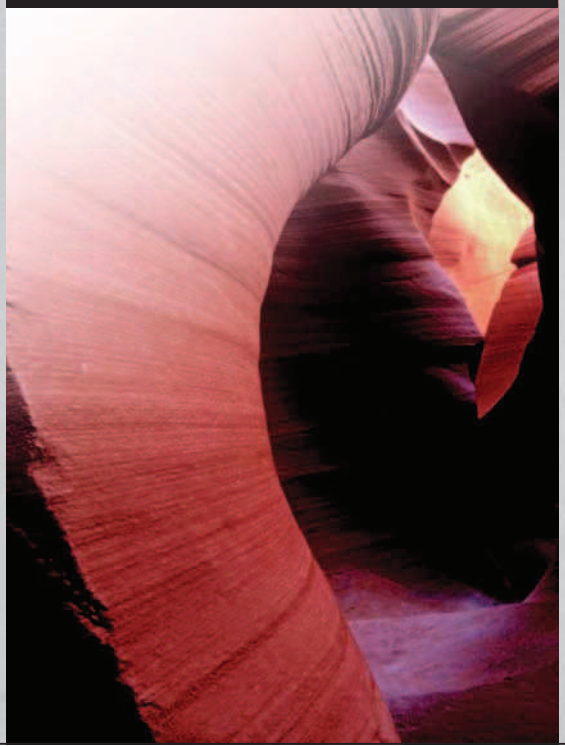
TOSHIBA

Leading Innovation

GRE110

Protection and Control
for MV Systems



FEATURES

- Overcurrent protection for phase and earth faults (50/51P, 50/51N).
- Dependent and independent time characteristics (IDMTL and DTL).
- Four independent current thresholds.
- Restricted earth fault protection(50/51N).
- Sensitive earth fault protection (50/51N).
- Phase undercurrent protection (37).
- Thermal overload protection (49).
- Negative phase sequence overcurrent protection (46).
- Broken conductor detection (46BC).
- Circuit breaker fail protection (50BF).
- Cold load protection..
- Five shot, three phase auto-reclose (Last trip over the set reclosing shot to lockout) (79).
- Control function.
- Local/Remote control.
- Trip circuit supervision scheme using two binary inputs for high integrity (74TC).
- Automatic self-supervision.
- Circuit breaker state monitoring.
- Programmable Logic Control (PLC) function.
- Two settings groups.
- Metering and recording functions.
- Combined 1A / 5A current inputs
- Configurable binary inputs and outputs.
- Menu-based HMI system.
- Configurable LED indication.
- Front mounted USB port for local PC communications.
- Rear mounted RS485 serial port for remote communications.
- Data communication with substation control and automation systems is supported according to the Modbus® RTU, DNP3, IEC 61850 and IEC 60870-5-103 standards.

APPLICATION

GRE110 is a range of fully numerical multi-function protection relays designed for feeder protection applications in medium voltage networks. The devices provide a comprehensive range of protection and control functions within a compact and cost-effective package, and can also be applied as motor protection, and as back-up protection for generators and transformers.

There are two models within the GRE110 range which differ depending on the application and each model has different types according to the number of binary inputs and outputs fitted, see Table 1. Combined 1A/5A current inputs and wide auxiliary supply ranges simplify type selection.

Table 1 - GRE110 Models

Model	Configuration
400:	Three Phase Fault and Earth Fault
GRE110-400	2 x BIs and 4 x BOs
GRE110-401	6 x BIs and 4 x BOs
GRE110-402	6 x BIs and 8 x BOs
420:	Three Phase Fault, Earth Fault and Sensitive Earth Fault
GRE110-420	2 x BIs and 4 x BOs
GRE110-421	6 x BIs and 4 x BOs
GRE110-422	6 x BIs and 8 x BOs

All models include multiple, high accuracy, overcurrent protection elements (for phase and/or earth fault) with inverse time and definite time delay functions in accordance with the IEC 60255-151 functional standard. A comprehensive range of additional protection functions are also supported, including thermal protection to IEC 60255-8, negative sequence overcurrent protection and a broken conductor detection feature, see Table 1**エラー! 参照元が見つかりません。**. Control functions such as two-step operation of circuit breakers are also provided.

In addition, GRE110 provided multi-shot, three phase autoreclose, with independent sequences for phase fault, and earth fault and sensitive earth fault. Autoreclose can also be triggered by external protection devises.

All models provide continuous monitoring of internal circuits and of software. A trip circuit supervision function using two binary inputs provides high-integrity monitoring of the circuit breaker tripping circuit in both the breaker open and closed conditions. Circuit breaker condition monitoring functions provide guidance of maintenance timing.

A user-friendly HMI is provided through a backlit LCD, programmable LEDs, keypad and menu-based operating system. PC access is provided for local connection via a front-mounted USB port. The communication system allows the user to read and modify the relay settings, and to access data gathered by the relay's metering and recording functions.

Data available either via the relay HMI or communications ports includes the following functions.

