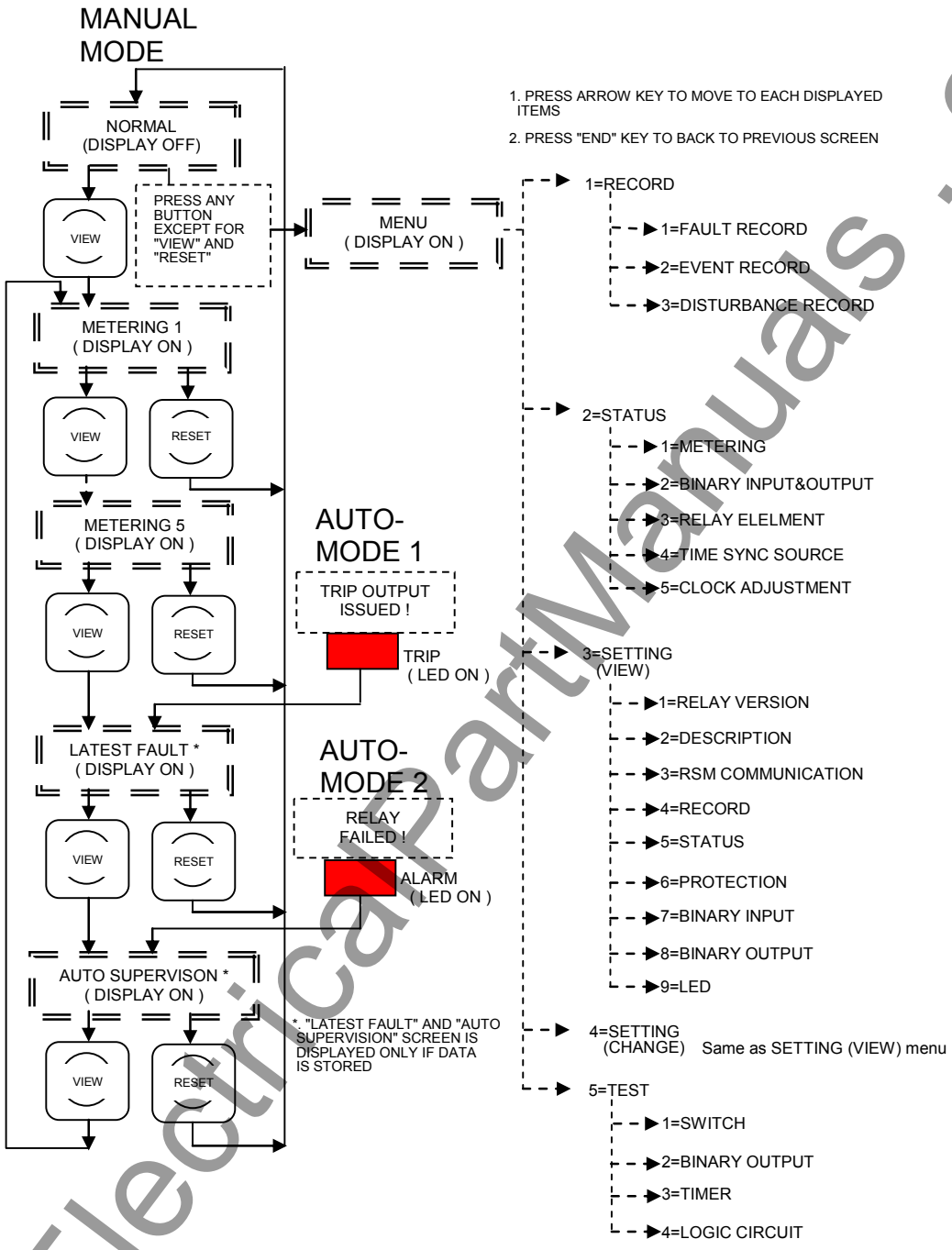








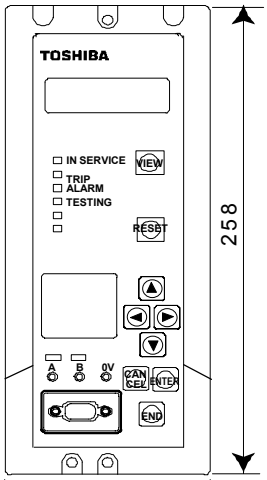
LCD AND BUTTON OPERATION INSTRUCTION



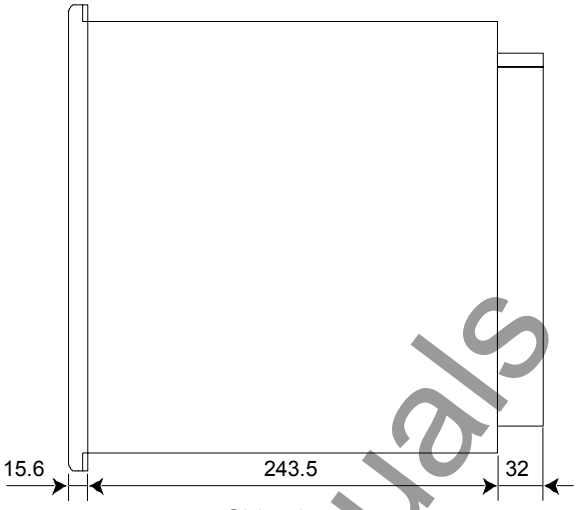
Appendix F

Case Outline of GRF100

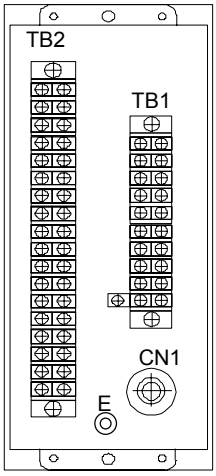
- Case Type: Flush Mount Type



