INSTRUCTION MANUAL

UNDER/OVERVOLTAGE PROTECTION RELAY

GRD130

TOSHIBA CORPORATION

(Ver. 2.4)

Safety Precautions

Before using this product, please read this chapter carefully.

This chapter describes the safety precautions recommended when using the GRD130. 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.

⚠WARNING

- **Exposed terminals**

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

- **Residual voltage**

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

- **Fiber optic**

Do not view directly with optical instruments.

⚠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 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.

- **DC power**

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

- **Modification**

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

- **Short-link**

Do not remove a short-link which is mounted at the terminal block on the rear of the relay before shipment, as this may cause the performance of this equipment such as withstand voltage, etc., to reduce.

- **Disposal**

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

Contents

■ The data given in this manual are subject to change without notice. (Ver.2.4)

1. Introduction

GRD130 series relays provide overvoltage and undervoltage protection for distribution substations, generators, motors and transformers.

The GRD130 series has two models and provides the following protection schemes in both models.

- Overvoltage and undervoltage protection with definite time or inverse time characteristics
- Instantaneous overvoltage and undervoltage protection

The GRD130 series provides the following protection schemes depending on the models.

- Zero phase sequence overvoltage protection
- Negative phase sequence overvoltage protection

The GRD130 series provides the following functions for all models.

- Four settings groups
- Configurable binary inputs and outputs
- Circuit breaker condition monitoring
- Trip circuit supervision
- Automatic self-supervision
- Menu-based HMI system
- Configurable LED indication
- Metering and recording functions
- Communications for remote setting and data download is provided by the RSM (Relay Setting and Monitoring) system.
- Front mounted RS232 serial port for local PC communications
- Rear mounted RS485 serial port for remote PC communications
- IEC60870-5-103 protocol is provided for communication with substation control and automation systems.

Table 1.1.1 shows the members of the GRD130 series and identifies the functions to be provided by each member.

Table 1.1.1 Series Members and Functions

: Scheme switch [APPL] setting

Model Number	GRD130 -						
	210			410			
	1PP	1PN	2PP	3PN	3PV	3PP	2PP
Voltage input	1PP + V_0	1PN + V_0	2PP	3PN	3PN + V_0	3PP + V_0	2PP + V_0
IDMT O/V	✓	✓	✓	✓	✓	✓	✓
DT O/V	✓	✓	✓	✓	✓	✓	✓
IDMT U/V	✓	✓	✓	✓	✓	✓	✓
DT U/V	✓	✓	✓	✓	✓	✓	✓
ZPS IDMT O/V	✓	✓		✓(*)	✓	✓	✓
ZPS DT O/V	✓	✓		✓(*)	✓	✓	✓
NPS IDMT O/V			✓	✓	✓	✓	✓
NPS DT O/V			✓	✓	✓	✓	✓
Trip circuit supervision	✓	✓	✓	✓	✓	✓	✓
Self supervision	✓	✓	✓	✓	✓	✓	✓
CB state monitoring	✓	✓	✓	✓	✓	✓	✓
Trip counter alarm	✓	✓	✓	✓	✓	✓	✓
Multiple settings groups	✓	✓	✓	✓	✓	✓	✓
Metering	✓	✓	✓	✓	✓	✓	✓
Fault records	✓	✓	✓	✓	✓	✓	✓
Event records	✓	✓	✓	✓	✓	✓	✓
Disturbance records	✓	✓	✓	✓	✓	✓	✓
Communication	✓	✓	✓	✓	✓	✓	✓

1PP: single phase-to-phase voltage
1PN: single phase-to-neutral voltage
2PP: two phase-to-phase voltage
3PP: three phase-to-phase voltage
3PN: three phase-to-neutral voltage
V_0: residual voltage (V_E)
IDMT: inverse definite minimum time
DT: definite time
O/V: overvoltage protection
U/V: undervoltage protection
ZPS: zero phase sequence
NPS: negative phase sequence
(*): V_0 calculated from three phase voltages.

CAUTION:

Do not change the APPL setting under service condition of the relay.

Model 210 provides single-phase overvoltage and undervoltage protection with zero sequence overvoltage protection or two-phase overvoltage and undervoltage with negative sequence overvoltage protection, depending on the scheme switch [APPL] setting.

Model 410 provides three-phase or two-phase overvoltage and undervoltage protection with zero sequence overvoltage protection and negative sequence overvoltage protection, depending on the scheme switch [APPL] setting.

2. Application Notes

2.1 Phase Overvoltage Protection

GRD130 provides three independent phase overvoltage elements. OV1 and OV2 are programmable for inverse time (IDMT) or definite time (DT) operation. OV3 has definite time characteristic only.

2.1.1 Inverse Time Overvoltage Protection

The inverse time overvoltage protection element OV1 and OV2 have the IDMT characteristic defined by equation (1):

$$t = TMS \times \left\{ \left[\frac{k}{\left(V / Vs \right)^{a} - 1} \right] + c \right\} \qquad (1)$$

where:

t = operating time for constant voltage V (seconds),

V = energising voltage (V),

Vs = overvoltage setting (V),

TMS = time multiplier setting

k, α, c = constants defining curve.

The standard IDMT characteristic [IDMT] of GRD130 is illustrated in Figure 2.1.1.

In addition to the standard IDMT curve, the OV1 and OV2 can provide user configurable IDMT curve. If required, set the scheme switch [OV∗EN] to "C" and set the curve defining constants k, α, and c. The following table shows the setting ranges of the curve defining constants.

Table 2.1.1 Specification of IDMT Curves

Curve Description	Curve Defining Constants		
	k	α	c
Standard "IDMT"	1	1	0
User configurable curve	0.00 – 300.00	0.00 – 5.00	0.000 – 5.000

Definite time reset

A definite time resetting characteristic is applied to the OV1 and OV2 elements when the inverse time delay is used.

If definite time resetting is selected, and the delay period is set to instantaneous, then no intentional delay is added. As soon as the energising voltage falls below the reset threshold, the element returns to its reset condition.

If the delay period is set to some value in seconds, then an intentional delay is added to the reset period. If the energising voltage exceeds the setting for a transient period without causing tripping, then resetting is delayed for a user-definable period. When the energising voltage falls below the reset threshold, the integral state (the point towards operation that it has travelled) of the timing function (IDMT) is held for that period.

This does not apply following a trip operation, in which case resetting is always instantaneous.

The OV1 and OV2 have a programmable dropoff/pickup(DO/PU) ratio.

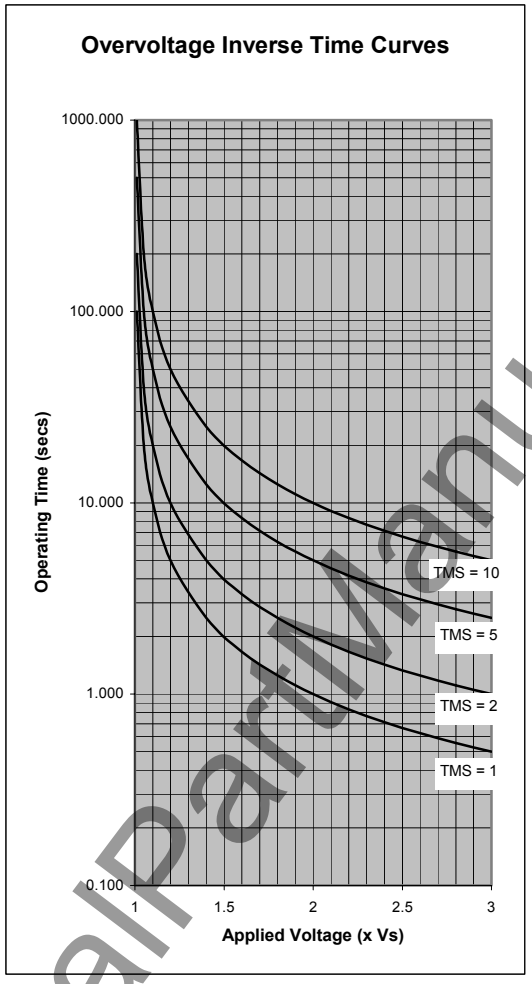


Figure 2.1.1 IDMT Characteristic for OV

Scheme Logic

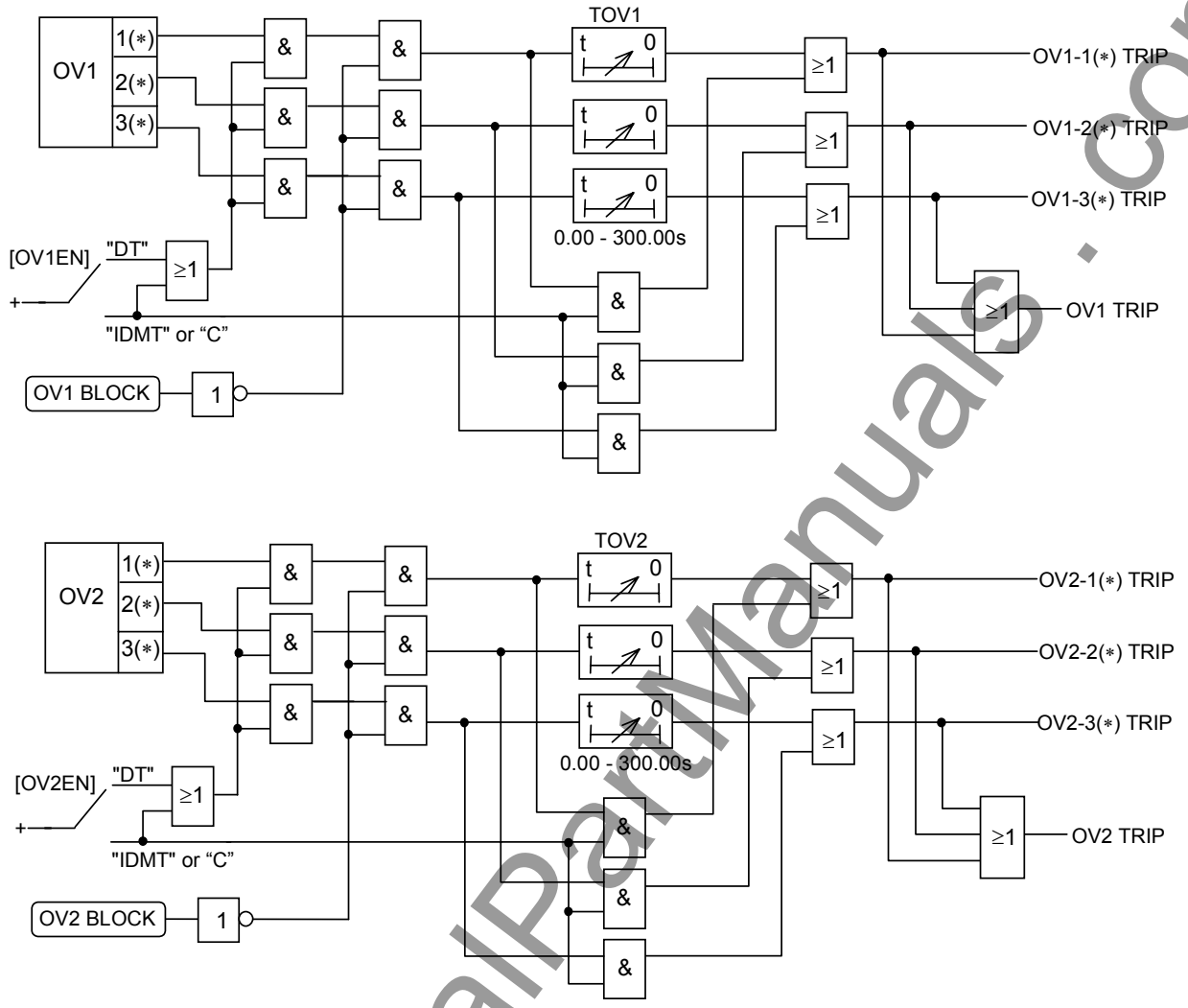
Figure 2.1.2 shows the scheme logic of the overvoltage protection with selective definite time or inverse time characteristic.

The definite time protection is selected by setting [OV1EN] to "DT". Definite time operation is enabled for overvoltage protection, and trip signal OV1 TRIP is given through the delayed pick-up timer TOV1.

The inverse time protection is selected by setting [OV1EN] to "IDMT" or "C". Inverse time operation is enabled for overvoltage protection, and trip signal OV1 TRIP is given.

These protections can be disabled by the scheme switch [OV1EN] or binary input signal OV1 BLOCK.

OV2 provides the same logic as the OV1.



(*)Note : Phases 1, 2 and 3 are replaced with the followings:

Phase	[APPL] setting				
	1PP	1PN	2PP	3PN, 3PV	3PP
1	phase-to-phase	phase-to-neutral	A - B phase	A phase	A - B phase
2	—	—	B - C phase	B phase	B - C phase
3	—	—	—	C phase	C - A phase

Figure 2.1.2 Overvoltage Protection (OV1, OV2)

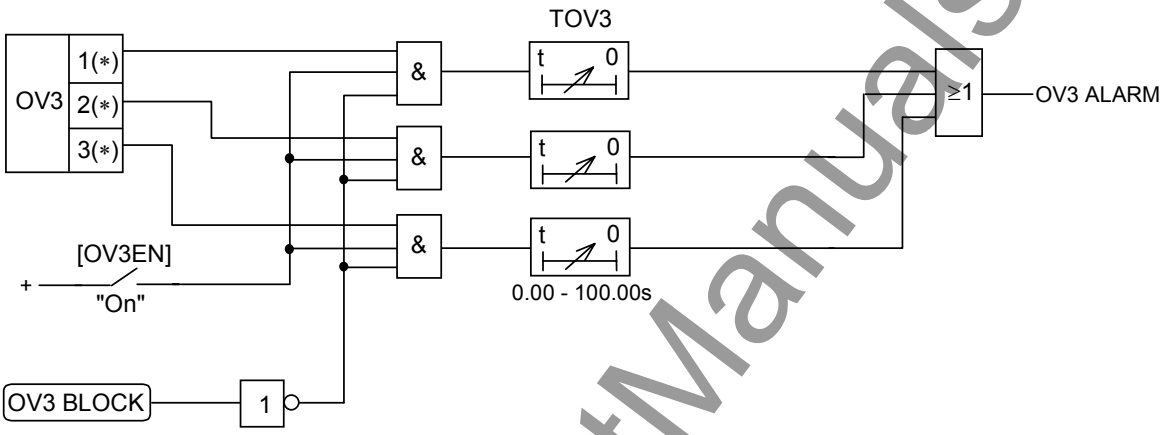
2.1.2 Definite Time Overvoltage Protection

OV3 element is used for definite time overvoltage protection.

The OV3 element has a programmable DO/PU ratio.

Scheme Logic

Figure 2.1.3 shows OV3 scheme logic. The OV3 gives a signal through delayed pick-up timer TOV3. The OV3 is mainly used to output alarm signal OV3 ALARM. The alarm can be blocked by incorporated scheme switch [OV3EN] and binary input signal OV3 BLOCK.



(*)Note : Phases 1, 2 and 3 are replaced with the followings:

Phase	[APPL] setting				
	1PP	1PN	2PP	3PN, 3PV	3PP
1	phase-to-phase	phase-to-neutral	A - B phase	A phase	A - B phase
2	—	—	B - C phase	B phase	B - C phase
3	—	—	—	C phase	C - A phase

Figure 2.1.3 Definite Time Overvoltage Protection (OV3)

2.1.3 Settings

The table shows the setting elements necessary for the overvoltage protection and their setting ranges.

Element	Range	Step	Default	Remarks
OV1	10.0 – 200.0 V	0.1 V	120.0 V	OV1 threshold setting
TOV1	0.05 – 100.00	0.01	10.00	OV1 IDMT time multiplier setting. Required if [OV1EN] = 2 or 3.
	0.00 – 300.00 s	0.01 s	0.10 s	OV1 definite time setting. Required if [OV1EN] = 1.
TOV1R	0.0 – 300.0 s	0.1 s	0.0 s	OV1 definite time delayed reset. Required if [OV1EN] = 2 or 3.
OV1DPR	10 – 98 %	1 %	95 %	OV1 DO/PU ratio setting.
OV2	10.0 – 200.0 V	0.1 V	140.0 V	OV2 threshold setting.
TOV2	0.05 – 100.00	0.01	10.00	OV2 IDMT time multiplier setting. Required if [OV2EN] = 2 or 3.
	0.00 – 300.00 s	0.01 s	0.10 s	OV2 definite time setting. Required if [OV2EN] = 1.
TOV2R	0.0 – 300.0 s	0.1 s	0.0 s	OV2 definite time delayed reset. Required if [OV2EN] = 2 or 3.
OV2DPR	10 - 98 %	1 %	95 %	OV2 DO/PU ratio setting.
OV3	10.0 – 200.0 V	0.1 V	160.0 V	OV3 threshold setting.
TOV3	0.00 – 300.00 s	0.01 s	0.10 s	OV3 definite time setting.
OV3DPR	10 - 98 %	1 %	95 %	OV3 DO/PU ratio setting.
[OV1EN]	Off / DT / IDMT / C		Off	OV1 Enable
[OV2EN]	Off / DT / IDMT / C		Off	OV2 Enable
[OV3EN]	Off / On		Off	OV3 Enable

2.2 Phase Undervoltage Protection

GRD130 provides three independent phase undervoltage elements. UV1 and UV2 programmable for inverse time (IDMT) or definite time (DT) operation. UV3 has definite time characteristic only.

2.2.1 Inverse Time Undervoltage Protection

The inverse time undervoltage protection element UV1 and UV2 have the IDMT characteristic defined by equation (2):

$$t = TMS \times \left\{ \left[\frac{k}{1 - \left(V / Vs \right)^{a}} \right] + c \right\} \qquad (2)$$

where:

t = operating time for constant voltage V (seconds),

V = energising voltage (V),

Vs = undervoltage setting (V),

TMS = time multiplier setting,

k, α, c = constants defining curve.

The standard IDMT characteristic of GRD130 is illustrated in Figure 2.2.1.

In addition to the standard IDMT curve, the UV1 and UV2 can provide user configurable IDMT curve. If required, set the scheme switch [UV∗EN] to "C" and set the curve defining constants k, α, and c. The following table shows the setting ranges of the curve defining constants.

Table 2.2.1 Specification of IDMT Curves

Curve Description	Curve Defining Constants		
	k	α	c
Standard "IDMT"	1	1	0
User configurable curve	0.00 – 300.00	0.00 – 5.00	0.000 – 5.000

Definite time reset

The definite time resetting char-acteristic is applied to the UV1 and UV2 elements when the inverse time delay is used.

If definite time resetting is selected, and the delay period is set to instantaneous, then no intentional delay is added. As soon as the energising voltage rises above the reset threshold, the element returns to its reset condition.

If the delay period is set to some value in seconds, then an intentional delay is added to the reset period. If the energising voltage is below the undercurrent setting for a transient period without causing tripping, then resetting is delayed for a user-definable period. When the energising voltage rises above the reset threshold, the integral state (the point towards operation that it has travelled) of the timing function (IDMT) is held for that period.

This does not apply following a trip operation, in which case resetting is always instantaneous.

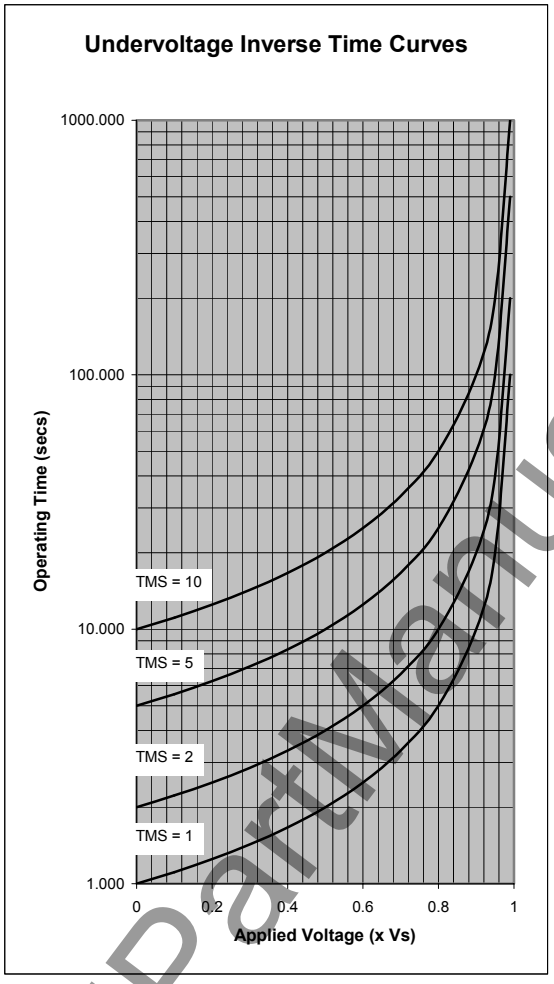


Figure 2.2.1 IDMT Characteristic for UV

Scheme Logic

Figure 2.2.2 shows the scheme logic of the undervoltage protection with selective definite time or inverse time characteristic.

The definite time protection is selected by setting [UV1EN] to "DT". Definite time operation is enabled for undervoltage protection, and trip signal UV1 TRIP is given through the delayed pick-up timer TUV1.

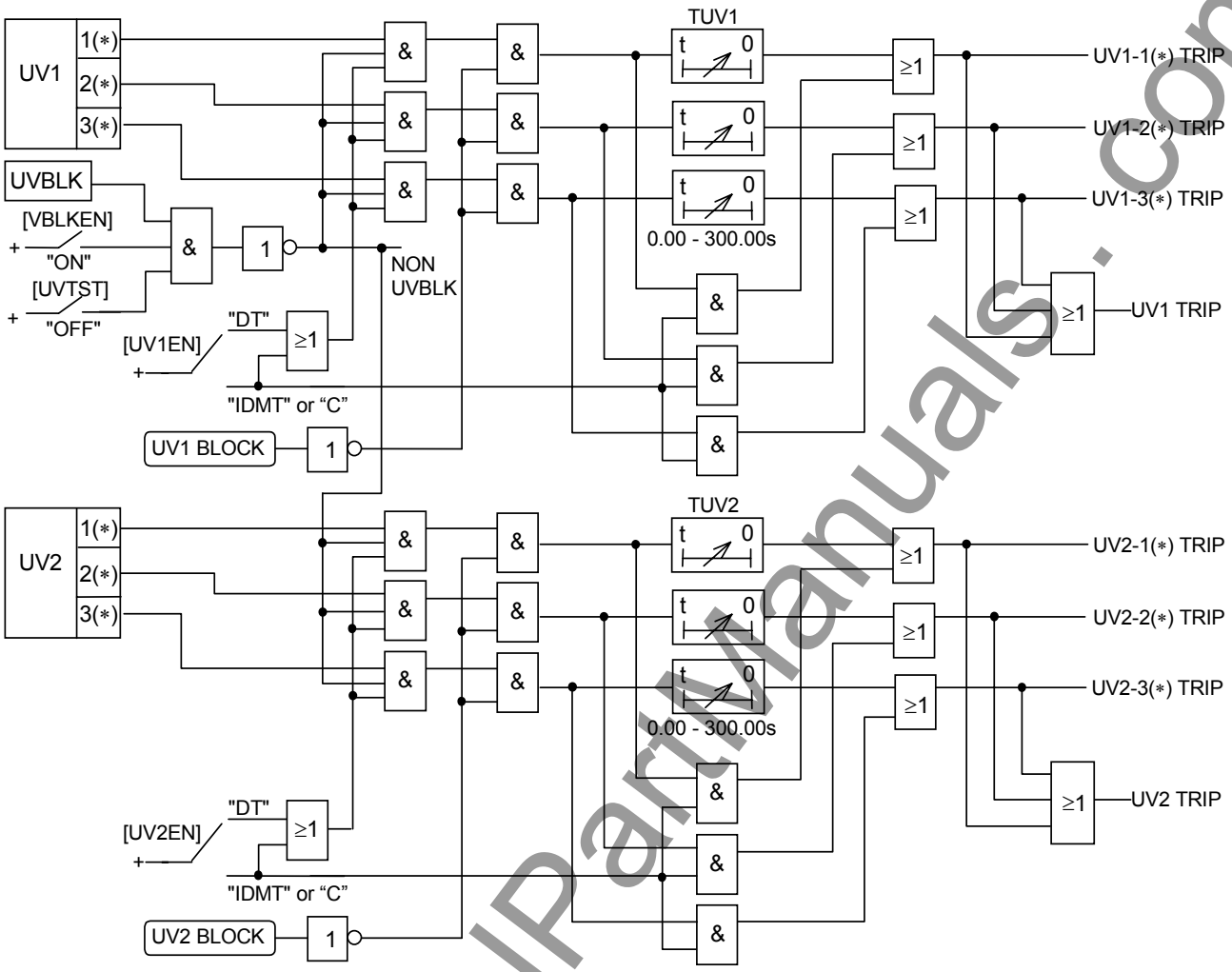
The inverse time protection is selected by setting [UV1EN] to "IDMT" or "C". Inverse time operation is enabled for undervoltage protection, and trip signal UV1 TRIP is given.

These protections can be disabled by the scheme switch [UV1EN] or binary input signal UV1 BLOCK.

In addition, when applying to detect the moderate voltage drop by load shedding, there is a user programmable voltage threshold VBLK. If all measured phase voltages drop below this setting, then the undervoltage protection is prevented from operating. This function can be disabled by the scheme switch [VBLKEN]. The [VBLKEN] should be set to "OFF" (no use) when the UV elements are used as fault detectors, and set to "ON" (use) when used for load shedding.

Note: When [VBLKEN] is "On", the VBLK must be set lower than any other UV setting values and the UV should be set to a time delayed tripping.

UV2 provides the same logic as the UV1.



(*)Note : Phases 1, 2 and 3 are replaced with the followings:

Phase	[APPL] setting				
	1PP	1PN	2PP	3PN, 3PV	3PP
1	phase-to-phase	phase-to-neutral	A - B phase	A phase	A - B phase
2	—	—	B - C phase	B phase	B - C phase
3	—	—	—	C phase	C - A phase

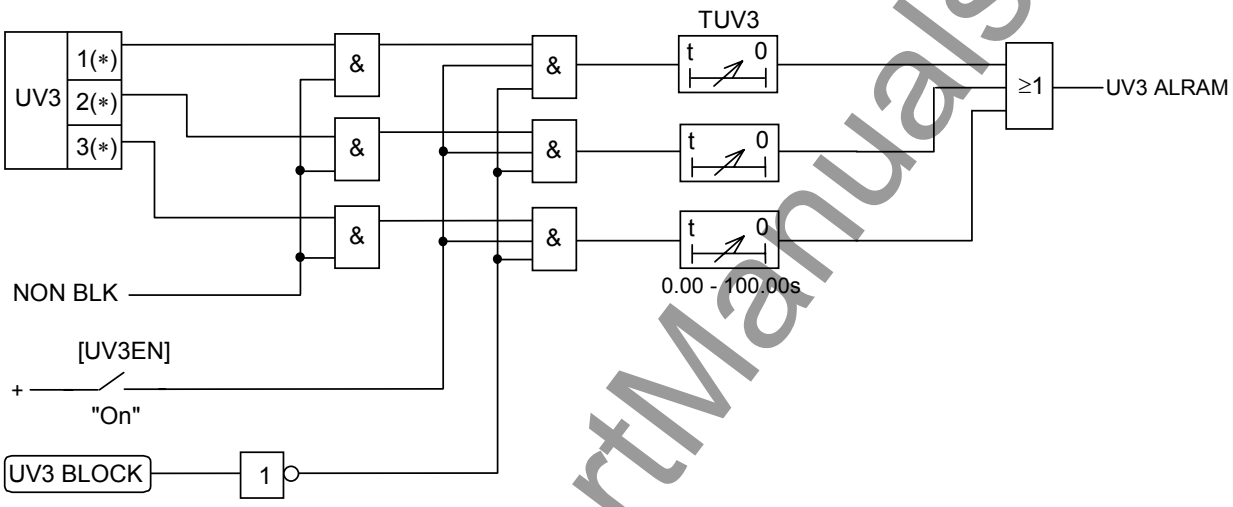
Figure 2.2.2 Undervoltage Protection (UV1, UV2)

2.2.2 Definite Time Undervoltage Protection

UV3 element is used for definite time undervoltage protection.

Scheme Logic

As shown in Figure 2.2.3, UV3 has independent scheme logic. The UV3 gives a signal through delayed pick-up timer TUV3. The UV3 is mainly used to output alarm signal UV3 ALARM. The alarm can be blocked by incorporated scheme switch [UV3EN] and binary input signal UV3 BLOCK.



(*)Note : Phases 1, 2 and 3 are replaced with the followings:

Phase	[APPL] setting				
	1PP	1PN	2PP	3PN, 3PV	3PP
1	phase-to-phase	phase-to-neutral	A - B phase	A phase	A - B phase
2	—	—	B - C phase	B phase	B - C phase
3	—	—	—	C phase	C - A phase

Figure 2.2.3 Definite Time Undervoltage Protection (UV3)

2.2.3 Settings

The table shows the setting elements necessary for the undervoltage protection and their setting ranges.

Element	Range	Step	Default	Remarks
UV1	5.0 – 130.0 V	0.1 V	60.0 V	UV1 threshold setting
TUV1	0.05– 100.00	0.01	10.00	UVI time multiplier setting. Required if [UV1EN] = 2 or 3.
	0.00 – 300.00 s	0.01 s	0.10 s	UV1definite time setting. Required if [UV1EN] = 1.
TUV1R	0.0 – 300.0 s	0.1 s	0.0 s	UV1 definite time delayed reset.
UV2	5.0 – 130.0 V	0.1 V	40.0 V	UV2 threshold setting.
TUV2	0.05– 100.00	0.01	10.00	UV2 time multiplier setting. Required if [UV2EN] = 2 or 3.
	0.00 – 300.00 s	0.01 s	0.10 s	UV2 definite time setting. Required if [UV2EN] = 1.
TUV2R	0.0 – 300.0 s	0.1 s	0.0 s	UV2 definite time delayed reset.
UV3	5.0 – 130.0 V	0.1 V	20.0 V	UV3 threshold setting.
TUV3	0.00 – 300.00 s	0.01 s	0.10 s	UV3 definite time setting.
VBLK	5.0 - 20.0 V	0.1 V	10.0 V	Undervoltage block threshold setting.
[UV1EN]	Off / DT / IDMT / C		DT	UV1 Enable
[VBLKEN]	Off / On		Off	UV block Enable
[UV2EN]	Off / DT / IDMT / C		Off	UV2 Enable
[UV3EN]	Off / On		Off	UV3 Enable

Note: When [VBLKEN] is “On”, the VBLK must be set lower than any other UV setting values and the UV should be set to a time delayed tripping.

2.3 Zero Phase Sequence Overvoltage Protection

The zero phase sequence overvoltage protection is applied to earth fault detection on unearthed, resistance-earthed system or on ac generators.

The zero phase sequence overvoltage (ZPS) element is available for the following models and their [APPL] settings:

Model	210			410			
[APPL] setting	1PP	1PN	2PP	3PN	3PV	3PP	2PP
ZPS	✓(∗1)	✓(∗1)	—	✓(∗2)	✓(∗3)	✓(∗3)	✓(∗3)

Note: (∗1) V_0 (V_E) must be measured directly.
(∗2) V_0 is calculated from the three measured phase voltages.
(∗3) V_0 (V_E) is measured directly in the form of the system residual voltage.

The low voltage settings which may be applied make the ZPS element susceptible to any 3rd harmonic component which may be superimposed on the input signal. Therefore, a 3rd harmonic filter is provided to suppress such superimposed components.

For the earth fault detection, following two methods are in general use.

- Measuring the zero sequence voltage produced by VT residual connection (broken-delta connection) as shown in Figure 2.3.1.
- Measuring the residual voltage across the earthing transformers as shown in Figure 2.3.2.

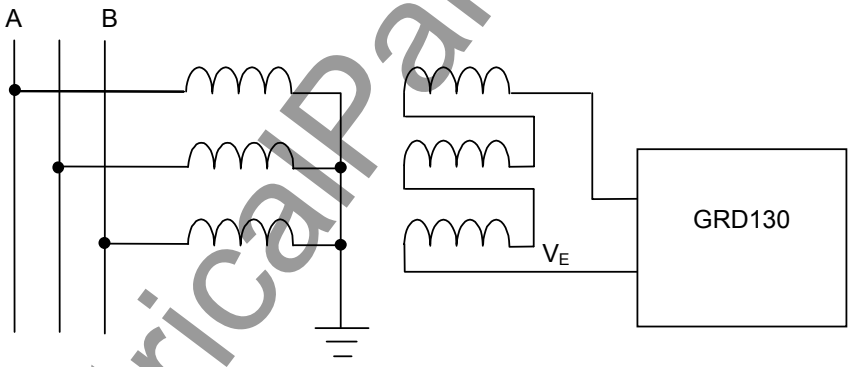


Figure 2.3.1 Earth Fault Detection on Unearthed System

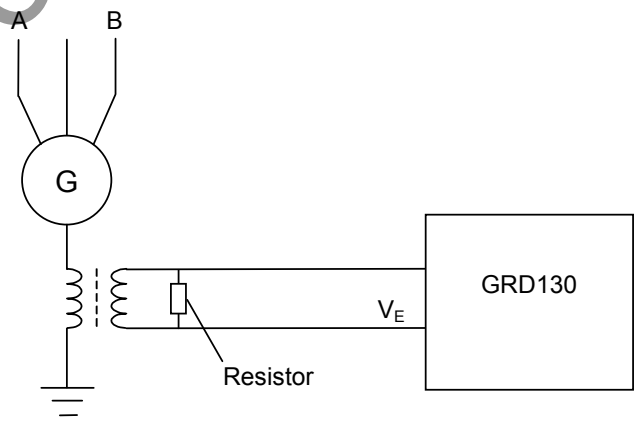


Figure 2.3.2 Earth Fault Detection on Generator

Two independent elements ZPS1 and ZPS2 are provided and are programmable for definite time delayed or inverse time delayed (IDMT) operation.

The inverse time characteristic is defined by equation (3).

$$t = TMS \times \left\{ \left[\frac{k}{\left(V_0 / V_S \right)^{a} - 1} \right] + c \right\} \qquad (3)$$

where:

t = operating time for constant voltage V_0 (seconds),

V_0 = Zero sequence voltage (V),

Vs = Zero sequence overvoltage setting (V),

TMS = time multiplier setting.

k, α, c = constants defining curve.

The standard IDMT characteristic is illustrated in Figure 2.3.3.

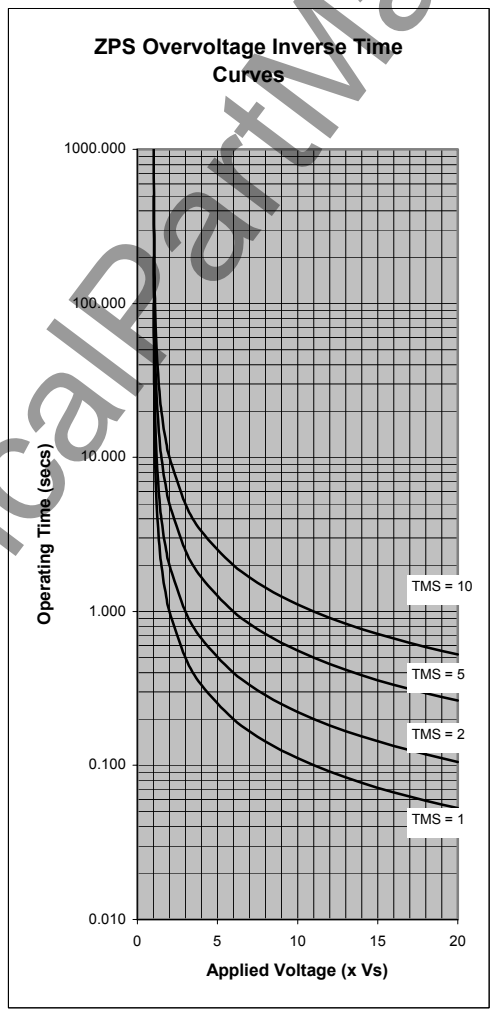


Figure 2.3.3 IDMT Characteristic of ZPS

In addition to the standard IDMT curve, the ZPS1 and ZPS2 can provide user configurable IDMT curve. If required, set the scheme switch [ZPS∗EN] to "C" and set the curve defining constants k, α, and c. The following table shows the setting ranges of the curve defining constants.

Table 2.3.1 Specification of IDMT Curves

Curve Description	Curve Defining Constants		
	k	α	c
Standard "IDMT"	1	1	0
User configurable curve	0.00 – 300.00	0.00 – 5.00	0.000 – 5.000

Definite time reset

A definite time reset characteristic is applied to the ZPS element when the inverse time delay is used. Its operation is identical to that for the phase overvoltage protection.

Scheme Logic

Figure 2.3.4 shows the scheme logic of the zero sequence overvoltage protection. Two zero sequence overvoltage elements ZPS1 and ZPS2 with independent thresholds output trip signal ZPS1 TRIP and alarm signal ZPS2 ALARM.

The tripping and alarming can be disabled by the scheme switches [ZPS1EN], [ZPS2EN], [APPL] or binary input signal ZPS BLOCK.

This protection is enabled when the scheme switch [APPL] is set to "1PP" and "1PN" in model 210.

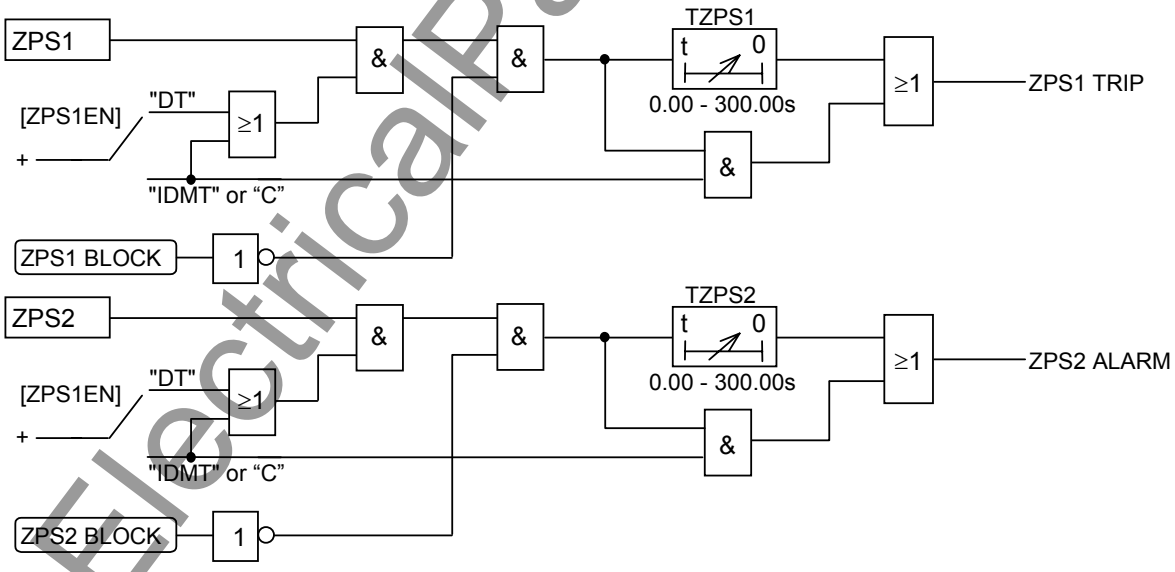


Figure 2.3.4 Zero Sequence Overvoltage Protection

Settings

The table below shows the setting elements necessary for the zero sequence overvoltage protection and their setting ranges.

Element	Range	Step	Default	Remarks
ZPS1	1.0 - 160.0 V	0.1V	20.0 V	ZPS1 threshold setting (V_0) for tripping.
TZPS1	0.05 – 100.00	0.01	10.00	ZPS1 time multiplier setting. Required if [ZPS1EN]=2 or 3.
	0.00 – 300.00 s	0.01 s	0.00 s	ZPS1 definite time setting. Required if [ZPS1EN]=1.
TZPS1R	0.0 – 300.0 s	0.1 s	0.0 s	ZPS1 definite time delayed reset.
ZPS2	1.0 - 160.0 V	0.1V	40.0 V	ZPS2 threshold setting (V_0) for alarming.
TZPS2	0.05 – 100.00	0.01	10.00	ZPS2 time multiplier setting. Required if [ZPS2EN]=2 or 3.
	0.00 – 300.00 s	0.01 s	0.00 s	ZPS2 definite time setting. Required if [ZPS2EN]=1.
TZPS2R	0.0 – 300.0 s	0.1 s	0.0 s	ZPS2 definite time delayed reset.
[ZPS1EN]	Off / DT / IDMT / C		DT	ZPS1 Enable
[ZPS2EN]	Off / DT / IDMT / C		Off	ZPS2 Enable

2.4 Negative Phase Sequence Overvoltage Protection

The negative phase sequence overvoltage protection is used to detect voltage unbalance conditions such as reverse-phase rotation, unbalanced voltage supplying etc..

The negative phase sequence overvoltage (NPS) element is available for the following models and their [APPL] settings:

Model	210			410			
[APPL] setting	1PP	1PN	2PP	3PN	3PV	3PP	2PP
NPS	—	—	✓	✓	✓	✓	✓

The NPS protection is applied to protect three-phase motors from the damage which may be caused by the voltage unbalance. Unbalanced voltage supply to motors due to a phase loss can lead to increases in the negative sequence voltage.

The NPS protection is also applied to prevent the starting of the motor in the wrong direction, if the phase sequence is reversed.

Two independent elements NPS1 and NPS2 are provided and are programmable for definite time delayed or inverse time delayed (IDMT) operation.

The inverse time characteristic is defined by equation (4).

$$t = TMS \times \left\{ \left[\frac{k}{\left(V_2 / V_S \right)^{\alpha} - 1} \right] + c \right\} \qquad (4)$$

where:

t = operating time for constant voltage V_2 (seconds),

V_2 = Negative sequence voltage (V),

Vs = Negative sequence overvoltage setting (V),

TMS = time multiplier setting.

k, α, c = constants defining curve.

The IDMT characteristic is illustrated in Figure 2.4.1.

In addition to the standard IDMT curve, the NPS1 and NPS2 can provide user configurable IDMT curve. If required, set the scheme switch [NPS∗EN] to "C" and set the curve defining constants k, α, and c. The following table shows the setting ranges of the curve defining constants.