- Metering
- Fault recording
- Event recording

- Disturbance recording (available via communications ports)

Table 2 - GRE110 Features

Model Number	GRE110 -	
	40∗	42∗
Phase Fault O/C (50/51P)	✓	✓
Earth Fault O/C (50N/51N)	✓	✓
SEF (50N/51N)		✓
Phase Undercurrent (37)	✓	✓
Thermal Overload (49)	✓	✓
NPS Overcurrent (46)	✓	✓
Broken Conductor (46BC)	✓	✓
Circuit Breaker Fail (50BF)	✓	✓
Cold Load Protection	✓	✓
Auto Reclose (79)	✓	✓
Local/Remote Control	✓	✓
Trip circuit supervision (74TC)	✓	✓
Self supervision	✓	✓
CB State Monitoring	✓	✓
Trip Counter Alarm	✓	✓
$\sum I^y$ Alarm	✓	✓
CB Operate Time Alarm	✓	✓
Programmable Logic Control (PLC) function	✓	✓
Two settings groups	✓	✓
Metering	✓	✓
Fault records	✓	✓
Event records	✓	✓
Disturbance records	✓	✓
Modbus Communication	✓* **	✓* **
IEC60870-5-103 Communication	✓	✓
DNP3 Communication	✓* **	✓* **
IEC61850 Communication	✓**	✓**

* Modbus® RTU, IEC 60870-5-103 and DNP3 are supported via built-in RS485 port.

** Modbus® TCP, DNP3 (TCP) and IEC 61850 are supported via an optional communication port for model 402 and 422 only.

PROTECTION FUNCTIONS

Phase Fault Overcurrent Protection

GRE110 provides three phase overcurrent protection and four independent overcurrent thresholds. The first and second thresholds may be set for inverse time or definite time operation. If inverse time is selected, then any one of nine curves may be chosen, including IEC and IEEE/ ANSI standard characteristics, (see Figure 1). The other overcurrent thresholds may be set for definite time, or instantaneous operation.

The first threshold has a programmable reset feature, selectable for instantaneous, definite time or dependent time reset. This feature can be used to protect against flashing fault conditions, or to grade correctly with electromechanical overcurrent relays.

All elements can be inhibited by binary input signals for operation in blocked overcurrent and busbar blocking protection schemes.

Earth Fault Protection

The standard earth fault protection is available in all models, and provides four independent overcurrent thresholds. Protection functionality is the same as for the phase fault elements, only with more sensitive current thresholds.

For model GRE110-400, 401 and 402, the earth fault quantity is measured directly, either by connecting the input in the residual circuit of the phase CTs, or, as is recommended for more sensitive settings, using a dedicated core balance earth fault CT. For model GRE110-420, 421 and 422, the standard earth fault quantity is derived internally from the residual sum of the three phases.

Sensitive Earth Fault Protection (SEF)

GRE110-420, 421 and 422 provide 4-stage earth fault protection with more sensitive settings for use in applications where the fault current magnitude may be very low. A 2-stage overcurrent function is provided, with the first stage programmable for inverse time or definite time operation. The second stage provides inverse or definite time operation and runs after operation of the first stage. Third and fourth overcurrent thresholds are provided, each with a definite time delay.

The sensitive earth fault element includes a digital filter which rejects all harmonics other than the fundamental power system frequency.

The sensitive earth fault quantity is measured directly, using a dedicated core balance earth fault CT.

This input can also be used in transformer restricted earth fault applications, by the use of external metrosils and setting resistors.

Phase Undercurrent Protection

Protection against loss of load is provided by the phase undercurrent protection. Two independent thresholds are provided, each with a programmable

definite time delay.

Thermal Overload Protection

The thermal overload feature provides protection for cables and other plant against the effects of prolonged operation under excess load conditions. A thermal replica algorithm is applied to create a model for the thermal characteristics of the protected plant. Tripping times depend not only on the level of overload current, but also on the level of prior load current, the thermal replica providing 'memory' of previous conditions.

The thermal characteristics of the system are defined by entering settings for full load current and thermal time constant. The GRE110 issues a trip according to the 'cold' and 'hot' curves specified in IEC60255-8 (see Figure 2), to prevent the protected system from exceeding its thermal capacity. The cold curve tripping times are applicable when the system is first energised, while the hot curves are relevant when the system has already been carrying some prior load for a period of time. An alarm output is also available to give early warning of high load current, set as a percentage of thermal capacity.

Negative Phase Sequence Overcurrent Protection (NPS)

NPS protection can be used in applications where certain fault conditions may not be detected by the normal phase and earth overcurrent protections, for example, in the case of a relay applied on the delta side of a delta-star transformer, to detect an earth fault on the star side. Alternatively, NPS can be used to protect a three phase motor against the severe overheating which results from operating with an unbalanced supply.

Two independent thresholds are provided, each with a programmable definite time delay.

Broken Conductor Protection

The unbalance condition caused by an open circuited conductor is detected by the broken conductor protection. An unbalance threshold with programmable definite time delay is provided.

Circuit Breaker Fail Protection (CBF)

Two stage CBF protection provides outputs for re-tripping of the local circuit breaker and/or back-tripping to upstream circuit breakers. The CBF functions can also be initiated by external protections via a binary input if required.

Cold Load Protection

The cold load function modifies the overcurrent protection settings for a period after energising the system. This feature is used to prevent unwanted protection operation when closing on to the type of load which takes a high level of current for a period after energisation. This is achieved by a 'Cold Load Settings Group' in which the user can programme alternative settings. Normally the user will choose higher current settings and/or longer time delays and/or disable elements altogether within this group.