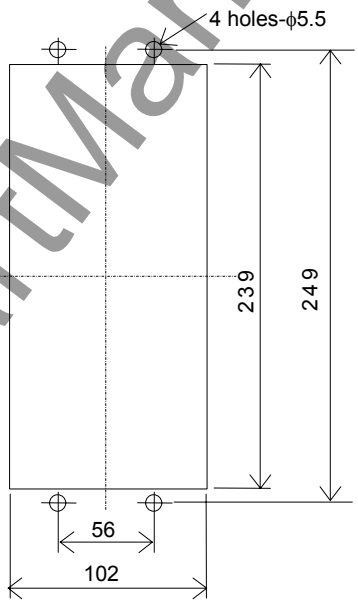
Front view



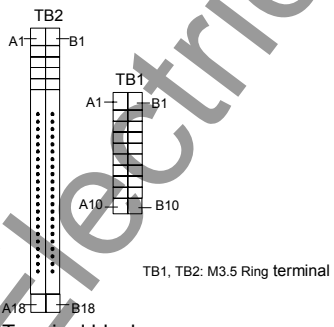
Side view



Rear view



Panel cut-out



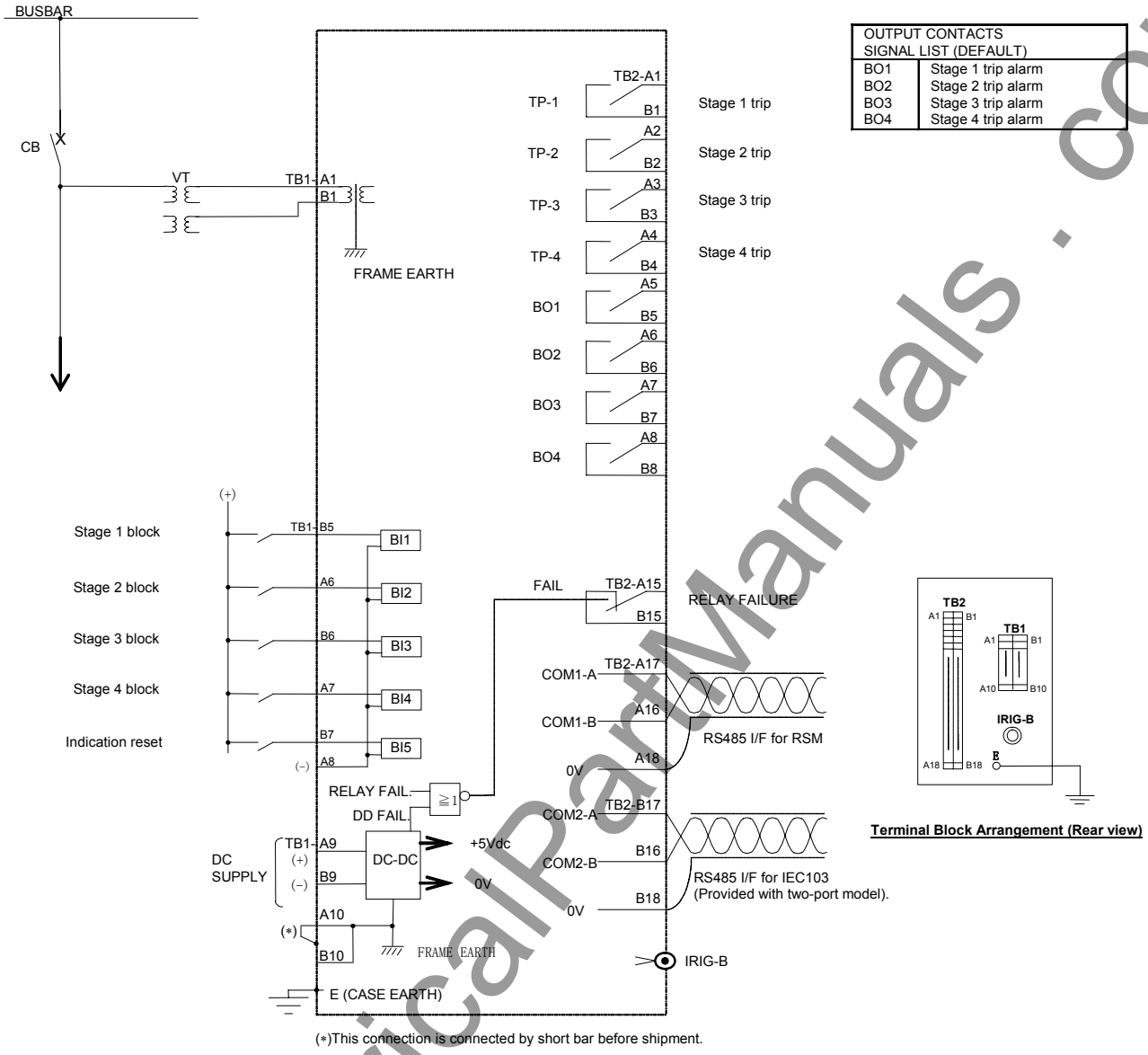
TB1, TB2: M3.5 Ring terminal

Terminal block

Case Outline of GRF100: Flush Mount Type

Appendix G

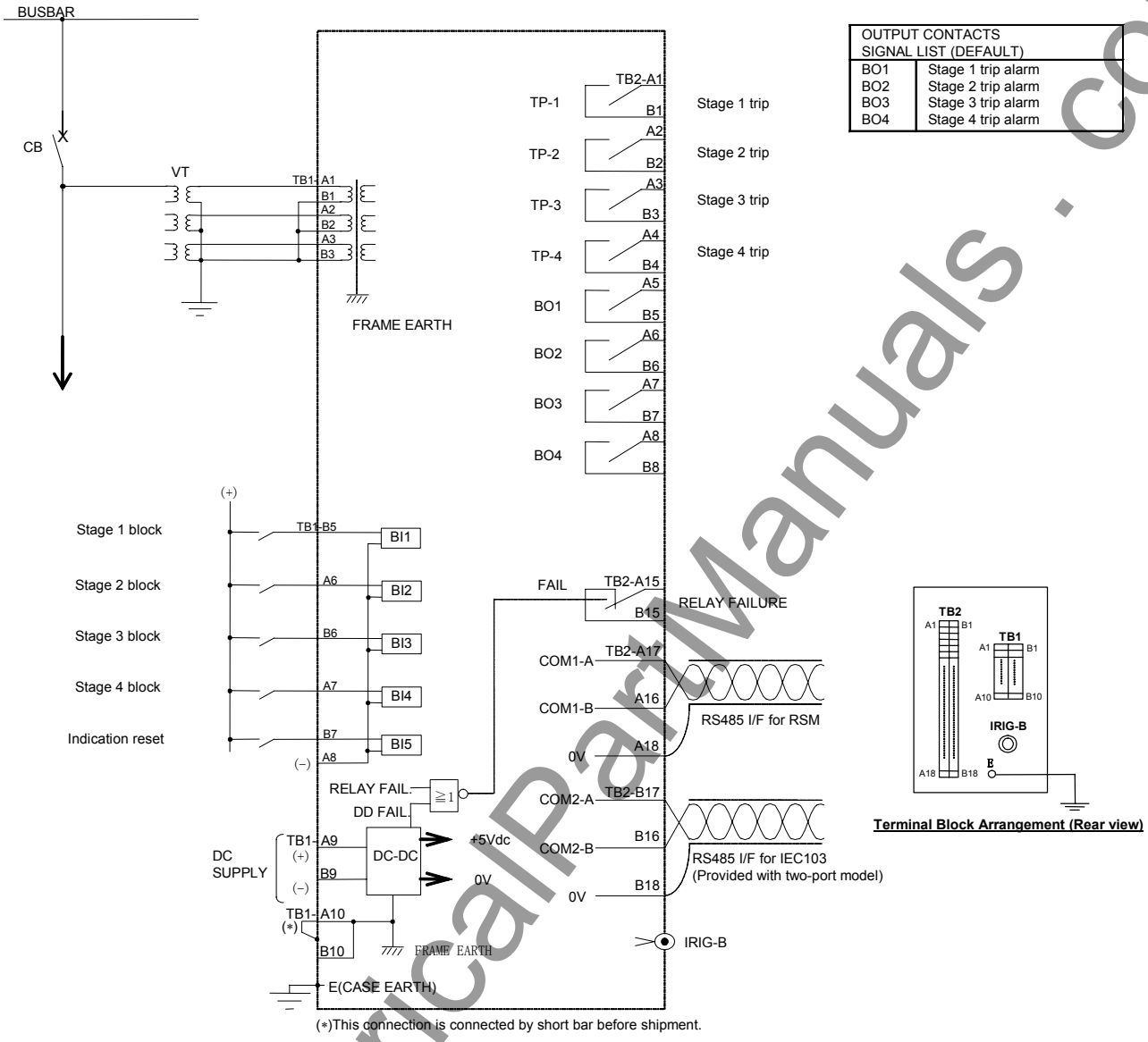
External Connection



Terminal Block Arrangement (Rear view)

(*)This connection is connected by short bar before shipment.

External connection of Model 101



OUTPUT CONTACTS SIGNAL LIST (DEFAULT)	
BO1	Stage 1 trip alarm
BO2	Stage 2 trip alarm
BO3	Stage 3 trip alarm
BO4	Stage 4 trip alarm