Table 2.4.1 Specification of IDMT Curves

Curve Description	Curve Defining Constants		
	k	α	c
Standard "IDMT"	1	1	0
User configurable curve	0.00 – 300.00	0.00 – 5.00	0.000 – 5.000

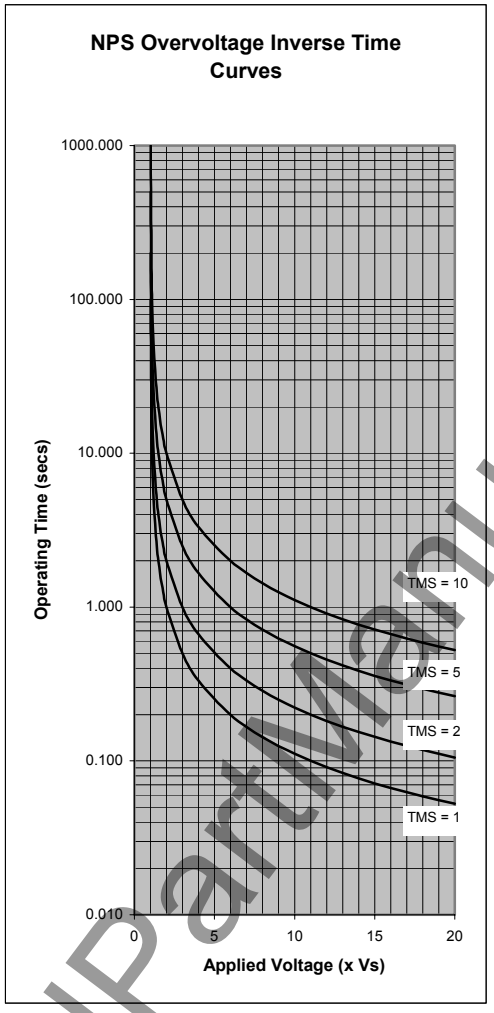


Figure 2.4.1 IDMT Characteristic of NPS

Definite time reset

A definite time reset characteristic is applied to the NPS element when the inverse time delay is used. Its operation is identical to that for the phase overvoltage protection.

Scheme Logic

Figure 2.3.2 shows the scheme logic of the negative sequence overvoltage protection. Two negative sequence overvoltage elements NPS1 and NPS2 with independent thresholds output trip signal NPS1 TRIP and alarm signal NPS2 ALARM.

The tripping and alarming can be disabled by the scheme switches [NPS1EN], [NPS2EN], [APPL] or binary input signal NPS BLOCK.

The scheme switch [APPL] is available in Model 210 and 410 in which three-phase or two-phase overvoltage protection can be selected. This protection is enabled when three-phase voltage is introduced and [APPL] is set to “2PP” in model 210.

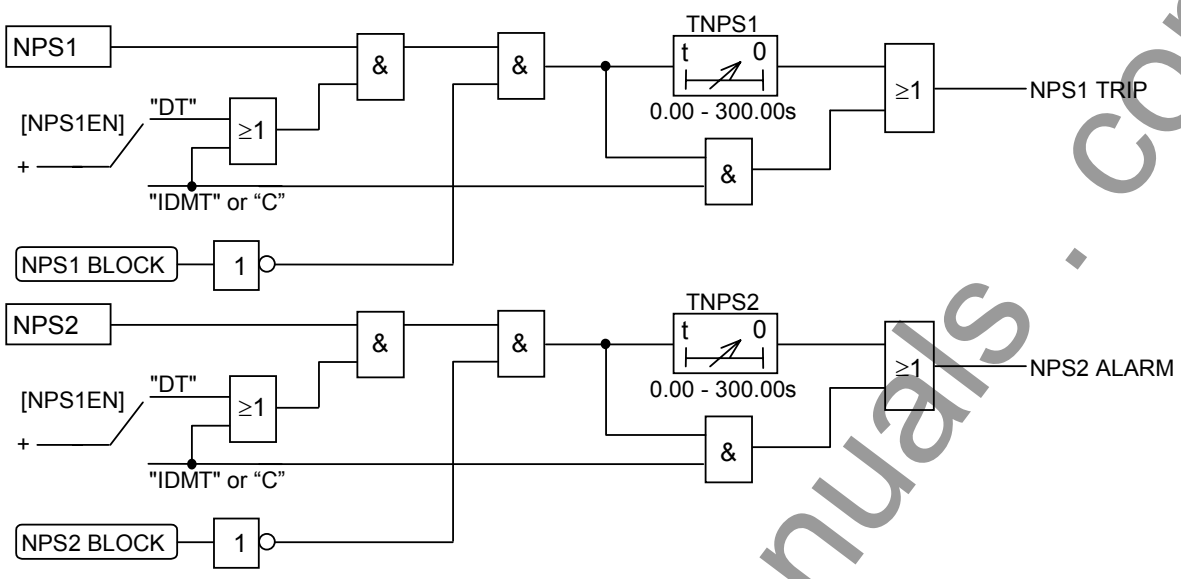


Figure 2.4.2 Negative Sequence Overvoltage

Settings

The table below shows the setting elements necessary for the negative sequence overvoltage protection and their setting ranges.

Element	Range	Step	Default	Remarks
NPS1	1.0 - 160.0 V	0.1V	20.0 V	NPS1 threshold setting for tripping.
TNPS1	0.05 – 100.00	0.01	10.00	NPS1 time multiplier setting. Required if [NPS1EN]=2 or 3.
	0.00 – 300.00 s	0.01 s	0.00 s	NPS1 definite time setting. Required if [NPS1EN]=1.
TNPS1R	0.0 – 300.0 s	0.1 s	0.0 s	NPS1 definite time delayed reset.
NPS2	1.0 - 160.0 V	0.1V	40.0 V	NPS2 threshold setting for alarming.
TNPS2	0.05 – 100.00	0.01	10.00	NPS2 time multiplier setting. Required if [NPS2EN]=2 or 3.
	0.00 – 300.00 s	0.01 s	0.00 s	NPS2 definite time setting. Required if [NPS2EN]=1.
TNPS2R	0.0 – 300.0 s	0.1 s	0.0 s	NPS2 definite time delayed reset.
[NPS1EN]	Off / DT / IDMT / C		Off	NPS1 Enable
[NPS2EN]	Off / DT / IDMT / C		Off	NPS2 Enable

The delay time setting TNPS1 and TNPS2 is added to the inherent delay of the measuring elements NPS1 and NPS2. The minimum operating time of the NPS elements is around 200ms.

2.5 Trip Signal Output

As shown in Figure 2.5.1, all the trip signals are introduced into one of the seven user configurable binary output circuits. One tripping output relay with a pair of normally open and closed contacts is provided to trip the local circuit breaker.

After the trip signal disappears by clearing the fault, the reset time of the tripping output relay can be set with the scheme switch [Reset] to "instantaneous(Inst)", "delayed(Dl)", "dwell(Dw)" or "latched(Latch)". The time of the delayed drop-off "Dl" or dwell operation "Dw" can be set by TBO. The setting is respective for each output relay.

When the relay is latched, it is reset with the RESET key on the relay front panel or a binary input signal REMOTE RESET. This resetting resets all the output relays collectively.

When instantaneous reset of the tripping output relay is selected, it must be checked that the tripping circuit is opened with a circuit breaker auxiliary contact prior to the tripping output relay resetting, in order to prevent the tripping output relay from directly interrupting the circuit breaker tripping coil current.

The tripping output relay has a pair of normally open and closed contact.

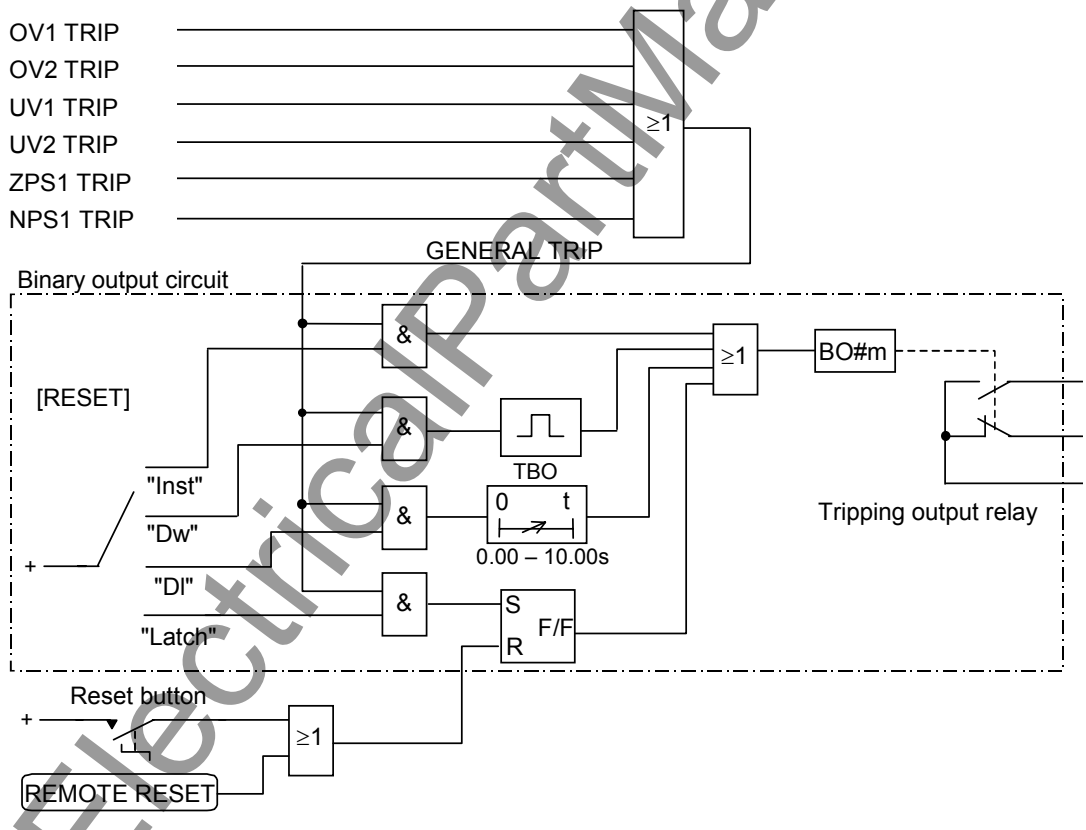


Figure 2.5.1 Tripping Output

Settings

The setting elements necessary for the trip signal output and their setting ranges are as follows:

Element	Range	Step	Default	Remarks
[RESET]	Inst / Dl / Dw / Latch		Del	Output relay reset time. Instantaneous, dwell, delayed or latched.
TBO	0.00 – 10.00s	0.01s	0.20s	

3. Technical Description

3.1 Hardware Description

3.1.1 Outline of Hardware Modules

The case outline of GRD130 is shown in Appendix E.

The hardware structure of GRD130 is shown in Figure 3.1.1.

The GRD130 relay unit consists of the following hardware modules. These modules are fixed in a frame and cannot be taken off individually. The human machine interface module is provided with the front panel.

- Power module (POWD)
- Signal processing module (SPMD)
- Human machine interface module (HMI)

The hardware block diagram of GRD130 is shown in Figure 3.1.2.

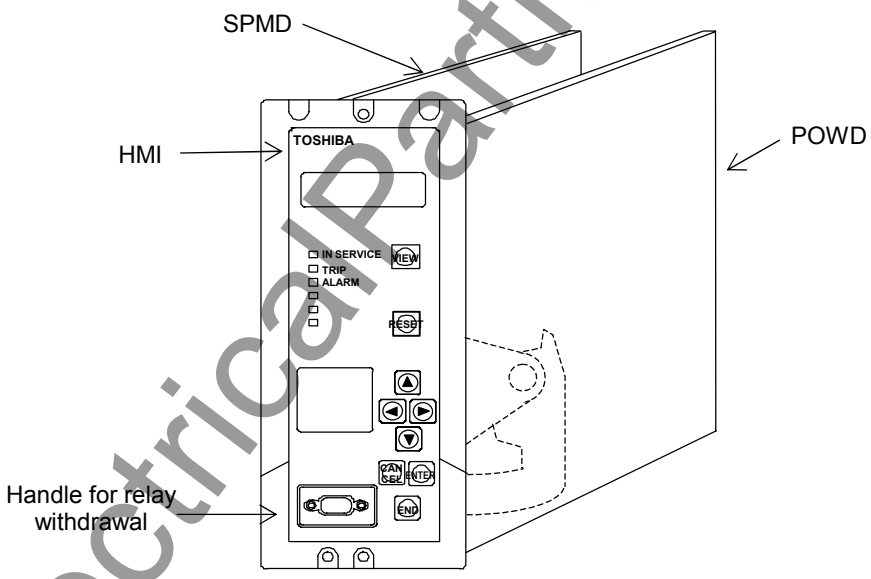


Figure 3.1.1 Hardware Structure without Case

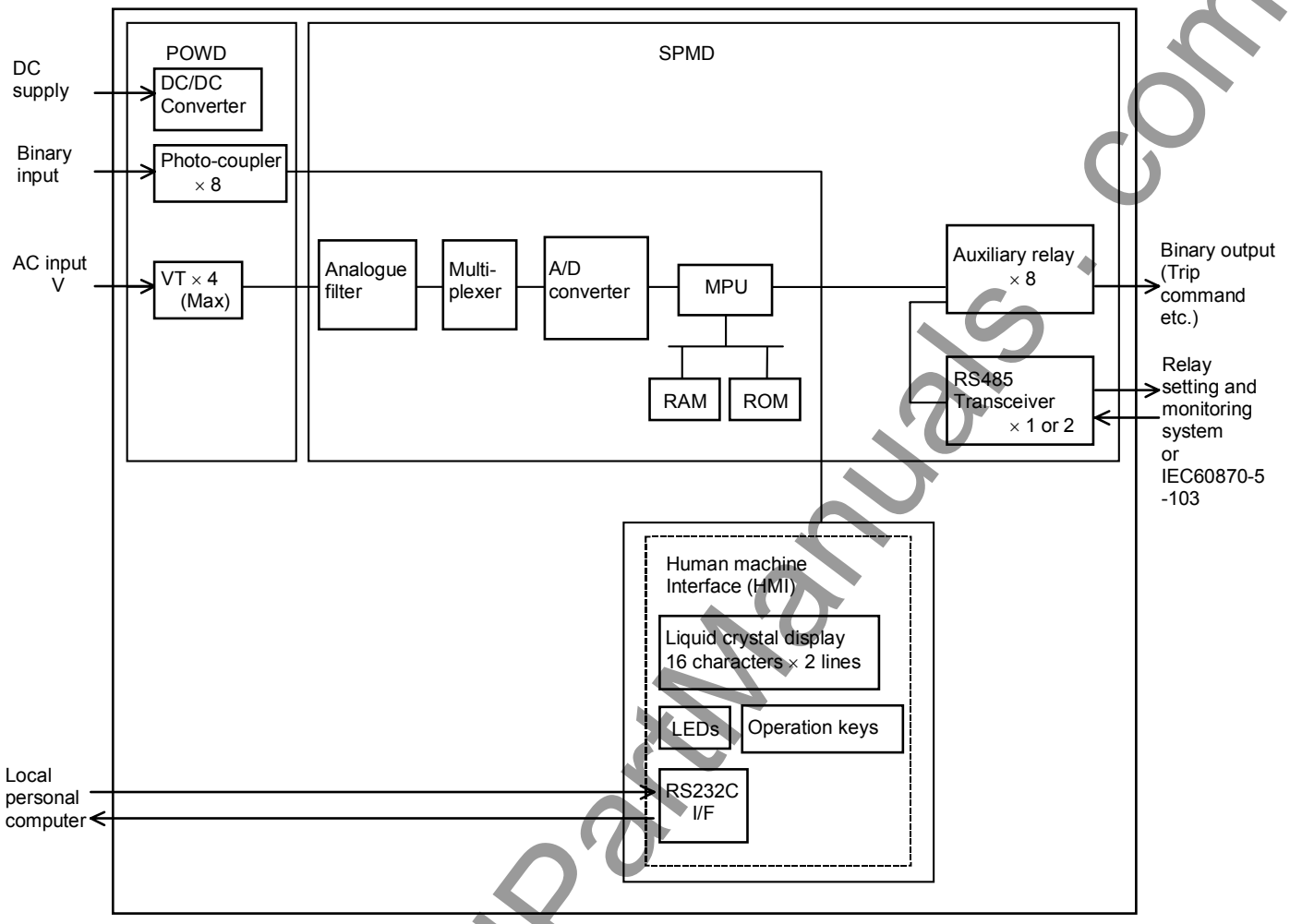


Figure 3.1.2 Hardware Block Diagram

POWD Module

The POWD 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 may be phase to neutral, phase to phase or residual voltages depending on the relay model and configuration..

This module incorporates max. 4 auxiliary VTs, DC/DC converter and photo-coupler circuits for binary input signals.

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

SPMD Module

The SPMD module consists of analogue filter, multiplexer, analogue to digital (A/D) converter, main processing unit (MPU), random access memory (RAM) and read only memory (ROM) and executes all kinds of processing such as protection, measurement, recording and display.

The analogue 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).

The MPU implements more than 240 MIPS and uses a RISC (Reduced Instruction Set Computer)

type 32-bit microprocessor.

The SPMD module also incorporates 8 auxiliary relays (BO1-BO7 and FAIL) for binary output signals and an RS485 transceiver.

BO1 to BO6 are user configurable output signals and have one normally open and one normally closed contact. BO7 is also a user-configurable output signal and has one normally open contact.

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

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

Human Machine Interface (HMI) Module

The operator can access the GRD130 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 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 and flickered when the relay is in "Test" menu.
TRIP	Red	Lit when a trip command is issued.
ALARM	Red	Lit when a failure is detected.
(LED1)	Yellow	Programmable
(LED2)	Yellow	Programmable
(LED3)	Yellow	Programmable

LED1, LED2 and LED3 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, the individual statuses of which can be viewed on the LCD screen as "Virtual LEDs." For the setting, see Section 4.2.6.10. For the operation, see Section 4.2.1.

The TRIP LED and an operated LED if latching operation is selected, must be reset by user, either by pressing the RESET key, by energising a binary input which has been programmed for 'Remote Reset' operation, or by a communications command. Other LEDs operate as long as a signal is present. The RESET key is ineffective for these LEDs. Further, the TRIP LED is controlled with the scheme switch [AOLED] whether it is lit or not by an output of alarm element such as OV3 ALARM, UV3 ALARM, etc..

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

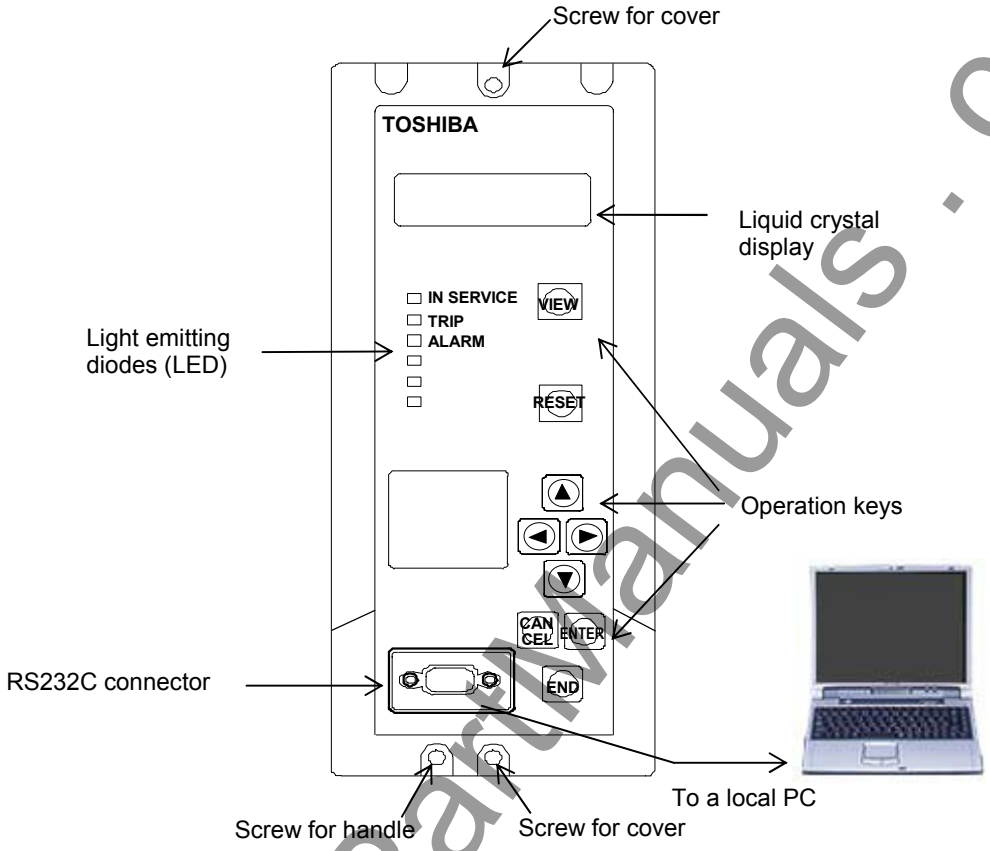


Figure 3.1.3 Front Panel

3.2 Input and Output Signals

3.2.1 AC Input Signals

Table 3.2.1 shows the AC input signals necessary for the GRD130 model and their respective input terminal numbers. Their terminal members depend on their scheme switch [APPL] setting.

Table 3.2.1 AC Input Signals

: Scheme switch [APPL] setting

Term. No. of TB1	Model						
	210	210	210	410	410	410	410
	1PP	1PN	2PP	3PN	3PV	3PP	2PP
1-2	Phase-to-phase voltage	Phase-to-neutral voltage	A-B phase voltage	A phase voltage	A phase voltage	A-B phase voltage	A-B phase voltage
3-4	Residual voltage (V_0)	Residual voltage (V_0)	B-C phase voltage	B phase voltage	B phase voltage	B-C phase voltage	B-C phase voltage
5-6	---	---	---	C phase voltage	C phase voltage	C-A phase voltage	---
7-8	---	---	---	---	Residual voltage (V_0)	Residual voltage (V_0)	Residual voltage (V_0)

3.2.2 Binary Input Signals

The GRD130 provides eight programmable binary input circuits. Each binary input circuit is programmable, and provided with the function of Logic level inversion and Function selection.

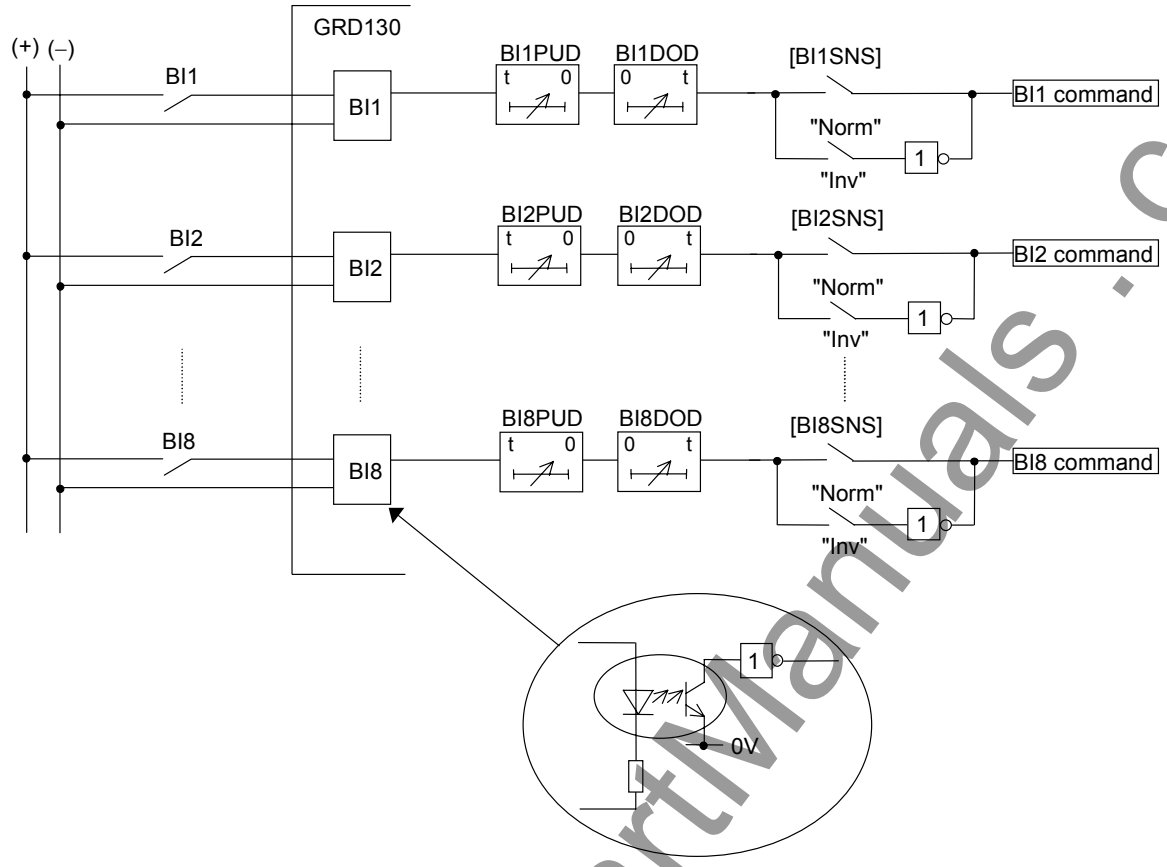
Logic level inversion

The binary input circuit of the GRD130 is provided with a logic level inversion function and a pick-up and drop-off delay timer function as shown in Figure 3.2.1. Each input circuit has a binary switch BISNS 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 then the BISNS can be set to "Norm" (normal). If not, then "Inv" (inverted) should be selected. The pick-up and drop-off delay times can be set 0.0 to 300.00s respectively.

Logic level inversion function, and pick-up and drop-off delay timer settings are as follow:

Element	Contents	Range	Step	Default
BI1SNS - BI8SNS	Binary switch	Norm/ Inv		Norm
BI1PUD - BI8PUD	Delayed pick-up timer	0.00 - 300.00s	0.01s	0.00
BI1DOD - BI8DOD	Delayed drop-off timer	0.00 - 300.00s	0.01s	0.00

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.



3.2.1 Logic Level Inversion

Function selection

The input signals BI1 COMMAND to BI8 COMMAND are used for the functions listed in Table 3.2.2. Each input signal can be allocated for one or some of those functions by setting. For the setting, refer to Section 4.2.6.8.

The Table also shows the signal name corresponding to each function used in the scheme logic and LCD indication and driving contact condition required for each function.

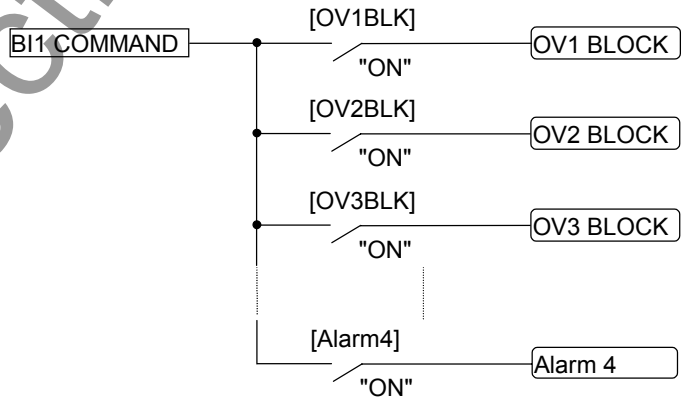


Figure 3.2.2 Function Scheme Logic

The logic of BI2 COMMAND to BI8 COMMAND are the same as that of BI1 COMMAND as shown in Figure 3.2.2.

Table 3.2.2 Function of Binary Input Signals

Functions	Signal Names (*1)	Driving Contact Condition
OV1 protection block	OV1 BLOCK / OV1BLK	Closed to block
OV2 protection block	OV2 BLOCK / OV2BLK	Closed to block
OV3 protection block	OV3 BLOCK / OV3BLK	Closed to block
UV1 protection block	UV1 BLOCK / UV1BLK	Closed to block
UV2 protection block	UV2 BLOCK / UV2BLK	Closed to block
UV3 protection block	UV3 BLOCK / UV3BLK	Closed to block
ZPS1 protection block	ZPS1 BLOCK / ZPS1BLK	Closed to block
ZPS2 protection block	ZPS2 BLOCK / ZPS2BLK	Closed to block
NPS1 protection block	NPS1 BLOCK / NPS1BLK	Closed to block
NPS2 protection block	NPS2 BLOCK / NPS2BLK	Closed to block
Trip circuit supervision	TC FAIL / TCFALM	Trip supply
CB monitoring	CB OPEN / CBOPN	CB normally open contact.
CB monitoring	CB CLOSE / CBCLS	CB normally closed contact.
External trip (3 phase)	EXT TRIP3PH / EXT3PH	External trip – 3 phase.
External trip (A phase)	EXT TRIP-APH / EXTAPH	External trip – A phase.
External trip (B phase)	EXT TRIP-BPH / EXTBPH	External trip – B phase
External trip (C phase)	EXT TRIP-CPH / EXTCPH	External trip – C phase
Indication remote reset	REMOTE RESET / RMTRST	Closed to reset TRIP LED indication and latch of binary output relays
Disturbance record store	STORE RECORD / STORCD	Closed to store the record
Alarm 1	Alarm 1 / Alarm1	Closed to display Alarm 1 text.
Alarm 2	Alarm 2 / Alarm2	Closed to display Alarm 2 text.
Alarm 3	Alarm 3 / Alarm3	Closed to display Alarm 3 text.
Alarm 4	Alarm 4 / Alarm4	Closed to display Alarm 4 text.

(*1) : Signal names are those used in the scheme logic / LCD indication.

The GRD130 binary input signals can be programmed to switch between 4 settings groups.

Element	Contents	Range	Step	Default
BI1SGS – BI8SGS	Setting group selection	OFF / 1 / 2 / 3 / 4		OFF

Four alarm messages can be set. The user can define a text message within 16 characters for each alarm. The messages are valid for any of the input signals BI1 to BI8 by setting. Then when inputs associated with that alarm are raised, the defined text is displayed on the LCD.

3.2.3 Binary Output Signals

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

The signals shown in the signal list in Appendix A can be assigned to the output relays BO1 to BO7 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 3.2.3. The output circuit can be configured according to the setting menu. Appendix C shows the factory default settings.

Further, each BO has a programmable reset characteristic, settable for instantaneous drop-off "Inst", for delayed drop-off "Dl", for dwell operation "Dw" or for latching operation "Latch" by the scheme switch [RESET]. The time of the delayed drop-off "Dl" or dwell operation "Dw" can be set by TBO. When "Dw" selected, the BO outputs for the TBO set time if the input signal does not continue on the TBO set time. If the input signal continues more, the BO output is continuous for the input signal time.

When the relay is latched, it can be reset with the RESET key on the relay front panel or a binary input. This resetting resets all the output relays collectively.

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

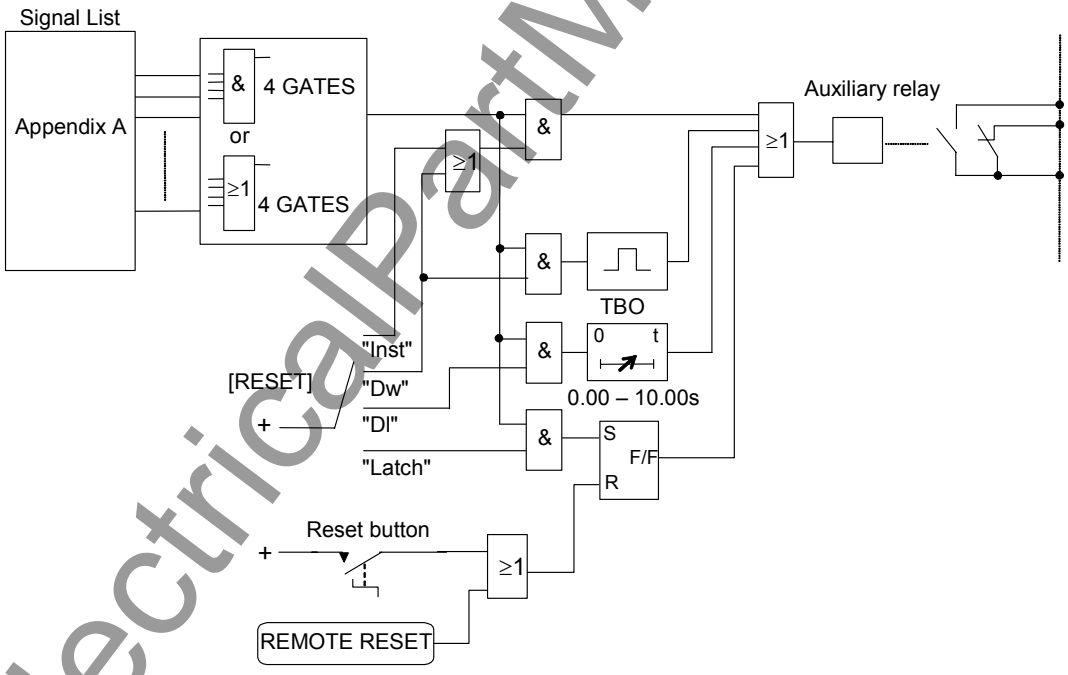


Figure 3.2.3 Configurable Output

Settings

The setting elements necessary for binary output relays and their setting ranges are as follows:

Element	Range	Step	Default	Remarks
[RESET]	Inst / Dl / Dw /Latch		See Appendix C	Output relay reset time. Instantaneous, delayed, dwell or latched.
TBO	0.00 – 10.00s	0.01s	See Appendix C	

3.3 Automatic Supervision

3.3.1 Basic Concept of Supervision

Though the protection system is in a non-operating state under normal conditions, it waits 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. The GRD130 implements an automatic supervision function, based on the following concepts:

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

3.3.2 Relay Monitoring

The relay is supervised by the following functions.

AC input imbalance monitoring

This monitoring is available only for [APPL]= "3P∗" setting in model 410s.

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 for [APPL]=3PN setting

  $|V_a + V_b + V_c| / 3 \leq 6.35$ (V)

- Negative sequence voltage monitoring for [APPL]=3PN, 3PV and 3PP setting

  $|V_a + a^2V_b + aV_c| / 3 \leq 6.35$ (V)

  where, a = Phase shifter of 120°, a^2 = Phase shifter of 240°

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 input 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

Memory is monitored as follows, depending on the type of memory, and checks are done to verify that 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 discrepancies between the setting values stored in duplicate.

Watchdog Timer

A hardware timer that is cleared periodically by the software is provided, which checks that the software is running normally.

DC Supply Monitoring

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

3.3.3 Trip Circuit Supervision

The circuit breaker tripping control circuit can be monitored by a binary input. Figure 3.3.1 shows a typical scheme. When the trip circuit is complete, a small current flows through the binary input, the circuit breaker auxiliary contacts and the trip coil. This current flows for both the breaker open and closed conditions. Then logic signal of the binary input circuit TC FAIL is "1".

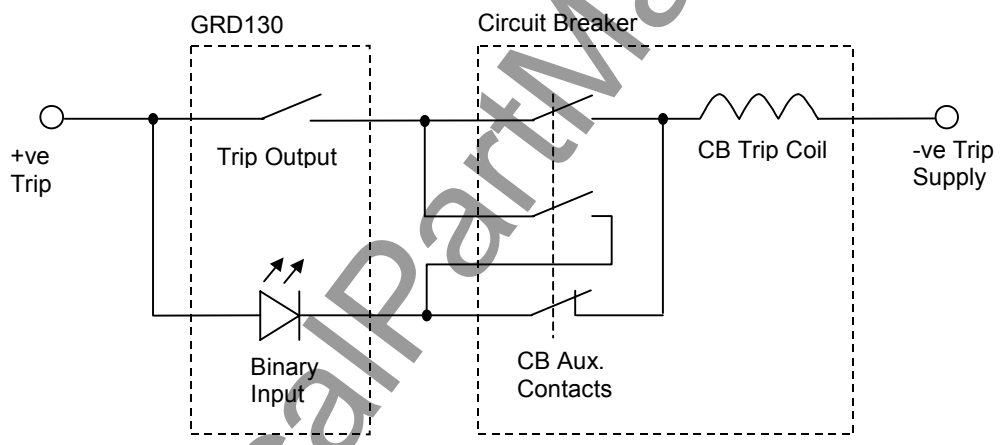


Figure 3.3.1 Trip Circuit Supervision

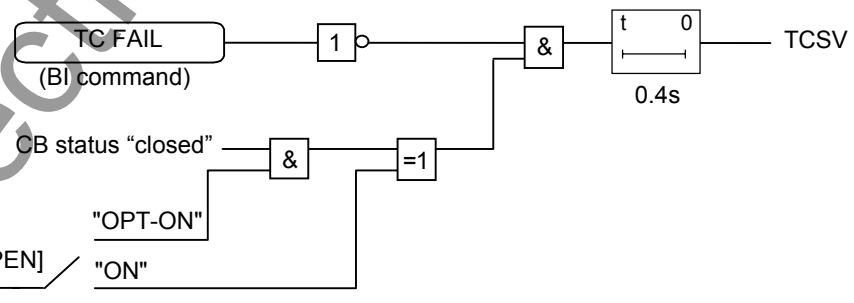


Figure 3.3.2 Supervision Scheme Logic

If the trip supply is lost or if a connection becomes an open circuit, then the binary input resets and TC FAIL is "0". Figure 3.3.2 shows the scheme logic. A trip circuit fail alarm TCSV is output when TC FAIL is "0".

The monitoring is enabled by setting the scheme switch [TCSPEN] to "ON" or "OPT-ON". When "OPT-ON" is selected, the monitoring is enabled only while CB is closed.

3.3.4 Circuit Breaker Monitoring

The relay provides the following circuit breaker monitoring functions.

Circuit Breaker State Monitoring

If two binary inputs are programmed to the functions 'CB OPEN' and 'CB CLOSED', then the CB state monitoring function becomes active. In normal circumstances these inputs are in opposite states. If both show the same state during one second, then "Err:CB" and "CB err" are displayed in LCD message and event record message respectively.

The monitoring can be enabled or disabled by setting the scheme switch [CBSMEN].

Trip Counter Alarm

- The trip counter increments the number of tripping operations performed. An alarm is issued when the count exceeds a user-defined setting TCALM.
  The trip count alarm can be enabled or disabled by setting the scheme switch [TCAEN].

The Trip Count Alarm function is triggered each time a trip is issued, and can also be triggered by an external device via a binary input.

3.3.5 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". The setting is used to block unnecessary alarms during commissioning, test or maintenance.

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

Table 3.3.1 Supervision Items and Alarms

Supervision Item	LCD Message	LED "IN SERVICE"	LED "ALARM"	External alarm	Event record Message
AC input imbalance monitoring	(1)	On/Off (2)	On	(4)	V_0 err, V_2 err Relay fail or Relay fail-A (2)
A/D accuracy check	(1)	Off	On	(4)	Relay fail
Memory monitoring					
Watchdog Timer	----	Off	On	(4)	----
DC supply monitoring	Err: DC	(3)	(3)	Off	Relay fail-A
Trip circuit supervision	Err: TC	On	On	Off	TC err, Relay fail-A
CB state monitoring	Err: CB	On	On	Off	CB err, Relay fail-A
Trip count alarm	ALM:TP COUNT	On	On	Off	TP COUNT ALM, Relay fail-A

(1): Diverse messages are provided as expressed with " Err:---" in the table in Section 6.7.2.
(2): The LED is on when the scheme switch [SVCNT] is set to "ALM" and off when set to "ALM & BLK" (refer to Section 3.3.6).
(3): Whether the LED is lit or not depends on the degree of the voltage drop.
(4): The binary output relay "FAIL" operates.

3.3.6 Trip Blocking

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

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

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

3.3.7 Setting

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

Element	Range	Step	Default	Remarks
[SVCNT]	ALM&BLK / ALM		ALM&BLK	Alarming and blocking or alarming only
[TCSPEN]	OFF/ON/OPT-ON		OFF	Trip circuit supervision
[CBSMEN]	OFF/ON		OFF	CB state monitoring
[TCAEN]	OFF/ON		OFF	Trip count alarm
TCALM	1 - 10000	1	10000	Trip count alarm threshold setting

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

3.4 Recording Function

The GRD130 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 GRD130 and the following items are recorded for one fault:

Date and time

Trip mode

Operating phase

Power system quantities

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

Date and time occurrence

This is the time at which a tripping command has been initiated.

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

Trip mode

This shows the protection scheme that output the tripping command.

Operating phase

This is the operating phase of relay element.

Power system quantities

The following power system quantities in pre-faults and post-faults are recorded.

- Magnitude and phase angle of phase voltage (V_a, V_b, V_c)
- Magnitude and phase angle of phase-to-phase voltage (V_{ab}, V_{bc}, V_{ca})
- Magnitude and phase angle of zero sequence voltage (V_0)
- Magnitude and phase angle of positive and negative sequence voltages (V_1, V_2)
- Frequency

Frequency is calculated from V_a (or V_{ab}). When only residual voltage (zero sequence voltage) is input to the relay, the frequency is displayed as "0Hz".

The displayed power system quantities depend on relay model and its [APPL] setting as shown in Table 3.4.1.

When V_0 is calculated from the three phase input voltages in relay internal, the calculated V_0 is displayed. When V_0 (V_e) is measured directly, the measured input voltage is displayed.

Table 3.4.1 Displayed Power System Quantities

Power system quantities	Model 210			Model 410			
	1PP	1PN	2PP	3PN	3PV	3PP	2PP
Phase voltage	—	V_{ph}	—	V_a, V_b, V_c with phase angle	V_a, V_b, V_c with phase angle	—	—
Phase-to-phase voltage	V_{ph}	—	V_{ab}, V_{bc} with phase angle	—	—	V_{ab}, V_{bc}, V_{ca} with phase angle	V_{ab}, V_{bc} with phase angle
Zero sequence voltage	$V_0(V_E)$	$V_0(V_E)$	—	V_0 with phase angle	$V_0(V_E)$ with phase angle	$V_0(V_E)$ with phase angle	$V_0(V_E)$ with phase angle
Positive sequence voltage	—	—	V_1 with phase angle	V_1 with phase angle	V_1 with phase angle	V_1 with phase angle	V_1 with phase angle
Negative sequence voltage	—	—	V_2 with phase angle	V_2 with phase angle	V_2 with phase angle	V_2 with phase angle	V_2 with phase angle
Frequency	f	f	f	f	f	f	f

Note: Phase angles are expressed taking that of positive sequence voltage (V1) as a reference phase angle. When the V1 is not available, phase angles are not displayed.
In the "2PP" setting, it is difficult to check the displayed V2 value with the actual value when the phase angle between Vab and Vbc is not clear.