Auto Reclose (ARC)

GRE110 provides an auto-reclose function. Five independent sequences are provided, one for each of the following:

- Phase fault
- Earth fault
- Sensitive earth fault
- External trip (initiated by a binary input)

Each sequence is independently programmable for single shot, two shot, three shot, four shot or five shot (i.e. sixth trip to lock-out when five shot is selected) auto-reclose. Each protection trip is programmable for instantaneous or delayed operation, and each ARC shot has a programmable dead time. Sequence co-ordination is maintained between the auto-reclose sequences of in-series relays on a feeder.

Programmable Logic Control (PLC) function

User can customize logic function functions on GRE110 such as trip and interlock sequence, etc., using PLC tool software. The PLC data produced by the PLC tool can be downloaded and uploaded to GRE110 via PC communication port.

CONTROL FUNCTIONS

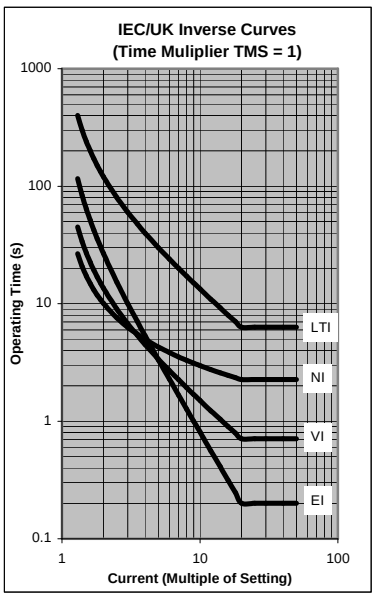
Switchgear Control

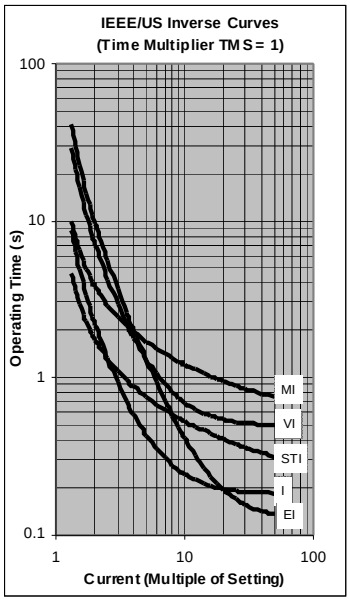
GRE110 provides the facility for switchgear control on the relay front panel. Two-stepped operation (select-control) is applied for the control procedure of circuit breakers to ensure highly secure operation. An interlock check function is included for safe operation of the switchgear. Password protection is provided for the above functions.

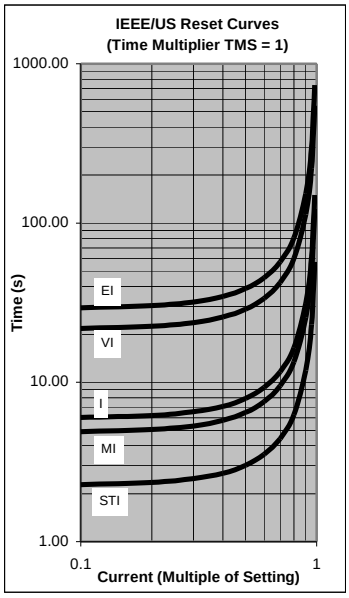
A local/remote selector switch is also provided on the relay front panel so that remote control from station level or load dispatching centre can be chosen.

Equipment status (Open or Closed) is indicated on front LEDs and relay fascia LCD.

Inverse Time Operate and Reset Curves







$$t(G) = TMS \times \left\{ \left[\frac{k}{\left(G/Gs\right)^{\alpha} - 1} \right] + c \right\}$$

Inverse time operate function

$$t_r(G) = RTMS \times \left[\frac{t_r}{1 - \left(G/G_S\right)^2} \right]$$

Dependent time reset function

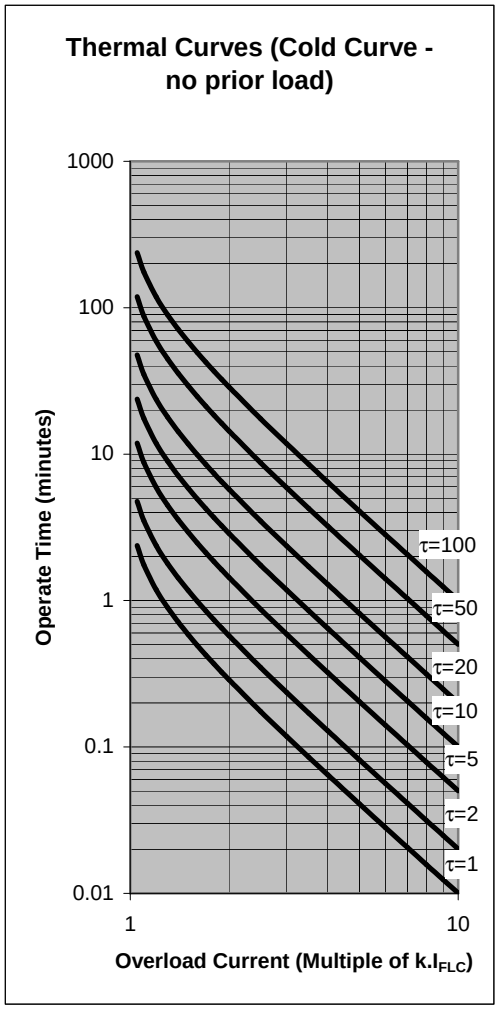
TMS setting range ; 0.010 – 1.500 in 0.001 steps
RTMS setting range ; 0.010 – 1.500 in 0.001 steps
Gs setting range :0.10 – 25.00A in 0.01A steps