External connection of Model 201

Appendix H

Relay Setting Sheet

1. Relay identification
2. Line parameters
3. Contacts setting
4. Relay setting sheet

1. Relay Identification **Date:**

Relay type _____ Serial Number _____

Frequency _____ AC voltage _____

DC supply voltage _____

Password _____

Active setting group

2. Line parameters

VT ratio _____

3. Contacts setting

(1) TB2 Terminal A5-B5 _____

Terminal A6-B6 _____

Terminal A7-B7 _____

Terminal A8-B8

4. Relay setting sheet

№	Name		Range		Units	Contents	Default Setting of Relay (50Hz / 60Hz)		Setting
			50Hz	60Hz			101	201	
1	Act.gp.		1 - 4		—	Active setting group	1		
2	Line name		Specified by user		—	Line name	Specified by user		
3	VT		1 - 20000		—	CT ratio	2000		
4	FT1		Off(0)/O(1)/U(2)/B(3)/OO(4)/UU(5)		—	Frequency protection of stage1	3		
5	DFT1		Off(0) / R(1) / D(2) / Both(3)		—	ditto	3		
6	Logic1		L1(0)/L2(1)/L3(2)/L4(3)/L5(4)		—	ditto	0		
7	OVT1	101	Off(0) / On(1)		—	OV trip of stage1	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
8	UVT1	101	Off(0) / On(1)		—	UV trip of stage1	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
9	OVIT1	101	Off(0) / On(1)		—	OVI trip of stage1	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
10	UVIT1	101	Off(0) / On(1)		—	UVI trip of stage1	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
11	UVHST1	101	Off(0) / On(1)		—	UVHS trip of stage1	0		
		201	Off(0) / S(1) / G(2) / Both(3)						
12	FT2		Off(0)/O(1)/U(2)/B(3)/OO(4)/UU(5)		—	Frequency protection of stage2	3		
13	DFT2		Off(0) / R(1) / D(2) / Both(3)		—	ditto	3		
14	Logic2		L1(0)/L2(1)/L3(2)/L4(3)/L5(4)		—	ditto	0		
15	OVT2	101	Off(0) / On(1)		—	OV trip of stage2	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
16	UVT2	101	Off(0) / On(1)		—	UV trip of stage2	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
17	OVIT2	101	Off(0) / On(1)		—	OVI trip of stage2	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
18	UVIT2	101	Off(0) / On(1)		—	UVI trip of stage2	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
19	UVHST2	101	Off(0) / On(1)		—	UVHS trip of stage2	0		
		201	Off(0) / S(1) / G(2) / Both(3)						
20	FT3		Off(0)/O(1)/U(2)/B(3)/OO(4)/UU(5)		—	Frequency protection of stage3	3		
21	DFT3		Off(0) / R(1) / D(2) / Both(3)		—	ditto	3		
22	Logic3		L1(0)/L2(1)/L3(2)/L4(3)/L5(4)		—	ditto	0		
23	OVT3	101	Off(0) / On(1)		—	OV trip of stage3	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
24	UVT3	101	Off(0) / On(1)		—	UV trip of stage3	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
25	OVIT3	101	Off(0) / On(1)		—	OVI trip of stage3	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
26	UVIT3	101	Off(0) / On(1)		—	UVI trip of stage3	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
27	UVHST3	101	Off(0) / On(1)		—	UVHS trip of stage3	0		
		201	Off(0) / S(1) / G(2) / Both(3)						
28	FT4		Off(0)/O(1)/U(2)/B(3)/OO(4)/UU(5)		—	Frequency protection of stage4	3		
29	DFT4		Off(0) / R(1) / D(2) / Both(3)		—	ditto	3		
30	Logic4		L1(0)/L2(1)/L3(2)/L4(3)/L5(4)		—	ditto	0		
31	OVT4	101	Off(0) / On(1)		—	OV trip of stage4	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
32	UVT4	101	Off(0) / On(1)		—	UV trip of stage4	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
33	OVIT4	101	Off(0) / On(1)		—	OVI trip of stage4	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
34	UVIT4	101	Off(0) / On(1)		—	UVI trip of stage4	0	3	
		201	Off(0) / S(1) / G(2) / Both(3)						
35	UVHST4	101	Off(0) / On(1)		—	UVHS trip of stage4	0		
		201	Off(0) / S(1) / G(2) / Both(3)						
36	SVCNT		ALM&BLK(0) / ALM(1)		—	Supervision control	--	0	
37	F11		45.00 - 55.00	54.00 - 66.00	Hz	Frequency 1 element of stage1	51.00 / 61.00		
38	TF11		0.00 - 100.00		s	F11 trip delay timer	1.00		
39	F12		45.00 - 55.00	54.00 - 66.00	Hz	Frequency 2 element of stage1	49.00 / 59.00		
40	TF12		0.00 - 100.00		s	F12 trip delay timer	1.00		
41	DF1		0.1 - 9.9		Hz/s	Frequency change of stage1	0.5		
42	F21		45.00 - 55.00	54.00 - 66.00	Hz	Frequency 1 element of stage2	51.00 / 61.00		
43	TF21		0.00 - 100.00		s	F21 trip delay timer	1.00		
44	F22		45.00 - 55.00	54.00 - 66.00	Hz	Frequency 2 element of stage2	49.00 / 59.00		
45	TF22		0.00 - 100.00		s	F22 trip delay timer	1.00		
46	DF2		0.1 - 9.9		Hz/s	Frequency change of stage2	0.5		
47	F31		45.00 - 55.00	54.00 - 66.00	Hz	Frequency 1 element of stage3	51.00 / 61.00		
48	TF31		0.00 - 100.00		s	F31 trip delay timer	1.00		
49	F32		45.00 - 55.00	54.00 - 66.00	Hz	Frequency 2 element of stage3	49.00 / 59.00		
50	TF32		0.00 - 100.00		s	F32 delay timer of stage3	1.00		
51	DF3		0.1 - 9.9		Hz/s	Frequency change of stage3	0.5		
52	F41		45.00 - 55.00	54.00 - 66.00	Hz	Frequency 1 element of stage4	51.00 / 61.00		
53	TF41		0.00 - 100.00		s	F41 trip delay timer of stage4	1.00		
54	F42		45.00 - 55.00	54.00 - 66.00	Hz	Frequency 2 element of stage4	49.00 / 59.00		
55	TF42		0.00 - 100.00		s	F42 trip delay timer of stage4	1.00		
56	DF4		0.1 - 9.9		Hz/s	Frequency change of stage4	0.5		