3.4.2 Event Recording

The events shown in Appendix B are recorded with the 1 ms resolution time-tag when the status changes. For BI1 to BI8 command, the user can select the recording items and their status change mode to initiate recording as below.

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"

Up to 480 records can be stored. If an additional event occurs when 480 records have been stored, the oldest event record is deleted and the latest event record is then stored.

3.4.3 Disturbance Recording

Disturbance recording is started when the overvoltage or undervoltage starter elements operates or a tripping command is initiated. The records include maximum four analogue signals as shown in Table 3.4.2, 32 binary signals and the dates and times at which recording started. Any binary signal shown in Appendix A can be assigned by the binary signal setting of disturbance record.

Table 3.4.2 Analog Signals for Disturbance Recording

Model	Model 210			Model 410			
APPL setting	1PP	1PN	2PP	3PN	3PV	3PP	2PP
Analog signals	V_{ab} $V_0(V_E)$	V_a $V_0(V_E)$	V_{ab} V_{bc}	V_a V_b V_c V_0	V_a V_b V_c $V_0(V_E)$	V_{ab} V_{bc} V_{ca} $V_0(V_E)$	V_{ab} V_{bc} ◆$V_0(V_E)$

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

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

The number of records stored depends on the post-fault recording time. The approximate relationship between the post-fault recording time and the number of records stored is shown in Table 3.4.3.

Note: If the recording time setting is changed, the records stored so far are deleted.

Table 3.4.3 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	25	15	10	9	7	6
60Hz	40	20	10	9	7	6	5

Settings

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

Element	Range	Step	Default	Remarks
OV	10.0-200.0 V	0.1 V	120.0 V	Overvoltage detection
UV	1.0-130.0 V	0.1 V	60.0 V	Undervoltage detection
ZPS	1.0-160.0 V	0.1 V	20.0 V	Zero sequence voltage detection
NPS	1.0-160.0 V	0.1 V	20.0 V	Negative sequence voltage detection

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

Element	Range	Step	Default	Remarks
[Trip]	OFF/ON		ON	Start by tripping command
[BI]	OFF/ON		ON	Start by Binary Input signal
[OV]	OFF/ON		ON	Start by OV operation
[UV]	OFF/ON		ON	Start by UV operation
[ZPS]	OFF/ON		ON	Start by ZPS operation
[NPS]	OFF/ON		ON	Start by NPS operation

3.5 Metering Function

The GRD130 performs continuous measurement of the analogue input quantities. The measurement data shown below is renewed every second and displayed on the LCD of the relay front panel or on the local or remote PC.

- Magnitude and phase angle of phase voltage (V_a, V_b, V_c)
- Magnitude and phase angle of phase-to-phase voltage (V_{ab}, V_{bc}, V_{ca})
- Magnitude and phase angle of zero sequence voltage (V_0)
- Magnitude and phase angle of positive and negative sequence voltages (V_1, V_2)
- Frequency

The above system quantities are displayed in values on the primary side or on the secondary side as determined by a setting. To display accurate values, it is necessary to set the VT ratio as well. For the setting method, see "Setting the metering" in 4.2.6.6 and "Setting the parameter" in 4.2.6.7.

Frequency is calculated from V_a (or V_{ab}). When only residual voltage (zero sequence voltage) is input to the relay, the frequency is displayed as "0Hz".

The displayed power system quantities depend on relay model and it's [APPL] setting as shown in Table 3.4.1.

When V_0 is calculated from the three phase input voltages in relay internal, the calculated V_0 is displayed. When V_0 (V_e) is measured directly, the measured input voltage is displayed.

4. User Interface

4.1 Outline of User Interface

The user can access the relay from the front panel.

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

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

4.1.1 Front Panel

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

LCD

The LCD screen, provided with a 2-line, 16-character display and back-light, provides the user with information such as records, statuses and settings. The LCD screen is normally unlit, but pressing the VIEW key will display the 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.
(LED1)	Yellow	
(LED2)	Yellow	
(LED3)	Yellow	

LED1, LED2 and LED3 are configurable. For the setting, see Section 4.2.6.10.

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

Operation keys

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

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

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

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

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

[VIEW] and [RESET] keys

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

Pressing [RESET] key turns off the display.

RS232C connector

The RS-232C connector is a 9-way D-type connector for serial RS232C connection with a local personal computer.

4.1.2 Communication Ports

The following two interfaces are mounted as communication ports:

- RS232C port
- RS485 port

RS232C port

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

RS485 port

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

One or two RS485 ports (COM1 and COM2) is provided on the rear of the relay as shown in Figure 4.1.1. In the relay provided with two RS485 ports, COM1 is used for the RSM or IEC60870-5-103 communication, and COM2 used for IEC60870-5-103 communication. When the COM1 is used for IEC60870-5-103 communication, the COM2 cannot be used for IEC60870-5-103 communication.

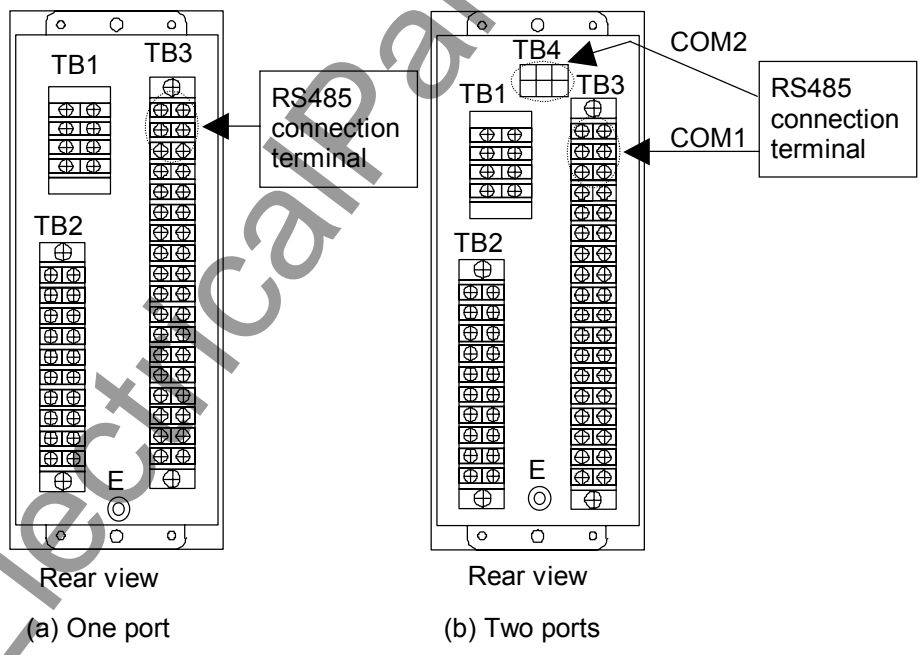


Figure 4.1.1 Location of RS485 Port

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 GRD130 is operating normally, the green "IN SERVICE" LED is lit and the LCD is off.

Press the [VIEW] key when the LCD is off to display the digest screens which are "Indication", "Metering1", "Metering2", "Metering3", "Metering4", "Metering5", "Metering6", "Latest fault", "Auto-supervision" and "Alarm Display" screens in turn. "Latest fault", "Auto-supervision" and "Alarm Display" screens are displayed only when there is some data. The following are the digest screens and can be displayed without entering the menu screens.

Indication

```
IND1[ 0000  0000 ]
IND2[ 0001  0000 ]
```

Metering1

```
Van      ****.**kV
           ***.*  °
```

Available for APPL=3PN and 3PV setting in model 410.

```
Vab      ****.**kV
           ***.*  °
```

Available for APPL=2PP setting in model 210, and APPL=3PP and 2PP in model 410.

```
Vph      ****.**kV
           ***.*  °
```

Available for APPL=1PP and 1PN setting in model 210.

Metering2

```
Vbn      ****.**kV
           ***.*  °
```

Available for APPL=3PN and 3PV setting in model 410.

```
Vbc      ****.**kV
           ***.*  °
```

Available for APPL=2PP setting in model 210, and APPL=3PP and 2PP in model 410.

Metering3

```
Vcn      ****.**kV
           ***.*  °
```

Available for APPL=3PN and 3PV setting in model 410.

```
Vca      ****.**kV
           ***.*  °
```

Available for APPL=3PP setting in model 410.

Metering4

```
V0       ****.**kV
           ***.*  °
```

Not Available for APPL=2PP setting in model 210.

Not available for APPL=1PP and 1PN setting in model 210.

Metering5

Not available for APPL=1PP and 1PN setting in model 210.

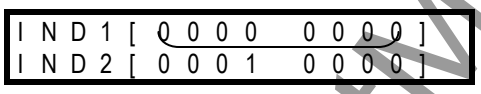
Metering6

To clear the latched indications (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.

Indication (Virtual LEDs)

This screen shows the status of elements assigned as a virtual LED.



Status of element,
Elements depend on user setting. 1: Operate, 0: Not operate (Reset)

Displays in tripping

Latest fault

Tripping element
Faulted voltage element

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

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

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

Notes:

1) When configurable LEDs (LED1 through LED3) 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. Regfer to Table 4.2.1 Step 2.
3) When only the "TRIP" LED is go off by pressing the RESET key in short period, press the RESET key again to reset remained LEDs in the manner 1) on the "Latest fault" screen or other digest screens. LED1 through LED3 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 – LED3)
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:ROM,A/D
```

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

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

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

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

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

Notes:

1) When configurable LEDs (LED1 through LED3) are assigned to latch signals by issuing an alarm, press the [RESET] key more than 3s until all LEDs reset except "IN SERVICE" LED.
2) When configurable LED is still lit by pressing [RESET] key in short period, press [RESET] key again to reset remained LED in the above manner.
3) LED1 through LED3 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.

Alarm Display

Alarm Display (ALM1 to ALM4)

```
* * * * * * * * * * * * * * *
* * * * * * * * *   : A L M 1
```

The four alarm screens can be provided, and their text messages are defined by user. (For setting, see Section 4.2.6.8) These alarms are raised by associated binary inputs.

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

To clear the Alarm Display, press RESET key. The clearing is available after displaying up to ALM4.

4.2.2 Relay Menu

Figure 4.2.1 shows the menu hierarchy in the GRD130. The menu has five sub-menus, "Record", "Status", "Set. (view)", "Set. (change)", and "Test". For details of the menu hierarchy, see Appendix D.

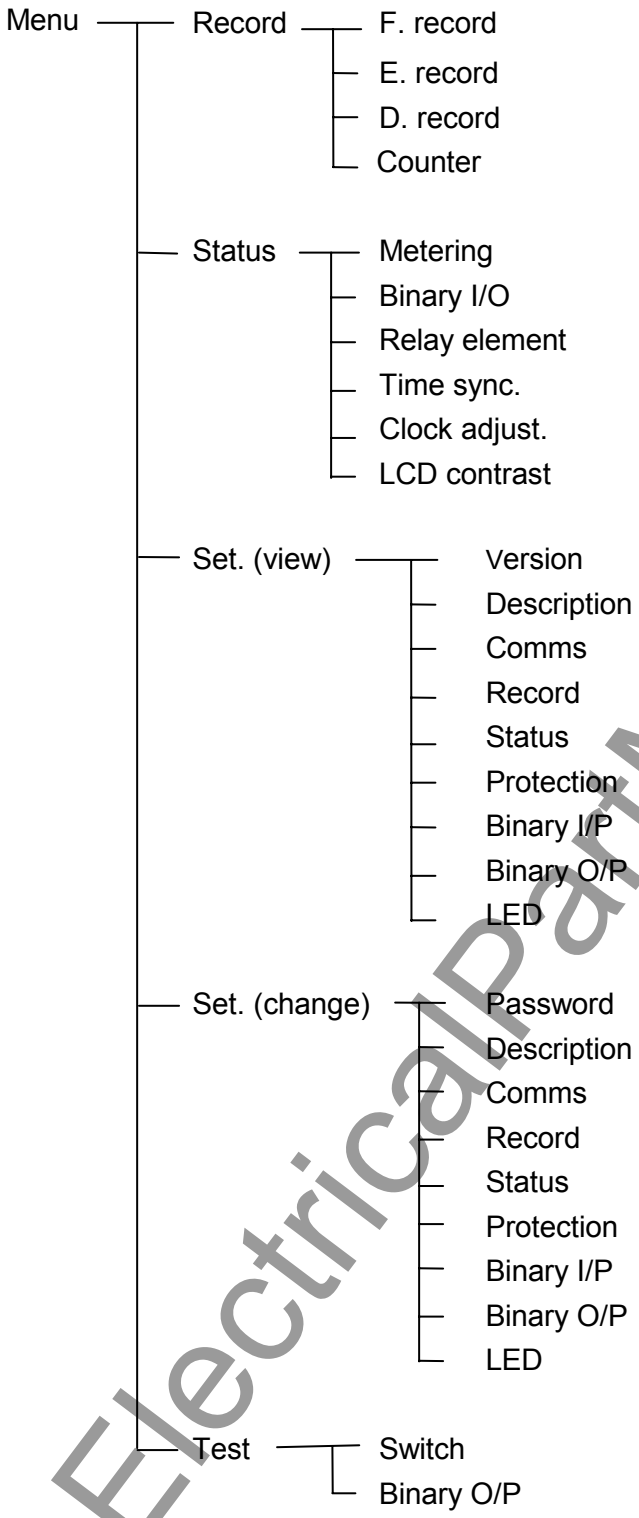


Figure 4.2.1 Relay Menu

Record

In the "Record" menu, the fault records event records, disturbance records and counts such as trip count.

Status

The "Status" menu displays the power system quantities, binary input and output status, relay measuring element status, signal source for time synchronisation (BI, RSM or IEC60870-5-103), clock adjustment 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 configurable LEDs.

Set. (change)

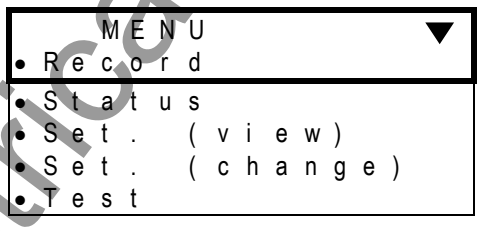
The "Set. (change)" menu is used to change the settings of password, description, relay address and baud rate in RSM or IEC60870-5-103 communication, record, status, protection, binary inputs, configurable binary outputs and configurable LEDs.

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

Test

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

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.

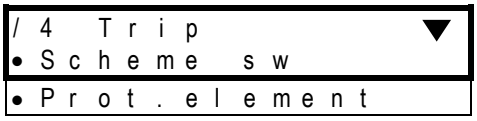


To display the "MENU" screen when the digest screen is displayed, press the [RESET] key to turn off the LCD, then press any key other than the [VIEW] and [RESET] keys.

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. "▼" or "▲" displayed on the far right shows that lower or upper lines exist.

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



To return to the higher screen or move from the right side screen to the left side screen in

Appendix D, press the [END] key.

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

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

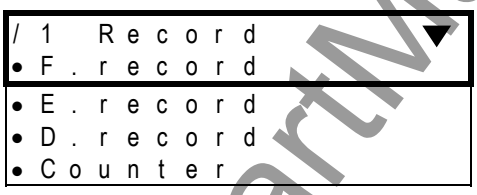
4.2.3 Displaying Records

The sub-menu of "Record" is used to display fault records, event records, disturbance records and counts such as trip count.

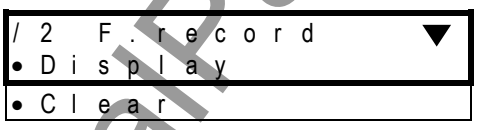
4.2.3.1 Displaying Fault Records

To display fault records, do the following:

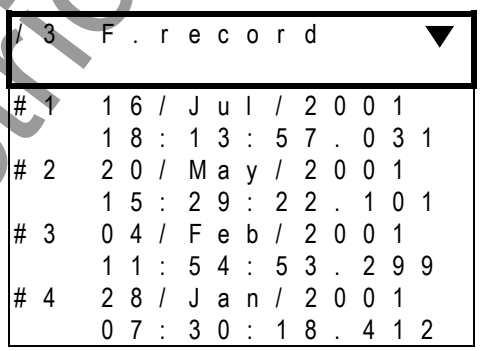
- Open the top "MENU" screen by pressing any keys other than the [VIEW] and [RESET] keys.
- Select "Record" to display the "Record" sub-menu.



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



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



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

/4 F.record #1 ▼	
16/Jul/2001	
18:13:57.031	
OV1	Trip element
Phase AB BC CA	Faulted voltage element.
Prefault values	
Van ***.** kV	Not available for model 210 and APPL=3PP and 2PP setting in model 410.
***.* °	
Vbn ***.** kV	Not available for model 210 and APPL=3PP and 2PP setting in model 410.
***.* °	
Vcn ***.** kV	Not available for model 210 and APPL=3PP and 2PP setting in model 410.
***.* °	
Vab ***.** kV	Not available for APPL=1PP, 1PN, 3PN and 3PV setting in models 210 and 410.
***.* °	
Vbc ***.** kV	Not available for APPL=1PP, 1PN, 3PN and 3PV setting in models 210 and 410.
***.* °	
Vca ***.** kV	Not available for model 210 and APPL=3PN, 3PV and 2PP setting in model 410.
***.* °	
Vph ***.** kV	Not available for model 410 and APPL=2PP setting in model 210.
V0 ***.** kV	Not available for APPL=2PP setting in model 210.
***.* °	
V1 ***.** kV	Not available for APPL=1PP and 1PN settings in model 210.
***.* °	
V2 ***.** kV	Not available for APPL=1PP and 1PN settings in model 210.
***.* °	
f **.** Hz	
Fault values	
Van ***.** kV	
***.* °	
Vbn ***.** kV	
***.* °	
Vcn ***.** kV	
***.* °	
Vab ***.** kV	
***.* °	
Vbc ***.** kV	
***.* °	
Vca ***.** kV	
***.* °	
Vph ***.** kV	
V0 ***.** kV	
***.* °	
V1 ***.** kV	
***.* °	
V2 ***.** kV	
***.* °	
f **.** Hz	

Note: Phase angles above are expressed taking that of positive sequence voltage (V1) as a reference phase angle. When the V1 is not available, phase angles are not displayed.
Frequency above is displayed as "0Hz" when only residual voltage (zero sequence voltage) is input to the relay.

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 "F. 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 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 "E. record" screen.

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

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

```
/3  E.record      ▼

21/Sep/2002  480
OV1      trip    On
21/Sep/2002  479
OV1-ab           On
```

The time is displayed by pressing the ▶ key.

```
/3  E.record      ▼

13:22:45.211
OV1      trip    On
13:22:45.211
OV1-ab           On
```

Press the ◀ key to return the screen with date.

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

To clear all the event records, do the following:

- Open the "Record" sub-menu.
- Select "E. record" to display the "E. 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 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 "D. record" screen.

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

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

```
/3  D.record      ▼

#1  16/Jul/2001
    18:13:57.401
#2  20/May/2001
    15:29:22.388
#3  04/Feb/2001
    11:54:53.444
#4  28/Jan/2001
    07:30:18.876
```

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

To clear all the disturbance records, do the following:

- Open the "Record" sub-menu.
- Select "D. record" to display the "D. 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 disturbance records stored in non-volatile memory.

4.2.3.4 Displaying Counter

- 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 "Counter" to display the "Counter" screen.

/2 Counter ▼ • Display	
• Clear Trips	
• Clear Trips A	(*)
• Clear Trips B	(*)
• Clear Trips C	(*)

(*) Note: These settings are only available when single phase External Trip BI functions are used. In this case, the main "Clear Trips" option is not available.

- Select "Display" to display the counts stored in the relay.

/3 Counter ▼ Trips ******	Range 0 - 100000
Trips A ******	Range 0 - 100000 (*)
Trips B ******	Range 0 - 100000 (*)
Trips C ******	Range 0 - 100000 (*)

(*) Note: These settings are only available when single phase External Trip BI functions are used. In this case, the main "Trips" option is not available.

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

To clear each count, do the following:

- Open the "Record" sub-menu.
- Select "Counter" to display the "Counter" screen.
- Select "Clear Trips" to display the following confirmation screen.

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

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

```
Clear Trips A?
END=Y CANCEL=N
```

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

```
Clear Trips B?
END=Y CANCEL=N
```

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

```
Clear Trips C?
END=Y CANCEL=N
```

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

4.2.4 Displaying the Status

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

Metering data of the protected line, apparatus, etc.

Status of binary inputs and outputs

Status of measuring elements output

Status of time synchronisation source

Status of clock adjustment

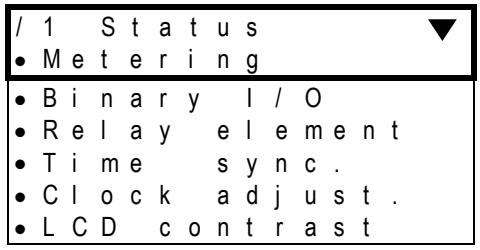
Status of LCD contrast

The data are updated every second.

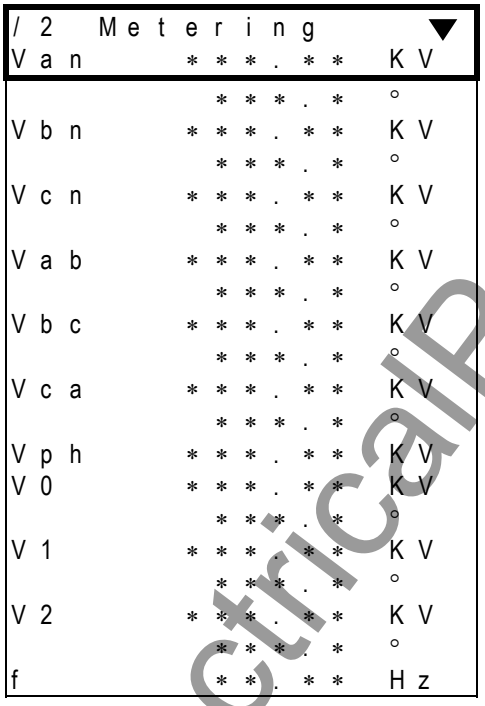
4.2.4.1 Displaying Metering Data

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

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



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



Not available for model 210 and APPL=3PP and 2PP setting in model 410.

Not available for model 210 and APPL=3PP and 2PP setting in model 410.

Not available for model 210 and APPL=3PP and 2PP setting in model 410.

Not available for APPL=1PP, 1PN, 3PN and 3PV setting in models 210 and 410.

Not available for APPL=1PP, 1PN, 3PN and 3PV setting in models 210 and 410.

Not available for model 210 and APPL=3PN, 3PV and 2PP setting in model 410.

Not available for model 410 and APPL=2PP setting in model 210.

Not available for APPL=2PP setting in model 210.

Not available for APPL=1PP and 1PN settings in model 210.

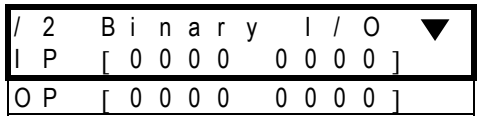
Not available for APPL=1PP and 1PN settings in model 210.

Note: Phase angles above are expressed taking that of positive sequence voltage (V1) as a reference phase angle. When the V1 is not available, phase angles are not displayed.
Frequency above is displayed as "0Hz" when only residual voltage (zero sequence voltage) is input to the relay

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	BI6	BI7	BI8
Output (OP)	BO1	BO2	BO3	BO4	BO5	BO6	BO7	FAIL

Line 1 shows the binary input status. BI1 to BI8 correspond to each binary input signal. For the binary input signal, see Appendix F. The status is expressed with logical level "1" or "0" at the photo-coupler output circuit.

Line 2 shows the binary output status. All binary outputs BO1 to BO7 are configurable. The status of these outputs is expressed with logical level "1" or "0" at the input circuit of the output relay driver. That is, the output relay is energised when the status is "1".

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

4.2.4.3 Displaying the Status of Measuring Elements

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

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

```
/ 2   R y   e l e m e n t      ▼
A N O V 1 - 3 [ 0 0 0          ]
B N O V 1 - 3 [ 0 0 0          ]
C N O V 1 - 3 [ 0 0 0          ]
A B O V 1 - 3 [ 0 0 0          ]
B C O V 1 - 3 [ 0 0 0          ]
C A O V 1 - 3 [ 0 0 0          ]
A N U V 1 - 3 [ 0 0 0          ]
B N U V 1 - 3 [ 0 0 0          ]
C N U V 1 - 3 [ 0 0 0          ]
A B U V 1 - 3 [ 0 0 0          ]
B C U V 1 - 3 [ 0 0 0          ]
C A U V 1 - 3 [ 0 0 0          ]
V Z P S 1 - 2 [ 0 0            ]
V N P S 1 - 2 [ 0 0            ]
```

The displayed elements depend on relay model. (See Table 1.1.1 in Section 1.)

The operation status of measuring elements are shown as below.

	[■	■	■	]
ANOV1-3	OV1	OV2	OV3	A phase OV1-3 elements
BNOV1-3	OV1	OV2	OV3	B phase OV1-3 elements
CNOV1-3	OV1	OV2	OV3	C phase OV1-3 elements
ABOV1-3	OV1	OV2	OV3	A-B phase OV1-3 elements
BCOV1-3	OV1	OV2	OV3	B-C phase OV1-3 elements
CAOV1-3	OV1	OV2	OV3	C-A phase OV1-3 elements
ANUV1-3	UV1	UV2	UV3	A phase UV1-3 elements
BNUV1-3	UV1	UV2	UV3	B phase UV1-3 elements
CNUV1-3	UV1	UV2	UV3	C phase UV1-3 elements
ABUV1-3	UV1	UV2	UV3	A-B phase UV1-3 elements

BCUV1-3	UV1	UV2	UV3	B-C phase UV1-3 elements
CAUV1-3	UV1	UV2	UV3	C-A phase UV1-3 elements
VZPS1-2	ZPS1	ZPS2		ZPS1-2 elements
VNPS1-2	NPS1	NPS2		NPS1-2 elements

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

4.2.4.4 Displaying the Status of the Time Synchronisation Source

The internal clock of the GRD130 can be synchronised with external clocks such as the binary input signal clock, RSM (relay setting and monitoring system) clock or IEC60870-5-103. To display on the LCD whether these clocks are active (=Act.) or inactive (=Inact.) and which clock the relay is synchronised with, do the following:

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

```
/2 Time sync.      ▼
*BI:       Act.
 RSM:      Inact.
 IEC:      Inact.
```

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

Note: If the Binary input signal has not been detected for one hour or more after the last detection, the status becomes "inactive".

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

4.2.4.5 Clock Adjustment

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

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

```
/2  12/Nov/2001 ▼
    22:56:19
Minute
      56  _
Hour
      22
Day
      12
Month
      11
Year
    2001
```

Line 1 and 2 show the current date and time. The time can be adjusted only when the clock is running locally. When [BI], [RSM] or [IEC] is active, the adjustment is invalid.

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

the previous screen.

If a date which does not exist in the calendar is set and [END] is pressed, "**** Error ****" is displayed on the top line and the adjustment is discarded. Return to the normal screen by pressing the [CANCEL] key and adjust again.

4.2.4.6 LCD Contrast

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

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

- Press the ◀ or ▶ key to adjust the contrast. The characters on the screen become thin by pressing the ◀ key and deep by pressing the ▶ key.

4.2.5 Viewing the Settings

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

The following items are displayed:

Relay version

Description

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

Record setting

Status setting

Protection setting

Binary input setting

Binary output setting

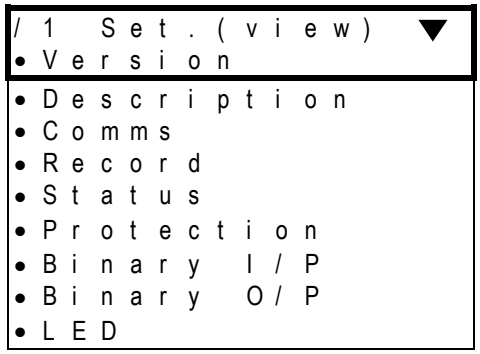
LED setting

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

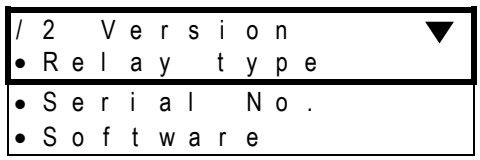
4.2.5.1 Relay Version

To view the relay version, do the following.

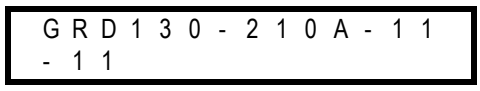
- Press the "Set.(view)" on the main menu.



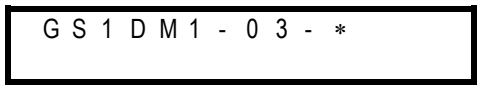
- Press the "Version" on the "Set.(view)" menu.



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



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



4.2.5.2 Settings

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

4.2.6 Changing the Settings

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

Password

Description

Relay address and baud rate in the RSM or IEC60870-5-103 communication

Recording setting

Status setting

Protection setting

Binary input setting

Binary output setting

LED setting

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

CAUTION

Modification of settings : Care should be taken when modifying settings for "active group", "scheme switch" and "protection element" in the "Protection" menu. Dependencies exist between the settings in the various menus, with settings in one menu becoming active (or inactive) depending on the selection made in another menu. Therefore, it is recommended that all necessary settings changes be made while the circuit breaker tripping circuit is disconnected.

Alternatively, if it is necessary to make settings changes with the tripping circuit active, then it is recommended to enter the new settings into a different settings group, and then change the "active group" setting, thus ensuring that all new settings become valid simultaneously.

4.2.6.1 Setting Method

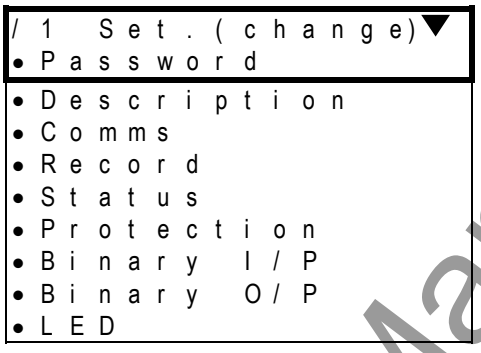
There are three setting methods as follows:

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

To enter a selected item

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

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

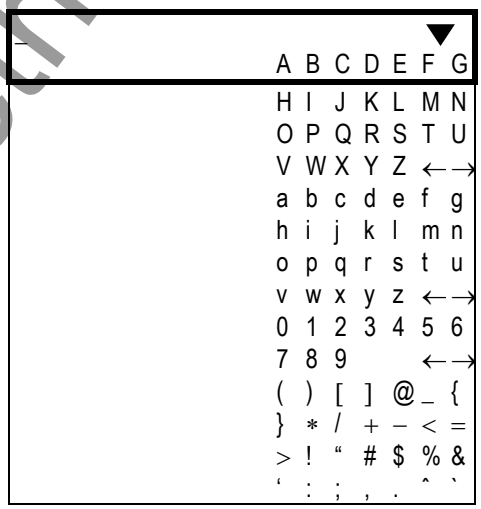


- Move the cursor to a setting item.
- Press the [ENTER] key.

To enter a text string

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

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



- Set the cursor position in the bracket by selecting "→" or "←" and pressing the [ENTER] key.
- Move the blinking cursor to a selecting character.
- Press the [ENTER] key to enter the blinking character at the cursor position in the brackets.

- Press the [END] key to confirm the entry and return to the upper screen.

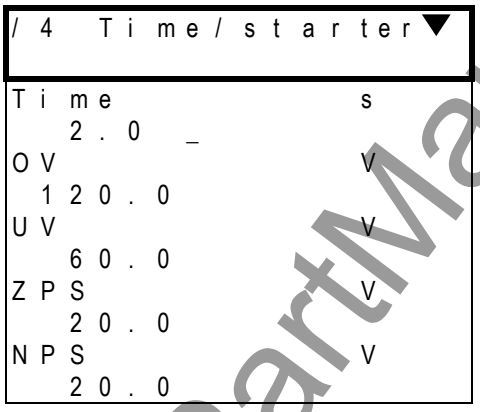
To correct the entered character, do either of the following:

- Discard the character by selecting "←" and pressing the [ENTER] key and enter the new character.
- Discard the whole entry by pressing the [CANCEL] key and restart the entry from the first.

To enter numerical values

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

The number to the left of the cursor shows the current setting or default setting set at shipment. The cursor can be moved to upper or lower lines within the screen by pressing the ▲ and ▼ keys. If setting (change) is not required, skip the line with the ▲ and ▼ keys.



- Move the cursor to a setting line.
- Press the ◀ or ▶ key to set a desired value. The value is up or down by pressing the ▶ or ◀ key.
- Press the [ENTER] key to enter the value.
- After completing the setting on the screen, press the [END] key to return to the upper screen.

To correct the entered numerical value, do the following.

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

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

To complete the setting

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

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

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

- When the screen is displayed, press the [ENTER] key to start operation using the new settings, or press the [CANCEL] key to correct or cancel entries. In the latter case, the screen turns back to the setting screen to enable re-entries. Press the [CANCEL] key to cancel entries made so far and to turn to the "Set. (change)" sub-menu.

4.2.6.2 Password

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

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

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

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

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

- Press the [END] key to display the confirmation screen. If the retyped number is different from that first entered, the following message is displayed on the bottom of the "Password" screen before returning to the upper screen.

  "Unmatch passwd!"

  Re-entry is then requested.

Password trap

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

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

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

Canceling or changing the password

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

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

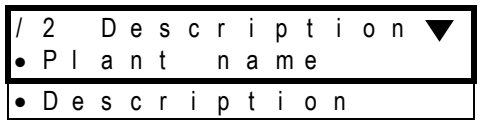
If you forget the password

Press [CANCEL] and [RESET] keys together for one second on the top "MENU" screen. The screen goes off, and the password protection of the GRD130 is canceled. Set the password again.

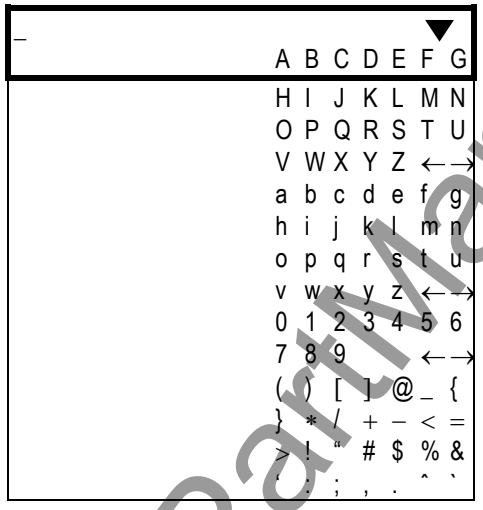
4.2.6.3 Plant Name

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

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



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

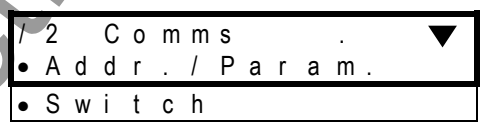


- Enter the text string.

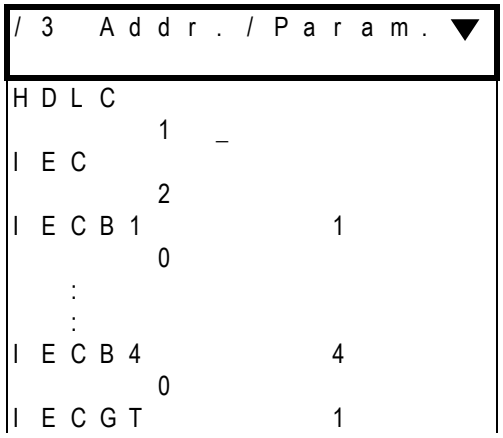
4.2.6.4 Communication

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

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



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



```
          1
IECAT             1
          1
IECBT             1
          1
IECCT             1
          1
IECE1             0
          0
    :
    :
IECE8             0
          0
IECI1             0
          0
    :
    :
IECI8             0
          0
```

- 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.

Settings for IEC60870-5-103 communication

The lines "IECB1" to "IECB4" are used for auxiliary inputs of IEC103 events INF27 to INF30 in Appendix M. Assign signals to the columns "IECB1" to "IECB4" by entering the number corresponding to each signal referring to Appendix C.

The lines "IECGT" to "IECCT" are used for fault indications of IEC103 events INF68 to INF71 in Appendix N. Assign signals to the columns "IECGT" to "IECCT" by entering the BO numbers (1 to 7) corresponding to the binary output settings.

The lines "IECE1" to "IECE8" are used to assign the signals for user customization. Assign signals to the columns "IECE1" to "IECE8" by entering the number corresponding to each signal referring to Appendix A.

Note: Assign "0" to the column when this function is not used.

The lines "IECI1" to "IECI8" are used to assign the above signals of "IECE1" to "IECE8" to each INF number. Enter the INF number to the columns "IECI1" to "IECI8".

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

```
/3 Switch      .    ▼
Protocol          0  _
HDLC/IEC
232C              0
9.6/19.2/57.6
IECBR             1
9.6/19.2
IECBLK            0
Normal/Blocked
IECNFI            0
1.2/2.4
IECGI1            0
```

```
No / Yes
    :
    :
IECGI8          0
No / Yes
```

- Select the number and press the [ENTER] key.

<Protocol>

- When the remote RSM system is applied, select 0 (=HDLC). When the IEC60870-5-103 is applied, select 1 (=IEC103).

CAUTION When changing the setting to the HDLC during the IEC103 operation, the IEC103 command INF18 in Appendix L is canceled.
The output of IEC103 command INF18 can be observed by assigning their signal numbers to LEDs or binary output relays (see Sections 4.2.6.9 and 4.2.6.10).

<232C>

This line is to select the RS-232C baud rate when the RSM system is applied.

Note: The default setting of the 232C is 9.6kbps. The 57.6kbps setting, if possible, is recommended to serve the user for comfortable operation. The setting of RSM100 is also set to the same baud rate.

<IECBR>

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

<IECBLK>

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

<IECNFV, IECNFf>

These lines are to select the normalized factor (1.2 or 2.4) of the following measurands.

IECNFV: Voltage

IECNFf: Frequency

<IECGI1 - 8 >

These lines are to use the GI (General Interrogation) or not for user customized signals. If use the GI, enter 1(=Yes).

4.2.6.5 Setting the Recording

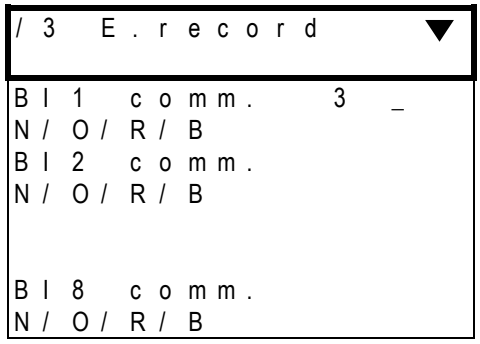
To set the recording function as described in Section 4.2.3, do the following:

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

```
/ 2  Record                ▼
• E. record
• D. record
• Counter
```

Setting the event recording

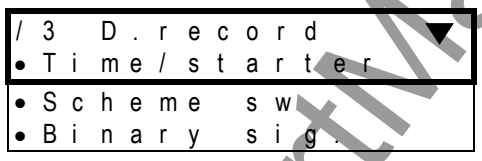
- Select "E. record" to display the "E. record" screen.



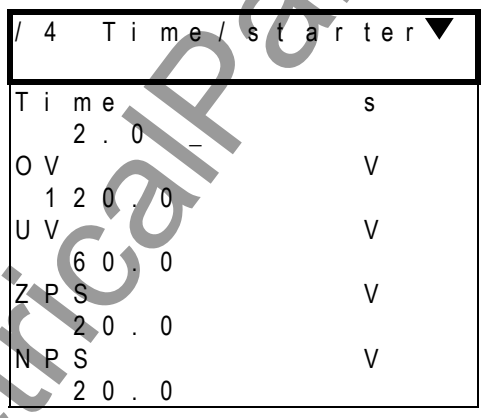
- Enter 0(=None) or 1(=Operate) or 2(=Reset) or 3(=Both) for BI command trigger setting and press the [ENTER] key.

Setting the disturbance recording

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



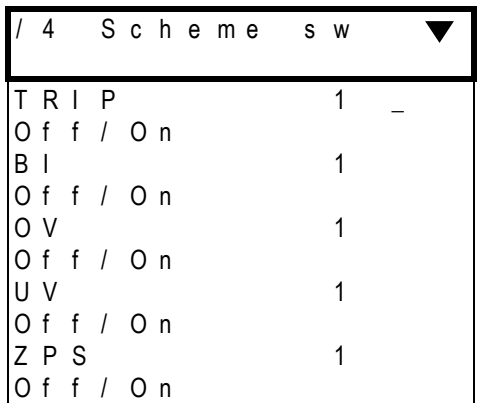
- Select "Time/starter" to display the "Time/starter" screen.



- 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.



```
NPS                 1
Off / On
```

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

To set each signal number to record binary signals, do the following:

- Select "Binary sig." on the "D. record" screen to display the "Binary sig." screen.

```
/4  Binary sig.  ▼

SIG1
    101  _
SIG2
    102
SIG32
    133
```

- Enter the signal number to record binary signals in Appendix A.

Setting the counter

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

```
/3  Counter      ▼
• Scheme sw
• Alarm set
```

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

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

```
/4  Scheme sw    ▼

TCSPEN          0  _
Off / On / OPT-On
CBSMEN          0
Off / On
TCAEN           0
Off / On
```

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

To set threshold setting, do the following:

- Select "Alarm set" on the "Counter" screen to display the "Alarm set" screen.

```
/4  Alarm set    ▼

TCALM
  10000  _
```

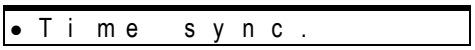
- Enter the threshold settings.

4.2.6.6 Status

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

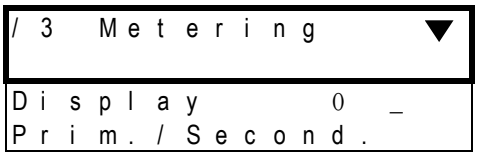
Select "Status" on the "Set. (change)" sub-menu to display the "Status" screen.