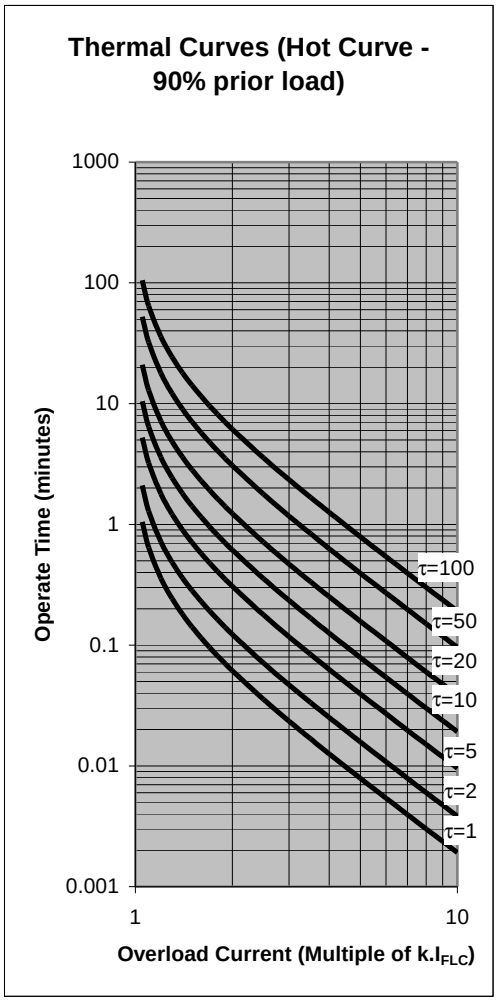
Constants for dependent time curves

Curve Type (IEC 60255-151)	Curve Description	k	α	C	t_r
A	IEC Normal Inverse (NI)	0.14	0.02	0	-
B	IEC Very Inverse (VI)	13.5	1	0	-
C	IEC Extremely Inverse (EI)	80	2	0	-
D	IEEE Moderately Inverse (MI)	0.0515	0.02	0.114	4.85
E	IEEE Very Inverse (VI)	19.61	2	0.491	21.6
F	IEEE Extremely Inverse (EI)	28.2	2	0.1217	29.1
-	UK Long Time Inverse (LTI)	120	1	0	-
-	US CO8 Inverse (I)	5.95	2	0.18	5.95
-	US CO2 Short Time Inverse (STI)	0.02394	0.02	0.01694	2.261

Figure 1 - Operate and Reset Characteristics

Thermal Characteristics (to IEC 60255-8)





$$t = \tau.Ln\left[\frac{I^2}{I^2 - (k.I_{FLC})^2}\right];$$

IEC 60255-8 'Cold' Curve

$$t = \tau.Ln\left[\frac{I^2 - I_P^2}{I^2 - (k.I_{FLC})^2}\right]$$

IEC 60255-8 'Hot' Curve

t = time to trip for constant overload current I (seconds)

I = overload current (largest phase current) (pu)

I_P = previous load current (pu)

$k.I_{FLC}$ (or I_θ) = thermal overload current setting (pu)

τ = thermal time constant (seconds)

Ln = natural logarithm

Figure 2 - Thermal Characteristics in accordance with IEC 60255-8

MONITORING FUNCTIONS

Trip Circuit Supervision

GRE110 provides a high-integrity trip circuit supervision scheme. Trip circuits can be monitored with the circuit breaker either closed or open using two binary inputs as shown in Figure 3.

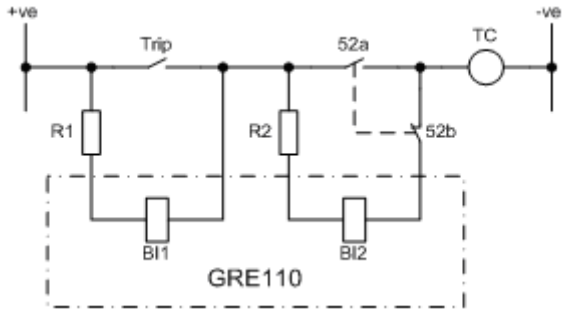


Figure 3 – Trip Circuit Supervision Scheme

CB Closed:
Under healthy conditions, binary input BI1 is energised via external resistor, R1.
If the trip circuit becomes open, BI1 resets and a Trip Circuit Fail alarm is raised.

CB Open:
Under healthy conditions, binary inputs BI1 & BI2 are energised via external resistors, R1 & R2 respectively.
If the trip circuit becomes open, both inputs reset and a Trip Circuit Fail alarm is raised.