№	Name		Range 50Hz	Range 60Hz	Units	Contents	Default Setting of Relay (50Hz / 60Hz) 101	Default Setting of Relay (50Hz / 60Hz) 201	Setting
57	UVBLK		40 - 100		V	Under voltage block	40		
58	OVS		5 - 190		V	OV element	132		
59	OVG		5 - 100		V	ditto	--	76	
60	TOV1		0.00 - 100.00		s	OV trip delay timer of stage1	1.00		
61	TOV2		0.00 - 100.00		s	OV trip delay timer of stage2	1.00		
62	TOV3		0.00 - 100.00		s	OV trip delay timer of stage3	1.00		
63	TOV4		0.00 - 100.00		s	OV trip delay timer of stage4	1.00		
64	UVS		20 - 140		V	UV element of stage1	88		
65	UVG		10 - 85		V	ditto	--	50	
66	TUV1		0.00 - 100.00		s	UV trip delay timer of stage1	1.00		
67	TUV2		0.00 - 100.00		s	UV trip delay timer of stage2	1.00		
68	TUV3		0.00 - 100.00		s	UV trip delay timer of stage3	1.00		
69	TUV4		0.00 - 100.00		s	UV trip delay timer of stage4	1.00		
70	OVIS		5 - 190		V	OVI element	132		
71	TOVIS		0.05 - 100.00		—	ditto	13.50		
72	OVIG		5 - 100		V	ditto	--	76	
73	TOVIG		0.05 - 100.00		—	ditto	--	13.50	
74	UVIS		20 - 140		V	UVI element	88		
75	TUVIS		0.05 - 100.00		—	ditto	13.50		
76	UVIG		10 - 85		V	ditto	--	50	
77	TUVIG		0.05 - 100.00		—	ditto	--	13.50	
78	UVHSS		20 - 140		V	UVHS element of stage1	80		
79	UVHSG		10 - 85		V	ditto	--	46	
80	BISW1		Norm(0) / Inv(1)		—	Binary input	0		
81	BISW2		Norm(0) / Inv(1)		—	ditto	0		
82	BISW3		Norm(0) / Inv(1)		—	ditto	0		
83	BISW4		Norm(0) / Inv(1)		—	ditto	0		
84	BISW5		Norm(0) / Inv(1)		—	ditto	0		
85	LED1	Logic	OR - AND		—	Configrable LEDs	OR		
86		Reset	Inst - Latch				Inst		
87		In #1	0 - 300				0		
88		In #2	0 - 300				0		
89		In #3	0 - 300				0		
90		In #4	0 - 300				0		
91	LED2	Logic	OR - AND		—	Configrable LEDs	OR		
92		Reset	Inst - Latch				Inst		
93		In #1	0 - 300				0		
94		In #2	0 - 300				0		
95		In #3	0 - 300				0		
96		In #4	0 - 300				0		
97	Plant name		Specified by user		—	Plant name	Specified by user		
98	Description		ditto		—	Memorandum for user	Specified by user		
99	HDLC		1 - 32		—	Relay ID No. for RSM	1		
100	IEC		0 - 254		—	Station address for IEC103	2		
101	IECBR		9.6(0) / 19.2(1)		—	IEC60870-5-103 baud rate	19.2		
102	IECBLK		Normal(0) / Blocked(1)		—	Monitor direction blocked	Normal		
103	Trip1		N(0) / O(1) / R(2) / B(3)		—	Event record trigger	3		
104	Trip2		N(0) / O(1) / R(2) / B(3)		—	ditto	3		
105	Trip3		N(0) / O(1) / R(2) / B(3)		—	ditto	3		
106	Trip4		N(0) / O(1) / R(2) / B(3)		—	ditto	3		
107	Trip1 block		N(0) / O(1) / R(2) / B(3)		—	ditto	3		
108	Trip2 block		N(0) / O(1) / R(2) / B(3)		—	ditto	3		
109	Trip3 block		N(0) / O(1) / R(2) / B(3)		—	ditto	3		
110	Trip4 block		N(0) / O(1) / R(2) / B(3)		—	ditto	3		
111	Ind.reset		N(0) / O(1) / R(2) / B(3)		—	ditto	3		
112	Relay fail		N(0) / O(1) / R(2) / B(3)		—	ditto	3		
113	V0 err		N(0) / O(1) / R(2) / B(3)		—	ditto	--	3	
114	V2 err		N(0) / O(1) / R(2) / B(3)		—	ditto	--	3	
115	Sys.change		N(0) / O(1)		—	ditto	1		
116	Rly.change		N(0) / O(1)		—	ditto	1		
117	Grp.change		N(0) / O(1)		—	ditto	1		
118	Time		0.1 - 3.0		s	Disturbance record	1.0		
119	OVP-S		5 - 190		V	OV element for disturbance recorder	132		
120	OVP-G		5 - 100		V	initiation	--	76	
121	UVP-S		20 - 140		V	UV element for disturbance recorder	88		
122	UVP-G		10 - 85		V	initiation	--	50	
123	TRIP		Off(0) / On(1)		—	Disturbance record trigger use or not	1		
124	FRQ		Off(0) / On(1)		—	ditto	1		
125	OVP-S		Off(0) / On(1)		—	ditto	1		
126	OVP-G		Off(0) / On(1)		—	ditto	1		
127	UVP-S		Off(0) / On(1)		—	ditto	1		
128	UVP-G		Off(0) / On(1)		—	ditto	1		
129	Display		Prim.(0) / Second.(1)		—	Metering	0		
130	Time sync		Off(0) / IRIG(1) / RSM(2) / IEC(3)		—	Time synchronization	0		
131	GMT		-12 - +12		hrs	Time zone	0		

Appendix I

Commissioning Test Sheet (sample)

1. Relay identification
2. Preliminary check
3. Hardware test
   - 3.1 User interface check
   - 3.2 Binary input/Binary output circuit check
   - 3.3 AC input circuit check
4. Function test
   - 4.1 Frequency elements test
   - 4.2 Overvoltage and undervoltage elements 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	☐
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 Frequency elements test