```
/2  Status       ▼
• Metering
```



Setting the metering

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

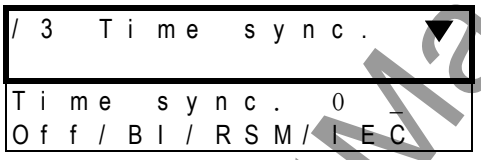


- Enter 0 (=Primary side) or 1 (=Secondary side) and press the ENTER key.

Setting the time synchronisation

The calendar clock can run locally or be synchronised with the binary input signal, RSM clock, or by an IEC60870-5-103. This is selected by setting as follows.

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



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

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

  Enter 1 (=BI) to be synchronised with the binary input signal.

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

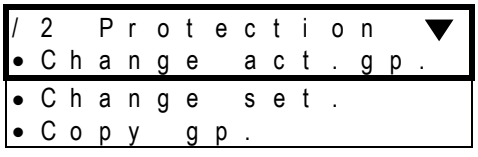
  Enter 3 (=IEC) to be synchronised with IEC60870-5-103.

  Note: When selecting BI, RSM or IEC, check that they are active on the "Status" screen in "Status" sub-menu.
  If BI is selected, the BI command trigger setting should be “None” because event records will become full soon. (See Section 4.2.6.5.)
  If it is set to an inactive BI, RSM or IEC, the calendar clock runs locally.

4.2.6.7 Protection

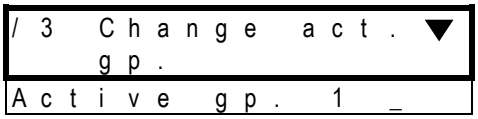
The GRD130 can have 4 setting groups for protection in order to accommodate changes in the operation of the power system, one setting group is assigned active. To set the protection, do the following:

- 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.

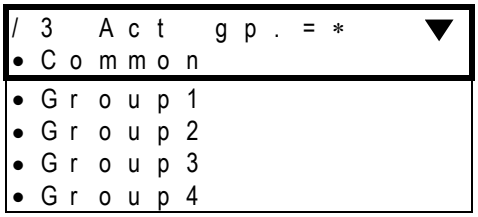


- Enter the group number and press the [ENTER] key.

Changing the settings

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

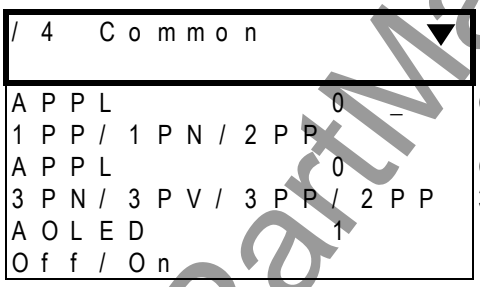
- Select "Change set." to display the "Act gp.= *" screen.



Setting the common

To set the application setting of GRD130-210 and 410, do the following.

- Select "APPL" on the "Protection" screen to display the "APPL" screen.



GRD130-210
$1V_{ph\text{-}ph}$+V_0, $1V_{ph\text{-}n}$+V_0, $2V_{ph\text{-}ph}$
GRD130-410
$3V_{ph\text{-}n}$, $3V_{ph\text{-}n}$+V_0, $3V_{ph\text{-}ph}$+V_0, $2V_{ph\text{-}ph}$+V_0

<APPL>

To set the APPL setting of GRD130-210

- Enter 0(=1PP, single phase-to-phase voltage and zero sequence voltage input) or 1(=1PN, single phase-to-neutral voltage and zero sequence voltage input) or 2(=2PP, two phase-to-phase voltage input) and press the [ENTER] key.

To set the APPL setting of GRD130-410

- Enter 0(=3PN, three phase-to-neutral voltage input) or 1(=3PV, three phase-to-neutral voltage and zero sequence voltage input) or 2(=3PP, three phase-to-phase voltage and zero sequence voltage input) or 3(=2PP, two phase-to-phase voltage and zero sequence voltage input) and press the [ENTER] key.

CAUTION:

Do not change the APPL setting under service condition of the relay.

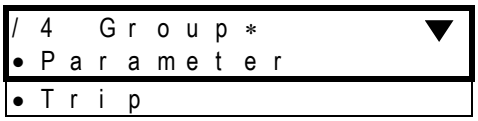
<AOLED>

This switch is used to control the “TRIP” LED lighting when an alarm element outputs.

- Enter 1 (=On) to light the “TRIP” LED when an alarm element outputs, and press the [ENTER] key. If not, enter 0 (=Off) and press the [ENTER] key.

Setting the group

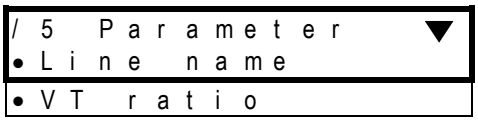
- Select the group to change the settings and press the [ENTER] key.



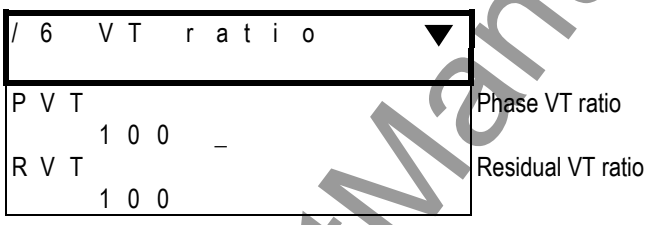
Setting the parameter

Enter the line name and the VT ratio as follows:

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



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



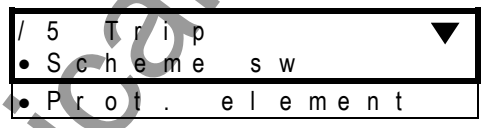
Note: The "VT ratio" screen depends on the APPL setting.

- Enter the VT ratio and press the (ENTER) key.

Setting the trip function

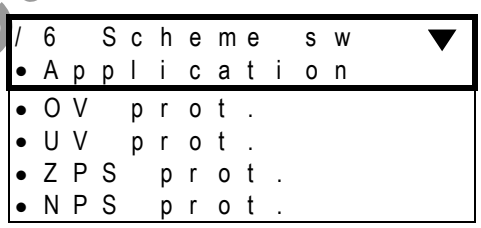
To set the scheme switches and protection elements, do the following.

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



Setting the scheme switch

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



Setting the application

To set the scheme switch "SVCNT", do the following.

- Select "Application on the "Scheme sw" screen.

- Enter 0 (=ALM&BLK) to alarm and to block the tripping if detecting the AC input imbalance and press the [ENTER] key. If alarming only, enter 1 (=ALM) and press the [ENTER] key.

Setting the OV protection

- Select "OV prot." on the "Scheme sw" screen to display the "OV prot." screen.

```
/ 7  OV  prot.          ▼

OV1 EN              0   _
Off / DT / IDMT / C
OV2 EN              0
Off / DT / IDMT / C
OV3 EN              0
Off / On
```

<OV1EN, OV2EN>

To set the OV1 or OV2 delay type, do the following.

- Enter 1 (=DT) or 2 (=IDMT) or 3 (=C) and press the [ENTER] key. If disabling the OV1 or OV2, enter 0 (=Off) and press the [ENTER] key.

<OV3EN>

- Enter 1 (=On) to enable the OV3 and press the [ENTER] key. If disabling the OV3, enter 0 (=Off) and press the [ENTER] key.
- After setting, press the [END] key to display the following confirmation screen.

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

- Press the [ENTER] (= Y) key to change settings and return to the "Scheme sw" screen.

Setting the UV protection

- Select "UV prot." to display the "UV prot." screen.

```
/ 7  UV  prot.          ▼

UV1 EN              1   _
Off / DT / IDMT / C
UV2 EN              0
Off / DT / IDMT / C
UV3 EN              0
Off / On
VBLK EN             0
Off / On
```

<UV1EN, UV2EN>

To set the UV1 or UV2 delay type, do the following.

- Enter 1 (=DT) or 2 (=IDMT) or 3(=C) and press the [ENTER] key. If disabling the UV1 or UV2, enter 0 (=Off) and press the [ENTER] key.

<UV3EN>

- Enter 1 (=On) to enable the UV3 and press the [ENTER] key. If disabling the UV3, enter 0 (=Off) and press the [ENTER] key.

<VBLKEN>

- Enter 1 (=On) to enable the UV blocking and press the [ENTER] key. If disabling the UV blocking, enter 0 (=Off) and press the [ENTER] key.
- After setting, press the [END] key to display the following confirmation screen.

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

- Press the [ENTER] (= Y) key to change settings and return to the "Scheme sw" screen.

Setting the ZPS protection

- Select "ZPS prot." to display the "ZPS prot." screen.

```
/ 7  ZPS prot.        ▼

ZPS1EN          1
Off/DT/IDMT/C
ZPS2EN          0
Off/DT/IDMT/C
```

<ZPS1EN, ZPS2EN>

To set the ZPS1 or ZPS2 delay type, do the following.

- Enter 1 (=DT) or 2 (=IDMT) or 3 (=C) and press the [ENTER] key. If disabling the ZPS1 or ZPS2, enter 0 (=Off) and press the [ENTER] key.
- After setting, press the [END] key to display the following confirmation screen.

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

- Press the [ENTER] (= Y) key to change settings and return to the "Scheme sw" screen.

Setting the NPS protection

- Select "NPS prot." to display the "NPS prot." screen.

```
/ 7  NPS prot.        ▼

NPS1EN          0
Off/DT/IDMT/C
NPS2EN          0
Off/DT/IDMT/C
```

<NPS1EN, NPS2EN>

To set the NPS1 or NPS2 delay type, do the following.

- Enter 1 (=DT) or 2 (=IDMT) or 3 (=C) and press the [ENTER] key. If disabling the NPS1 or

NPS2, enter 0 (=Off) and press the ENTER key.

- After setting, press the END key to display the following confirmation screen.

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

- Press the ENTER (= Y) key to change settings and return to the "Scheme sw" screen.

Setting the protection elements

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

```
/ 6 Prot. element▼
• OV prot.
• UV prot.
• ZPS prot.
• NPS prot.
```

Setting the OV protection

- Select "OV prot." to display the "OV prot." screen.

```
/ 7 OV prot.  ▼
```

OV1 120.0 _	V	OV1 Threshold setting.
TOV1 10.00		OV1 Time multiplier setting. Display if [OV1EN] = 2 or 3.
TOV1 0.00	s	OV1 Definite time setting. Display if [OV1EN]= 1.
TOV1R 0.0	s	OV1 Definite time reset delay. Display if [OV1EN] = 2 or 3.
OV1DPR 95	%	OV1 DO/PU ratio
OV2 140.0	V	OV2 Threshold setting.
TOV2 10.00		OV2 Time multiplier setting. Display if [OV2EN] = 2 or 3.
TOV2 0.00	s	OV2 Definite time setting. Display if [OV2EN]= 1.
TOV2R 0.0	s	OV2 Definite time reset delay. Display if [OV2EN] = 2 or 3.
OV2DPR 95	%	OV2 DO/PU ratio
OV3 160.0	V	OV3 Threshold setting.
TOV3 0.00	s	OV3 Definite time setting.
OV3DPR 95	%	OV3 DO/PU ratio
OV1-k 1.00		IDMT curve setting of OV1
OV1-α 1.00		IDMT curve setting of OV1
OV1-c 0.000		IDMT curve setting of OV1
OV2-k 1.00		IDMT curve setting of OV2

OV2 - α 1.00	IDMT curve setting of OV2
OV2 - c 0.000	IDMT curve setting of OV2

- Enter the numerical value and press the [ENTER] key.
- After setting, press the [END] key to display the following confirmation screen.

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

- Press the [ENTER] (= Y) key to change settings and return to the " Prot. element" screen.

Setting the UV protection

- Select "UV prot." to display the "UV prot." screen.

```
/7 UV prot.          ▼
```

UV1 60.0 _	V	UV1 Threshold setting.
TUV1 10.00		UV1 Time multiplier setting. Display if [UV1EN] = 2 or 3.
TUV1 0.00	s	UV1 Definite time setting. Display if [UV1EN]= 1.
TUV1R 0.0	s	UV1 Definite time reset delay. Display if [UV1EN] = 2 or 3.
UV2 40.0	V	UV2 Threshold setting.
TUV2 10.00		UV2 Time multiplier setting. Display if [UV2EN] = 2 or 3.
TUV2 0.00	s	UV2 Definite time setting. Display if [UV2EN]= 1.
TUV2R 0.0	s	UV2 Definite time reset delay. Display if [UV2EN] = 2 or 3.
UV3 20.0	V	UV3 Threshold setting.
TUV3 0.00	s	UV3 Definite time setting.
UV1 - k 1.00		IDMT curve setting of UV1
UV1 - α 1.00		IDMT curve setting of UV1
UV1 - c 0.000		IDMT curve setting of UV1
UV2 - k 1.00		IDMT curve setting of UV2
UV2 - α 1.00		IDMT curve setting of UV2
UV2 - c 0.000		IDMT curve setting of UV2

- Enter the numerical value and press the [ENTER] key.
- After setting, press the [END] key to display the following confirmation screen.

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

- Press the [ENTER] (= Y) key to change settings and return to the " Prot. element" screen.

Setting the ZPS protection

- Select "ZPS prot." to display the "ZPS prot." screen.

/7 ZPS prot. ▼		
ZPS1	V	ZPS1 Threshold setting.
20.0 _		
TZPS1		ZPS1 Time multiplier setting. Display if [ZPS1EN] = 2 or 3.
10.00		
TZPS1	s	ZPS1 Definite time setting. Display if [ZPS1EN]= 1.
0.00		
TZPS1R	s	ZPS1 Definite time reset delay. Display if [ZPS1EN] = 2 or 3.
0.0		
ZPS2	V	ZPS2 Threshold setting.
40.0		
TZPS2		ZPS2 Time multiplier setting. Display if [ZPS2EN] = 2 or 3.
0.00		
TZPS2	s	ZPS2 Definite time setting. Display if [ZPS2EN]= 1.
0.00		
TZPS2R	s	ZPS2 Definite time reset delay. Display if [ZPS2EN] = 2 or 3.
0.0		
ZPS1-k		IDMT curve setting of ZPS1
1.00		
ZPS1-α		IDMT curve setting of ZPS1
1.00		
ZPS1-c		IDMT curve setting of ZPS1
0.000		
ZPS2-k		IDMT curve setting of ZPS2
1.00		
ZPS2-α		IDMT curve setting of ZPS2
1.00		
ZPS2-c		IDMT curve setting of ZPS2
0.000		

- Enter the numerical value and press the [ENTER] key.
- After setting, press the [END] key to display the following confirmation screen.

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

- Press the [ENTER] (= Y) key to change settings and return to the " Prot. element" screen.

Setting the NPS protection

- Select "NPS prot." to display the "NPS prot." screen.

/7 NPS prot. ▼		
NPS1	V	NPS1 Threshold setting.
20.0 _		
TNPS1		NPS1 Time multiplier setting. Display if [NPS1EN] = 2 or 3.
10.00		
TNPS1	s	NPS1 Definite time setting. Display if [NPS1EN]= 1.
0.00		

TNPS1R 0.0	s	NPS1 Definite time reset delay. Display if [NPS1EN] = 2 or 3.
NPS2 40.0	V	NPS2 Threshold setting.
TNPS2 0.00		NPS2 Time multiplier setting. Display if [NPS2EN] = 2 or 3.
TNPS2 0.00	s	NPS2 Definite time setting. Display if [NPS2EN]= 1.
TNPS2R 0.0	s	NPS2 Definite time reset delay. Display if [NPS2EN] = 2 or 3.
NPS1-k 1.00		IDMT curve setting of NPS1
NPS1-α 1.00		IDMT curve setting of NPS1
NPS1-c 0.0000		IDMT curve setting of NPS1
NPS2-k 1.00		IDMT curve setting of NPS2
NPS2-α 1.00		IDMT curve setting of NPS2
NPS2-c 0.0000		IDMT curve setting of NPS2

- Enter the numerical value and press the [ENTER] key.
- After setting, press the [END] key to display the following confirmation screen.

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

- Press the [ENTER] (= Y) key to change settings and return to the " Prot. element" 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 requirements 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 ▼
. BI 1
. BI 2
. BI 3
. BI 4
. BI 5
. BI 6
```

```
. BI 7
. BI 8
. Alarm1  Text
. Alarm2  Text
. Alarm3  Text
. Alarm4  Text
```

Selection of Binary Input

- Select the input relay number (BI number) and press the [ENTER] key to display the "BI∗" screen.

```
/ 3  BI *                    ▼
• Timers
• Functions
```

Setting Alarm ∗ Text

- Select the Alarm∗ text and press the [ENTER] key to display the text input screen.

```
_                            ▼
                  A B C D E F G
                  H I J K L M N
                  O P Q R S T U
                  V W X Y Z ←→
                  a b c d e f g
                  h i j k l m n
                  o p q r s t u
                  v w x y z ←→
                  0 1 2 3 4 5 6
                  7 8 9     ←→
                  ( ) [ ] @ _ {
                  } * / + − < =
                  > ! " # $ % &
                  ' : ; , . ^ `
```

- Enter the characters (up to 22 characters) according to the text setting method.

Setting timers

- Select "Timers" on the "BI" screen to display the "Timers" screen.

```
/ 4  Timers                  ▼
BI 1 PUD              s      Pick-up delay setting
   0.00  _
BI 1 DOD              s      Drop-off delay setting
   0.00
```

- Enter the numerical value and press the [ENTER] key.
- After setting, press the [END] key to return to the "BI∗" screen.

Setting Functions

- Select "Functions" on the "BI" screen to display the "Functions" screen.

```
/ 4  Functions               ▼
```

BI1SNS	0	_
Norm/Inv		
BI1SGS	0	
Off/1/2/3/4		
OV1BLK	0	
Off/On		
OV2BLK	0	
Off/On		
OV3BLK	0	
Off/On		
UV1BLK	0	
Off/On		
UV2BLK	0	
Off/On		
UV3BLK	0	
Off/On		
ZP1BLK	0	
Off/On		
ZP2BLK	0	
Off/On		
NP1BLK	0	
Off/On		
NP2BLK	0	
Off/On		
TCFALM	0	
Off/On		
CBOPN	0	
Off/On		
CBCLS	0	
Off/On		
EXT3PH	0	
Off/On		
EXTAPH	0	
Off/On		
EXTBPH	0	
Off/On		
EXTCPH	0	
Off/On		
RMTRST	0	
Off/On		
SYNCLK	0	
Off/On		
STORCD	0	
Off/On		
Alarm1	0	
Off/On		
Alarm2	0	
Off/On		
Alarm3	0	
Off/On		
Alarm4	0	
Off/On		

<BI1SNS>

To set the Binary Input 1 Sense, do the following.

- Enter 0 (=Normal) or 1 (=Inverted) and press the ENTER key.

<BI1SGS>

To set the Binary Input 1 Settings Group Select, do the following.

- Enter 0 (=Off) or 1 (=1) or 2 (=2) or 3 (=3) or 4 (=4) and press the ENTER key.

<Others>

- Enter 1 (=On) to set the function and press the ENTER key. If not setting the function, enter 0 (=Off) and press the ENTER key.
- After setting, press the END key to return to the "BI∗" screen.

4.2.6.9 Binary Output

All the binary outputs of the GRD130 except the relay failure signal are user-configurable. It is possible to assign one signal or up to four ANDing or ORing signals to one output relay. Available signals are listed in Appendix A.

It is also possible to attach Instantaneous or delayed or latched reset timing to these signals.

Appendix C shows the factory default settings.

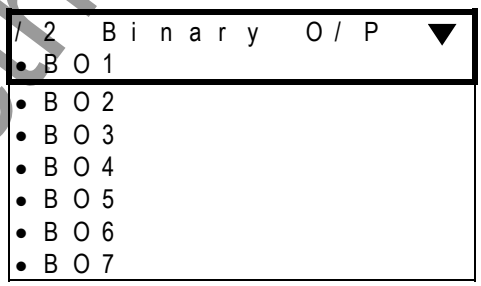
CAUTION

When having changed the binary output settings, release the latch state on a digest screen by pressing the RESET key for more than 3 seconds.

To configure the binary output signals, do the following:

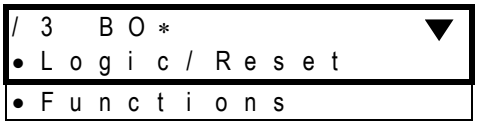
Selection of output relay

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



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

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



Setting the logic gate type and reset type

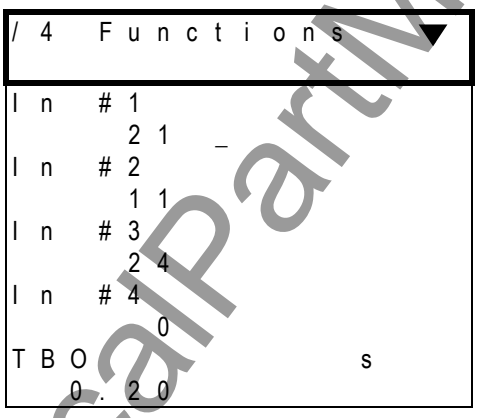
- Select "Logic/Reset" to display the "Logic/Reset" screen.

- Enter 0 (= OR) or 1 (= AND) to use an OR gate or AND gate and press the ENTER key.
- Enter 0 (=Instantaneous) or 1 (=Delayed) or 2 (=Dwell) or 3 (=Latched) to select the reset timing and press the ENTER key.
- Press the END key to return to the "BO∗" screen.

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

Assigning signals

- Select "Functions" on the "BO∗" screen to display the "Functions" screen.



- Assign signals to gates (In #1 to #4) by entering the number corresponding to each signal referring to Appendix A. Do not assign the signal numbers 170 to 176 (signal names: "BO1 OP" to "BO7 OP"). And set the delay time of timer TBO.

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

Repeat this process for all the outputs to be configured.

4.2.6.10 LEDs

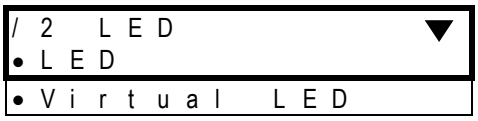
Three LEDs of the GRD130 are user-configurable. A configurable LED can be programmed to indicate the OR combination of a maximum of 4 elements, the individual statuses of which can be viewed on the LED screen as "Virtual LEDs." The signals listed in Appendix A can be assigned to each LED as follows.

CAUTION

When having changed the LED settings, release the latch state on a digest screen by pressing the RESET key for more than 3 seconds.

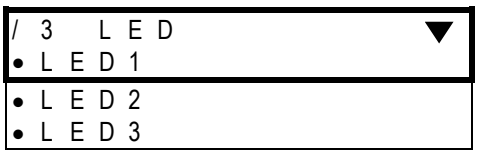
Selection of LEDs

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



Selection of real LEDs

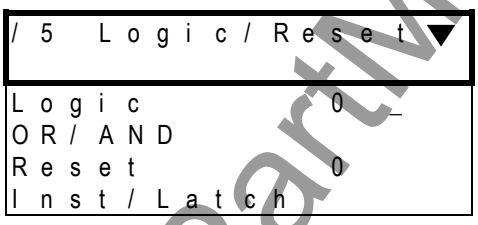
- Select "LED" on the "/2 LED" screen to display the "/3 LED" screen.



- 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.

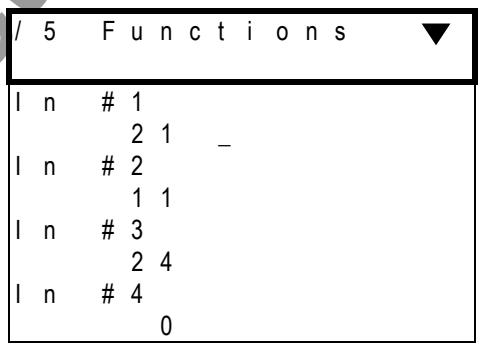


- Enter 0 (= OR) or 1 (= AND) to use an OR gate or AND gate and press the ENTER key.
- Enter 0 (=Instantaneous) or 1(=Latched) to select the reset timing and press the ENTER key.
- Press the END key to return to the "LED∗" screen.

Note: To release the latch state, refer to Section 4.2.1.

Assigning signals

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



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

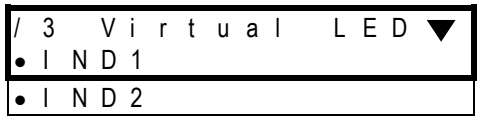
Note: If signals are not assigned to all the gates #1 to #4, enter 0 for the unassigned gate(s).

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

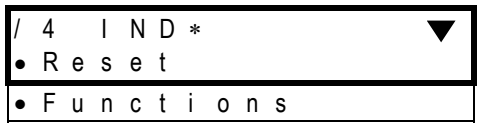
Repeat this process for all the LEDs to be configured.

Selection of virtual LEDs

- Select "Virtual LED" on the "/2 LED" screen to display the "Virtual LED" screen.

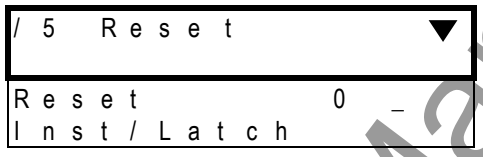


- Select the IND number and press the ENTER key to display the "IND∗" screen.



Setting the reset timing

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

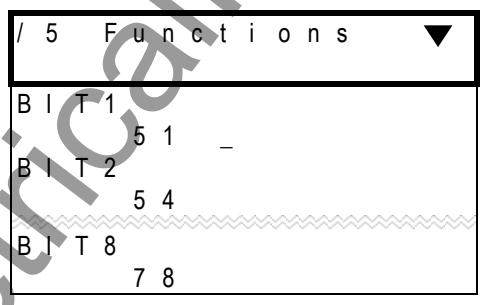


- Enter 0 (= Instantaneous) or 1(=Latched) to select the reset timing and press the ENTER key.
- Press the END key to return to the "IND∗" screen.

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

Assigning signals

- Select "Functions" on the "IND∗" screen to display the "Functions" screen.



- Assign signals to bits (1 to 8) by entering the number corresponding to each signal referring to Appendix A.

Note: If signals are not assigned to all the bits 1 to 8, enter 0 for the unassigned bit(s).

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

Repeat this process for both IND functions.

4.2.7 Testing

The sub-menu "Test" provides such functions as disabling the automatic monitoring function and forced operation of binary outputs.

Note: When operating the "Test" menu, the "IN SERVICE" LED is flickering. But if an alarm occurs during the test, the flickering stops. The "IN SERVICE" LED flickers only in a lighting state.

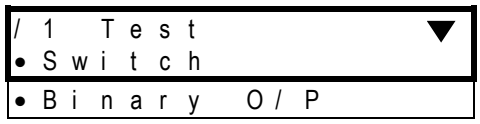
4.2.7.1 Scheme Switch

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

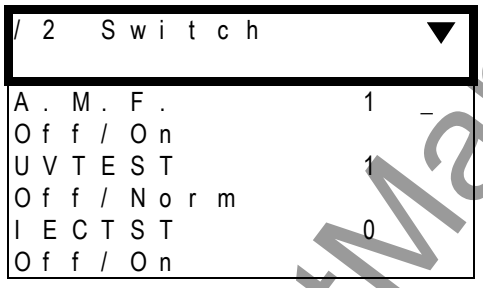
Disabling the A.M.F. inhibits trip blocking even in the event of a failure in the items being monitored by this function. It also prevents failures from being displayed on the "ALARM" LED and LCD described in Section 4.2.1. No events related to A.M.F. are recorded, either.

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

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



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

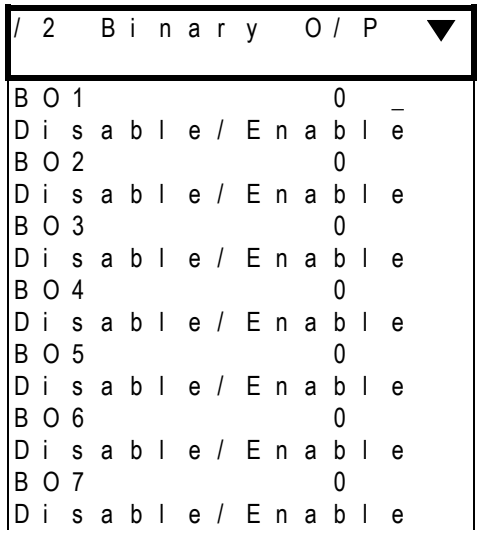


- Enter 0 or 1 to disable the A.M.F. or not and press the [ENTER] key.
- Enter 0 (=Off) or 1 (=Norm, enable) to set disable/enable the UV blocking (for UVTEST) and press the [ENTER] key.
- Enter 1(=On) for IECTST to transmit 'test mode' to the control system by IEC60870-5-103 communication when testing the local relay, and press the [ENTER] key.
- Press the [END] key to return to the "Test" screen.

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.



```
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.

4.3 Personal Computer Interface

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

- Display of current waveform: Oscillograph display
- Symmetrical component analysis: On arbitrary time span
- Harmonic analysis: On arbitrary time span
- Frequency analysis: On arbitrary time span

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

4.4 Relay Setting and Monitoring System

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

Figure 4.4.1 shows the 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.

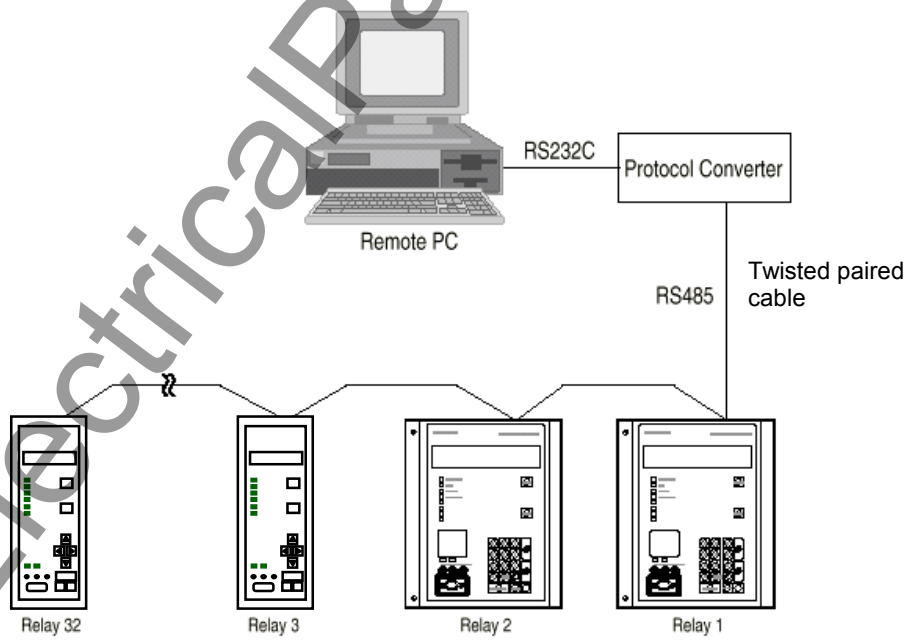


Figure 4.4.1 Relay Setting and Monitoring System

4.5 IEC 60870-5-103 Interface

The GRD130 supports 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 and status data from the relay to the control system. (For details, see Appendix L)

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

The protocol can be used through the RS485 port on the relay rear panel.

The relay supports two baud-rates 9.6kbps and 19.2kbps, and supports two normalizing factors 1.2 and 2.4 for measurand. These are selected by setting. See Section 4.2.6.4.

Note: In the relay model with phase-to-phase voltage input and the IECNFV=2.4 setting, if the phase-to-phase voltage Vab overs the full-scale of LCD indication, the measurand data will reach to the saturated value at approximately 1.5 [p.u.].

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

For the settings, see the Section 4.2.6.

4.6 Clock Function

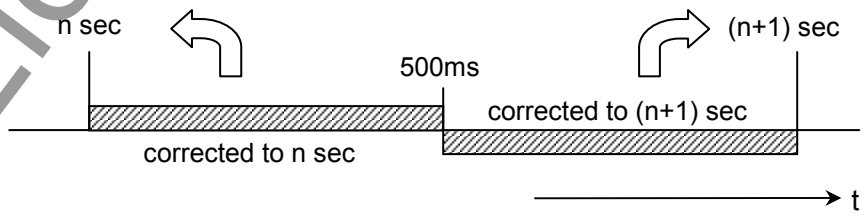
The clock function (Calendar clock) is used for time-tagging for the following purposes:

- Event records
- Disturbance records
- Fault records

The calendar clock can run locally or be synchronised with the external clock such as the binary time standard input signal, RSM clock or IEC60870-5-103. This can be selected by setting.

The "clock synchronise" function synchronises the relay internal clock to the binary input signal by the following method. Since the BI signal is an "ON" or "OFF" signal which cannot express year-month-day and hour-minute-second etc, synchronising is achieved by setting the number of milliseconds to zero. This method will give accurate timing if the synchronising BI signal is input every second.

Synchronisation is triggered by an "OFF" to "ON" (rising edge) transition of the BI signal. When the trigger is detected, the millisecond value of the internal clock is checked, and if the value is between 0~500ms then it is rounded down. If it is between 500~999ms then it is rounded up (ie the number of seconds is incremented).



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

Always store the relays in a clean, dry environment.

5.2 Relay Mounting

A flush mounting relay is included. Appendix E shows the case outlines.

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

5.3 Electrostatic Discharge

⚠CAUTION

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

5.4 Handling Precautions

A person's normal movements can easily generate electrostatic potentials of several thousand volts. Discharge of these voltages into semiconductor devices when handling electronic circuits can cause serious damage. This damage 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 the relay unit unnecessarily.

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

⚠CAUTION

- Before removing the relay unit, ensure that you are at the same electrostatic potential as the equipment by touching the case.
- Use the handle to draw out the relay unit. Avoid touching the electronic components, printed circuit board or connectors.
- Do not pass the relay unit to another person without first ensuring you are both at the same electrostatic potential. Shaking hands achieves equipotential.
- Place the relay unit on an anti-static surface, or on a conducting surface which is at the same potential as yourself.
- Do not place the relay unit in polystyrene trays.

It is strongly recommended that detailed investigations on electronic circuitry should be carried

out in a Special Handling Area such as described in the aforementioned IEC 60747.

5.5 External Connections

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

6. Commissioning and Maintenance

6.1 Outline of Commissioning Tests

The GRD130 is fully numerical and the hardware is continuously monitored.

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

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

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

Hardware tests

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

User interfaces
Binary input circuits and output circuits
AC input circuits

Function tests

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

Measuring elements
Metering and recording

Conjunctive tests

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

The following tests are included:

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

6.2 Cautions

6.2.1 Safety Precautions

⚠CAUTION

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

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

6.2.2 Cautions on Tests

⚠CAUTION

- While the power is on, do not drawout/insert the relay unit.
- Before turning on the power, check the following:
  - Make sure the polarity and voltage of the power supply are correct.
  - Make sure the VT circuit is not short.
- Be careful that the relay is not damaged due to an overcurrent or overvoltage.
- If settings are changed for testing, remember to reset them to the original settings.

Failure to observe any of the precautions above may cause damage or malfunction of the relay.

6.3 Preparations

Test equipment

The following test equipment is required for the commissioning tests.

1 Single-phase voltage source
1 Three-phase voltage source
1 DC power supply
3 AC voltmeter
1 Time counter, precision timer
1 PC (not essential)

Relay settings

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

For the default settings, see the following appendixes:

Appendix C Binary Output Default Setting List
Appendix G Relay Setting Sheet

Visual inspection

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

Relay ratings

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

Local PC

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

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

6.4 Hardware Tests

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

6.4.1 User Interfaces

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

LCD display

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

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

- Press the [RESET] key for one second or more and check that black dots appear on the whole screen.

LED display

- Apply the rated DC voltage and check that the "IN SERVICE" LED is lit in green.
- Press the [RESET] key for one second or more and check that remaining five LEDs are lit in red or yellow. (Programmable LEDs are yellow.)

VIEW and RESET keys

- Press the [VIEW] key when the LCD is off and check that the "Virtual LED" and "Metering" screens are sequentially 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.

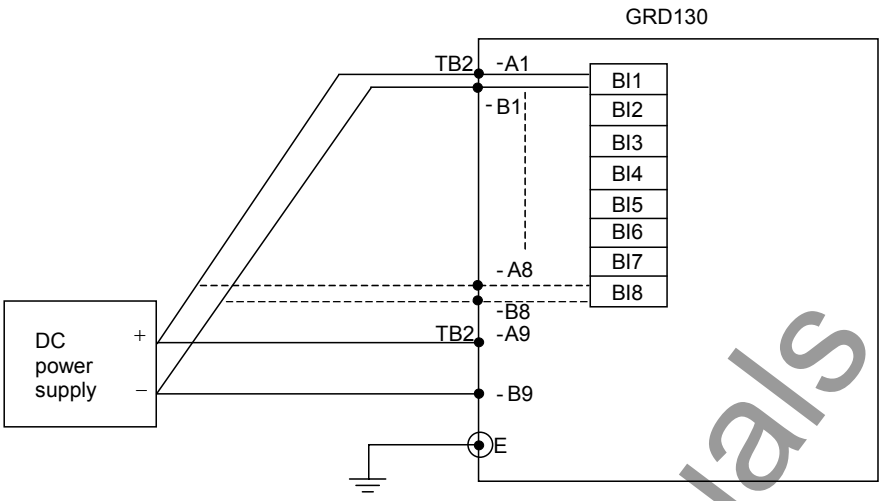


Figure 6.4.1 Testing Binary Input Circuit

- 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 0 0 0 ]
O P  [ 0 0 0 0  0 0 0 0 ]
```

- Apply the rated DC voltage to terminal A1-B1, A2-B2, ..., A8-B8 of terminal block TB2. Check that the status display corresponding to the input signal (IP) changes from 0 to 1. (For details of the binary input status display, see Section 4.2.4.2.)

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

6.4.3 Binary Output Circuit

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

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

```
/ 2  B i n a r y  O / P  ▼

B O 1                0  _
D i s a b l e / E n a b l e
B O 2                0
D i s a b l e / E n a b l e
B O 3                0
D i s a b l e / E n a b l e
B O 4                0
D i s a b l e / E n a b l e
B O 5                0
D i s a b l e / E n a b l e
B O 6                0
D i s a b l e / E n a b l e
B O 7                0
D i s a b l e / E n a b l e
```

- Enter 1 and press the [ENTER] key.

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

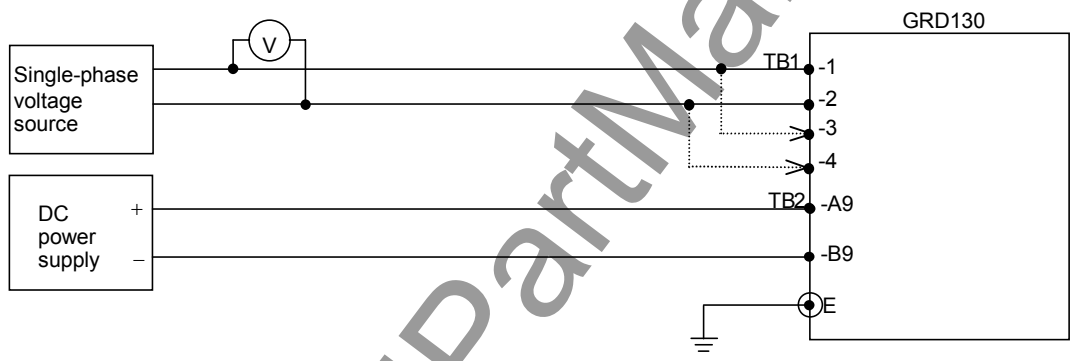
```
Operate?
ENTER=Y  CANCEL=N
```

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

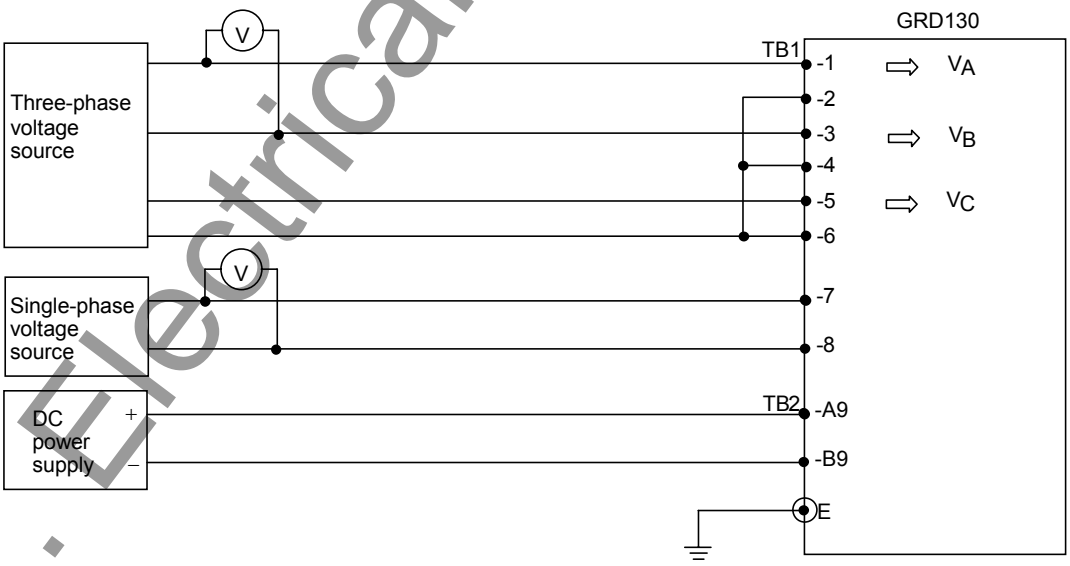
6.4.4 AC Input Circuits

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

The testing circuit is shown in Figure 6.4.2.



(a) Testing Circuit for Model 210



(b) Testing Circuit for Model 410

Figure 6.4.2 Testing AC Input Circuit

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

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

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

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

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

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

  "Status" sub-menu → "Metering" screen

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

6.5 Function Test

6.5.1 Measuring Element

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

Operation of the element under test is observed by assigning the signal number to a configurable LED or a binary output relay.

CAUTION

After testing, the original settings must be restored.