The Trip Circuit Fail alarm incorporates a time delay of 400ms to prevent false alarms during normal tripping operations or voltage dips and is given in the form of an output contact operation and LCD/LED indication.

Automatic Self-Supervision

Automatic monitoring of internal circuits and software is provided. In the event of a failure being detected, the ALARM LED or the RELAY FAIL on the relay front panel is illuminated, the 'RELAY FAILURE' binary output operates, and the date and time of the failure is recorded in the event record.

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 then a 'CB Defective' alarm is raised.

Circuit Breaker Condition Monitoring

The following CB condition monitoring functions are provided:

- The trip counter increments the number of tripping operations performed. An alarm is issued when the count exceeds a user-defined setting.
- The $\sum I^y$ counter increments the value of current to the power 'y', recorded at the time of issuing the tripping signal, on a phase by phase basis. An alarm is issued when the count for any phase exceeds a user-defined setting.
- The operating time monitor records the time between issuing the tripping signal and the phase currents falling to zero. An alarm is issued when the operate time for any phase exceeds a user-defined setting.

The CB condition monitoring functions are triggered each time a trip is issued, and they can also be triggered by an external device via a binary input.

METERING AND RECORDING

Metering

The following data is continuously available on the relay front panel LCD and at a local or remote PC.

- Primary and secondary currents for each input.
- Positive and negative phase sequence currents.
- Ratio of negative phase sequence to positive phase sequence currents.
- Peak phase current demand.
- Thermal condition of system.
- Relay element output status.
- Binary input and output status.

Event Record

Records are stored for the 200 most recent events, time-tagged to 1ms resolution. The event record is available on the relay front panel LCD and at a local or remote PC. Events are recorded as follows:

- Tripping operations.
- Alarms.
- Operation of protection elements.
- Change of state of binary inputs / outputs.
- Change of relay setting.
- Failure detected by automatic supervision.

Fault Record

A relay trip initiates fault recording. Records are stored for the 4 most recent faults, time-tagged to 1ms resolution. The fault record is available on the relay front panel LCD and at a local or remote PC. Fault records include the following data:

- Date and time of trip operation.
- Operating phase.
- Protection scheme responsible for trip.
- Measured current data.

Disturbance Record

The relay can record 8 analog and 32 binary signals, initiated by relay tripping. The post-trigger recording time can be set, and the maximum number of records which can be stored is dependent on the recording time chosen.

Date and Time

GRE110 provides a date and time feature for tagging of records.

USER INTERFACE

Relay Front Panel

A user friendly interface is provided on the relay front panel. A menu-based system provides for easy programming of relay functions and access to real-time and stored data. The front panel includes the following features.

- 16 character, 8-line LCD with backlight.
- 14 LEDs (8 fixed display and 6 configurable).
- Keypad.
- USB2.0 port for connection of local PC.

Local PC Connection

The user can communicate with the GRE110 from a local PC via the USB2.0 port on the front panel. Using RSM100 software, the user can view and modify settings, monitor real-time metering and analyse recorded data.

Figure 4 shows the configuration of typical displays from the RSM100 software.

Modbus and DNP3 Communications

GRE110 supports the Modbus and DNP3 communication protocol. These protocols are used for communication with a substation control and monitoring system or automation system to be linked with SCADA or regional control center, and are used to transfer measurand data, status data and general commands between the relay and the control system.

IEC 60870-5-103 Communications

GRE110 supports the IEC 60870-5-103 communication protocol. This protocol is used for communication with a substation control and monitoring system and is used to transfer measured data, status data and general commands between the relay and the control system via RS485.

IEC 61850 Communication

GRE110-402A and 422A can support data communication according to the IEC 61850 standard via an optional communication port.

Relay Setting

The user can modify relay settings either using the front panel keypad or using the RSM100 software from a local PC. Password protection is available for added security.

Two settings groups are provided, allowing the user to set one group for normal conditions, while the other group may be set to cover alternative operating conditions.

Using the RSM software, the user can create a settings file on a PC (without being connected to a relay), and store the file ready for download to a relay at a later date.

Binary Outputs

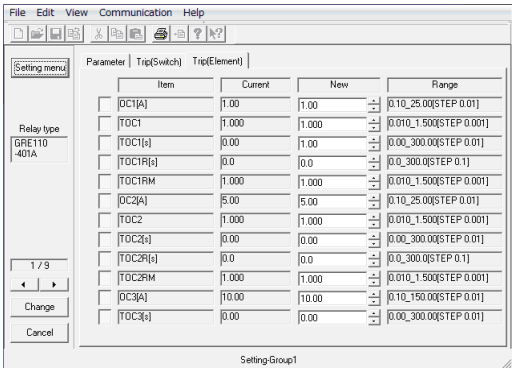
GRE110 provides four or eight user programmable binary output contacts for tripping and alarm. Each of the programmable binary outputs is driven via a logic gate which can be programmed for OR gate or AND gate operation. Further, each output has a programmable reset characteristic, settable for instantaneous drop-off, delayed drop-off, or for latching operation. If latching operation is selected then an operated relay must be reset by the user, either by pressing the RESET button, by energising a binary input which has been programmed for ‘Remote Reset’ operation, or by a communications command.