Element	Setting	Measured voltage
F11		
F12		
F21		
F22		
F31		
F32		
F41		
F42		
DFD1		
DFD2		
DFD3		
DFD4		
DFR1		
DFR2		
DFR3		
DFR4		

4.2 Overvoltage and undervoltage elements test

(1) Operating value check

Element	Setting	Measured voltage
OVS		
OVG		
OVIS		
OVIG		
UVS		
UVG		
UVIS		
UVIG		
UVHSS		
UVHSG		

(2) Operating time check

Element	Setting	Measured angle
OVIS		
OVIG		
UVIS		
UVIG		

5. Protection scheme test

6. Metering and recording check

7. Conjunctive test

Scheme	Results
Tripping circuit	

Appendix J

Return / Repair Form

RETURN / REPAIR FORM

Please fill in this form and return it to Toshiba Corporation with the GRF100 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: GRF100 Model: _____
(Example: Type: GRF100 Model: 201B - 22 - 10)

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

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

     _____
     _____
     _____
     _____

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

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

4. Which LEDs were lit at the time of the incident?

5. Describe the details of the incident:

6. Date incident occurred

   Day/Month/Year: / / /

   (Example: 10/July/1998)

7. Give any comments about the GRF100, including the documents:

Customer

Name: _____

Company Name: _____

Address: _____

_____

_____

Telephone No.: _____

Facsimile No.: _____

Signature: _____

Appendix K

Technical Data

TECHNICAL DATA

Ratings	
AC voltage	100V, 110V, 115V, 120V
Frequency	50Hz or 60Hz
DC power supply	110Vdc/125Vdc (Operative range: 88 to 150Vdc) 220Vdc/250Vdc (Operative range: 176 to 300Vdc) 48Vdc/54Vdc/60Vdc (Operative range: 38.4 to 72Vdc)
AC ripple on DC supply IEC 60255-11	maximum 12%
DC supply interruption IEC 60255-11	
Permissive duration of DC supply voltage interruption to maintain normal operation	maximum 50ms at 110Vdc
Restart time	less than 10s
Binary input circuit DC voltage	110Vdc/125Vdc (Operative range: 88 to 150Vdc) 220Vdc/250Vdc (Operative range: 176 to 300Vdc) 48Vdc/54Vdc/60Vdc(Operative range: 38.4 to 72Vdc)
Overload rating	
AC voltage input	
Model 101	1.2 times rated continuous 1.5 times rated for 1s
Model 201	2 times rated continuous 2.5 times rated for 1s
Burden	
AC voltage input	0.1VA per phase (at rated voltage)
DC power supply	less than 10W (quiescent) less than 15W(operation)
Binary input circuit	0.5W/input at 110Vdc
Frequency protection	
Underfrequency	45.00 to 50.00Hz in 0.01Hz steps 54.00 to 60.00Hz in 0.01Hz steps
Overfrequency	50.00 to 55.00Hz in 0.01Hz steps 60.00 to 66.00Hz in 0.01Hz steps
Frequency rate-of-change	+0.1 to +9.9Hz/s in 0.1Hz/s steps −0.1 to −9.9Hz/s in 0.1Hz/s steps
Operating time	less than 200ms
Timer for stage 1 to 4	0.00 to 100.00s in 0.01s steps
Undervoltage block	40 to 100V in 1V steps
Resetting value	±2%
Accuracy of frequency protection	
Frequency	±0.005Hz at rated frequency ±5%
Frequency change	±0.05Hz
Undervoltage block	±5%
Timer	±2%
Overvoltage protection	
Definite time	
Phase-to-phase element	5 to 190V in 1V steps
Phase-to-neutral element	5 to 100V in 1V steps
Timer for stage 1 to 4	0.00 to 100.00s in 0.01s steps
Inverse time	
Phase-to-phase element	5 to 190V in 1V steps
Phase-to-neutral element	5 to 100V in 1V steps
IDMT	$t = \frac{1}{V/Vs - 1} \times TMS$ Vs: setting value
Time multiplier (TMS)	0.05 to 100.00 in 0.01 steps

Undervoltage protection	
Definite time	
Phase-to-phase element	20 to 140V in 1V steps
Phase-to-neutral element	10 to 85V in 1V steps
Timer for stage 1 to 4	0.00 to 100.00s in 0.01s steps
Inverse time	
Phase-to-phase element	20 to 140V in 1V steps
Phase-to-neutral element	10 to 85V in 1V steps
IDMT	$t = \frac{1}{1 - V/Vs} \times TMS$ Vs: setting value
Time multiplier (TMS)	0.05 to 100.00 in 0.01 steps
High speed	
Phase-to-phase element	20 to 140V in 1V steps
Phase-to-neutral element	10 to 85V in 1V steps
Operating time	Less than 20ms
Accuracy of undervoltage and overvoltage protection	
Pickup value	±5%
Timer	±2%
Communication port	
Front communication port (local PC)	
Connection	Point to point
Cable type	Multi-core (straight)
Cable length	15m (max.)
Connector	RS232C 9-pin D-subminiature connector female
Rear communication port (remote PC)	
RS485 I/F	
Transmission data rate for RSM system	64kbps
Connection	Multidrop mode (max. 32 relays)
Connector	Screw terminals
Cable and length	Twisted pair cable, max. 1200m
Isolation	2kVac for 1min.
IRIG-B port	
Connection	BNC connector
Cable type	50 ohm coaxial cable
Binary inputs	
Minimum operating voltage	Typical 74Vdc(min. 70Vdc) for 110Vdc/125Vdc rating Typical 138Vdc(min. 125Vdc) for 220Vdc/250Vdc rating Typical 31Vdc(min. 28Vdc) for 48V/54V/60Vdc rating
Contact ratings	
Trip contacts	
Make and carry	5A continuously, 30A, 290Vdc for 0.5s (L/R=10ms)
Break	0.15A, 290Vdc (L/R=40ms)
Auxiliary contacts	
Make and carry	4A continuously, 10A, 220Vdc for 0.5s (L/R≧5ms)
Break	0.1A, 220Vdc (L/R=40ms)
Durability	
Make and carry	10,000 operations minimum
Break	100,000 operations minimum
Mechanical design	
Weight	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 L