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

Assigning a signal to an LED

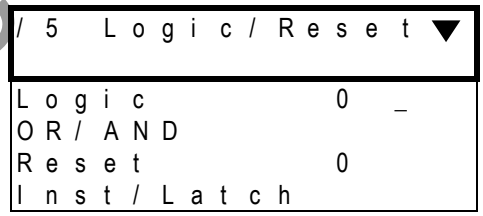
- Select "LED" on the "Set. (change)" screen to display the "2/ LED" screen.

- Select "LED" on the "/2 LED" screen to display the "/3 LED" screen.

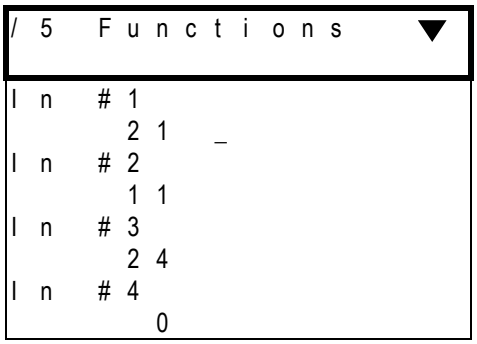
Note: The setting is required for all the LEDs. If any of the LEDs are not used, enter 0 to logic gates #1 to #4 in assigning signals.

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

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



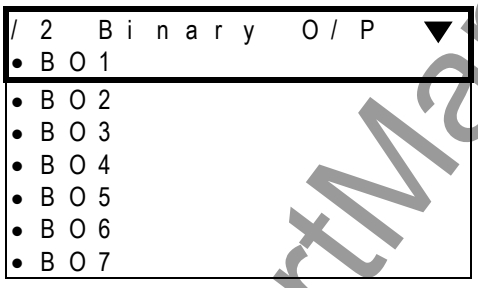
- Enter 0 (= OR) and press the [ENTER] key.
- Enter 0 (= Instantaneous) and press the [ENTER] key.
- Press the [END] key to return to the "LED∗" screen.
- Select "Functions" on the "LED∗" screen to display the "Functions" screen.



- Assign the gate In #1 the number corresponding to the testing element referring to Appendix A, and assign other gates the "0".

Assigning signal to Binary Output Relay

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

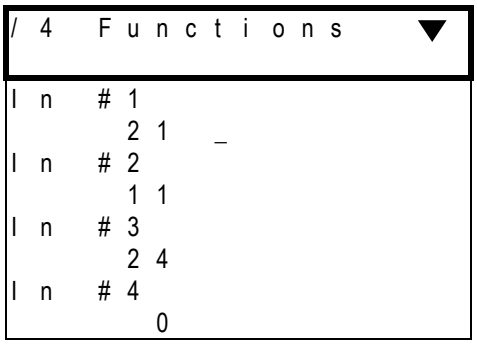


Note: The setting is required for all the binary outputs. If any of the binary outputs are not used, enter 0 to logic gates In #1 to #4 in assigning signals.

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

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

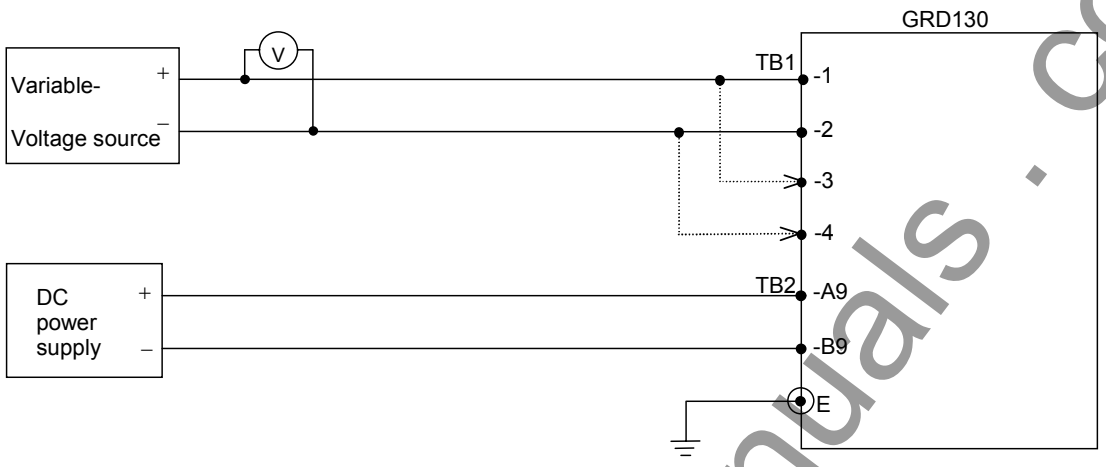
- Enter 0 (= OR) and press the ENTER key.
- Enter 0 (= Instantaneous) and press the ENTER key.
- Press the END key to return to the "BO∗" screen.
- Select "Functions" on the "BO∗" screen to display the "Functions" screen.



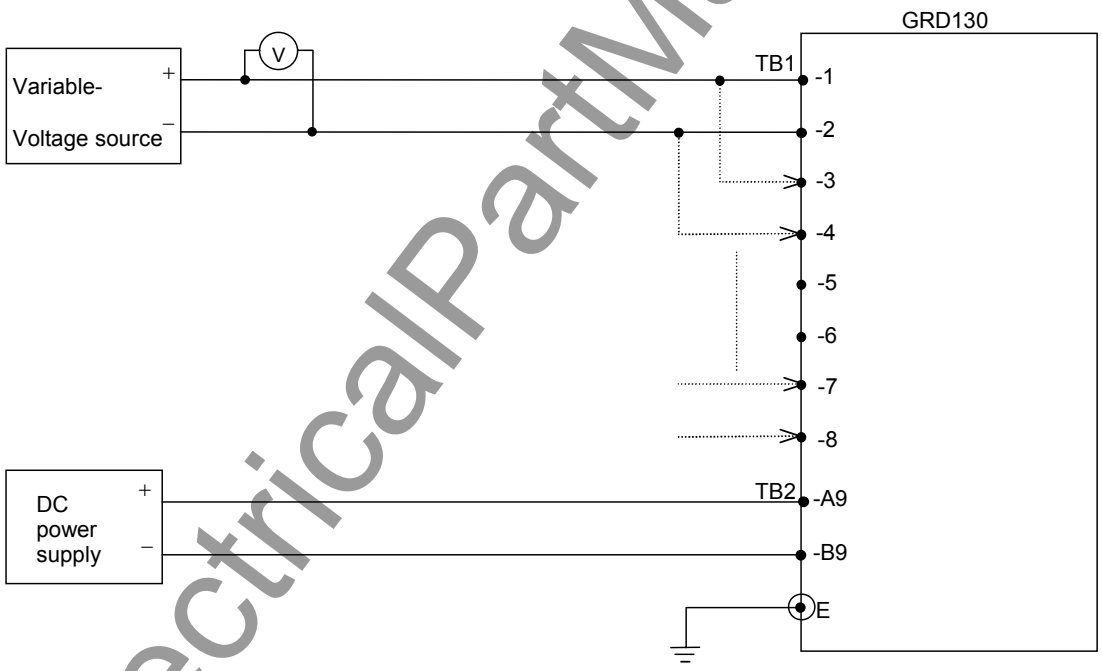
- Assign the gate In #1 the number corresponding to the testing element referring to Appendix A, and assign other gates the “0”.

6.5.1.1 Overvoltage and Undervoltage Elements

The testing circuit is shown in Figure 6.5.1.



(a) Testing Circuit for Model 210



(b) Testing Circuit for Model 410

Figure 6.5.1 Operating Value Test Circuit

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

Measuring element for Model 210	Signal number
OV1-AB, -BC	69, 70
OV2-AB, -BC	72, 73
OV3-AB, -BC	75, 76
UV1-AB, -BC	78, 79
UV2-AB, -BC	81, 82
UV3-AB, -BC	84, 85
OV1	87
OV2	88
OV3	89
UV1	90
UV2	91
UV3	92
ZPS1	93
ZPS2	94

Measuring element for Model 410	Signal number
OV1-A, -B, -C	51, 52, 53
OV2-A, -B, -C	54, 55, 56
OV3-A, -B, -C	57, 58, 59
UV1-A, -B, -C	60, 61, 62
UV2-A, -B, -C	63, 64, 65
UV3-A, -B, -C	66, 67, 68
OV1-AB, -BC, -CA	69, 70, 71
OV2-AB, -BC, -CA	72, 73, 74
OV3-AB, -BC, -CA	75, 76, 77
UV1-AB, -BC, -CA	78, 79, 80
UV2-AB, -BC, -CA	81, 82, 83
UV3-AB, -BC, -CA	84, 85, 86
ZPS1	93
ZPS2	94

Operating Value Test

Overvoltage element OV1, OV2, OV3, ZPS1, ZPS2

- 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 UV1, UV2, UV3

- 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 Check For Inverse Time (IDMT) Curve

- 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.

6.5.1.2 Negative sequence overvoltage element NPS1 and NPS2

The testing circuit is shown in Figure 6.5.2.

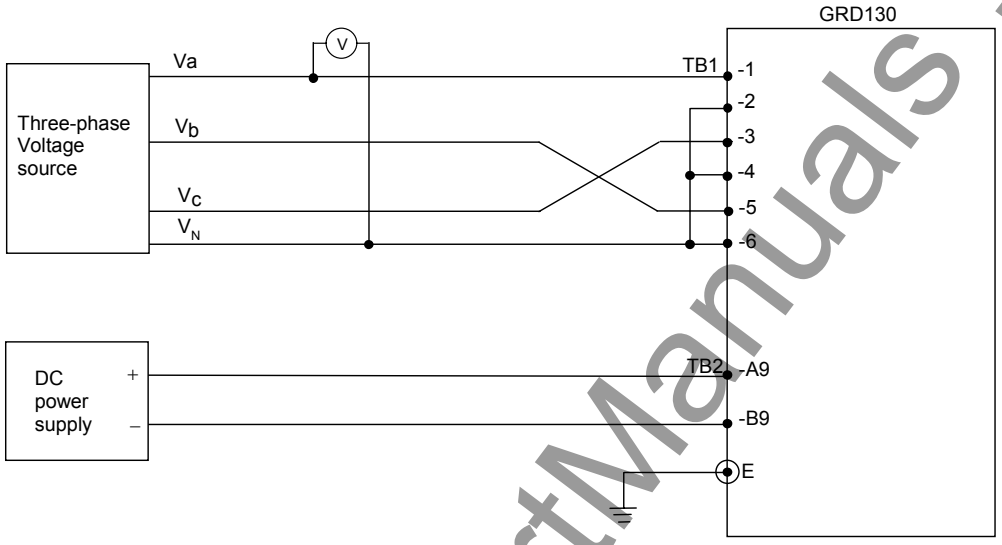


Figure 6.5.2 Testing NPS elements

The output signal of testing element is assigned to a configurable LED.

The output signal numbers of the elements are as follows:

Element	Signal No.
NPS1	95
NPS2	96

- Enter the signal number to observe the operation at the LED as shown in Section 6.5.1 and press the ENTER key.
- Apply the three-phase balance voltage and the operating voltage value is checked by increasing the magnitude of the voltage applied.

Check that the measured value is within 5% of the setting value.

6.5.2 Protection Scheme

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

Tripping is observed with the tripping command output relays.

Check that the indications and recordings are correct.

6.5.3 Metering and Recording

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

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

Recording events are listed in Appendix B. There are internal events and external events by binary input commands. Event recording on the external event can be checked by changing the status of binary input command 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. Record" screen is correct. 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. record" screen and check that the descriptions are correct.

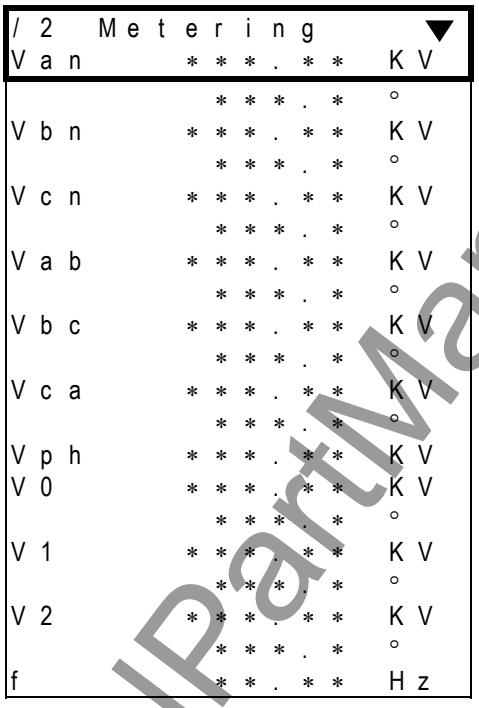
Details can be displayed on the PC. Check that the descriptions on the PC are correct. For details on how to obtain disturbance records on the PC, see the RSM100 Manual.

6.6 Conjunctive Tests

6.6.1 On Load Test

For the polarity check of the voltage transformers, check the voltage and phase angle with the metering displays on the LCD screen.

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



Note: The magnitude of voltage can be set in values on the primary side or on the secondary side by the setting. (The default setting is the secondary side.)
Phase angles above are expressed taking that of positive sequence voltage (V1) as a reference phase angle. When the V1 is not available, phase angles are not displayed.

6.6.2 Tripping Circuit Test

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

Tripping circuit

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

```
/2 Binary O/P ▼
BO1                0 _
Disable/Enable
BO2                0
Disable/Enable
BO3                0
Disable/Enable
BO4                0
Disable/Enable
BO5                0
Disable/Enable
BO6                0
Disable/Enable
BO7                0
Disable/Enable
```

BO1 to BO7 are output relays with one normally open contact.

- Enter 1 for BO1 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 BO1 and check that the A-phase breaker is tripped.
- Stop pressing the [ENTER] key to reset the operation.
- Repeat the above for BO2 to BO7.

6.7 Maintenance

6.7.1 Regular Testing

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

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

6.7.2 Failure Tracing and Repair

Failures will be detected by automatic supervision or regular testing.

When a failure is detected by supervision, a remote alarm is issued with the binary output relay of FAIL and the failure is indicated on the front panel with LED indicators or LCD display. It is also recorded in the event record.

Failures detected by supervision are traced by checking the "Err: " screen on the LCD. Table 6.7.1 shows LCD messages and failure locations.

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

Table 6.7.1 LCD Message and Failure Location

Message	Failure location		
	Relay Unit	AC cable	CB or cable
Err: SUM	×(Flash memory)		
Err: RAM	×(SRAM)		
Err: BRAM	×(Backup RAM)		
Err: EEP	×(EEPROM)		
Err: A/D	×(A/D converter)		
Err: DC	×(DC power supply circuit)		
Err: TC	×(Tripping circuit)(1)		× (2)
Err: V_0, V_2	× (AC input circuit)(1)	× (2)	
Err: CB	× (Circuit breaker)(1)		× (2)

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

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

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

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

6.7.3 Replacing Failed Relay Unit

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

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

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

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

Replacing the relay unit

CAUTION After replacing the relay unit, check the settings.

The procedure of relay withdrawal and insertion is as follows:

- Switch off the DC power supply.

  ⚠ WARNING Hazardous voltage may remain in the DC circuit just after switching off the DC power supply. It takes about 30 seconds for the voltage to discharge.

- Disconnect the trip outputs.
- Open 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.
- Check that the relay unit and its case have the identical Model Number when inserting the relay unit.

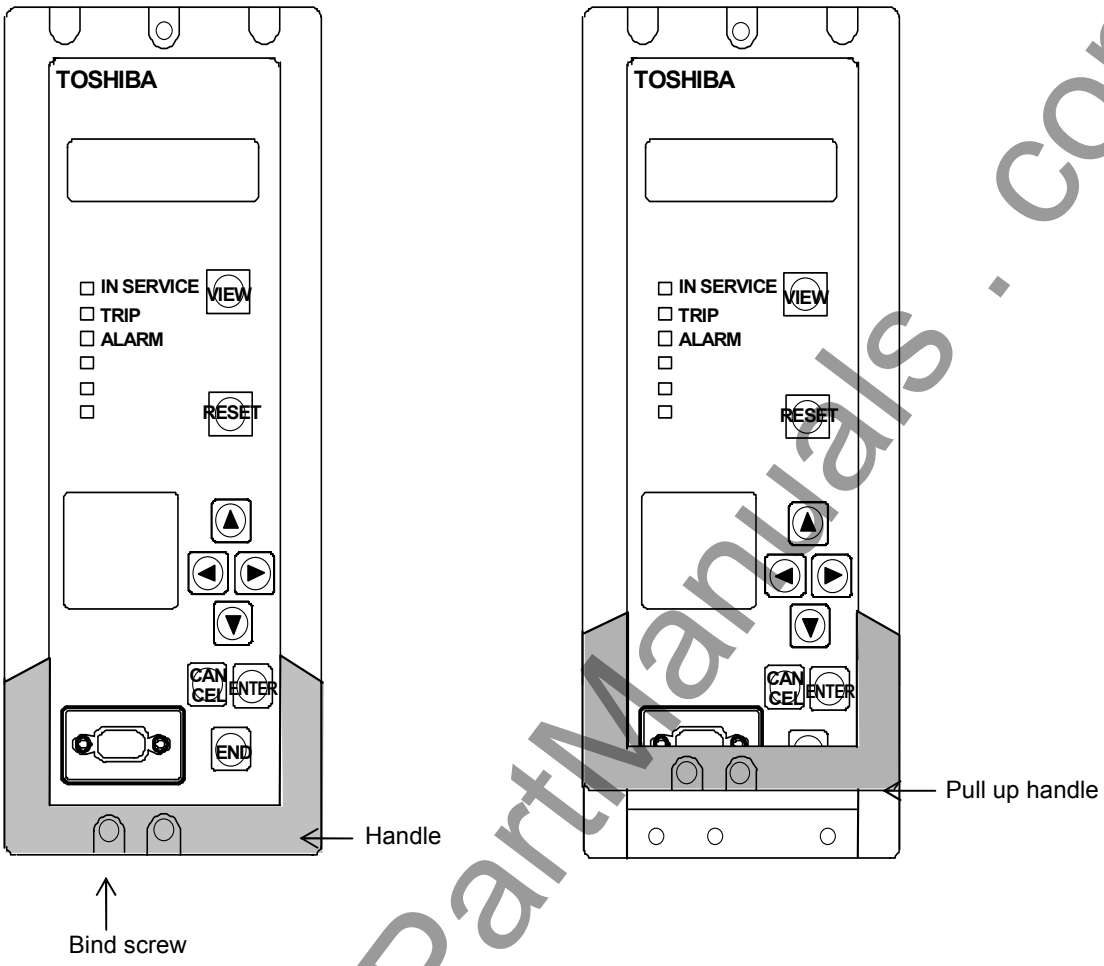


Figure 6.7.1 Handle of Relay Unit

6.7.4 Resumption of Service

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

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

6.7.5 Storage

The spare relay should be stored in a dry and clean room. Based on IEC Standard 60255-6 the storage temperature should be –25°C to +70°C, but the temperature of 0°C to +40°C is recommended for long-term storage.

7. Putting Relay into Service

The following procedure must be adhered to when putting the relay into service after finishing the commissioning tests or maintenance tests.

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

  In particular, when settings are changed temporarily for testing, be sure to restore them.
- Clear any unnecessary records on faults, events and disturbances which are recorded during the tests.
- If dc power has not been supplied to the relay for two days or more, then internal clock may be cleared soon after restoring the power. This is because the back-up RAM may have discharged and may contain uncertain data. Set the internal clock again.
- 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

Signal List

Signal list

No.		Contents
0		Not in use
1	BI1 COMMAND	Binary input signal of BI1
2	BI2 COMMAND	Binary input signal of BI2
3	BI3 COMMAND	Binary input signal of BI3
4	BI4 COMMAND	Binary input signal of BI4
5	BI5 COMMAND	Binary input signal of BI5
6	BI6 COMMAND	Binary input signal of BI6
7	BI7 COMMAND	Binary input signal of BI7
8	BI8 COMMAND	Binary input signal of BI8
9		
10		
11	SET.GROUP1	BI command of change active setting group1
12	SET.GROUP2	2
13	SET.GROUP3	3
14	SET.GROUP4	4
15	OV1 BLOCK	BI command of OV1 protection scheme block
16	OV2 BLOCK	OV2
17	OV3 BLOCK	OV3
18	UV1 BLOCK	BI command of UV1 protection scheme block
19	UV2 BLOCK	UV2
20	UV3 BLOCK	UV3
21	ZPS1 BLOCK	BI command of ZPS1 protection scheme block
22	ZPS2 BLOCK	ZPS2
23	NPS1 BLOCK	BI command of NPS1 protection scheme block
24	NPS2 BLOCK	NPS2
25	TC FAIL	BI command of Trip circuit Fail Alarm
26	CB CONT OPN	BI command of CB N/O contact
27	CB CONT CLS	BI command of CB N/C contact
28	EXT TRIP-3PH	BI command of External trip (3 Phase)
29	EXT TRIP-APH	(A Phase)
30	EXT TRIP-BPH	(B Phase)
31	EXT TRIP-CPH	(C Phase)
32	REMOTE RESET	BI command of Remote reset
33	SYNC CLOCK	BI command of Synchronise Clock
34	STORE RECORD	BI command of Store Disturbance Record
35	ALARM1	BI command of Alarm1
36	ALARM2	2
37	ALARM3	3
38	ALARM4	4
39	OV1-A_INST	OV1-A relay element start
40	OV1-B_INST	OV1-B relay element start
41	OV1-C_INST	OV1-C relay element start
42	OV1-AB_INST	OV1-AB relay element start
43	OV1-BC_INST	OV1-BC relay element start
44	OV1-CA_INST	OV1-CA relay element start
45	OV2-A_INST	OV2-A relay element start
46	OV2-B_INST	OV2-B relay element start
47	OV2-C_INST	OV2-C relay element start
48	OV2-AB_INST	OV2-AB relay element start
49	OV2-BC_INST	OV2-BC relay element start
50	OV2-CA_INST	OV2-CA relay element start
51	OV1-A	OV1-1 relay element output
52	B	2
53	C	3
54	OV2-A	OV2-1 relay element output
55	B	2
56	C	3
57	OV3-A	OV3-1 relay element output
58	B	2
59	C	3
60	UV1-A	UV1-1 relay element output
61	B	2
62	C	3
63	UV2-A	UV2-1 relay element output
64	B	2
65	C	3

Signal list

No.	Signal name	Contents
66	UV3-A	UV3-1 relay element output
67	B	2
68	C	3
69	OV1-AB	OV1-1 relay element output (phase to phase)
70	BC	2
71	CA	3
72	OV2-AB	OV2-1 relay element output
73	BC	2
74	CA	3
75	OV3-AB	OV3-1 relay element output
76	BC	2
77	CA	3
78	UV1-AB	UV1-1 relay element output
79	BC	2
80	CA	3
81	UV2-AB	UV2-1 relay element output
82	BC	2
83	CA	3
84	UV3-AB	UV3-1 relay element output
85	BC	2
86	CA	3
87	OV1	OV1-1 relay element output for 1PP and 1PN settings
88	OV2	OV2-1 relay element output for 1PP and 1PN settings
89	OV3	OV3-1 relay element output for 1PP and 1PN settings
90	UV1	UV1-1 relay element output for 1PP and 1PN settings
91	UV2	UV2-1 relay element output for 1PP and 1PN settings
92	UV3	UV3-1 relay element output for 1PP and 1PN settings
93	ZPS1	ZPS1 relay element ouput
94	2	2
95	NPS1	NPS1 relay element ouput
96	2	2
97	UVBLK	UV blocked element operating
98		
99	OV1_INST	OV1 relay element start
100	OV2_INST	OV2 relay element start
101	OV1 TRIP	OV1 trip command
102	OV1-A TRIP	ditto (Phase 1)
103	B	2
104	C	3
105	OV1-AB TRIP	ditto (Phase 1)
106	BC	2
107	CA	3
108	OV2 TRIP	OV2 trip command
109	OV2-A TRIP	ditto (Phase 1)
110	B	2
111	C	3
112	OV2-AB TRIP	ditto (Phase 1)
113	BC	2
114	CA	3
115	OV3 ALARM	OV3 alarm command
116	OV3-A ALARM	ditto (Phase 1)
117	B	2
118	C	3
119	OV3-AB ALARM	ditto (Phase 1)
120	BC	2
121	CA	3
122	UV1 TRIP	UV1 trip command
123	UV1-A TRIP	ditto (Phase 1)
124	B	2
125	C	3
126	UV1-AB TRIP	ditto (Phase 1)
127	BC	2
128	CA	3
129	UV2 TRIP	UV2 trip command
130	UV2-A TRIP	ditto (Phase 1)
131	B	2
132	C	3

Signal list

No.	Signal name	Contents
133	UV2-AB TRIP	ditto (Phase 1)
134	BC	2
135	CA	3
136	UV3 ALARM	UV3 alarm command
137	UV3-A ALARM	ditto (Phase 1)
138	B	2
139	C	3
140	UV3-AB ALARM	ditto (Phase 1)
141	BC	2
142	CA	3
143	ZPS1 TRIP	ZPS1 trip command
144	2 ALARM	2 alarm command
145	NPS1 TRIP	NPS1 trip command
146	2 ALARM	2 alarm command
147	GEN.TRIP	General trip command
148	GEN.TRIP-A	ditto (Phase 1)
149	B	2
150	C	3
151	GEN.TRIP-AB	ditto (Phase 1)
152	BC	2
153	CA	3
154	GEN.ALARM	General alarm command
155		
156		
157	UV1-A_INST	UV1-A relay element start
158	UV1-B_INST	UV1-B relay element start
159	UV1-C_INST	UV1-C relay element start
160	A.M.F.OFF	Auotmatic monitoring function off
161	RELAY FAIL	Relay failure & trip blocked alarm
162	RELAY FAIL-A	Relay failure alarm (Trip not blocked)
163	TCSV	Trip circiut supervision failure
164	CBSV	Circuit breaker status monitoring failure
165	TC ALARM	Trip counter alarm
166		
167	UV1-AB_INST	UV1-AB relay element start
168	UV1-BC_INST	UV1-BC relay element start
169	UV1-CA_INST	UV1-CA relay element start
170	BO1 OP	Binary output 1
171	BO2 OP	Binary output 2
172	BO3 OP	Binary output 3
173	BO4 OP	Binary output 4
174	BO5 OP	Binary output 5
175	BO6 OP	Binary output 6
176	BO7 OP	Binary output 7
177	UV2-A_INST	UV2-A relay element start
178	UV2-B_INST	UV2-B relay element start
179	UV2-C_INST	UV2-C relay element start
180		
181	LCD IND.	LCD indication(Birtual LED) command
182	LCD IND1.	LCD indication1(Birtual LE1) command
183	LCD IND2.	LCD indication2(Birtual LED) command
184		
185		
186	TESTING	Testing LED lit output
187	UV2-AB_INST	UV2-AB relay element start
188	UV2-BC_INST	UV2-BC relay element start
189	UV2-CA_INST	UV2-CA relay element start
190		
191	UV1_INST	UV1 relay element start
192	UV2_INST	UV2 relay element start
193	PROT.COM.ON	IEC103 communication command
194	IECTST	IEC103 communication test
195	IECBLK	IEC103 communication block
196		
197	ZPS1_INST	ZPS1 element start
198	ZPS2_INST	ZPS2 element start
199	NPS1_INST	NPS1 element start
200	NPS2_INST	NPS2 element start

Appendix B

Event Record Items

Event Record Item

	Record item (LCD indication)								
	Model 210 APPL setting			Model 410 APPL setting					
No.	1PP	1PN	2PP	3PN	3PV	3PP	2PP		Contents
1	GEN.trip	GEN.trip	GEN.trip	GEN.trip	GEN.trip	GEN.trip	GEN.trip	Off/On	General trip command
2				GEN.trip-A	GEN.trip-A			Off/On	General trip command (Phase 1)
3				GEN.trip-B	GEN.trip-B			Off/On	General trip command (Phase 2)
4				GEN.trip-C	GEN.trip-C			Off/On	General trip command (Phase 3)
5			GEN.trip-AB			GEN.trip-AB	GEN.trip-AB	Off/On	General trip command (Phase 1)
6			GEN.trip-BC			GEN.trip-BC	GEN.trip-BC	Off/On	General trip command (Phase 2)
7						GEN.trip-CA		Off/On	General trip command (Phase 3)
8				OV1-A trip	OV1-A trip			Off/On	OV1 trip command (Phase 1)
9				OV1-B trip	OV1-B trip			Off/On	OV1 trip command (Phase 2)
10				OV1-C trip	OV1-C trip			Off/On	OV1 trip command (Phase 3)
11				OV2-A trip	OV2-A trip			Off/On	OV2 trip command (Phase 1)
12				OV2-B trip	OV2-B trip			Off/On	OV2 trip command (Phase 2)
13				OV2-C trip	OV2-C trip			Off/On	OV2 trip command (Phase 3)
14				OV3-A alarm	OV3-A alarm			Off/On	OV3 alarm command (Phase 1)
15				OV3-B alarm	OV3-B alarm			Off/On	OV3 alarm command (Phase 2)
16				OV3-C alarm	OV3-C alarm			Off/On	OV3 alarm command (Phase 3)
17				UV1-A trip	UV1-A trip			Off/On	UV1 trip command (Phase 1)
18				UV1-B trip	UV1-B trip			Off/On	UV1 trip command (Phase 2)
19				UV1-C trip	UV1-C trip			Off/On	UV1 trip command (Phase 3)
20				UV2-A trip	UV2-A trip			Off/On	UV2 trip command (Phase 1)
21				UV2-B trip	UV2-B trip			Off/On	UV2 trip command (Phase 2)
22				UV2-C trip	UV2-C trip			Off/On	UV2 trip command (Phase 3)
23				UV3-A alarm	UV3-A alarm			Off/On	UV3 alarm command (Phase 1)
24				UV3-B alarm	UV3-B alarm			Off/On	UV3 alarm command (Phase 2)
25				UV3-C alarm	UV3-C alarm			Off/On	UV3 alarm command (Phase 3)
26			OV1-AB trip			OV1-AB trip	OV1-AB trip	Off/On	OV1 trip command (Phase 1)
27			OV1-BC trip			OV1-BC trip	OV1-BC trip	Off/On	OV1 trip command (Phase 2)
28						OV1-CA trip		Off/On	OV1 trip command (Phase 3)
29			OV2-AB trip			OV2-AB trip	OV2-AB trip	Off/On	OV2 trip command (Phase 1)
30			OV2-BC trip			OV2-BC trip	OV2-BC trip	Off/On	OV2 trip command (Phase 2)
31						OV2-CA trip		Off/On	OV2 trip command (Phase 3)
32			OV3-AB alarm			OV3-AB alarm	OV3-AB alarm	Off/On	OV3 alarm command (Phase 1)
33			OV3-BC alarm			OV3-BC alarm	OV3-BC alarm	Off/On	OV3 alarm command (Phase 2)
34						OV3-CA alarm		Off/On	OV3 alarm command (Phase 3)
35			UV1-AB trip			UV1-AB trip	UV1-AB trip	Off/On	UV1 trip command (Phase 1)
36			UV1-BC trip			UV1-BC trip	UV1-BC trip	Off/On	UV1 trip command (Phase 2)
37						UV1-CA trip		Off/On	UV1 trip command (Phase 3)
38			UV2-AB trip			UV2-AB trip	UV2-AB trip	Off/On	UV2 trip command (Phase 1)
39			UV2-BC trip			UV2-BC trip	UV2-BC trip	Off/On	UV2 trip command (Phase 2)
40						UV2-CA trip		Off/On	UV2 trip command (Phase 3)
41			UV3-AB alarm			UV3-AB alarm	UV3-AB alarm	Off/On	UV3 alarm command (Phase 1)
42			UV3-BC alarm			UV3-BC alarm	UV3-BC alarm	Off/On	UV3 alarm command (Phase 2)
43						UV3-CA alarm		Off/On	UV3 alarm command (Phase 3)
44	OV1 trip	OV1 trip						Off/On	OV1 trip command (Phase 1)
45	OV2 trip	OV2 trip						Off/On	OV2 trip command (Phase 1)
46	OV3 alarm	OV3 alarm						Off/On	OV3 alarm command (Phase 1)
47	UV1 trip	UV1 trip						Off/On	UV1 trip command (Phase 1)
48	UV2 trip	UV2 trip						Off/On	UV2 trip command (Phase 1)
49	UV3 alarm	UV3 alarm						Off/On	UV3 alarm command (Phase 1)
50	ZPS1 trip	ZPS1 trip		ZPS1 trip	ZPS1 trip	ZPS1 trip	ZPS1 trip	Off/On	ZPS1 trip command
51	ZPS2 alarm	ZPS2 alarm		ZPS2 alarm	ZPS2 alarm	ZPS2 alarm	ZPS2 alarm	Off/On	ZPS2 alarm command
52			NPS1 trip	NPS1 trip	NPS1 trip	NPS1 trip	NPS1 trip	Off/On	NPS1 trip command
53			NPS2 alarm	NPS2 alarm	NPS2 alarm	NPS2 alarm	NPS2 alarm	Off/On	NPS2 alarm command

	Record item (LCD indication)								
	Model 210 APPL setting			Model 410 APPL setting					
No.	1PP	1PN	2PP	3PN	3PV	3PP	2PP		Contents
54				OV1-A	OV1-A			Off/On	OV1-1 relay element operating
55				OV1-B	OV1-B			Off/On	OV1-2 relay element operating
56				OV1-C	OV1-C			Off/On	OV1-3 relay element operating
57				OV2-A	OV2-A			Off/On	OV2-1 relay element operating
58				OV2-B	OV2-B			Off/On	OV2-2 relay element operating
59				OV2-C	OV2-C			Off/On	OV2-3 relay element operating
60				OV3-A	OV3-A			Off/On	OV3-1 relay element operating
61				OV3-B	OV3-B			Off/On	OV3-2 relay element operating
62				OV3-C	OV3-C			Off/On	OV3-3 relay element operating
63				UV1-A	UV1-A			Off/On	UV1-1 relay element operating
64				UV1-B	UV1-B			Off/On	UV1-2 relay element operating
65				UV1-C	UV1-C			Off/On	UV1-3 relay element operating
66				UV2-A	UV2-A			Off/On	UV2-1 relay element operating
67				UV2-B	UV2-B			Off/On	UV2-2 relay element operating
68				UV2-C	UV2-C			Off/On	UV2-3 relay element operating
69				UV3-A	UV3-A			Off/On	UV3-1 relay element operating
70				UV3-B	UV3-B			Off/On	UV3-2 relay element operating
71				UV3-C	UV3-C			Off/On	UV3-3 relay element operating
72			OV1-AB			OV1-AB	OV1-AB	Off/On	OV1-1 relay element operating
73			OV1-BC			OV1-BC	OV1-BC	Off/On	OV1-2 relay element operating
74						OV1-CA		Off/On	OV1-3 relay element operating
75			OV2-AB			OV2-AB	OV2-AB	Off/On	OV2-1 relay element operating
76			OV2-BC			OV2-BC	OV2-BC	Off/On	OV2-2 relay element operating
77						OV2-CA		Off/On	OV2-3 relay element operating
78			OV3-AB			OV3-AB	OV3-AB	Off/On	OV3-1 relay element operating
79			OV3-BC			OV3-BC	OV3-BC	Off/On	OV3-2 relay element operating
80						OV3-CA		Off/On	OV3-3 relay element operating
81			UV1-AB			UV1-AB	UV1-AB	Off/On	UV1-1 relay element operating
82			UV1-BC			UV1-BC	UV1-BC	Off/On	UV1-2 relay element operating
83						UV1-CA		Off/On	UV1-3 relay element operating
84			UV2-AB			UV2-AB	UV2-AB	Off/On	UV2-1 relay element operating
85			UV2-BC			UV2-BC	UV2-BC	Off/On	UV2-2 relay element operating
86						UV2-CA		Off/On	UV2-3 relay element operating
87			UV3-AB			UV3-AB	UV3-AB	Off/On	UV3-1 relay element operating
88			UV3-BC			UV3-BC	UV3-BC	Off/On	UV3-2 relay element operating
89						UV3-CA		Off/On	UV3-3 relay element operating
90	OV1	OV1						Off/On	OV1-1 relay element operating
91	OV2	OV2						Off/On	OV2-1 relay element operating
92	OV3	OV3						Off/On	OV3-1 relay element operating
93	UV1	UV1						Off/On	UV1-1 relay element operating
94	UV2	UV2						Off/On	UV2-1 relay element operating
95	UV3	UV3						Off/On	UV3-1 relay element operating
96	ZPS1	ZPS1		ZPS1	ZPS1	ZPS1	ZPS1	Off/On	ZPS1 relay element operating
97	ZPS2	ZPS2		ZPS2	ZPS2	ZPS2	ZPS2	Off/On	ZPS2 relay element operating
98			NPS1	NPS1	NPS1	NPS1	NPS1	Off/On	NPS1 relay element operating
99			NPS2	NPS2	NPS2	NPS2	NPS2	Off/On	NPS2 relay element operating
100	UVBLK	UVBLK	UVBLK	UVBLK	UVBLK	UVBLK	UVBLK	On	UV blocked element operationg

	Record item (LCD indication)								
	Model 210			Model 410					
	APPL setting			APPL setting					Contents
No.	1PP	1PN	2PP	3PN	3PV	3PP	2PP		
101	BI1 command	BI1 command	BI1 command	BI1 command	BI1 command	BI1 command	BI1 command	Off/On	Binary input signal of BI1
102	BI2 command	BI2 command	BI2 command	BI2 command	BI2 command	BI2 command	BI2 command	Off/On	Binary input signal of BI2
103	BI3 command	BI3 command	BI3 command	BI3 command	BI3 command	BI3 command	BI3 command	Off/On	Binary input signal of BI3
104	BI4 command	BI4 command	BI4 command	BI4 command	BI4 command	BI4 command	BI4 command	Off/On	Binary input signal of BI4
105	BI5 command	BI5 command	BI5 command	BI5 command	BI5 command	BI5 command	BI5 command	Off/On	Binary input signal of BI5
106	BI6 command	BI6 command	BI6 command	BI6 command	BI6 command	BI6 command	BI6 command	Off/On	Binary input signal of BI6
107	BI7 command	BI7 command	BI7 command	BI7 command	BI7 command	BI7 command	BI7 command	Off/On	Binary input signal of BI7
108	BI8 command	BI8 command	BI8 command	BI8 command	BI8 command	BI8 command	BI8 command	Off/On	Binary input signal of BI8
109	SET.group1	SET.group1	SET.group1	SET.group1	SET.group1	SET.group1	SET.group1	Off/On	BI command of change active setting group1
110	SET.group2	SET.group2	SET.group2	SET.group2	SET.group2	SET.group2	SET.group2	Off/On	BI command of change active setting group2
111	SET.group3	SET.group3	SET.group3	SET.group3	SET.group3	SET.group3	SET.group3	Off/On	BI command of change active setting group3
112	SET.group4	SET.group4	SET.group4	SET.group4	SET.group4	SET.group4	SET.group4	Off/On	BI command of change active setting group4
113	OV1 block	OV1 block	OV1 block	OV1 block	OV1 block	OV1 block	OV1 block	Off/On	BI command of OV1 protection scheme block
114	OV2 block	OV2 block	OV2 block	OV2 block	OV2 block	OV2 block	OV2 block	Off/On	BI command of OV2 protection scheme block
115	OV3 block	OV3 block	OV3 block	OV3 block	OV3 block	OV3 block	OV3 block	Off/On	BI command of OV3 protection scheme block
116	UV1 block	UV1 block	UV1 block	UV1 block	UV1 block	UV1 block	UV1 block	Off/On	BI command of UV1 protection scheme block
117	UV2 block	UV2 block	UV2 block	UV2 block	UV2 block	UV2 block	UV2 block	Off/On	BI command of UV2 protection scheme block
118	UV3 block	UV3 block	UV3 block	UV3 block	UV3 block	UV3 block	UV3 block	Off/On	BI command of UV3 protection scheme block
119	ZPS1 block	ZPS1 block		ZPS1 block	ZPS1 block	ZPS1 block	ZPS1 block	Off/On	BI command of ZPS1 protection scheme block
120	ZPS2 block	ZPS2 block		ZPS2 block	ZPS2 block	ZPS2 block	ZPS2 block	Off/On	BI command of ZPS2 protection scheme block
121			NPS1 block	NPS1 block	NPS1 block	NPS1 block	NPS1 block	Off/On	BI command of NPS1 protection scheme block
122			NPS2 block	NPS2 block	NPS2 block	NPS2 block	NPS2 block	Off/On	BI command of NPS2 protection scheme block
123	TC fail	TC fail	TC fail	TC fail	TC fail	TC fail	TC fail	Off/On	BI command of Trip circuit Fail Alarm
124	CB CONT OPN	CB CONT OPN	CB CONT OPN	CB CONT OPN	CB CONT OPN	CB CONT OPN	CB CONT OPN	Off/On	BI command of CB N/O contact
125	CB CONT CLS	CB CONT CLS	CB CONT CLS	CB CONT CLS	CB CONT CLS	CB CONT CLS	CB CONT CLS	Off/On	BI command of CB N/C contact
126	EXT trip-3PH	EXT trip-3PH	EXT trip-3PH	EXT trip-3PH	EXT trip-3PH	EXT trip-3PH	EXT trip-3PH	Off/On	BI command of External trip (3 Phase)
127	EXT trip-APH	EXT trip-APH	EXT trip-APH	EXT trip-APH	EXT trip-APH	EXT trip-APH	EXT trip-APH	Off/On	BI command of External trip (A Phase)
128	EXT trip-BPH	EXT trip-BPH	EXT trip-BPH	EXT trip-BPH	EXT trip-BPH	EXT trip-BPH	EXT trip-BPH	Off/On	BI command of External trip (B Phase)
129	EXT trip-CPH	EXT trip-CPH	EXT trip-CPH	EXT trip-CPH	EXT trip-CPH	EXT trip-CPH	EXT trip-CPH	Off/On	BI command of External trip (C Phase)
130	Remote reset	Remote reset	Remote reset	Remote reset	Remote reset	Remote reset	Remote reset	Off/On	BI command of Remote reset
131	SYNC clock	SYNC clock	SYNC clock	SYNC clock	SYNC clock	SYNC clock	SYNC clock	Off/On	BI command of Synchronise Clock
132	Store record	Store record	Store record	Store record	Store record	Store record	Store record	Off/On	BI command of Store Disturbance Record
133	Alarm1	Alarm1	Alarm1	Alarm1	Alarm1	Alarm1	Alarm1	Off/On	BI command of Alarm1
134	Alarm2	Alarm2	Alarm2	Alarm2	Alarm2	Alarm2	Alarm2	Off/On	BI command of Alarm2
135	Alarm3	Alarm3	Alarm3	Alarm3	Alarm3	Alarm3	Alarm3	Off/On	BI command of Alarm3
136	Alarm4	Alarm4	Alarm4	Alarm4	Alarm4	Alarm4	Alarm4	Off/On	BI command of Alarm4
137	Relay fail	Relay fail	Relay fail	Relay fail	Relay fail	Relay fail	Relay fail	Off/On	Relay failure & trip blocked alarm
138	Relay fail-A	Relay fail-A	Relay fail-A	Relay fail-A	Relay fail-A	Relay fail-A	Relay fail-A	Off/On	Relay failure alarm (Trip not blocked)
139	TC err	TC err	TC err	TC err	TC err	TC err	TC err	Off/On	Trip circiut supervision failure
140	CB err	CB err	CB err	CB err	CB err	CB err	CB err	Off/On	Circuit breaker status monitoring failure
141				V0 err				Off/On	Analog input imbalance failure (V0)
142				V2 err	V2 err	V2 err		Off/On	Analog input imbalance failure (V2)
143	TP COUNT ALM	TP COUNT ALM	TP COUNT ALM	TP COUNT ALM	TP COUNT ALM	TP COUNT ALM	TP COUNT ALM	Off/On	Trip counter alarm
144	F.record CLR	F.record CLR	F.record CLR	F.record CLR	F.record CLR	F.record CLR	F.record CLR	On	Clear Fault records
145	E.record CLR	E.record CLR	E.record CLR	E.record CLR	E.record CLR	E.record CLR	E.record CLR	On	Clear Event records
146	D.record CLR	D.record CLR	D.record CLR	D.record CLR	D.record CLR	D.record CLR	D.record CLR	On	Clear Disturbance records
147	TP COUNT CLR	TP COUNT CLR	TP COUNT CLR	TP COUNT CLR	TP COUNT CLR	TP COUNT CLR	TP COUNT CLR	On	Clear Trip counter
148	IND.reset	IND.reset	IND.reset	IND.reset	IND.reset	IND.reset	IND.reset	On	Reset the indication of Trip mode,Alarm etc
149	Data lost	Data lost	Data lost	Data lost	Data lost	Data lost	Data lost	On	Record and time date lost by DC power supply off for a long time
150	Sys.change	Sys.change	Sys.change	Sys.change	Sys.change	Sys.change	Sys.change	On	Setting change command
151	Rly.change	Rly.change	Rly.change	Rly.change	Rly.change	Rly.change	Rly.change	On	ditto
152	Grp.change	Grp.change	Grp.change	Grp.change	Grp.change	Grp.change	Grp.change	On	ditto