Binary Inputs

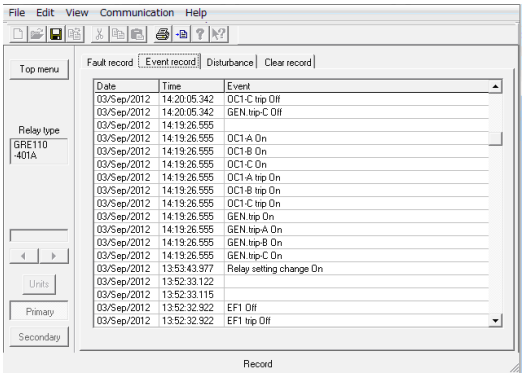
GRE110 provides two programmable binary inputs as standard and a further four available as an option. Each binary input is individually user-programmable for normal or inverted operation and for delayed pick-up and/or drop-off. Each input can also be used to switch relay operation to a different settings group.

General purpose alarm functions are also included. The user can define a text message for each alarm. Then when inputs associated with that alarm are raised, the defined text is displayed on the LCD.

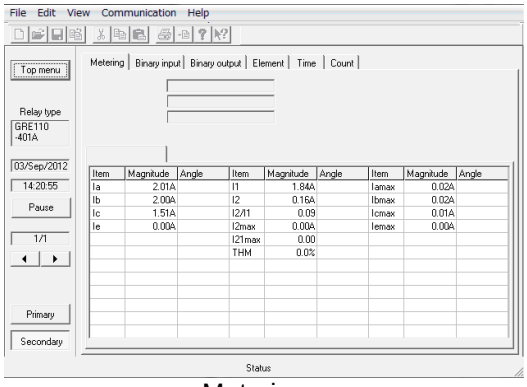
PC DISPLAY



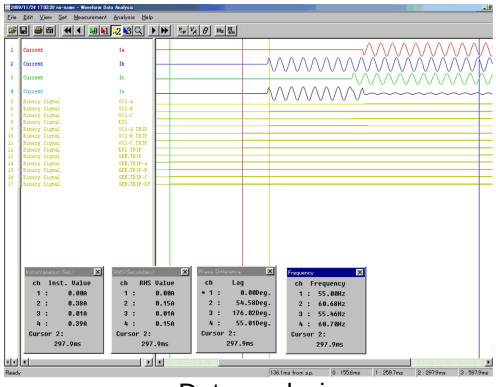
Setting



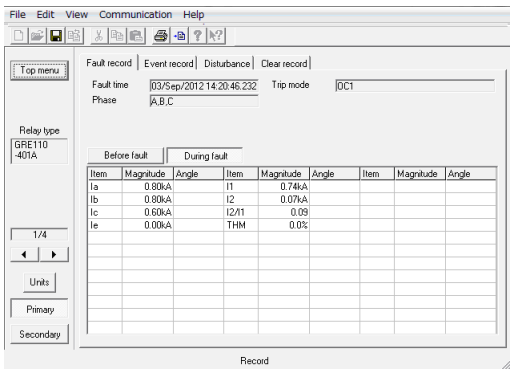
Event record



Metering



Data analysis



Fault record

Figure 4 - Relay Setting and Monitoring System - PC Displays

TECHNICAL DATA

Ratings	
AC current I_n:	1/5A (combined)
Frequency:	50/60Hz
Auxiliary supply:	110-250Vdc or 100-220Vac (Operative range: 88–300Vdc / 80–264Vac) 48-110Vdc (Operative range: 38.4 – 132Vdc) 24-48Vdc (Operative range: 19.2 – 60.0Vdc)
Superimposed AC ripple on DC supply:	maximum 12%
DC supply interruption:	maximum 50ms at 110V
Binary input circuit DC voltage:	For alarm indication 110-250Vdc (Operative range: 88 - 300Vdc) 48-110Vdc (Operative range: 38.4 – 132Vdc) 24-48Vdc (Operative range: 19.2 – 60.0Vdc) For trip circuit supervision Operative range: ≥38.4V (for 110Vdc rating) ≥88V (for 220/250Vdc rating) ≥19.2V (for 48Vdc rating) ≥9.6V (for 24Vdc rating)
Overload Ratings	
AC phase current inputs:	4 times rated current continuous 100 times rated current for 1 second
Burden	
AC phase current inputs:	≤ 0.2VA
AC earth current inputs:	≤ 0.4VA
AC sensitive earth inputs:	≤ 1.2VA
DC power supply:	≤ 10W (quiescent) ≤ 15W (maximum)
Binary input circuit:	≤ 0.5W per input at 220Vdc
Current Transformer Requirements	
Phase Inputs	Typically 5P20 with rated burden according to load, (refer to manual for detailed instructions).
Standard Earth Inputs:	Core balance CT or residual connection of phase CTs.
Sensitive Earth Inputs:	Core balance CT.
Phase Overcurrent Protection (50, 51)	
1st, 2nd Overcurrent threshold:	OFF, 0.10 – 25.00A in 0.01A steps
Delay type:	DTL, IEC NI, IEC VI, IEC EI, UK LTI, IEEE MI, IEEE VI, IEEE EI, US CO8 I, US CO2 STI
IDMTL Time Multiplier Setting TMS:	0.010 – 1.500 in 0.001 steps
DTL delay:	0.00 - 300.00s in 0.01s steps
Reset Type:	Definite Time or Dependent Time.
Reset Definite Delay:	0.0 – 300.0s in 0.1s steps
Reset Time Multiplier Setting RTMS:	0.010 – 1.500 in 0.001 steps
3rd, 4th Overcurrent thresholds:	OFF, 0.10 - 150.00A in 0.01A steps
DTL delay:	0.00 - 300.00s in 0.01s steps