Symbols Used in Scheme Logic

Symbols used in the scheme logic and their meanings are as follows:

Signal names

Marked with ▭ : Measuring element output signal

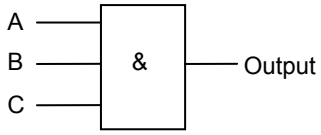
Marked with ⬭ : Binary signal input from or output to the external equipment

Marked with [ ] : Scheme switch

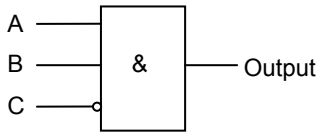
Marked with " " : Scheme switch position

Unmarked : Internal scheme logic signal

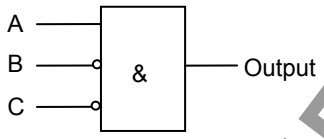
AND gates



A	B	C	Output
1	1	1	1
Other cases			0

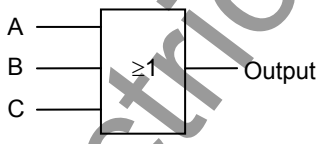


A	B	C	Output
1	1	0	1
Other cases			0

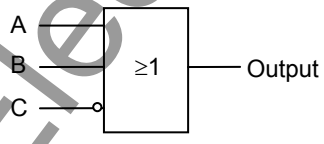


A	B	C	Output
1	0	0	1
Other cases			0

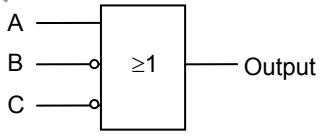
OR gates



A	B	C	Output
0	0	0	0
Other cases			1

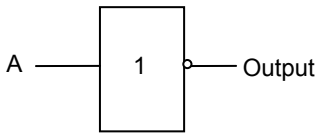


A	B	C	Output
0	0	1	0
Other cases			1



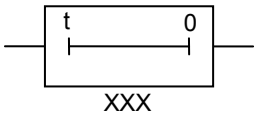
A	B	C	Output
0	1	1	0
Other cases			1

Signal inversion



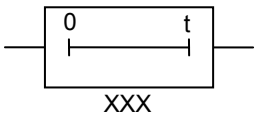
A	Output
0	1
1	0

Timer



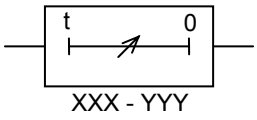
Delayed pick-up timer with fixed setting

XXX: Set time



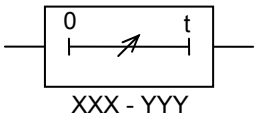
Delayed drop-off timer with fixed setting

XXX: Set time



Delayed pick-up timer with variable setting

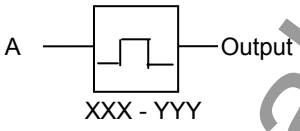
XXX - YYY: Setting range

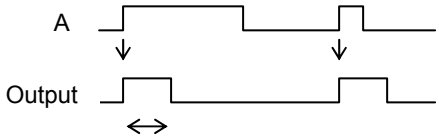


Delayed drop-off timer with variable setting

XXX - YYY: Setting range

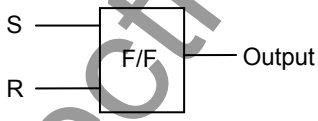
One-shot timer





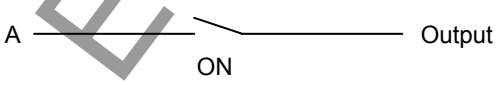
XXX - YYY: Setting range

Flip-flop

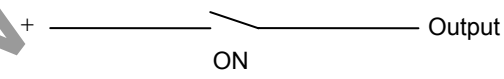


S	R	Output
0	0	No change
1	0	1
0	1	0
1	1	0

Scheme switch



A	Switch	Output
1	ON	1
Other cases		0



Switch	Output
ON	1
OFF	0

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.6F2S0812.)

- Items for "Time-tagged message": Type ID(1/2), INF, FUN, Transmission condition(Signal number), COT
- Items for "Time-tagged measurands": INF, FUN, Transmission condition(Signal number), COT, Type of measurand quantities
- Items for "General command": INF, FUN, Control condition(Signal number)
- Items for "Measurands": Type ID(3/9), INF, FUN, Number of measurand, Type of measurand quantities
- Common setting
  - Transmission cycle of Measurand frame
  - FUN of System function
  - Test mode, etc.