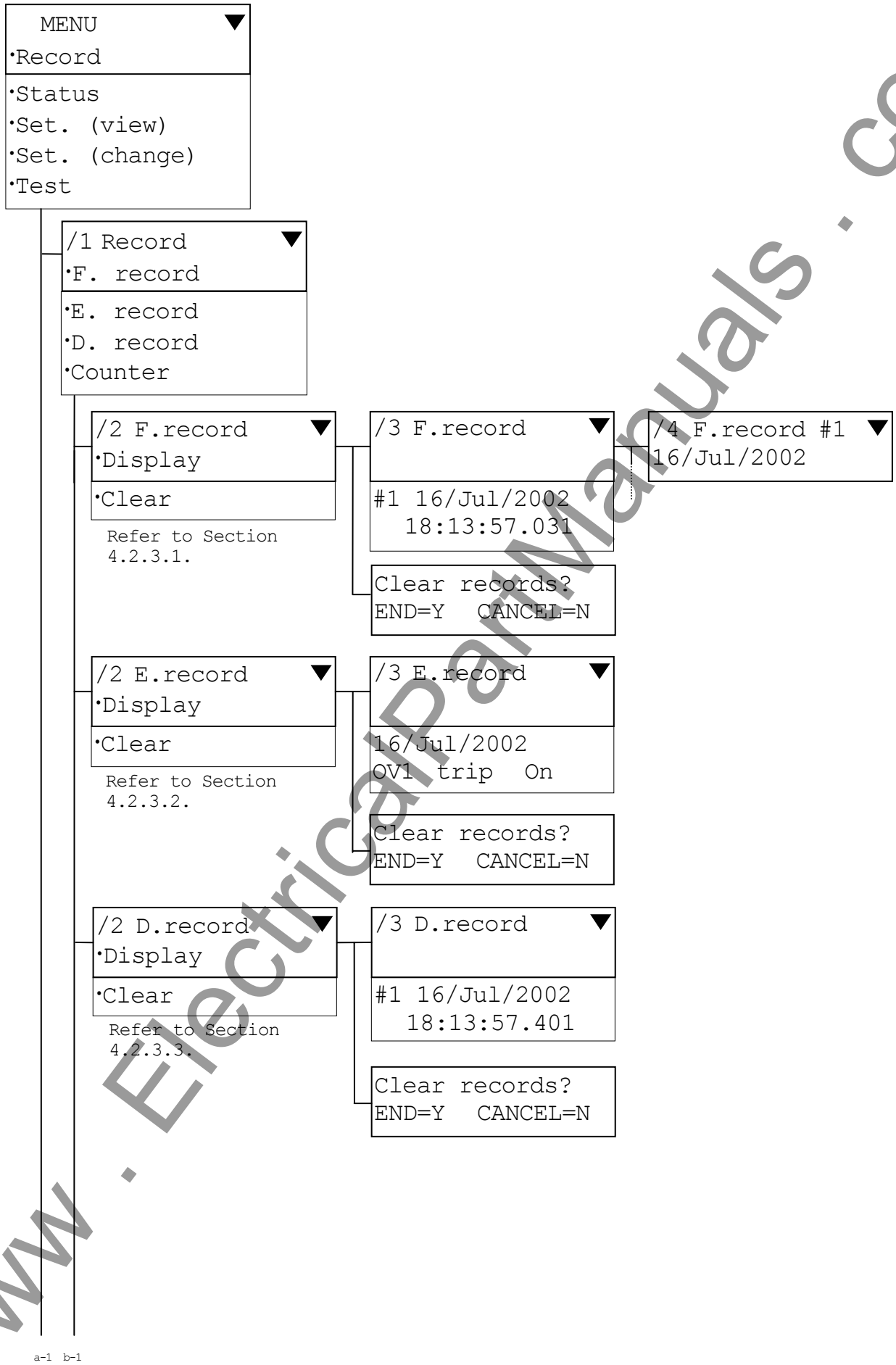
Appendix C

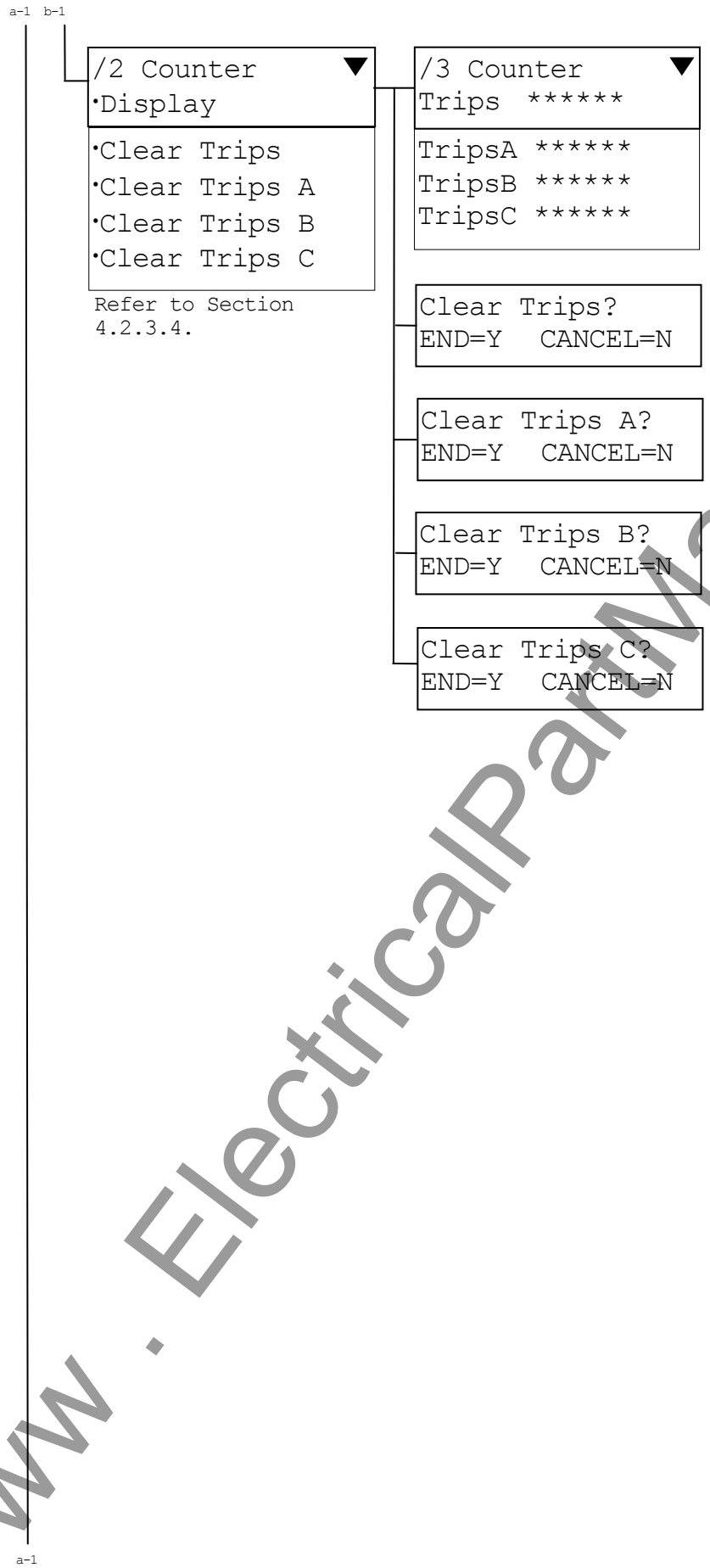
Binary Output Default Setting List

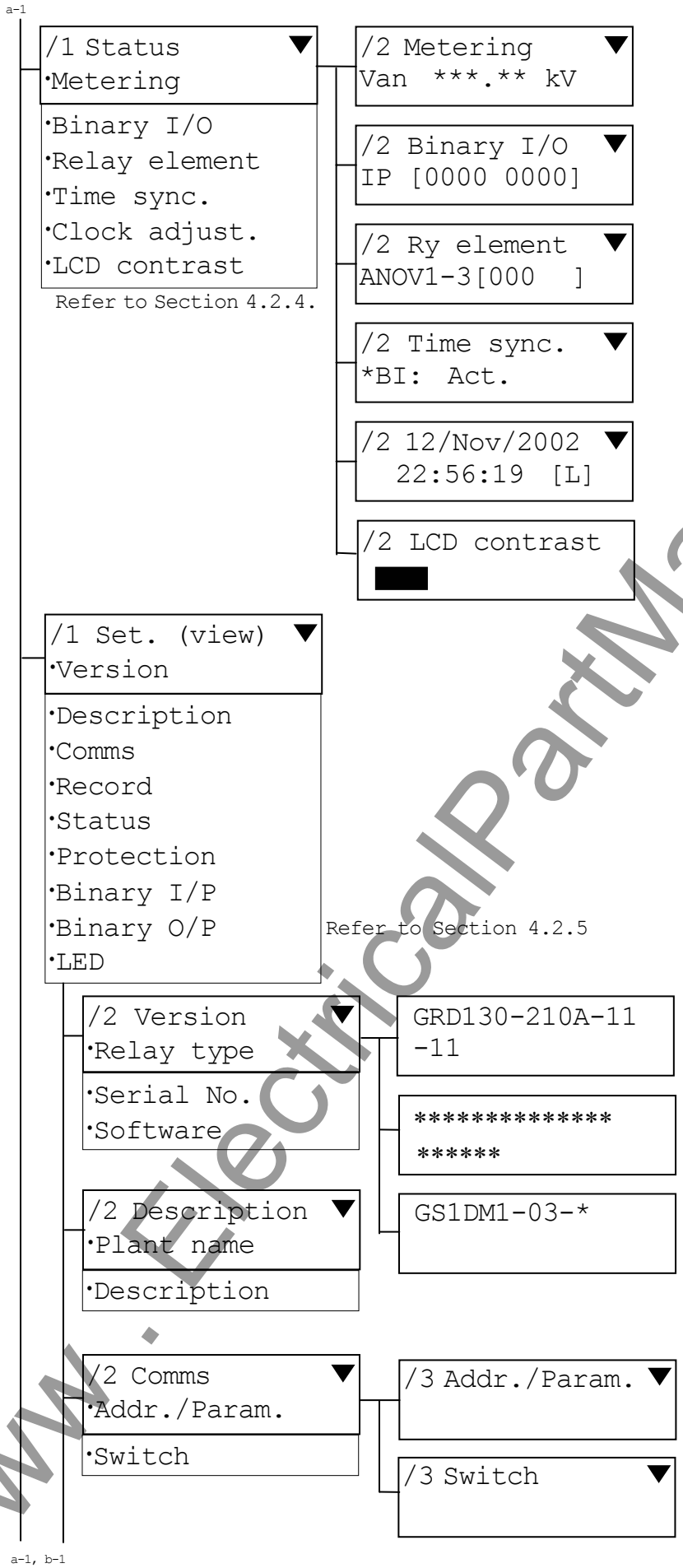
Relay Model	BO No.	Terminal No.	Signal Name	Contents	Setting		
					Signal No.	Logic (OR:0, AND:1)	Reset (Inst:0, DI:1, Dw:2, Latch:3)
		TB3:					
GRD130-210	BO1	A5-B4, A4	GENERAL TRIP	Relay trip (General)	147	0	1, 0.2s
	BO2	A6-A7, B7	GENERAL TRIP	Relay trip (General)	147	0	1, 0.2s
	BO3	A9-B8, A8	GENERAL TRIP	Relay trip (General)	147	0	1, 0.2s
	BO4	A11-A10, B10	GENERAL TRIP	Relay trip (General)	147	0	1, 0.2s
	BO5	A12-A13, B13	UV1 TRIP	UV1 element trip	122	0	1, 0.2s
	BO6	A15-A14, B14	UV1 TRIP	UV1 element trip	122	0	1, 0.2s
	BO7	B16-A16	ZPS1 TRIP	ZPS1 element trip	143	0	1, 0.2s
		TB3:					
GRD130-410	BO1	A5-B4, A4	GENERAL TRIP	Relay trip (General)	147	0	1, 0.2s
	BO2	A6-A7, B7	GENERAL TRIP	Relay trip (General)	147	0	1, 0.2s
	BO3	A9-B8, A8	GENERAL TRIP	Relay trip (General)	147	0	1, 0.2s
	BO4	A11-A10, B10	GENERAL TRIP	Relay trip (General)	147	0	1, 0.2s
	BO5	A12-A13, B13	UV1 TRIP	UV1 element trip	122	0	1, 0.2s
	BO6	A15-A14, B14	UV1 TRIP	UV1 element trip	122	0	1, 0.2s
	BO7	B16-A16	ZPS1 TRIP	ZPS1 element trip	143	0	1, 0.2s