Earth Fault Protection (50N, 51N)	
1st, 2nd Overcurrent threshold:	OFF, 0.05 – 25.00A in 0.01A steps
Delay type:	DTL, IEC NI, IEC VI, IEC EI, UK LTI, IEEE MI, IEEE VI, IEEE EI, US CO8 I, US CO2 STI
IDMTL Time Multiplier Setting TMS:	0.010 - 1.500 in 0.001 steps
DTL delay:	0.00 – 300.00s in 0.01s steps
Reset Type:	Definite Time or Dependent Time
Reset Definite. Delay:	0.0 - 300.0s in 0.1s steps
Reset Time Multiplier Setting RTMS:	0.010 – 1.500 in 0.001 steps
3rd, 4th thresholds:	OFF, 0.05 – 100.00A in 0.01A steps
DTL delay:	0.00 – 300.00s in 0.01s steps
Sensitive Earth Fault Protection (50Ns, 51Ns)	
1st, 2nd Overcurrent threshold:	OFF, 0.001 - 0.250A in 0.001A steps
Delay Type:	DTL, IEC NI, IEC VI, IEC EI, UK LTI, IEEE MI, IEEE VI, IEEE EI, US CO8 I, US CO2 STI
Stage 1 TMS:	0.010 - 1.500 in 0.001 steps
Stage 1 DTL delay:	0.00 - 300.00s in 0.01s steps
Stage 1 Reset Type:	Definite Time or Dependent Time
Stage 1 Reset Def. Delay:	0.0 - 300.0s in 0.1s steps
Stage 1 RTMS:	0.010 - 1.500 in 0.001 steps
Stage 2 DTL delay:	0.00 - 300.00s in 0.01s steps
3rd, 4th thresholds:	OFF, 0.001 - 0.250A in 0.001A steps
DTL delay:	0.00 - 300.00s in 0.01s steps
Phase Undercurrent Protection (37)	
1st, 2nd threshold:	OFF, 0.10 – 10.00A in 0.01A steps
DTL delay:	0.00 - 300.00s in 0.01s steps
Thermal Overload Protection (49)	
$I_\theta = k.I_{FLC}$ (Thermal setting):	OFF, 0.50 - 10.00A in 0.01A steps
Time constant (τ):	0.5 - 500.0mins in 0.1min steps
Thermal alarm:	OFF, 50% to 99% in 1% steps
Negative Phase Sequence Protection (46)	
1st, 2nd threshold:	OFF, 0.10 - 10.00A in 0.01A steps
DTL delay:	0.00 - 300.00s in 0.01s steps
Broken Conductor Protection (46BC)	
Broken conductor threshold (I_2/I_1):	OFF, 0.10 - 1.00 in 0.01 steps
DTL delay:	0.00 - 300.00s in 0.01s steps
CBF Protection (50BF)	
CBF threshold:	OFF, 0.10 - 10.00A in 0.01A steps
CBF stage 1 DTL:	0.00 - 300.00s in 0.01s steps
CBF stage 2 DTL:	0.00 - 300.00s in 0.01s steps
Inrush Current Detector	
Second harmonic ratio setting (I_{2f}/I_{1f}):	10 – 50% in 1% steps
Overcurrent thresholds:	1.00 – 25.00A in 0.01A steps

Autoreclose (79)	
ARC Reclaim Time	0.0 – 600.0s in 0.1s steps
Close Pulse Width	0.01 – 10.00s in 0.01s steps
Lock-out Recovery Time	OFF, 0.1 – 600.0s in 0.1s steps
Sequences	1 -5 Shots to Lock-out, each trip programmable for inst or Delayed operation
Dead Times (Programmable for each shot)	0.01 – 300.00s in 0.01s steps
Accuracy	
IDMTL Overcurrent Pick-up:	105% of setting ± 5%
All Other Overcurrent Pick-ups:	100% of setting ± 3% (Gs>0.2A)
Overcurrent PU/DO ratio:	approx, 95%
Undercurrent Pick-up:	100% of setting ± 3% (Gs>0.2A)
Undercurrent PU/DO ratio:	approx, 105%
Inverse Overcurrent Operate Time:	IEC60255-151, ±5% or 50ms ($2 \leq G/Gs \leq 20$) G_T = 1.1Gs G_D = 20Gs (Gs ≤ 10A), 200A (Gs > 10A)
OC Definite Operate Time	≤ DTL + 45ms (DT, input: ≥ 200% of setting)
EF Definite Operate Time	≤ DTL + 45ms (DT, input: ≥ 200% of setting)
UC Operate Time	≤ DTL + 85ms (input: ≤ 80% of setting)
NPS Operate Time	≤ DTL + 150ms (input: ≥ 200% of setting)
CBF Operate Time	≤ DTL + 30ms (input: ≥ 200% of setting)
Transient Overreach for instantaneous elements:	<5% Time delays includs operating time of trip contacts
Front Communication port - local PC (USB)	
Connector type:	USB-Type B
Cable length:	5m (max.)
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:	19.2 kbps
Rear Communication port (Ethernet)	
100BASE-TX	RJ-45 connector
100BASE-FX	SC connector
Binary Inputs	
Operating Voltage	For alarm indication Typical 154Vdc (min. 110Vdc) for 220Vdc rating Typical 77Vdc (min. 70Vdc) for 110Vdc rating Typical 33.6Vdc (min. 24Vdc) for 48Vdc rating Typical 16.8Vdc(min. 12Vdc) for 24Vdc rating For trip circuit supervision ≥88V for 220/250Vdc rating ≥38.4Vdc for 110Vdc rating ≥19.2V for 48Vdc rating ≥9.6V for 24Vdc rating