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.	DPI OFF	DPI 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	222	--	--	--
3	Reset CU	Reset CU ACK	--	5	4	222	--	--	--
4	Start/Restart	Relay start/restart	--	5	5	222	--	--	--
5	Pow er On	Relay pow er 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, 9, 12	222	255	1	2
19	LED reset	Reset of latched LEDs	--	1	1, 11, 12	222	249	--	2
20	Monitor direction blocked	Block the 103 transmission from a relay to control system. IECBLK: "Blocked" settimg.	GI	1	9, 11	222	231	1	2
21	Test mode	Transmission of testmode situation from a relay to control system. IECTST "ON" setting.	GI	1	9, 11	222	232	1	2
22	Local parameter Setting	When a setting change has done at the local, the event is sent to control system.	Not supported						
23	Characteristic1	Setting group 1 active	GI	1	1, 9, 11, 12	222	233	1	2
24	Characteristic2	Setting group 2 active	GI	1	1, 9, 11, 12	222	234	1	2
25	Characteristic3	Setting group 3 active	GI	1	1, 9, 11, 12	222	235	1	2
26	Characteristic4	Setting group 4 active	GI	1	1, 9, 11, 12	222	236	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	GI	1	1, 9	222	206	1	2
35	Phase sequence supervision	Negative sequence voltage supevision	GI	1	1, 9	222	207	1	2
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 w arning	Only alarming	GI	1	1, 9	222	204	1	2
47	Group alarm	Trip blocking and alarming	GI	1	1, 9	222	202	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 Fw d	Earth fault forw ard	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.	DPI OFF	DPI 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	222	263	--	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 forw ard/line	Forw ard 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	Va, Vb, Vc, f measurand <meaurand II>	--	9	2, 7	222	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)						
	Va	1	6	short	0	4096	2.15
	Vb	1	8	short	0	4096	2.15
	Vc	1	10	short	0	4096	2.15
	(empty)						
	(empty)						
	f	1	96	long	0	4096	0.068

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	255
0	Time synchronization		--	6	8	255
General commands						
16	Auto-recloser on/off		Not supported			
17	Teleprotection on/off		Not supported			
18	Protection on/off	(*1)	ON/OFF	20	20	222
19	LED reset	Reset indication of latched LEDs.	ON	20	20	222
23	Activate characteristic 1	Setting Group 1	ON	20	20	222
24	Activate characteristic 2	Setting Group 2	ON	20	20	222
25	Activate characteristic 3	Setting Group 3	ON	20	20	222
26	Activate characteristic 4	Setting Group 4	ON	20	20	222
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	287	287	✓	0
19	0	288		200
23	0	293		1000
24	0	294		1000
25	0	295		1000
26	0	296		1000

✓: signal reverse

	Description	Contents	GRF100 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	Va	Configurable	
	Voltage L2-E	Vb	Configurable	
	Voltage L3-E	Vc	Configurable	
	Active power P	P	No	
	Reactive power Q	Q	No	
	Frequency f	f	Configurable	
	Voltage L1 - L2	Vab	Configurable	

Details of Common settings in IEC103 configurator

- Setting file's remark: GRF100_1.01
- Remote operation valid time [ms]: 4000
- Local operation valid time [ms]: 4000
- Measurand period [s]: 2
- Function type of System functions: 222
- Signal No. of Test mode: 232
- Signal No. for Real time and Fault number: 262

[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:

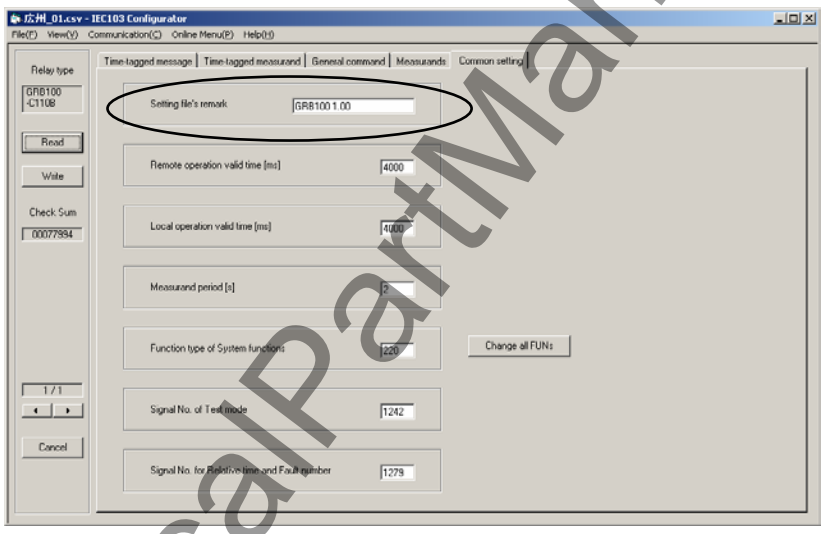
First draft: ******_01.csv

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

Frequency, Voltage Relay	G	R	F	1	0	0	–		0	1	B	–		0	–		0	–	
Relay Model																			
Single-phase input								1											
Three-phase input								2											
Rating																			
50Hz, 110/125Vdc													1						
60Hz, 110/125Vdc													2						
50Hz, 220/250Vdc													5						
60Hz, 220/250Vdc													6						
50Hz, 48/54/60Vdc													A						
60Hz, 48/54/60Vdc													B						
Communication																			
Dual RS485																3			
LED Label																			
Standard																			None
Option: User configurable LED label																			J

Version-up Records

Version No.	Date	Revised Section	Contents
0.0	May. 30, 2005	--	First issue
1.0	Jan. 31, 2006	Appendices	Modified Appendix J, K and N.
2.0	Mar. 28, 2006	Appendices	Modified Appendix G and N.
3.0	Aug. 02, 2007	2.2 2.5.1 4.2.1 4.4 Appendices	Modified the description. Modified the description. Modified the description. Modified the description. Modified Appendix E, M and N.
4.0	Jan. 22, 2008	3.1.1 4.1.2 4.2.3.1 Appendices	Modified Figure 3.1.2. Modified the description. Modified the sample of LCD screen. (Fault record) Modified Appendix G, K and N.

TOSHIBA CORPORATION