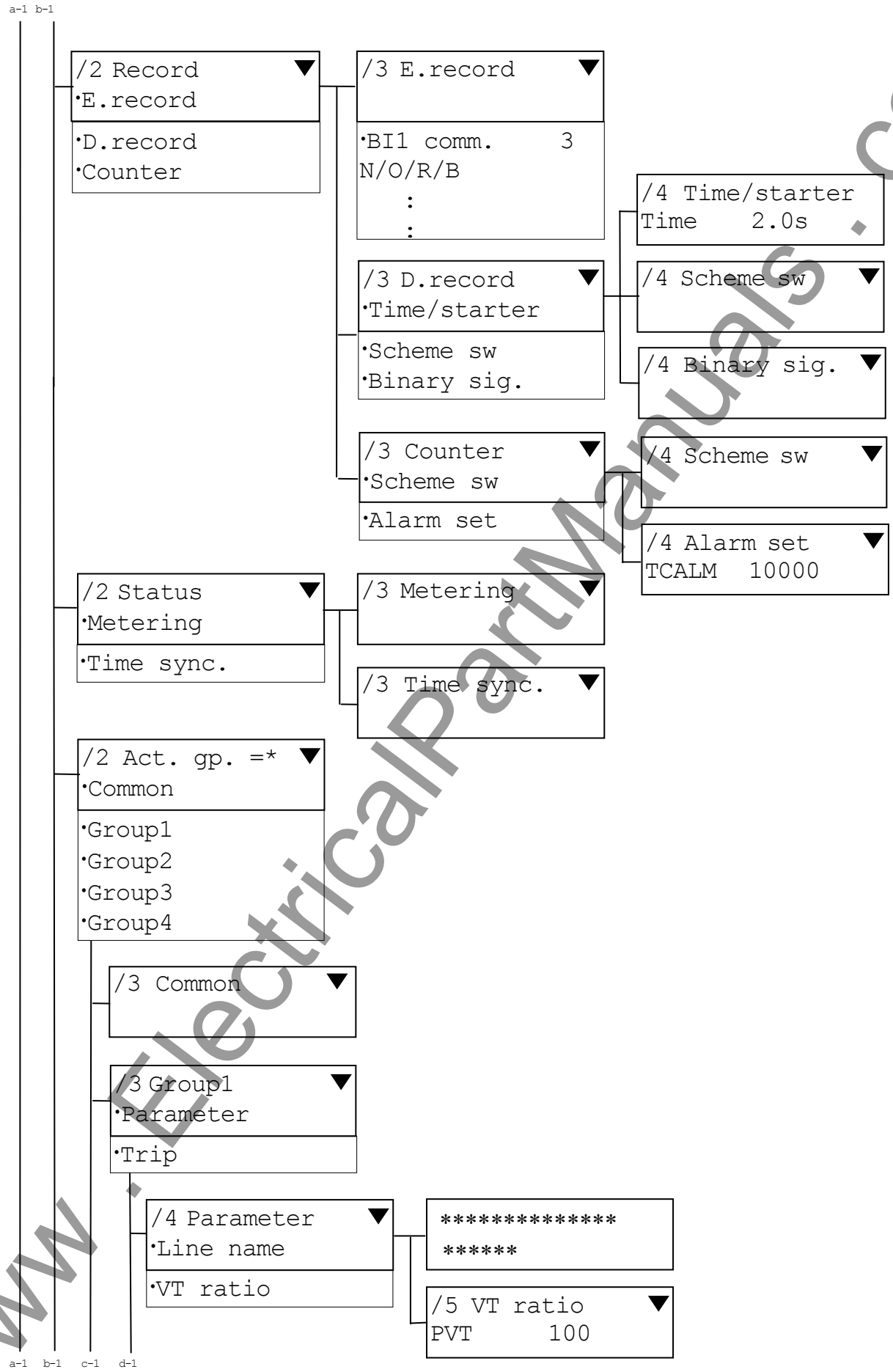
Appendix D

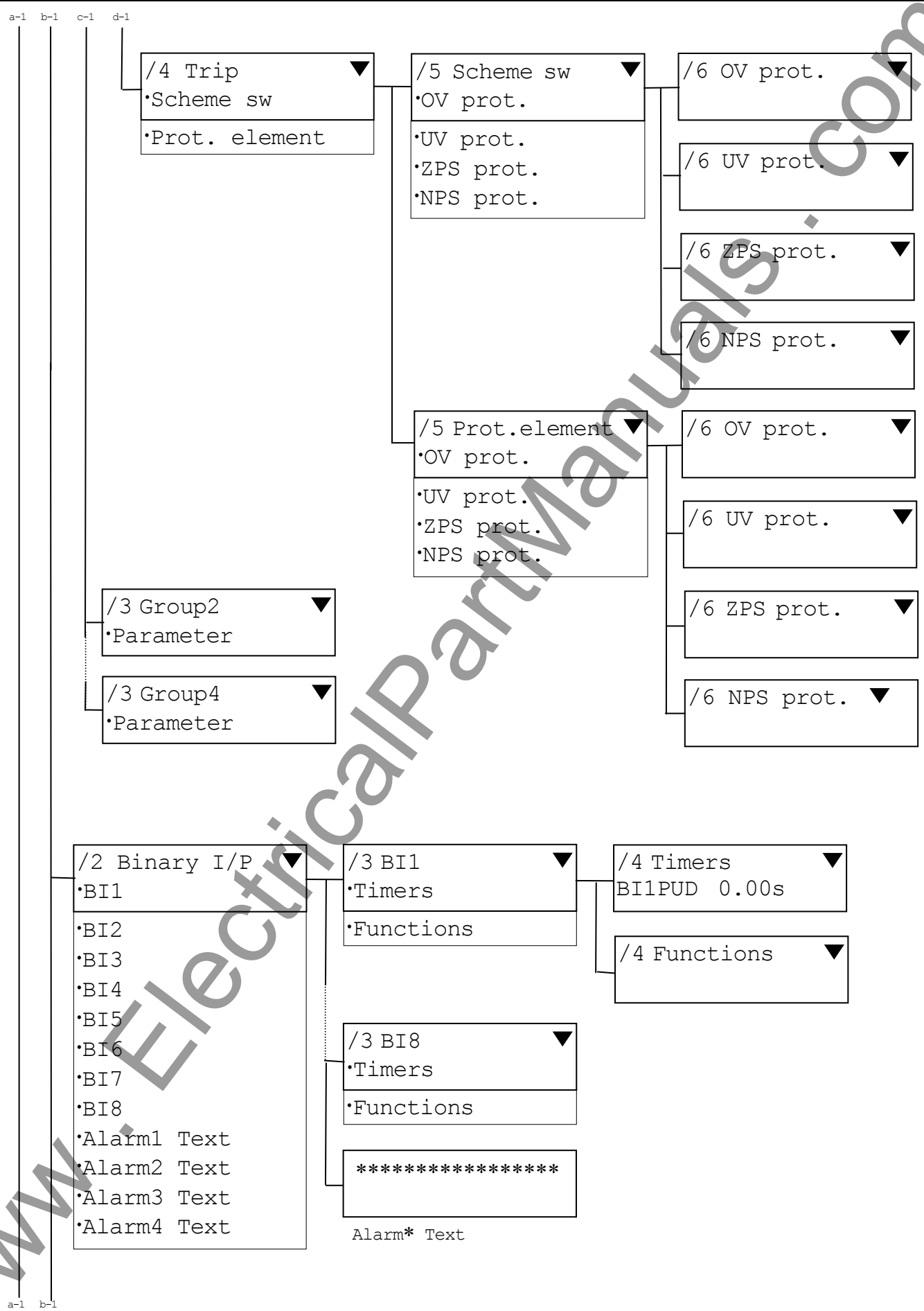
Details of Relay Menu

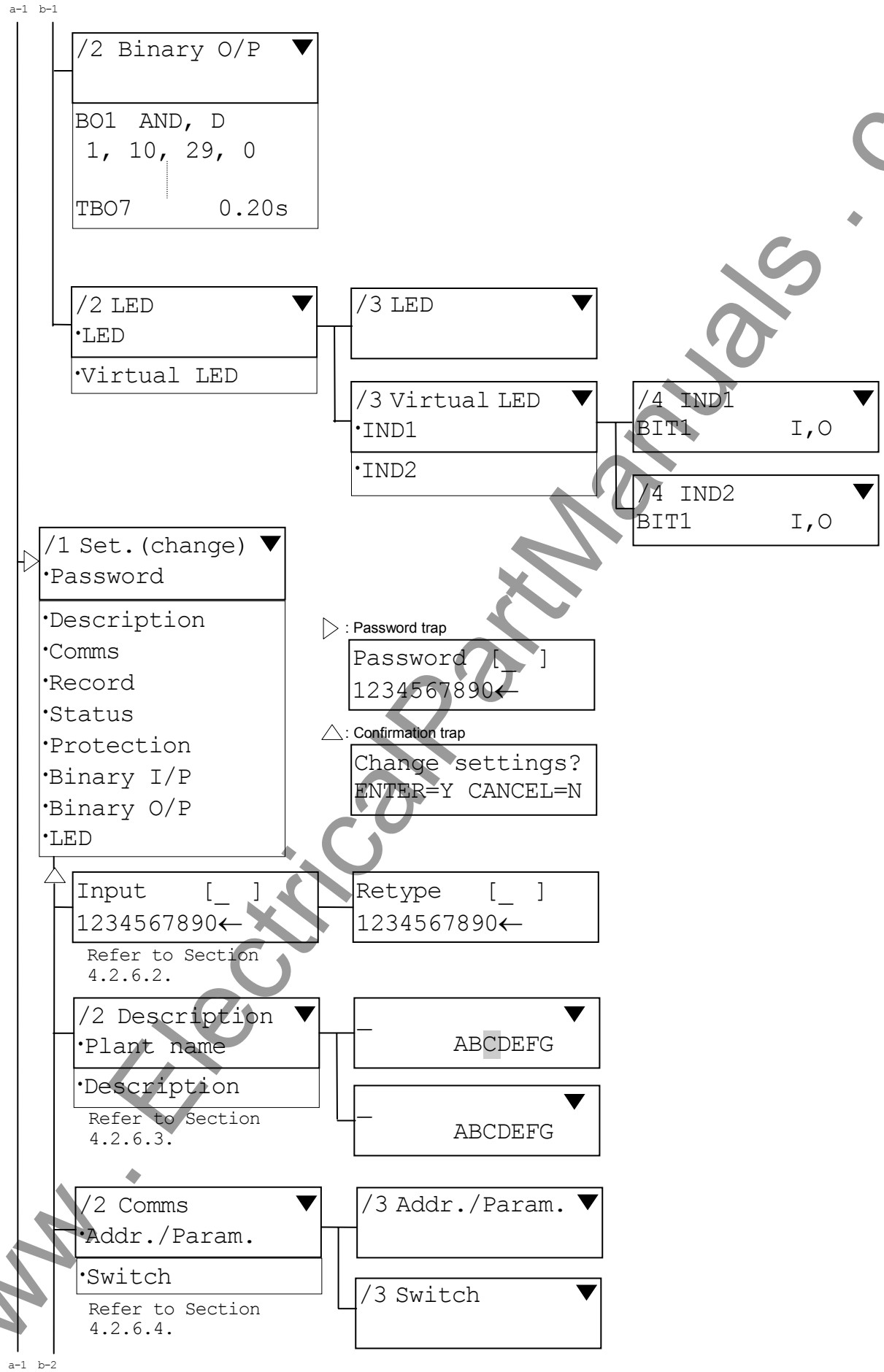


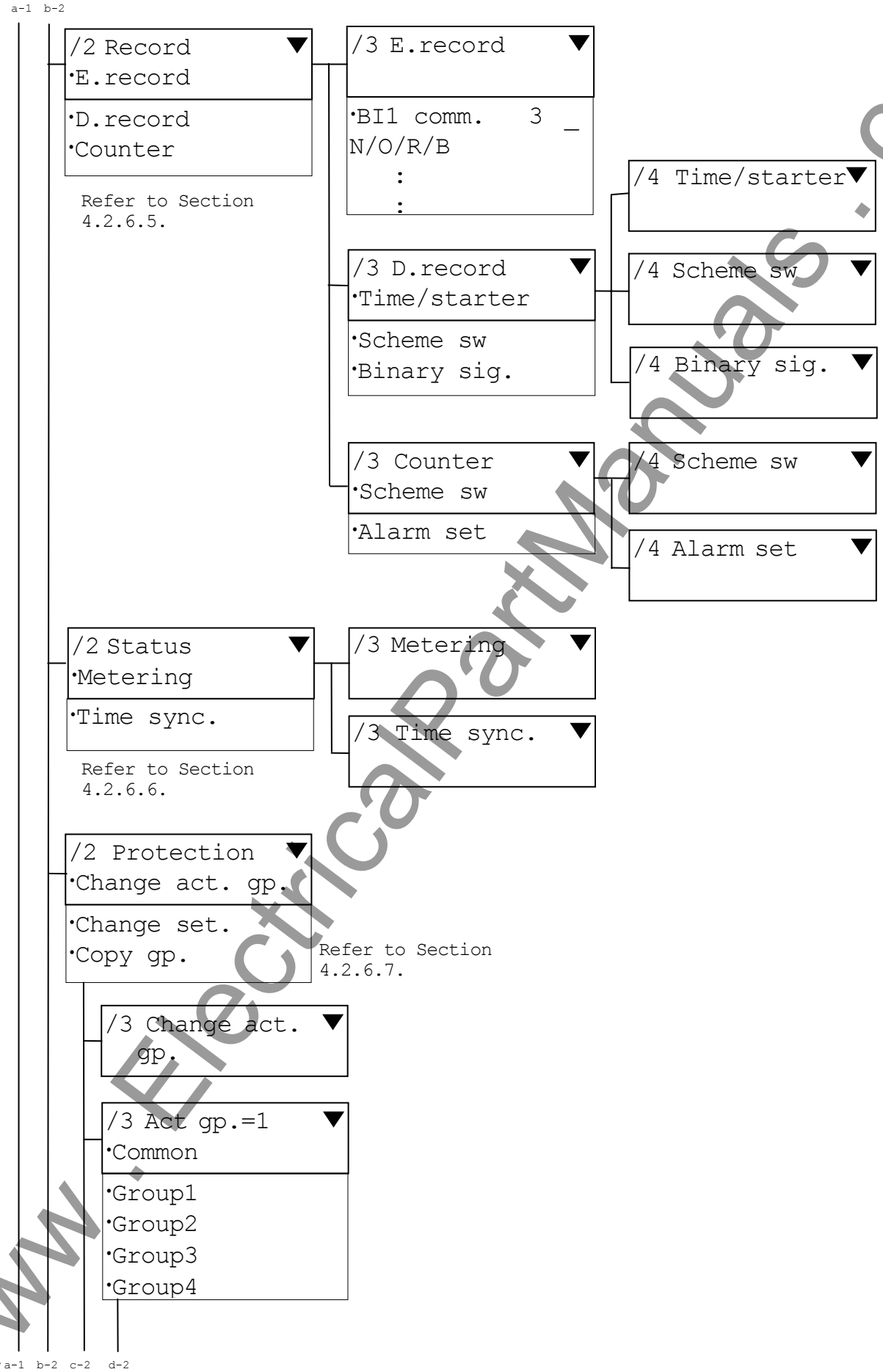


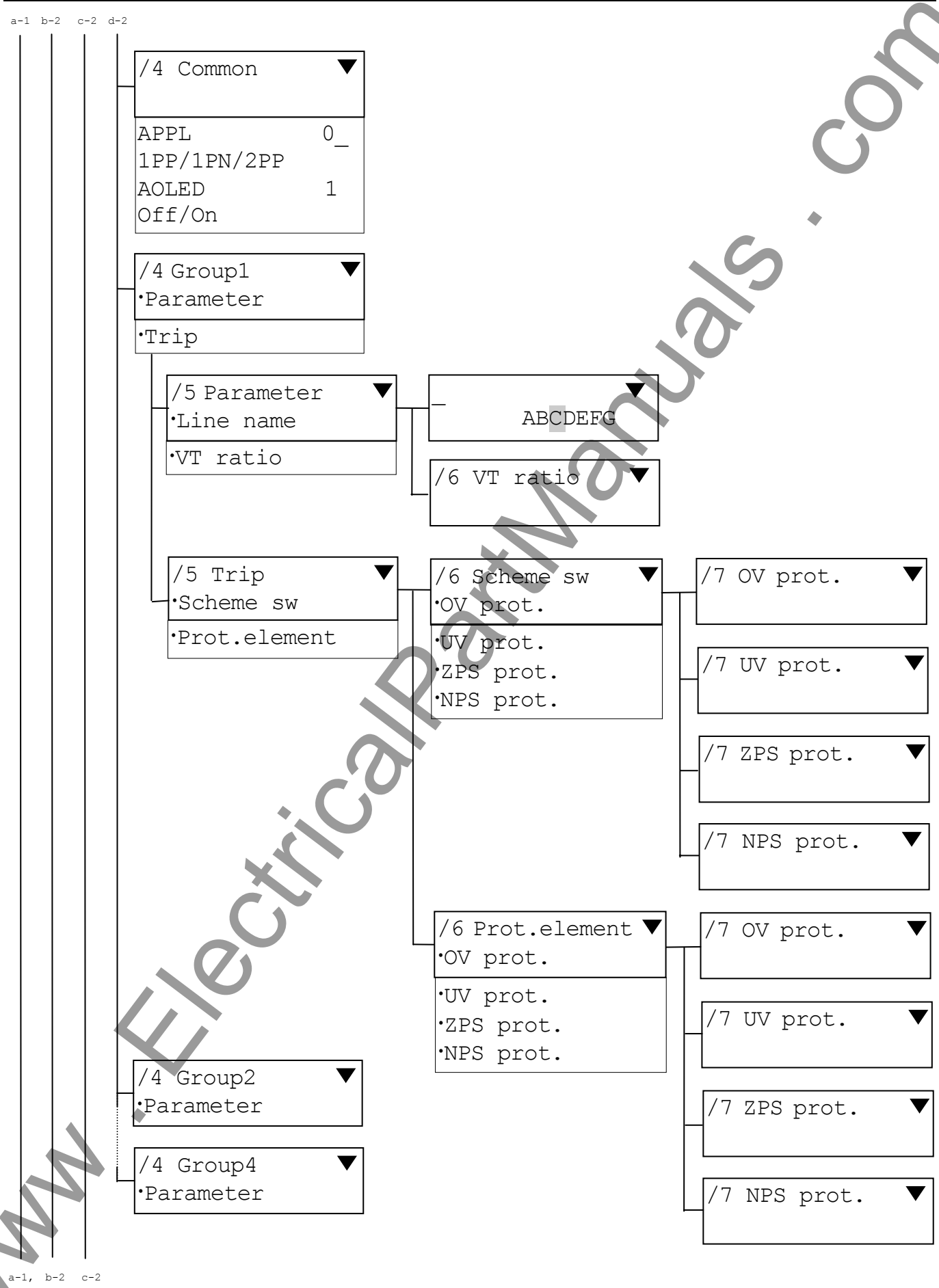


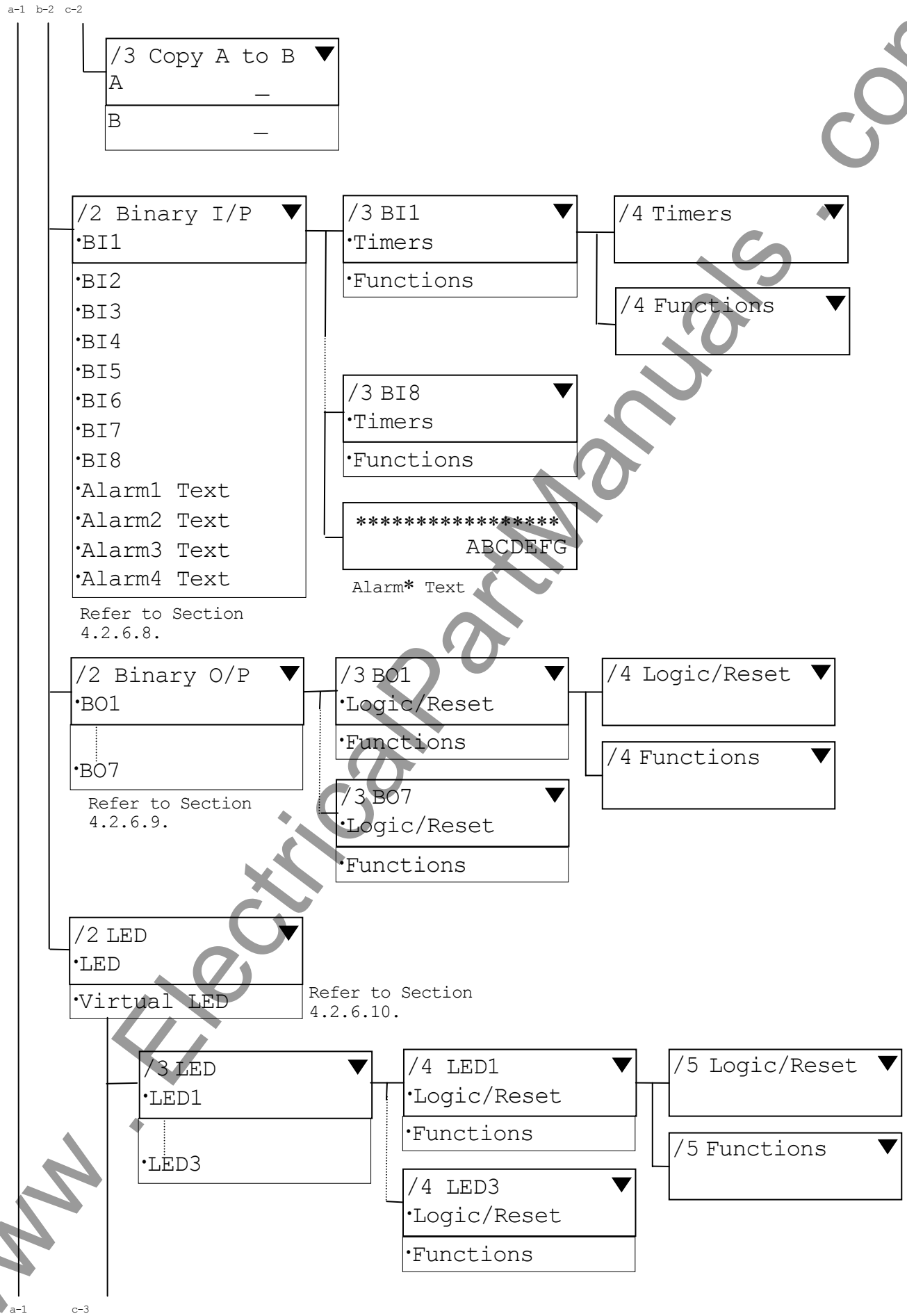


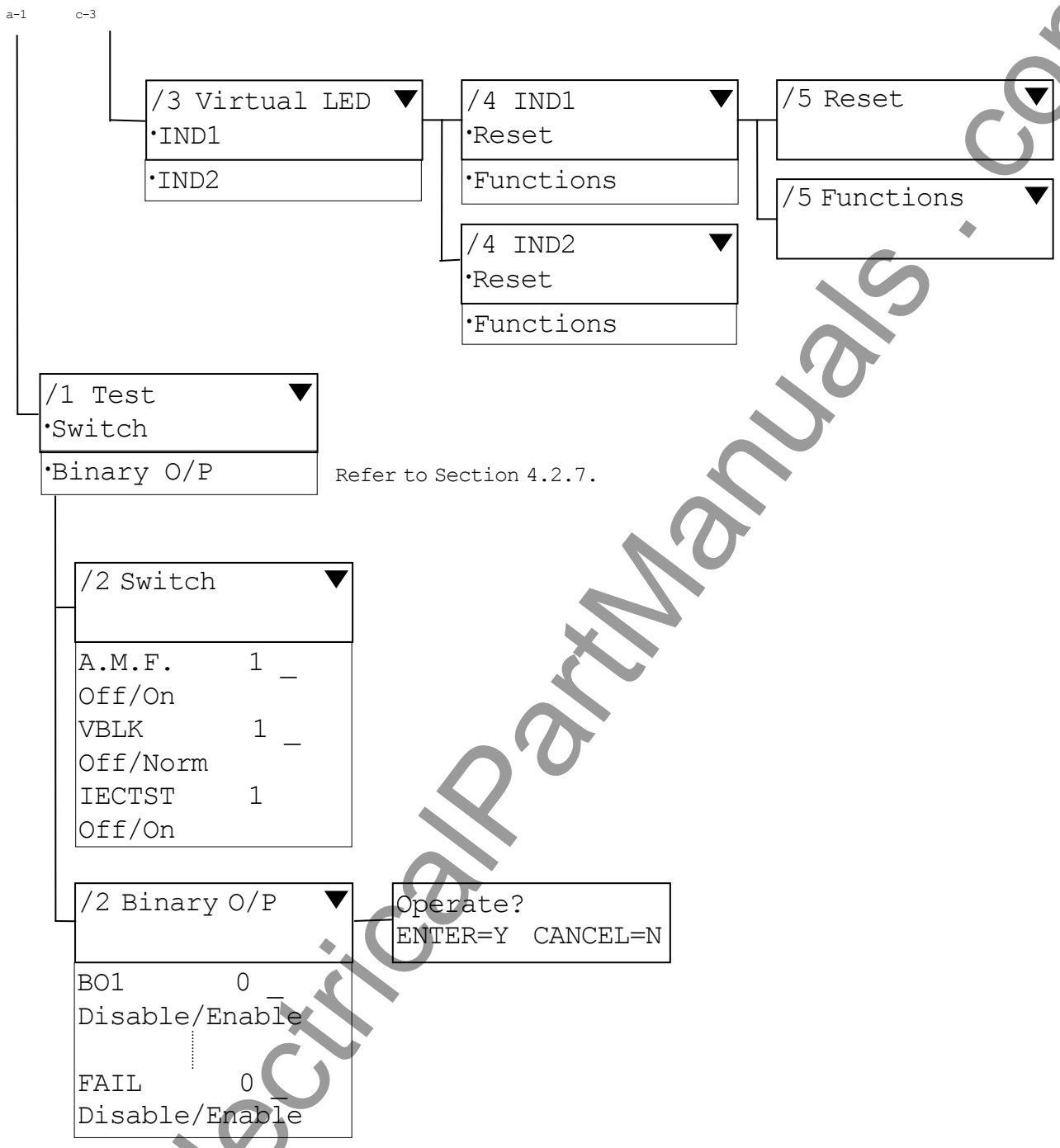




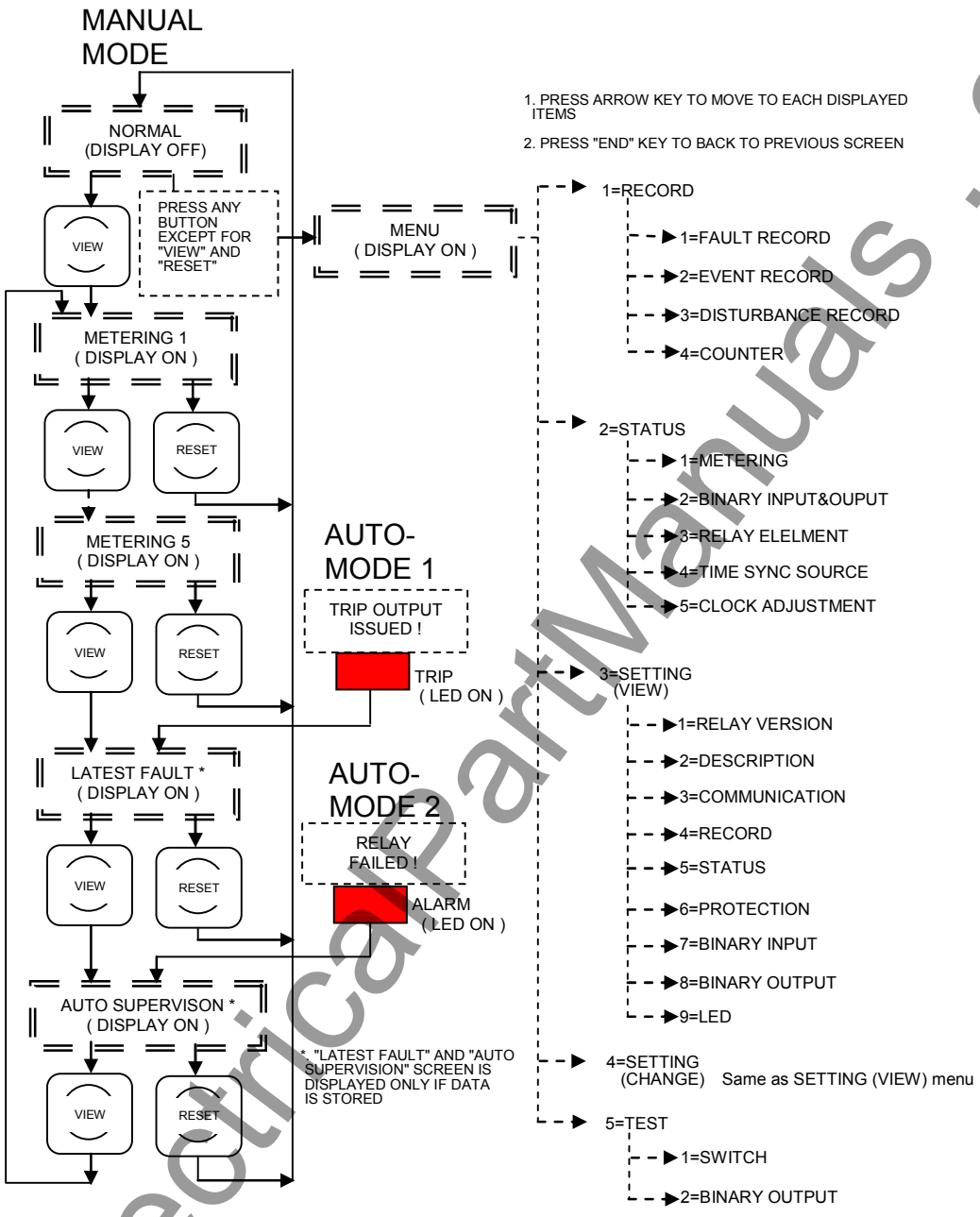






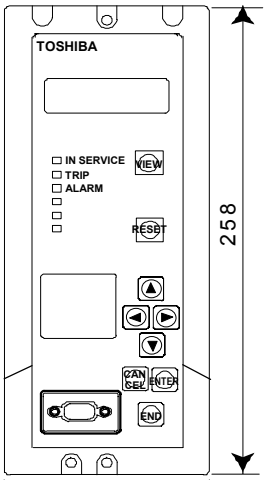


LCD AND BUTTON OPERATION INSTRUCTION

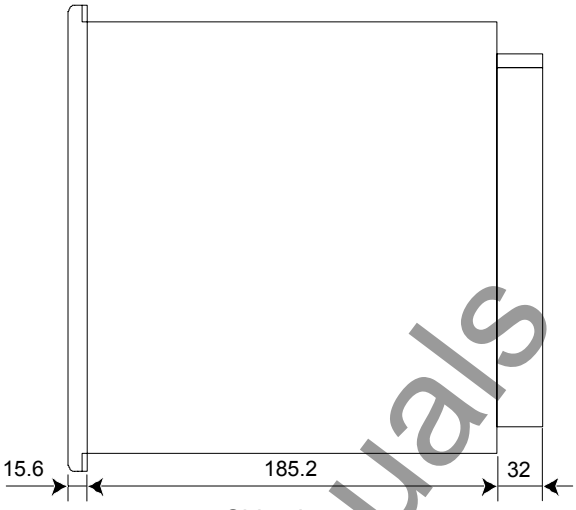


Appendix E

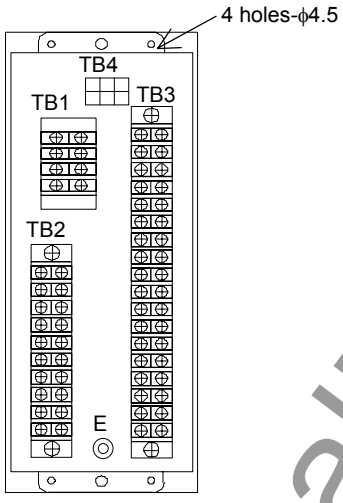
Case Outline



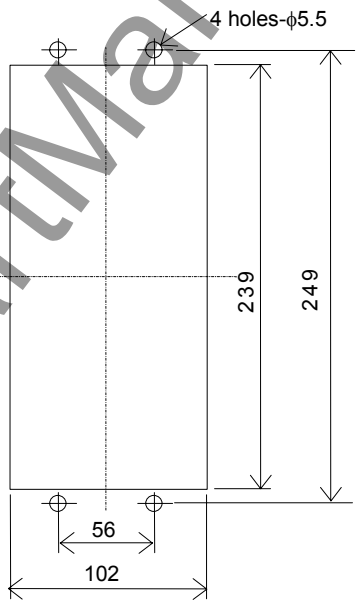
Front view



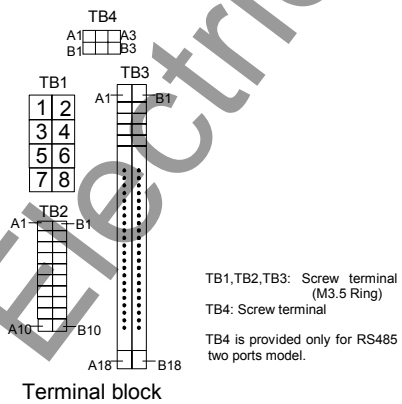
Side view



Rear view



Panel cut-out



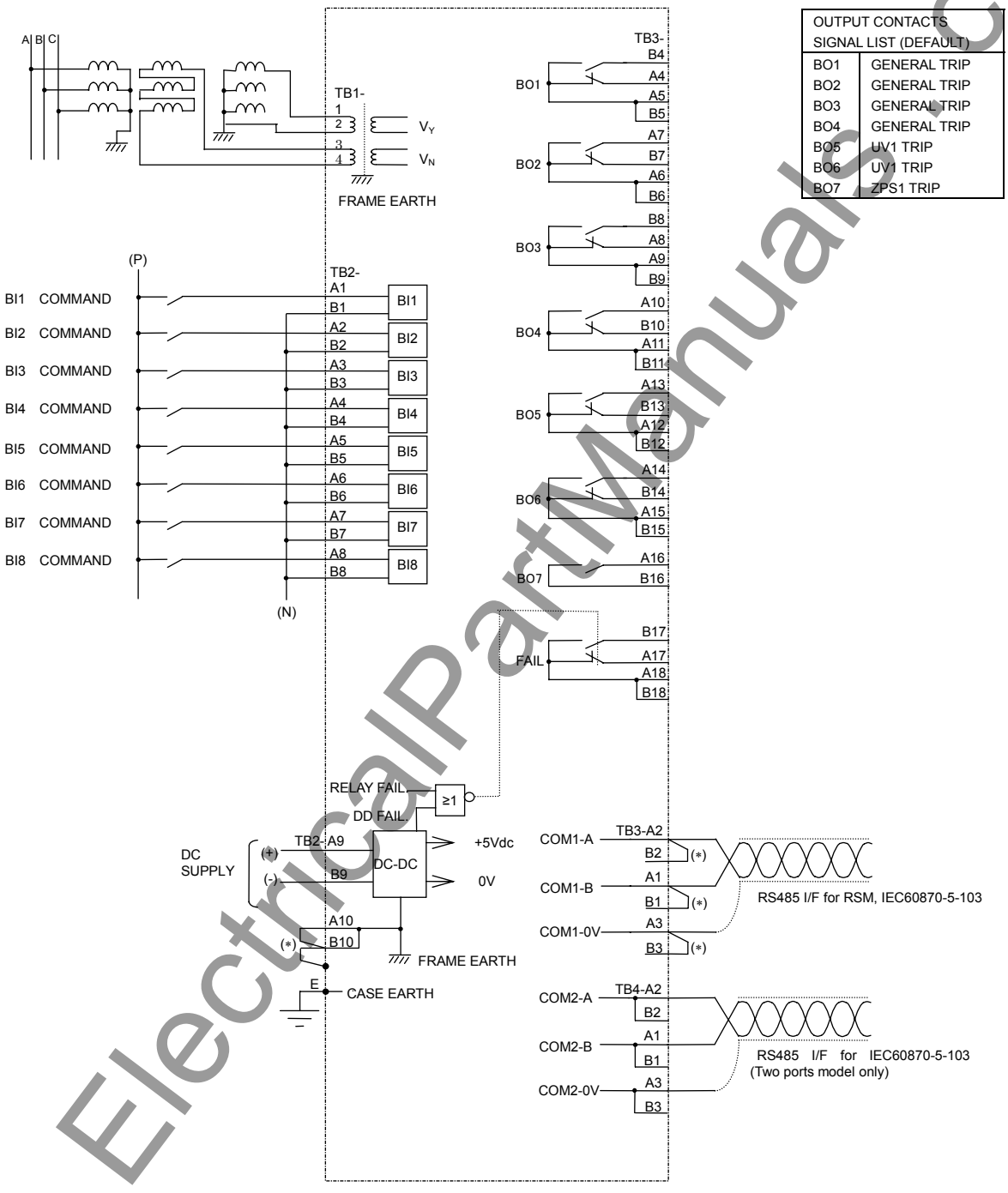
Terminal block

Case Outline

Appendix F

Typical External Connection

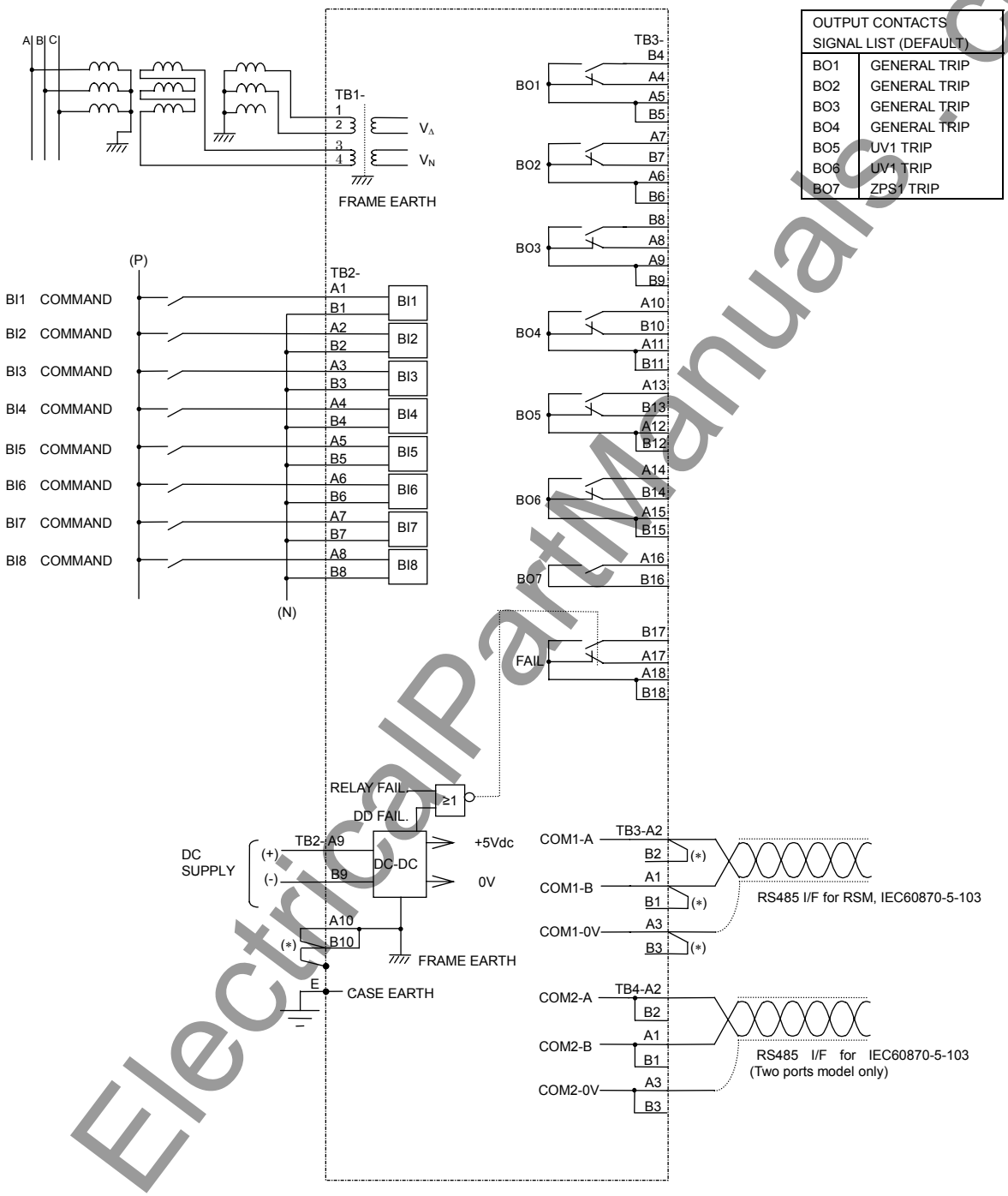
GRD130 - 210 (1PN setting)



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

Typical External Connection

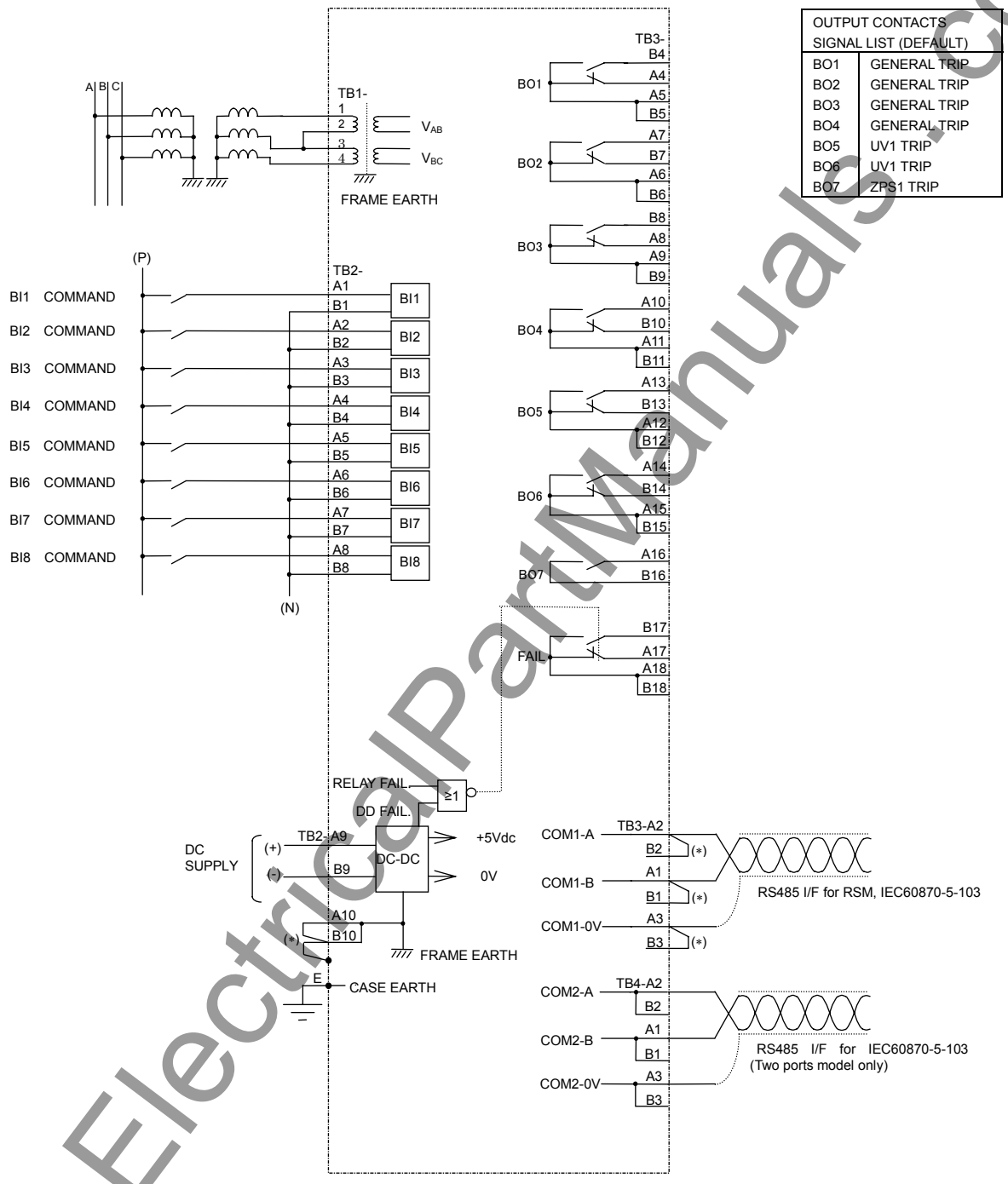
GRD130 - 210 (1PP setting)



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

Typical External Connection

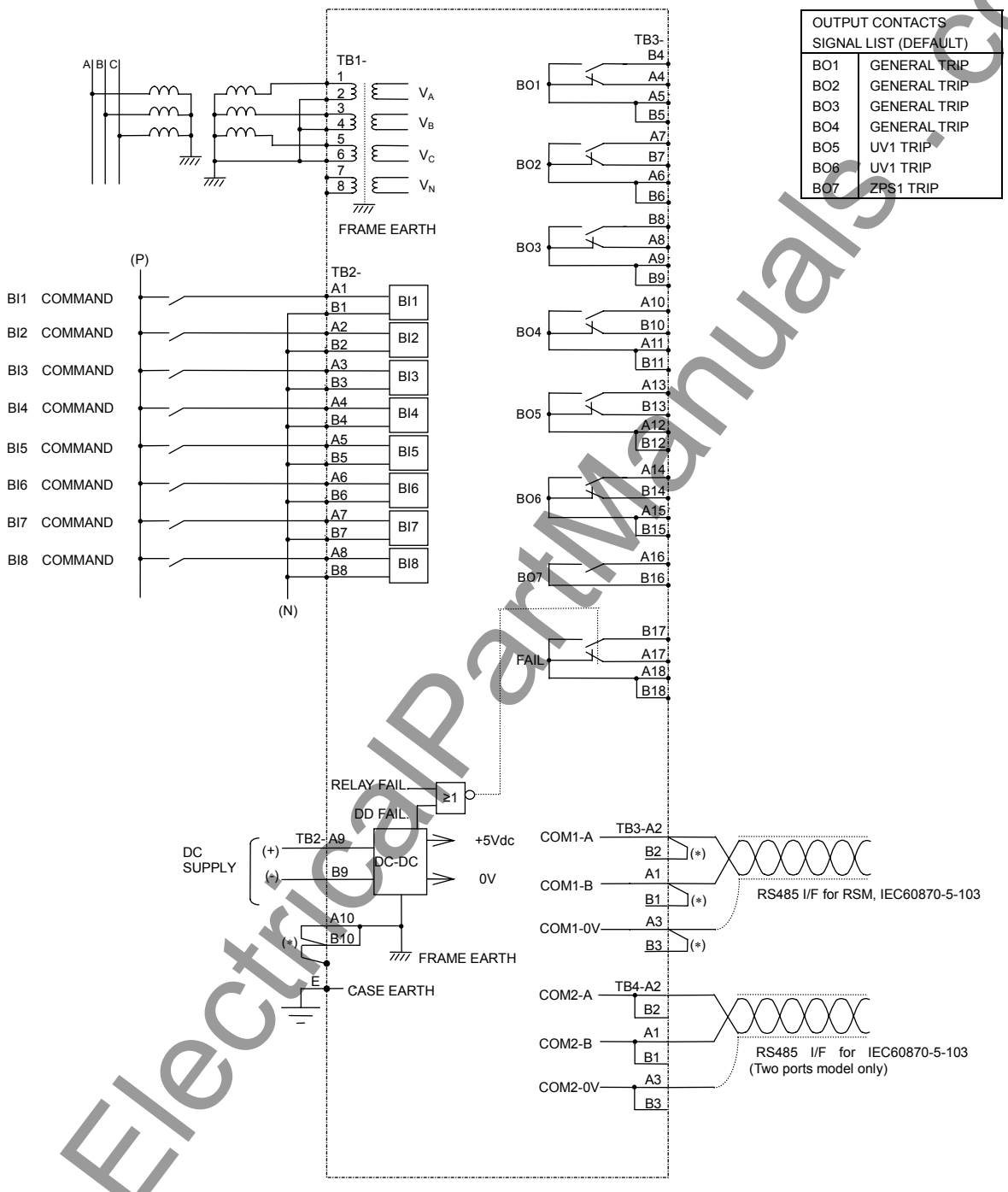
GRD130 - 210 (2PP setting)



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

Typical External Connection

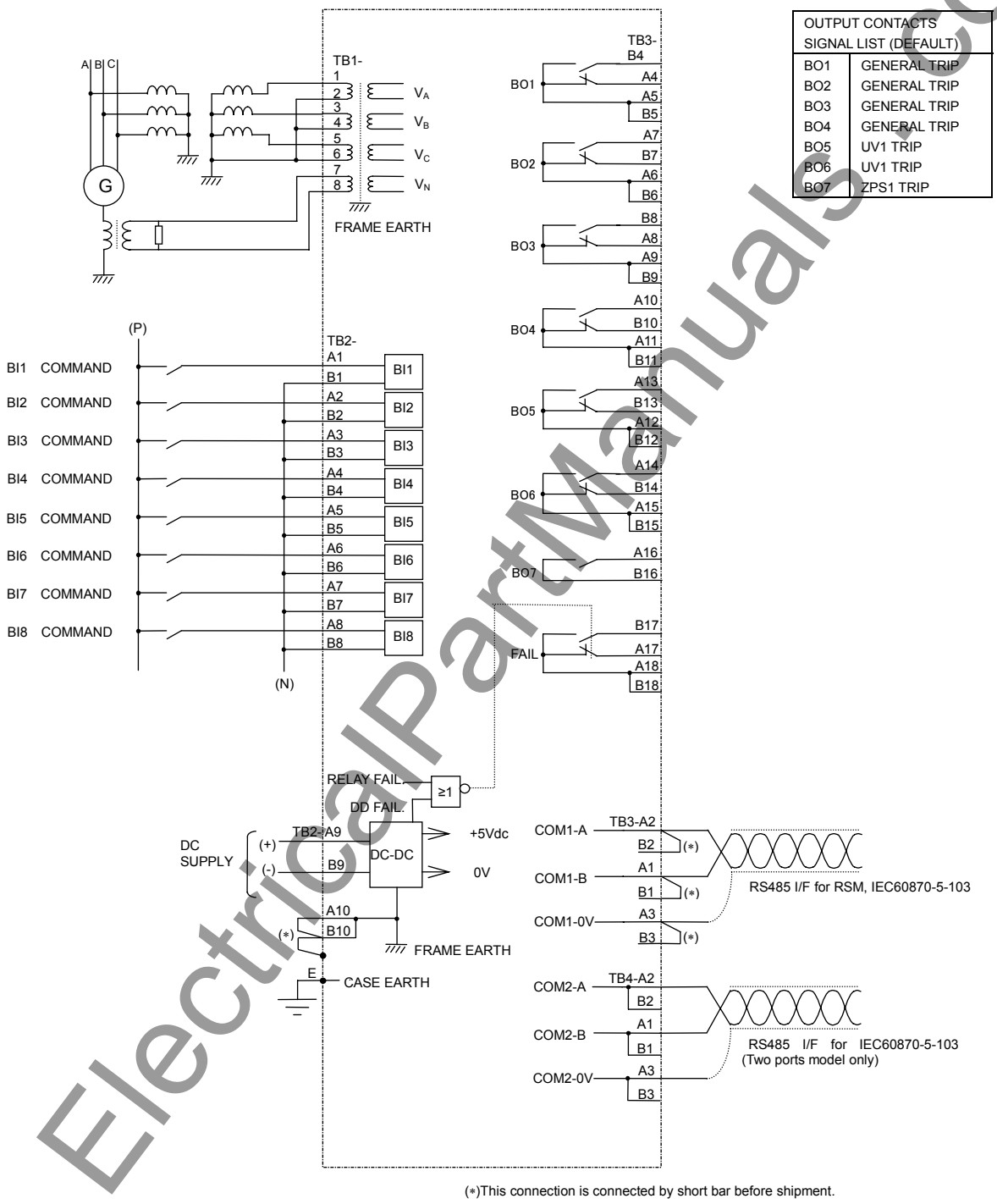
GRD130 - 410 (3PN setting)



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

Typical External Connection

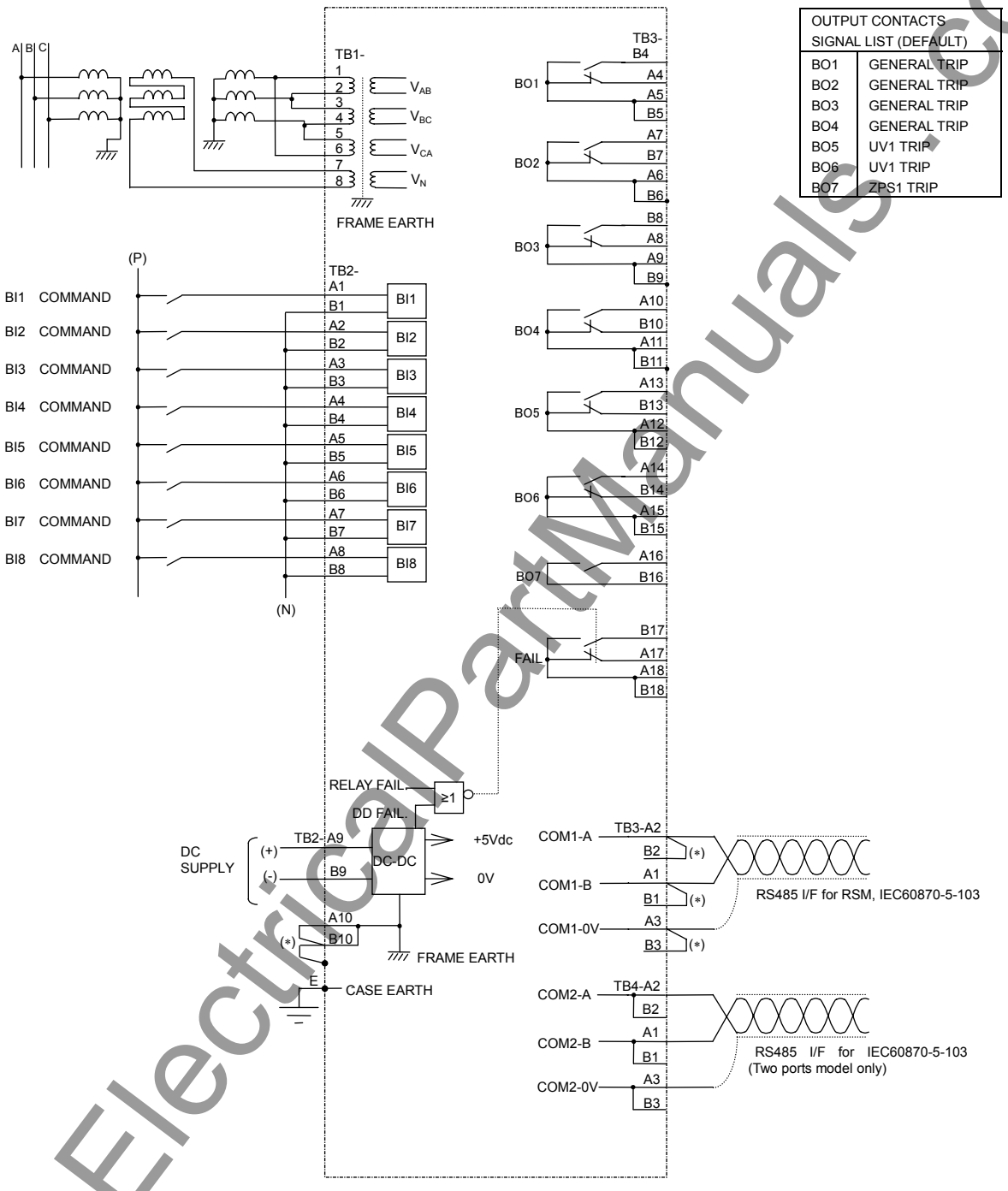
GRD130 - 410 (3PV setting)



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

Typical External Connection

GRD130 - 410 (3PP setting)

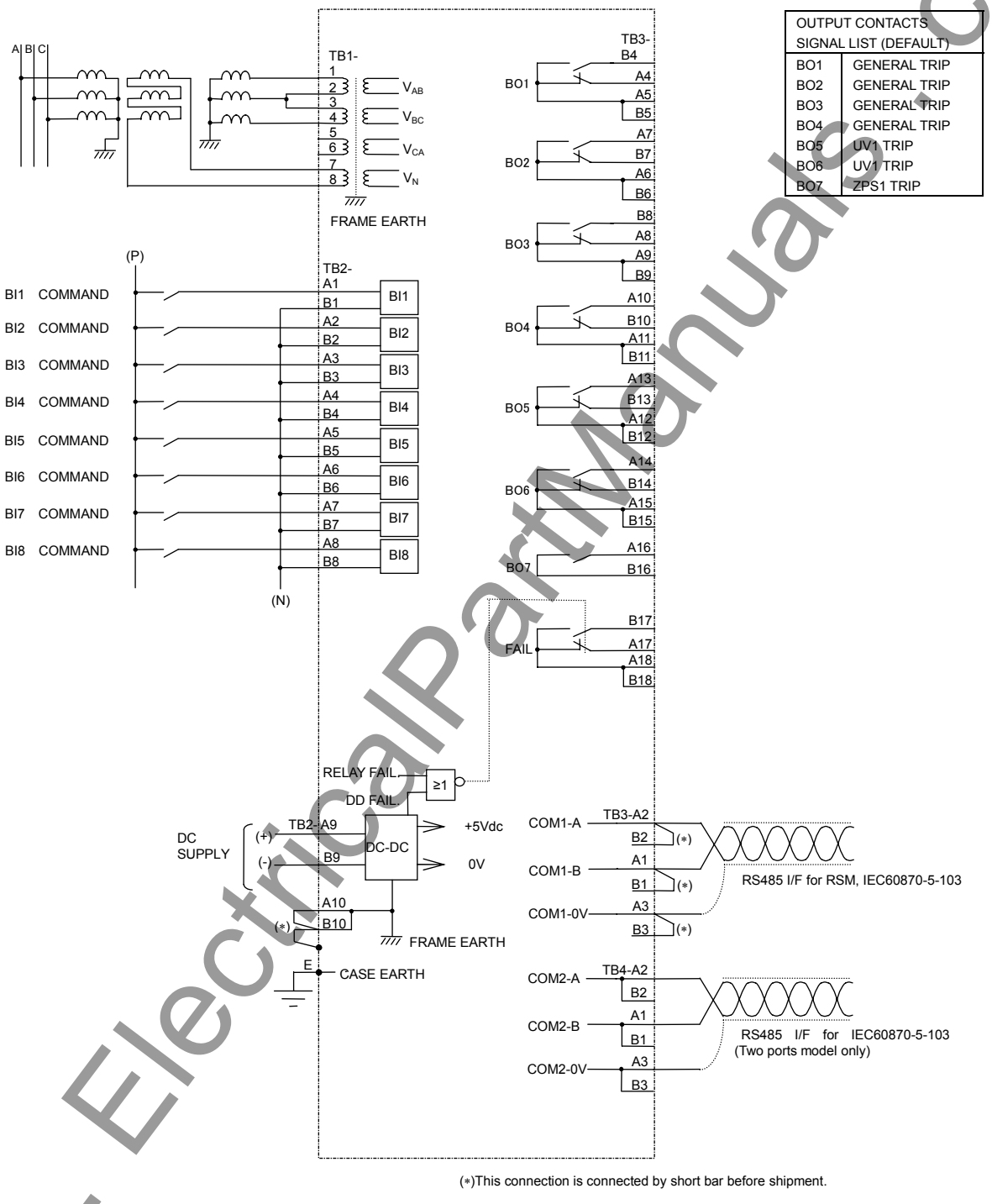


OUTPUT CONTACTS SIGNAL LIST (DEFAULT)	
BO1	GENERAL TRIP
BO2	GENERAL TRIP
BO3	GENERAL TRIP
BO4	GENERAL TRIP
BO5	UV1 TRIP
BO6	UV1 TRIP
BO7	ZPS1 TRIP

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

Typical External Connection

GRD130 - 410 (2PP setting)



OUTPUT CONTACTS SIGNAL LIST (DEFAULT)	
BO1	GENERAL TRIP
BO2	GENERAL TRIP
BO3	GENERAL TRIP
BO4	GENERAL TRIP
BO5	UV1 TRIP
BO6	UV1 TRIP
BO7	ZPS1 TRIP

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

Typical External Connection

Appendix G

Relay Setting Sheet

1. Relay Identification
2. Line parameter
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 parameter

VT ratio PVT: RVT:

3. Contacts setting

TB3	Terminal A5(B5)-B4, A4	
	Terminal A6(B6)-A7, B7	
	Terminal A9(B9)-B8, A8	
	Terminal A11(B11)-A10, B10	
	Terminal A12(B12)-A13, B13	
	Terminal A15(B15)-A14, B14	
	Terminal B16-A16	

4. Relay setting sheet

№	Name		Range	Units	Contents	Default Setting of Relay Model		User Setting
						210	410	
1	Active gp.		1 - 4	—	Active setting group	1		
2	Line name		Specified by user	—	Line name	Specified by user		
3	PVT		1 - 20000	—	Phase VT ratio	100		
4	RVT		1 - 20000	—	Neutral VT ratio	100		
5	APPL		1PP/1PN/2PP	—	Application setting (210)	1PP	--	
6	APPL		3PN/3PV/3PP/2PP	—	Application setting (410)	--	3PV	
7	SVCNT		ALM&BLK/ALM	—	AC Input Imbalance	ALM&BLK		
8	ADLED		Off/On	—	TRIP LED lighting control at alarm output	Off		
9	OV	OV1EN	Off/DT/IDMT/C	—	OV1 Enable	Off		
10		OV2EN	Off/DT/IDMT/C	—	OV2 Enable	Off		
11		OV3EN	Off/On	—	OV3 Enable	Off		
12	UV	UV1EN	Off/DT/IDMT/C	—	UV1 Enable	DT		
13		UV2EN	Off/DT/IDMT/C	—	UV2 Enable	Off		
14		UV3EN	Off/On	—	UV3 Enable	Off		
15		VBLKEN	Off/On	—	UV Block Enable	Off		
16	ZPS	ZPS1EN	Off/DT/IDMT/C	—	ZPS1 Enable	DT		
17		ZPS2EN	Off/DT/IDMT/C	—	ZPS2 Enable	Off		
18	NPS	NPS1EN	Off/DT/IDMT/C	—	NPS1 Enable	Off		
19		NPS2EN	Off/DT/IDMT/C	—	NPS2 Enable	Off		
20	OV	OV1	10.0 - 200.0	V	OV1 Threshold setting.	120.0		
21		TOV1	0.05 - 100.00	--	OV1 Time multiplier setting, if [OV1EN]=2 or 3.	10.00		
22		TOV1	0.00 - 300.00	s	OV1 Definite time setting, if [OV1EN]=1.	0.10		
23		TOV1R	0.0 - 300.0	s	OV1 Definite time reset delay.	0.0		
24		OV1DPR	10 - 98	%	OV1 DO/PU ratio	95		
25		OV2	10.0 - 200.0	V	OV2 Threshold setting.	140.0		
26		TOV2	0.05 - 100.00	--	OV2 Time multiplier setting, if [OV2EN]=2 or 3.	10.00		
27		TOV2	0.00 - 300.00	s	OV2 Definite time setting, if [OV2EN]=1.	0.10		
28		TOV2R	0.0 - 300.0	s	OV2 Definite time reset delay, if [OV2EN]=2 or 3.	0.0		
29		OV2DPR	10 - 98	%	OV2 DO/PU ratio	95		
30		OV3	10.0 - 200.0	V	OV3 Threshold setting.	160.0		
31		TOV3	0.00 - 300.00	s	OV3 Definite time setting.	0.10		
32		OV3DPR	10 - 98	%	OV3 DO/PU ratio	95		
33		OV1-k	0.00 - 300.00	--	IDMT Curve settig of OV1,if [OV1EN]=3.	1.00		
34		OV1-α	0.00 - 5.00	--	ditto	1.00		
35		OV1-C	0.000 - 5.000	--	ditto	0.000		
36		OV2-k	0.00 - 300.00	--	IDMT Curve settig of OV2, if [OV2EN]=3.	1.00		
37		OV2-α	0.00 - 5.00	--	ditto	1.00		
38		OV2-C	0.000 - 5.000	--	ditto	0.000		
39	UV	UV1	5.0 - 130.0	V	UV1 Threshold setting.	60.0		
40		TUV1	0.05 - 100.00	--	UV1 Time multiplier setting. if [UV1EN]=2 or 3.	10.00		
41		TUV1	0.00 - 300.00	s	UV1 Definite time setting. if [UV1EN]=1.	0.10		
42		TUV1R	0.0 - 300.0	s	UV1 Definite time reset delay, if [UV1EN]=2 or 3.	0.0		
43		UV2	5.0 - 130.0	V	UV2 Threshold setting.	40.0		
44		TUV2	0.05 - 100.00	--	UV2 Time multiplier setting. if [UV2EN]=2 or 3.	10.00		
45		TUV2	0.00 - 300.00	s	UV2 Definite time setting, if [UV2EN]=1.	0.10		
46		TUV2R	0.0 - 300.0	s	UV2 Definite time reset delay, if [UV2EN]=2 or 3.	0.0		
47		UV3	5.0 - 130.0	V	UV3 Threshold setting.	20.0		
48		TUV3	0.00 - 300.00	s	UV3 Definite time setting.	0.10		
49		VBLK	5.0 - 20.0	V	UV Blocking threshold	10.0		
50		UV1-k	0.00 - 300.00	--	IDMT Curve settig of UV1, if [UV1EN]=3.	1.00		
51		UV1-α	0.00 - 5.00	--	ditto	1.00		
52		UV1-C	0.000 - 5.000	--	ditto	0.000		
53		UV2-k	0.00 - 300.00	--	IDMT Curve settig of UV2, if [UV2EN]=3.	1.00		
54		UV2-α	0.00 - 5.00	--	ditto	1.00		
55		UV2-C	0.000 - 5.000	--	ditto	0.000		

No	Name		Range	Units	Contents	Default Setting of Relay Model		User Setting
						210	410	
56	ZPS	ZPS1	1.0 - 160.0	V	ZPS1 Threshold setting.	20.0		
57		TZPS1	0.05 - 100.00	--	ZPS1 Time multiplier setting, if [ZPS1EN]=2 or 3.	10.00		
58		TZPS1	0.00 - 300.00	s	ZPS1 Definite time setting, if [ZPS1EN]=1.	0.00		
59		TZPS1R	0.0 - 300.0	s	ZPS1 Definite time reset delay.	0.0		
60		ZPS2	1.0 - 160.0	V	ZPS2 Threshold setting.	40.0		
61		TZPS2	0.05 - 100.00	--	ZPS2 Time multiplier setting, if [ZPS2EN]=2 or 3.	10.00		
62		TZPS2	0.00 - 300.00	s	ZPS2 Definite time setting, if [ZPS2EN]=1.	0.00		
63		TZPS2R	0.0 - 300.0	s	ZPS2 Definite time reset delay.	0.0		
64		ZPS1-k	0.00 - 300.00	--	IDMT Curve settig of ZPS1, if [ZPS1EN]=3.	1.00		
65		ZPS1-α	0.00 - 5.00	--	ditto	1.00		
66		ZPS1-C	0.000 - 5.000	--	ditto	0.000		
67		ZPS2-k	0.00 - 300.00	--	IDMT Curve settig of ZPS2, if [ZPS2EN]=3.	1.00		
68		ZPS2-α	0.00 - 5.00	--	ditto	1.00		
69		ZPS2-C	0.000 - 5.000	--	ditto	0.000		
70	NPS	NPS1	1.0 - 160.0	V	NPS1 Threshold setting.	20.0		
71		TNPS1	0.05 - 100.00	--	NPS1 Time multiplier setting, if [NPS1EN]=2 or 3.	10.00		
72		TNPS1	0.00 - 300.00	s	NPS1 Definite time setting, if [NPS1EN]=1.	0.00		
73		TNPS1R	0.0 - 300.0	s	NPS1 Definite time reset delay, if [NPS1EN]=2 or 3.	0.0		
74		NPS2	1.0 - 160.0	V	NPS2 Threshold setting.	40.0		
75		TNPS2	0.05 - 100.00	--	NPS2 Time multiplier setting, if [NPS2EN]=2 or 3.	10.00		
76		TNPS2	0.00 - 300.00	s	NPS2 Definite time setting, if {NPS2EN}=1.	0.00		
77		TNPS2R	0.0 - 300.0	s	NPS2 Definite time reset delay, if [NPS2EN]=2 or 3.	0.0		
78		NPS1-k	0.00 - 300.00	--	IDMT Curve settig of NPS1, if [NPS1EN]=3.	1.00		
79		NPS1-α	0.00 - 5.00	--	ditto	1.00		
80		NPS1-C	0.000 - 5.000	--	ditto	0.000		
81		NPS2-k	0.00 - 300.00	--	IDMT Curve settig of NPS2, if [NPS2EN]=3.	1.00		
82		NPS2-α	0.00 - 5.00	--	ditto	1.00		
83		NPS2-C	0.000 - 5.000	--	ditto	0.000		
	Setting of Binary Input							
84	Alarm1 Text		Specified by user	—	Alarm1 Text	ALARM 1		
85	Alarm2 Text		Specified by user	—	Alarm2 Text	ALARM 2		
86	Alarm3 Text		Specified by user	—	Alarm3 Text	ALARM 3		
87	Alarm4 Text		Specified by user	—	Alarm4 Text	ALARM 4		
88	BI1PUD		0.00 - 300.00	s	Binary Input 1 Pick-up delay	0.00		
89	BI1DOD		0.00 - 300.00	s	Binary Input 1 Drop-off delay	0.00		
90	BI2PUD		0.00 - 300.00	s	Binary Input 2 Pick-up delay	0.00		
91	BI2DOD		0.00 - 300.00	s	Binary Input 2 Drop-off delay	0.00		
92	BI3PUD		0.00 - 300.00	s	Binary Input 3 Pick-up delay	0.00		
93	BI3DOD		0.00 - 300.00	s	Binary Input 3 Drop-off delay	0.00		
94	BI4PUD		0.00 - 300.00	s	Binary Input 4 Pick-up delay	0.00		
95	BI4DOD		0.00 - 300.00	s	Binary Input 4 Drop-off delay	0.00		
96	BI5PUD		0.00 - 300.00	s	Binary Input 5 Pick-up delay	0.00		
97	BI5DOD		0.00 - 300.00	s	Binary Input 5 Drop-off delay	0.00		
98	BI6PUD		0.00 - 300.00	s	Binary Input 6 Pick-up delay	0.00		
99	BI6DOD		0.00 - 300.00	s	Binary Input 6 Drop-off delay	0.00		
100	BI7PUD		0.00 - 300.00	s	Binary Input 7 Pick-up delay	0.00		
101	BI7DOD		0.00 - 300.00	s	Binary Input 7 Drop-off delay	0.00		
102	BI8PUD		0.00 - 300.00	s	Binary Input 8 Pick-up delay	0.00		
103	BI8DOD		0.00 - 300.00	s	Binary Input 8 Drop-off delay	0.00		
	Repeat Following Switches from Binary Input 2 to Binary Input 8.							
104	BI1SNS		Norm/Inv	—	Binary Input 1 Sense	Norm		
105	BI1SGS		Off/1/2/3/4	—	Binary Input 1 Settings Group Select	Off		
106	OV1BLK		Off/On	—	OV1 Block	Off		
107	OV2BLK		Off/On	—	OV2 Block	Off		
108	OV3BLK		Off/On	—	OV3 Block	Off		
109	UV1BLK		Off/On	—	UV1 Block	Off		
110	UV2BLK		Off/On	—	UV2 Block	Off		
111	UV3BLK		Off/On	—	UV3 Block	Off		
112	ZP1BLK		Off/On	—	ZPS1 Block	Off		
113	ZP2BLK		Off/On	—	ZPS2 Block	Off		
114	NP1BLK		Off/On	—	NPS1 Block	Off		
115	NP2BLK		Off/On	—	NPS2 Block	Off		

№	Name	Range	Units	Contents	Default Setting of Relay Model		User Setting
					210	410	
116	TCFALM	Off/On	—	Trip Circuit Fail Alarm	Off		
117	CBOPN	Off/On	—	Circuit Breaker Open	Off		
118	CBCLS	Off/On	—	Circuit Breaker Closed	Off		
119	EXT3PH	Off/On	—	External Trip - 3phase	Off		
120	EXTAPH	Off/On	—	External Trip - Aphase	Off		
121	EXTBPH	Off/On	—	External Trip - Bphase	Off		
122	EXTCPH	Off/On	—	External Trip - Cphase	Off		
123	RMTRST	Off/On	—	Remote Reset	Off		
124	SYNCLK	Off/On	—	Synchronize clock	Off		
125	STORCD	Off/On	—	Store Disturbance Record	Off		
126	Alarm1	Off/On	—	Alarm screen 1.	Off		
127	Alarm2	Off/On	—	Alarm screen 2.	Off		
128	Alarm3	Off/On	—	Alarm screen 3.	Off		
129	Alarm4	Off/On	—	Alarm screen 4.	Off		
				Repeat Following Switches from LED 2 to LED 3.			
130	Logic	OR/AND	—	LED1 Logic Gate Type	OR		
131	Reset	Inst/Latch	—	LED1 Reset operation	Inst		
132	In #1	0 - 200	—	LED Functions	0		
133	In #2	0 - 200	—	ditto	0		
134	In #3	0 - 200	—	ditto	0		
135	In #4	0 - 200	—	ditto	0		
				Repeat Following Switches for IND2.			
136	Reset	Inst/Latch	—	IND1 Reset operation	Inst		
137	BIT1	0 - 200	—	Virtual LED	0		
138	BIT2	0 - 200	—	ditto	0		
139	BIT3	0 - 200	—	ditto	0		
140	BIT4	0 - 200	—	ditto	0		
141	BIT5	0 - 200	—	ditto	0		
142	BIT6	0 - 200	—	ditto	0		
143	BIT7	0 - 200	—	ditto	0		
144	BIT8	0 - 200	—	ditto	0		
145	Plant name	Specified by user	—	Plant name	Specified by user		
146	Description	ditto	—	Memorandum for user	Specified by user		
147	HDLC	1 - 32	—	Relay ID No. for RSM	1		
148	IEC	0 - 254	—	Relay ID No. for IEC	2		
149	IECB1	0 - 200	—	IEC user specified signal 1	1		
150	IECB2	0 - 200	—	IEC user specified signal 2	2		
151	IECB3	0 - 200	—	IEC user specified signal 3	3		
152	IECB4	0 - 200	—	IEC user specified signal 4	4		
153	IECGT	0 - 7	—	IEC General trip	1		
154	IECAT	0 - 7	—	IEC Trip A phase	1		
155	IECBT	0 - 7	—	IEC Trip B phase	1		
156	IECCT	0 - 7	—	IEC Trip C phase	1		
157	IECE1	0 - 200	—	IEC user event 1	0		
158	IECE2	0 - 200	—	IEC user event 2	0		
159	IECE3	0 - 200	—	IEC user event 3	0		
160	IECE4	0 - 200	—	IEC user event 4	0		
161	IECE5	0 - 200	—	IEC user event 5	0		
162	IECE6	0 - 200	—	IEC user event 6	0		
163	IECE7	0 - 200	—	IEC user event 7	0		
164	IECE8	0 - 200	—	IEC user event 8	0		
165	IECI1	0 - 255	—	IEC user INF 1	0		
166	IECI2	0 - 255	—	IEC user INF 2	0		
167	IECI3	0 - 255	—	IEC user INF 3	0		
168	IECI4	0 - 255	—	IEC user INF 4	0		
169	IECI5	0 - 255	—	IEC user INF 5	0		
170	IECI6	0 - 255	—	IEC user INF 6	0		
171	IECI7	0 - 255	—	IEC user INF 7	0		
172	IECI8	0 - 255	—	IEC user INF 8	0		
173	Protocol	HDLC/IEC	—	Switch for communications	HDLC		
174	232C	9.6/19.2/57.6	—	ditto	9.6		
175	IECBR	9.6/19.2	—	ditto	19.2		
176	IECBLK	Normal/Blocked	—	ditto	Normal		
177	IECNFV	1.2/2.4	—	ditto	1.2		
178	IECNFf	1.2/2.4	—	ditto	1.2		

№	Name	Range	Units	Contents	Default Setting of Relay Model		User Setting
					210	410	
179	IECGI1	No/Yes	—	IEC event type setting 1	No		
180	IECGI2	No/Yes	—	IEC event type setting 2	No		
181	IECGI3	No/Yes	—	IEC event type setting 3	No		
182	IECGI4	No/Yes	—	IEC event type setting 4	No		
183	IECGI5	No/Yes	—	IEC event type setting 5	No		
184	IECGI6	No/Yes	—	IEC event type setting 6	No		
185	IECGI7	No/Yes	—	IEC event type setting 7	No		
186	IECGI8	No/Yes	—	IEC event type setting 8	No		
				Setting of Event Record			
187	BI1 comm.	None/Operate/Reset/Both	—	BI 1 command trigger setting	Both		
188	BI2 comm.	None/Operate/Reset/Both	—	BI 2 command trigger setting	Both		
189	BI3 comm.	None/Operate/Reset/Both	—	BI 3 command trigger setting	Both		
190	BI4 comm.	None/Operate/Reset/Both	—	BI 4 command trigger setting	Both		
191	BI5 comm.	None/Operate/Reset/Both	—	BI 5 command trigger setting	Both		
192	BI6 comm.	None/Operate/Reset/Both	—	BI 6 command trigger setting	Both		
193	BI7 comm.	None/Operate/Reset/Both	—	BI 7 command trigger setting	Both		
194	BI8 comm.	None/Operate/Reset/Both	—	BI 8 command trigger setting	Both		
				Setting of Disturbance Record			
195	Time	0.1 - 3.0	s	Disturbance record	2.0		
196	OV	10.0 -200.0	V	OV element for disturbance	120.00		
197	UV	1.0 - 130.0	V	UV element for disturbance	60.0		
198	ZPS	1.0 - 160.0	V	ZPS element for disturbance	20.0		
199	NPS	1.0 - 160.0	V	NPS element for disturbance	20.0		
200	Trip	Off / On	—	Disturbance trigger	On		
201	BI	Off / On	—	ditto	On		
202	OV	Off / On	—	ditto	On		
203	UV	Off / On	—	ditto	On		
204	ZPS	Off / On	—	ditto	On		
205	NPS	Off / On	—	ditto	On		
206	SIG1	0 - 200	—	Disturbance trigger	See other sheet		
207	SIG2	0 - 200	—	ditto	ditto		
208	SIG3	0 - 200	—	ditto	ditto		
209	SIG4	0 - 200	—	ditto	ditto		
210	SIG5	0 - 200	—	ditto	ditto		
211	SIG6	0 - 200	—	ditto	ditto		
212	SIG7	0 - 200	—	ditto	ditto		
213	SIG8	0 - 200	—	ditto	ditto		
214	SIG9	0 - 200	—	ditto	ditto		
215	SIG10	0 - 200	—	ditto	ditto		
216	SIG11	0 - 200	—	ditto	ditto		
217	SIG12	0 - 200	—	ditto	ditto		
218	SIG13	0 - 200	—	ditto	ditto		
219	SIG14	0 - 200	—	ditto	ditto		
220	SIG15	0 - 200	—	ditto	ditto		
221	SIG16	0 - 200	—	ditto	ditto		
222	SIG17	0 - 200	—	ditto	ditto		
223	SIG18	0 - 200	—	ditto	ditto		
224	SIG19	0 - 200	—	ditto	ditto		
225	SIG20	0 - 200	—	ditto	ditto		
226	SIG21	0 - 200	—	ditto	ditto		
227	SIG22	0 - 200	—	ditto	ditto		
228	SIG23	0 - 200	—	ditto	ditto		
229	SIG24	0 - 200	—	ditto	ditto		
230	SIG25	0 - 200	—	ditto	ditto		
231	SIG26	0 - 200	—	ditto	ditto		
232	SIG27	0 - 200	—	ditto	ditto		
233	SIG28	0 - 200	—	ditto	ditto		
234	SIG29	0 - 200	—	ditto	ditto		
235	SIG30	0 - 200	—	ditto	ditto		
236	SIG31	0 - 200	—	ditto	ditto		
237	SIG32	0 - 200	—	ditto	ditto		
238	TCSPEN	Off / On / Opt-On	—	Trip Circuit Supervision Enable	Off		
239	CBSMEN	Off / On	—	Circuit Breaker State Monitoring Alarm Enable	Off		
240	TCAEN	Off / On	—	Trip Count Alarm Enable	Off		
241	TCALM	1 - 10000	—	Trip Count Alarm Threshold setting	10000		
242	Display	Prim. / Second.	—	Metering	Prim.		
243	Time sync	Off / BI / RSM / IEC	—	Time	Off		

Disturbance record default setting

Name	Range	Unit	Model 210		Model 410	
			NO.	Signal name	NO.	Signal name
SIG1	0-200	—	90	UV1	60	UV1-A
SIG2	0-200	—	93	ZPS1	61	UV1-B
SIG3	0-200	—	122	UV1 TRIP	62	UV1-C
SIG4	0-200	—	143	ZPS1 TRIP	93	ZPS1
SIG5	0-200	—	147	GEN.TRIP	123	UV1-A TRIP
SIG6	0-200	—	0		124	UV1-B TRIP
SIG7	0-200	—	0		125	UV1-C TRIP
SIG8	0-200	—	0		143	ZPS1 TRIP
SIG9	0-200	—	0		147	GEN.TRIP
SIG10	0-200	—	0		148	GEN.TRIP-A
SIG11	0-200	—	0		149	GEN.TRIP-B
SIG12	0-200	—	0		150	GEN.TRIP-C
SIG13	0-200	—	0		0	
SIG14	0-200	—	0		0	
SIG15	0-200	—	0		0	
SIG16	0-200	—	0		0	
SIG17	0-200	—	0		0	
SIG18	0-200	—	0		0	
SIG19	0-200	—	0		0	
SIG20	0-200	—	0		0	
SIG21	0-200	—	0		0	
SIG22	0-200	—	0		0	
SIG23	0-200	—	0		0	
SIG24	0-200	—	0		0	
SIG25	0-200	—	0		0	
SIG26	0-200	—	0		0	
SIG27	0-200	—	0		0	
SIG28	0-200	—	0		0	
SIG29	0-200	—	0		0	
SIG30	0-200	—	0		0	
SIG31	0-200	—	0		0	
SIG32	0-200	—	0		0	

User setting of Virtual LED

	1	2	3	4	5	6	7	8	
IND1	[								]
IND2	[								]

Appendix H

Commissioning Test Sheet (sample)

1. Relay identification
2. Preliminary check
3. Hardware check
   - 3.1 User interface check
   - 3.2 Binary input/binary output circuit check
   - 3.3 AC input circuit check
4. Function test
   - 4.1 Overvoltage and undervoltage elements test
   - 4.2 Negative sequence overvoltage elements test
5. Protection scheme test
6. Metering and recording check

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 ☐

Wiring ☐

Calendar and clock ☐

3. Hardware check

3.1 User interface check ☐

3.2 Binary input/binary output circuit check

Binary input circuit ☐

Binary output circuit ☐

3.3 AC input circuit check ☐

4. Function test

4.1 Overvoltage and undervoltage elements test

(1) Operating value test

Element	Voltage setting	Measured voltage
OV1		
OV2		
OV3		
UV1		
UV2		
UV3		
ZPS1		
ZPS2		

(2) Operating time test (IDMT)

Element	Multiplier setting	Changed voltage	Measured time
OV1		× Voltage setting × Voltage setting × Voltage setting	
OV2		× Voltage setting × Voltage setting × Voltage setting	
UV1		× Voltage setting × Voltage setting × Voltage setting	
UV2		× Voltage setting × Voltage setting × Voltage setting	
ZPS1		× Voltage setting × Voltage setting × Voltage setting	
ZPS2		× Voltage setting × Voltage setting × Voltage setting	

4.2 Negative overvoltage elements test

(1) Operating value test

Element	Voltage setting	Measured voltage
NPS1		
NPS2		

(2) Operating time test (IDMT)

Element	Multiplier setting	Changed voltage	Measured time
NPS1		× Voltage setting × Voltage setting × Voltage setting	
NPS2		× Voltage setting × Voltage setting × Voltage setting	

5. Protection scheme test

6. Metering and recording check

Appendix I

Return Repair Form

RETURN / REPAIR FORM

Please fill in this form and return it to TOSHIBA CORPORATION with the GRD130 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: GRD130 Model:_____

(Example: Type: GRD130 Model: 210A)

Product No.: _____

Serial No.: _____

Date: _____

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

     _____

     _____

     _____

     _____

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

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

Fault Record

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

(Example: 04/ Jul./ 2002 15:09:58.442)

Faulty phase:

Prefault values

V_{an}: V
V_{bn}: V
V_{cn}: V
V_{ab}: V
V_{bc}: V
V_{ca}: V
V_{ph}: V
V_0: V
V_1: V
V_2: V
f: Hz

Fault values

V_{an}: V
V_{bn}: V
V_{cn}: V
V_{ab}: V
V_{bc}: V
V_{ca}: V
V_{ph}: V
V_0: V
V_1: V
V_2: V
f: Hz

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

4. Describe the details of the incident:

5. Date incident occurred

   Day/Month/Year: / / /

   (Example: 10/Dec/2002)

6. Give any comments about the GRD130, including the documents:

Customer

Name: _____

Company Name: _____

Address: _____

_____

_____

Telephone No.: _____

Facsimile No.: _____

Signature: _____

Appendix J

Technical Data

TECHNICAL DATA

Ratings	
AC voltage V_n:	110V
Frequency:	50Hz or 60Hz
DC auxiliary supply:	110/125Vdc (Operative range: 88 - 150Vdc) 220/250Vdc (Operative range: 176 - 300Vdc) 48/54/60Vdc (Operative range: 38.4 - 72Vdc)
Superimposed AC ripple on DC supply:	maximum 12%
DC supply interruption:	maximum 50ms at 110V
Binary input circuit DC voltage:	110/125Vdc (Operative range: 88 - 150Vdc) 220/250Vdc (Operative range: 176 - 300Vdc) 48/54/60Vdc (Operative range: 38.4 - 72Vdc)
Overload Ratings	
AC voltage inputs:	2 times rated voltage continuous
Burden	
AC phase voltage inputs:	≤ 0.1VA (at rated voltage)
DC power supply:	≤ 10W (quiescent), ≤ 15W (maximum)
Binary input circuit:	≤ 0.5W per input at 110Vdc
Overvoltage Protection	
1st, 2nd, 3rd Overvoltage thresholds:	OFF, 10.0 – 200.0V in 0.1V steps
Delay type (1st, 2nd threshold):	DTL, IDMTL
IDMTL Time Multiplier Setting TMS:	0.05 - 100.00 in 0.01 steps
DTL delay:	Inst, 0.01 - 300.00s in 0.01s steps
DO/PU ratio	10 - 98% in 1% steps
Reset Delay (1st, 2nd threshold and IDMTL):	Instantaneous, 0.1 – 300.0s in 0.1s steps
Undervoltage Protection	
1st, 2nd, 3rd Undervoltage thresholds:	OFF, 5.0 – 130.0V in 0.1V steps
Delay type (1st, 2nd threshold):	DTL, IDMTL
IDMTL Time Multiplier Setting TMS:	0.05 - 100.00 in 0.01 steps
DTL delay:	Inst, 0.01 - 300.00s in 0.01s steps
Reset Delay (1st, 2nd threshold and IDMTL):	Instantaneous, 0.1 – 300.0s in 0.1s steps
Zero Sequence Overvoltage (ZPS) Protection	
1st, 2nd ZPS Overvoltage thresholds:	OFF, 1.0 – 160.0V in 0.1V steps
Delay type:	DTL, IDMTL
IDMTL Time Multiplier Setting TMS:	0.05 - 100.00 in 0.01 steps
DTL delay:	Inst, 0.01 - 300.00s in 0.01s steps
Reset Delay (IDMTL):	Instantaneous, 0.1 – 300.0s in 0.1s steps
Negative Sequence Overvoltage (NPS) Protection	
1st, 2nd NPS Overvoltage thresholds:	OFF, 1.0 – 160.0V in 0.1V steps
Delay type:	DTL, IDMTL
IDMTL Time Multiplier Setting TMS:	0.05 - 100.00 in 0.01 steps
DTL delay:	Inst, 0.01 - 300.00s in 0.01s steps
Reset Delay (IDMTL):	Instantaneous, 0.1 – 300.0s in 0.1s steps

Accuracy	
IDMTL Overvoltage Pick-up:	105% of setting ± 5%
All Other Overvoltage Pick-ups:	100% of setting ± 5%
Overvoltage PU/DO ratio:	≥95% (settable for phase overvoltage)
IDMTL Undervoltage Pick-up:	95% of setting ± 5%
All Other Undervoltage Pick-ups:	100% of setting ± 5%
Undervoltage PU/DO ratio:	≤105%
Inverse Time Delays:	± 5% or 30ms
Definite Time Delays:	± 1% or 10ms
Front Communication port - local PC (RS232)	
Connection:	Point to point
Cable type:	Multi-core (straight)
Cable length:	15m (max.)
Connector:	RS232C 9-way D-type female
Rear Communication port - remote PC (RS485)	
Connection:	Multidrop (max. 32 relays)
Cable type:	Twisted pair
Cable length:	1200m (max.)
Connector:	Screw terminals
Isolation:	1kVac for 1 min.
Transmission rate:	64kpbs for RSM system 9.6, 19.2kbps for IEC60870-5-103
Rear Communication port - remote PC (Fibre Optic for IEC60870-5-103: option)	
Connection:	Multidrop (max. 32 relays)
Cable type:	50/125 or 62.5/125μm fibre
Cable length:	1000m (max.)
Connector:	ST
Transmission rate:	9.6, 19.2kbps for IEC60870-5-103
Binary Inputs	
Operating voltage	Typical 74Vdc(min. 70Vdc) for 110V/125Vdc rating Typical 138Vdc(min. 125Vdc) for 220V/250Vdc rating Typical 31Vdc(min. 28Vdc) for 48V/54V/60Vdc rating
Binary Outputs	
Number	8
Ratings:	Make and carry: 4A continuously Make and carry: 10A, 220Vdc for 0.5s (L/R≥5ms) Break: 0.1A, 220Vdc (L/R=40ms)
Durability:	Make and carry: 10000 operations Break: 100000 operations
Mechanical design	
Weight	4.5kg
Case color	Munsell No. 10YR8/0.5
Installation	Flush mounting

ENVIRONMENTAL PERFORMANCE

Test	Standards	Details
Atmospheric Environment		
Temperature	IEC60068-2-1/2	Operating range: -10°C to +55°C. Storage / Transit: -25°C to +70°C.
Humidity	IEC60068-2-78	56 days at 40°C and 93% relative humidity.
Enclosure Protection	IEC60529	IP51 (Rear: IP20)
Mechanical Environment		
Vibration	IEC60255-21-1	Response - Class 1 Endurance - Class 1
Shock and Bump	IEC60255-21-2	Shock Response Class 1 Shock Withstand Class 1 Bump Class 1
Seismic	IEC60255-21-3	Class 1
Electrical Environment		
Dielectric Withstand	IEC60255-5	2kVrms for 1 minute between all terminals and earth. 2kVrms for 1 minute between independent circuits. 1kVrms for 1 minute across normally open contacts.
High Voltage Impulse	IEC60255-5	Three positive and three negative impulses of 5kV(peak), 1.2/50μs, 0.5J between all terminals and between all terminals and earth.
Electromagnetic Environment		
High Frequency Disturbance / Damped Oscillatory Wave	IEC60255-22-1 Class 3, IEC61000-4-12 / EN61000-4-12	1MHz 2.5kV applied to all ports in common mode. 1MHz 1.0kV applied to all ports in differential mode.
Electrostatic Discharge	IEC60255-22-2 Class 3, IEC61000-4-2 / EN61000-4-2	6kV contact discharge, 8kV air discharge.
Radiated RF Electromagnetic Disturbance	IEC60255-22-3 Class 3, IEC61000-4-3 / EN61000-4-3	Field strength 10V/m for frequency sweeps of 80MHz to 1GHz and 1.7GHz to 2.2GHz. Additional spot tests at 80, 160, 450, 900 and 1890MHz.
Fast Transient Disturbance	IEC60255-22-4, IEC61000-4-4 / EN61000-4-4	4kV, 2.5kHz, 5/50ns applied to all inputs.
Surge Immunity	IEC60255-22-5, IEC61000-4-5 / EN61000-4-5	1.2/50μs surge in common/differential modes: HV ports: 2kV/1kV (peak) PSU and I/O ports: 2kV/1kV (peak) RS485 port: 1kV (peak)
Conducted RF Electromagnetic Disturbance	IEC60255-22-6 Class 3, IEC61000-4-6 / EN61000-4-6	10Vrms applied over frequency range 150kHz to 100MHz. Additional spot tests at 27 and 68MHz.
Power Frequency Disturbance	IEC60255-22-7, IEC61000-4-16 / EN61000-4-16	300V 50Hz for 10s applied to ports in common mode. 150V 50Hz for 10s applied to ports in differential mode. Not applicable to AC inputs.
Conducted and Radiated Emissions	IEC60255-25, EN55022 Class A, IEC61000-6-4 / EN61000-6-4	Conducted emissions: 0.15 to 0.50MHz: <79dB (peak) or <66dB (mean) 0.50 to 30MHz: <73dB (peak) or <60dB (mean) Radiated emissions (at 30m): 30 to 230MHz: <30dB 230 to 1000MHz: <37dB

European Commission Directives		
CE	89/336/EEC	Compliance with the European Commission Electromagnetic Compatibility Directive is demonstrated according to EN 61000-6-2 and EN 61000-6-4.
	73/23/EEC	Compliance with the European Commission Low Voltage Directive is demonstrated according to EN 50178 and EN 60255-5.

Appendix K

Symbols Used in Scheme Logic

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

Signal names

Marked with ▭ : Measuring element output signal

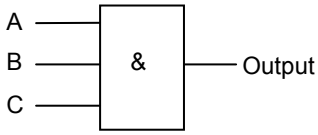
Marked with ⬭ : Binary signal input from or output to the external equipment

Marked with [ ] : Scheme switch

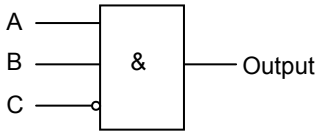
Marked with " " : Scheme switch position

Unmarked : Internal scheme logic signal

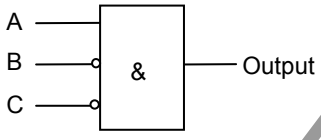
AND gates



A	B	C	Output
1	1	1	1
Other cases			0

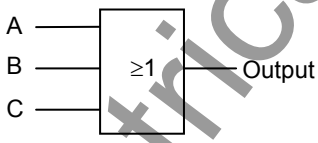


A	B	C	Output
1	1	0	1
Other cases			0

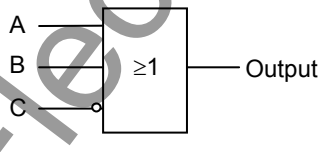


A	B	C	Output
1	0	0	1
Other cases			0

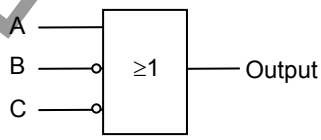
OR gates



A	B	C	Output
0	0	0	0
Other cases			1

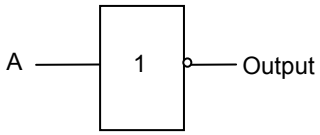


A	B	C	Output
0	0	1	0
Other cases			1



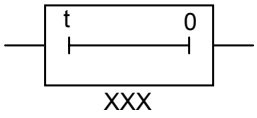
A	B	C	Output
0	1	1	0
Other cases			1

Signal inversion



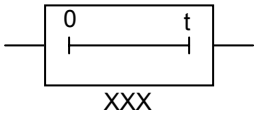
A	Output
0	1
1	0

Timer



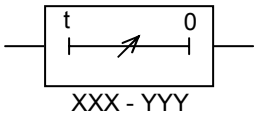
Delayed pick-up timer with fixed setting

XXX: Set time



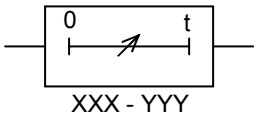
Delayed drop-off timer with fixed setting

XXX: Set time



Delayed pick-up timer with variable setting

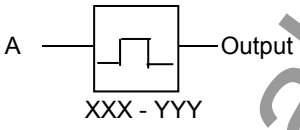
XXX - YYY: Setting range

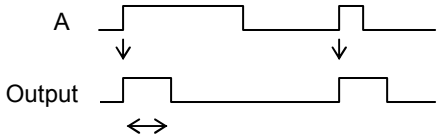


Delayed drop-off timer with variable setting

XXX - YYY: Setting range

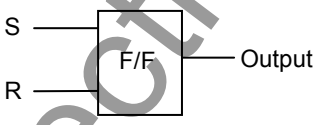
One-shot timer





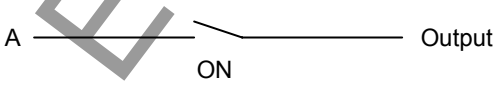
XXX - YYY: Setting range

Flip-flop

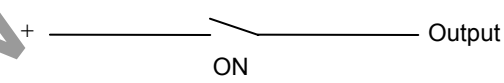


S	R	Output
0	0	No change
1	0	1
0	1	0
1	1	0

Scheme switch



A	Switch	Output
1	ON	1
Other cases		0



Switch	Output
ON	1
OFF	0

Appendix L

IEC60870-5-103: Interoperability

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. IEC60870-5-103 Interface

3.1 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. 8 wide-use events are provided.

3.2 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.

3.3 Cyclic measurements

The relay will produce measured values using Type ID=3 and 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 is 2 seconds.

It should be noted that the measurands transmitted by the relay are sent as a proportion of either 1.2 or 2.4 times the rated value of the analog value. Either 1.2 or 2.4 can be selected by the "IECNF∗" setting.

3.4 Commands

A list of the supported commands is contained in the table below. The relay will respond to other commands with an ASDU 1, with a cause of transmission (COT) of negative acknowledgement of a command.

3.5 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.

3.6 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.

4. List of Information

List of Information

INF	Description	Contents	GI	Type ID	COT	FUN
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	215
3	Reset CU	Reset CU ACK	--	5	4	215
4	Start/Restart	Relay start/restart	--	5	5	215
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, 7, 9, 12, 20, 21	215
19	LED reset	Reset of latched LEDs	--	1	1, 7, 11, 12, 20, 21	215
20	Monitor direction blocked	Block the 103 transmission from a relay to control system. IECBLK: "Blocked" setting.	GI	1	9, 11	215
21	Test mode	Transmission of testmode situation from a relay to control system. IECTST: "ON" setting.	GI	1	9, 11	215
22	Local parameter Setting	When a setting change has done at the local, the event is sent to control system.	Not supported			
23	Characteristic1	Setting group 1 active	GI	1	1, 7, 9, 11, 12, 20, 21	215
24	Characteristic2	Setting group 2 active	GI	1	1, 7, 9, 11, 12, 20, 21	215
25	Characteristic3	Setting group 3 active	GI	1	1, 7, 9, 11, 12, 20, 21	215
26	Characteristic4	Setting group 4 active	GI	1	1, 7, 9, 11, 12, 20, 21	215
27	Auxiliary input1	User specified signal 1 (Signal specified by IECB1: ON) (*1)	GI	1	1, 7, 9	215
28	Auxiliary input2	User specified signal 2 (Signal specified by IECB2: ON) (*1)	GI	1	1, 7, 9	215
29	Auxiliary input3	User specified signal 3 (Signal specified by IECB3: ON) (*1)	GI	1	1, 7, 9	215
30	Auxiliary input4	User specified signal 4 (Signal specified by IECB4: ON) (*1)	GI	1	1, 7, 9	215
Supervision Indications						
32	Measurand supervision I	Zero sequence current supervision	Not supported			
33	Measurand supervision V	Zero sequence voltage supervision	GI	1	1, 7, 9	215
35	Phase sequence supervision	Negative sequence voltage supevision	GI	1	1, 7, 9	215
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, 7, 9	215
47	Group alarm	Trip blocking and alarming	GI	1	1, 7, 9	215
Earth Fault Indications						
48	Earth Fault L1	A phase earth fault	Not supported			
49	Earth Fault L2	B phase earth fault	Not supported			
50	Earth Fault L3	C phase earth fault	Not supported			
51	Earth Fault Fw d	Earth fault forw ard	Not supported			
52	Earth Fault Rev	Earth fault reverse	Not supported			

INF	Description	Contents	GI	Type ID	COT	FUN
Fault Indications						
64	Start/pick-up L1	A phase, A-B phase or C-A phase element pick-up	GI	2	1, 7, 9	215
65	Start/pick-up L2	B phase, A-B phase or B-C phase element pick-up	GI	2	1, 7, 9	215
66	Start/pick-up L3	C phase, B-C phase or C-A phase element pick-up	GI	2	1, 7, 9	215
67	Start/pick-up N	Earth fault element pick-up	GI	2	1, 7, 9	215
68	General trip	BO status specified by IECGT: ON (*1)	--	2	1, 7	215
69	Trip L1	BO status specified by IECAT: ON (*1)	--	2	1, 7	215
70	Trip L2	BO status specified by IECBT: ON (*1)	--	2	1, 7	215
71	Trip L3	BO status specified by IECCT: ON (*1)	--	2	1, 7	215
72	Trip I>>(back-up)	Back up trip	Not supported			
73	Fault location X In ohms	Fault location (prim. [ohm] / second. [ohm] / km selectable by IECFL)	Not supported			
74	Fault 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	GI	2	1, 7, 9	215
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			

Note (*1): Not available if the setting is "0".

INF	Description	Contents	GI	Type ID	COT	FUN
IECI1	User specified 1	Signal specified by IECE1: ON (*1)	IECG1 (yes/no)	2	1, 7	215
IECI2	User specified 2	Signal specified by IECE2: ON (*1)	IECG2 (yes/no)	2	1, 7	215
IECI3	User specified 3	Signal specified by IECE3: ON (*1)	IECG3 (yes/no)	2	1, 7	215
IECI4	User specified 4	Signal specified by IECE4: ON (*1)	IECG4 (yes/no)	2	1, 7	215
IECI5	User specified 5	Signal specified by IECE5: ON (*1)	IECG5 (yes/no)	2	1, 7	215
IECI6	User specified 6	Signal specified by IECE6: ON (*1)	IECG6 (yes/no)	2	1, 7	215
IECI7	User specified 7	Signal specified by IECE7: ON (*1)	IECG7 (yes/no)	2	1, 7	215
IECI8	User specified 8	Signal specified by IECE8: ON (*1)	IECG8 (yes/no)	2	1, 7	215
Measurands(*2)						
144	Measurand I	<meaurand I>	Not supported			
145	Measurand I,V	Vab measurand <measurand I>	--	3.2	2, 7	215
146	Measurand I,V,P,Q	Vab measurand <measurand I>	--	3.3	2, 7	215
147	Measurand IN,VEN	Vo measurand <measurand I>	--	3.4	2, 7	215
148	Measurand IL1,2,3, VL1,2,3, P,Q,f	Va, Vb, Vc, f measurand <measurand II>	--	9	2, 7	215
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			

Note (*2): depends on relay model as follows:

	Type ID=3.1	Type ID=3.2		Type ID=3.3				Type ID=3.4	
Model and [APPL]	(INF=144)	(INF=145)		(INF=146)				(INF=147)	
setting	IL2	IL2	VL1-VL2	IL2	VL1-VL2	3-phase P	3-phase Q	IN	VEN
Model 210, [APPL]=1PP	0	0	Vph-ph	0	Vph-ph	–	–	0	Ve
Model 210, [APPL]=1PN	0	0	0	0	0	–	–	0	Ve
Model 210, [APPL]=2PP	0	0	Vab	0	Vab	–	–	0	0
Model 410, [APPL]=3PN	0	0	Vab	0	Vab	–	–	0	3×V0
Model 410, [APPL]=3PV	0	0	Vab	0	Vab	–	–	0	Ve
Model 410, [APPL]=3PP	0	0	Vab	0	Vab	–	–	0	Ve
Model 410, [APPL]=2PP	0	0	Vab	0	Vab	–	–	0	Ve

	Type ID=9								
Model and [APPL]	(INF=148)								
setting	IL1	IL2	IL3	VL1	VL2	VL3	3-phase P	3-phase Q	f
Model 210, [APPL]=1PP	0	0	0	0	0	0	0	0	f
Model 210, [APPL]=1PN	0	0	0	Vph-n	0	0	0	0	f
Model 210, [APPL]=2PP	0	0	0	0	0	0	0	0	f
Model 410, [APPL]=3PN	0	0	0	Van	Vbn	Vcn	0	0	f
Model 410, [APPL]=3PV	0	0	0	Van	Vbn	Vcn	0	0	f
Model 410, [APPL]=3PP	0	0	0	0	0	0	0	0	f
Model 410, [APPL]=2PP	0	0	0	0	0	0	0	0	f

Above values are normalized by IECNF*.

INF	Description	Contents	COM	Type ID	COT	FUN
Selection of standard information numbers in control direction						
System functions						
0	Initiation of general interrogation		--	7	9	255
0	Time synchronization		--	6	8	255
General commands						
16	Auto-recloser on/off		Not supported			
17	Teleprotection on/off		Not supported			
18	Protection on/off	(*3)	ON/OFF	20	20	215
19	LED reset	Reset indication of latched LEDs.	ON	20	20	215
23	Activate characteristic 1	Setting Group 1	ON	20	20	215
24	Activate characteristic 2	Setting Group 2	ON	20	20	215
25	Activate characteristic 3	Setting Group 3	ON	20	20	215
26	Activate characteristic 4	Setting Group 4	ON	20	20	215
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			
251	Write entry abort		Not supported			

Note (*3): While the relay receives the "Protection off" command, " IN SERVICE LED" is off.

	Description	Contents	GRD130 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	1,2 or 2,4	IECNFV setting
	Voltage L2-E	Vb	1,2 or 2,4	IECNFV setting
	Voltage L3-E	Vc	1,2 or 2,4	IECNFV setting
	Active power P	P	No	
	Reactive power Q	Q	No	
	Frequency f	f	1,2 or 2,4	IECNFf setting
	Voltage L1 - L2	Vab	1,2 or 2,4	IECNFV setting

[Legend]

GI: General Interrogation

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

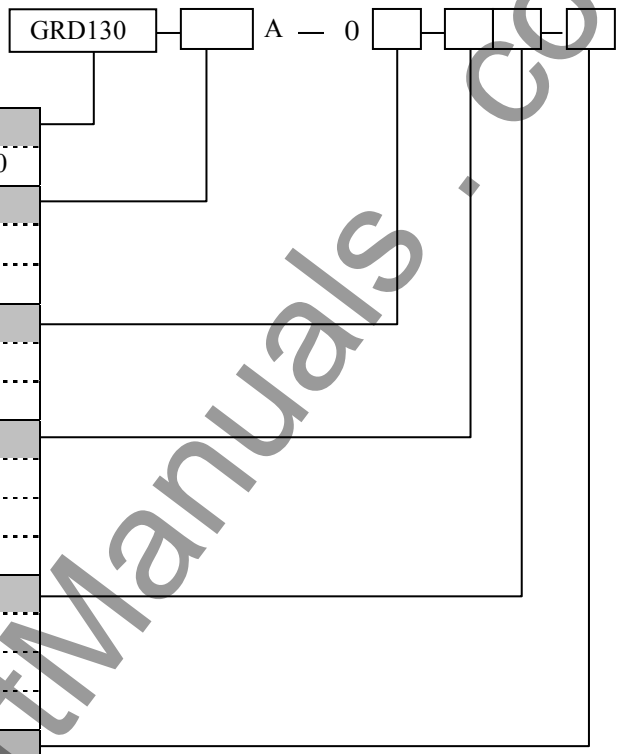
COT: Cause of Transmission (refer to IEC60870-5-103 section 7.2.3)

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

Appendix M

Ordering

Ordering



Type:	
Overvoltage and undervoltage Relay	GRD130
Model:	
-Model 210: Two pole	210
-Model 410: Four pole	410
Frequency:	
50Hz	1
60Hz	2
DC auxiliary supply rating:	
110V/125V	1
220V/250V	2
48V	3
Rear communication port:	
RS485	1
Fibre optic	2
Dual RS485	3
LED label:	
Standard Option: User configurable LED label	None J

Version-up Records

Version No.	Date	Revised Section	Contents
0.0	May 13, 2003	--	First issue
0.1	Jun. 11, 2003	6.7.3 Appendix F	Added the description in CAUTION. Modified the TB number of RS485 I/F.
1.1	Dec. 11, 2003	 2.1.3, 2.2.3 2.3, 2.4 3.1.1 3.2.2 3.4.2 4.1, 4.1.2 4.2.2 4.2.6.4 4.2.6.5 4.2.6.9, 4.2.6.10 4.2.7.1 Appendices	RS485 two-port type is added. Modified the setting range of timers. Modified the setting range of timers. Modified Figure 3.1.2. Modified Table 3.2.2. Modified the description. Modified the description and Figure 4.1.1. Modified the description. Modified the description and changed the LCD sample screens for communication. Added the “Setting the event recording”. Added the CAUTION for releasing the latch state when changing settings. Modified the description and changed the LCD sample screen of Switch. Modified the Appendix A, D, E, F, G, J and L.
1.2	Apr. 8, 2004	3.3.5 Appendix F Appendix M	Modified Table 3.3.1. Modified the Appendix F. Added the Appendix M.
1.3	Aug. 19, 2004	3.2.2 Appendix L	Modified the description. Modified the Appendix L.
2.3	Dec. 22, 2005	2.1 2.1.1 2.1.2 2.1.3 2.2 2.2.1 2.2.2 2.2.3 2.3 2.4 2.5 3.1.1 3.2.3 4.2.6.7 6.5.1 Appendices	Modified the description. Modified the description and Figure 2.1.2, and added Table 2.1.1. Modified the description and Figure 2.1.3. Modified the setting range table. Modified the description. Modified the description and Figure 2.2.2, and added Table 2.2.1. Modified the description and Figure 2.2.3. Modified the setting range table. Modified the description, Figure 2.3.4 and the setting range table, and added Table 2.3.1. Modified the description, Figure 2.4.2 and the setting range table, and added Table 2.4.1. Modified the description, Figure 2.5.1 and the setting range table. Modified the description in “HMI module”. Modified the description and Figure 3.2.3. Modified the description and LCD sample screens. Modified LCD sample screens. Modified Appendix A, D, G and J.
2.4	Apr. 13, 2007	4.2, 4.4 Appendices	Modified the description. Modified Appendix D.

TOSHIBA CORPORATION