Binary Outputs	
Number	4 or 8 (excluding Relay Fail contact)
Ratings	
model 4∗0 and 4∗1; BO#1 and #2	Make and carry: 5A continuously
model 4∗2: BO#1,#2,#5 and #6	Make and carry: 30A, 250Vdc for 0.5s (L/R≥40ms) Break: 0.1A, 250Vdc (L/R=40ms)
other BOs	Make and carry: 4A continuously Make and carry: 8A, 250Vdc for 0.2s (L/R≥40ms) Break: 0.1A, 250Vdc (L/R=40ms)
Durability:	Loaded contact: ≥1,000 operations Unloaded contact: ≥10,000 operations
Pickup time:	Less than 15ms
Reset time:	Less than 10ms
Mechanical design	
Weight	1.5kg for model 400A, 401A, 420A and 421A 1.8kg for model 402A and 422A
Width	149mm for model 400A, 401A, 420A and 421A 223mm for model 402A and 422A
Height	177mm
Depth	168mm
Case color	Munsell No. 10YR8/0.5
Installation	Flush mounting with attachment kits

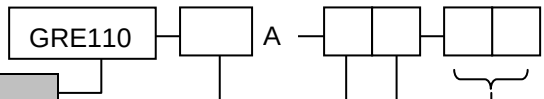
ENVIRONMENTAL PERFORMANCE

Test	Standards	Details
Atmospheric Environment		
Temperature	IEC 60068-2-1/2 IEC 60068-2-30	Operating range: -20°C to +60°C. Storage / Transit: -25°C to +70°C.
Humidity	IEC 60068-2-78	56 days at 40°C and 93% relative humidity.
Enclosure Protection	IEC 60529	IP52 (front), IP20 (rear), IP40 (top)
Mechanical Environment		
Vibration	IEC 60255-21-1	Response - Class 1 Endurance - Class 1
Shock and Bump	IEC 60255-21-2	Shock Response Class 1 Shock Withstand Class 1 Bump Class 1
Seismic	IEC 60255-21-3	Class 1
Electrical Environment		
Dielectric Withstand	IEC 60255-5 IEEE C37.90.0	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	IEC 60255-5	Three positive and three negative impulses of 5kV(peak) for CT, Power Supply Unit, BI and BO circuits; between terminals and earth, and between independent circuits 3kV (peak) for RS485 circuit; between terminals and earth 3kV (peak) for BO circuit; across normally open contacts 1.2/50μs, 0.5J between all terminals and between all terminals and earth.

Test	Standards	Details
Electromagnetic Environment		
High Frequency Disturbance / Damped Oscillatory Wave	IEC 60255-22-1 Class 3, IEC 61000-4-12 IEEE C37.90.1	1MHz 2.5kV to 3kV (peak) applied to all ports in common mode. 1MHz 1.0kV applied to all ports in differential mode.
Electrostatic Discharge	IEC 60255-22-2 Class 3, IEC 61000-4-2	6kV contact discharge, 8kV air discharge.
Radiated RF Electromagnetic Disturbance	IEC 60255-22-3 Class 3, IEC 61000-4-3	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	IEC 60255-22-4 Class A, IEC 61000-4-4, IEEE C37.90.1	4kV, 2.5kHz, 5/50ns applied to all inputs.
Surge Immunity	IEC 60255-22-5, IEC 61000-4-5	1.2/50µs surge in common/differential modes: HV, Power Supply Unit and I/O ports: 2kV/1kV (peak) RS485 port: 1kV (peak)
Conducted RF Electromagnetic Disturbance	IEC 60255-22-6 Class 3, IEC 61000-4-6	10Vrms applied over frequency range 150kHz to 100MHz. Additional spot tests at 27 and 68MHz.
Power Frequency Disturbance	IEC 60255-22-7 Class A, IEC 61000-4-16	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	IEC 60255-25, EN 55022 Class A, IEC 61000-6-4	Conducted emissions: 0.15 to 0.50MHz: <79dB (peak) or <66dB (mean) 0.50 to 30MHz: <73dB (peak) or <60dB (mean) Radiated emissions (at 10m): 30 to 230MHz: <40dB 230 to 1000MHz: <47dB
European Commission Directives		
CE	89/336/EEC	Compliance with the European Commission Electromagnetic Compatibility Directive is demonstrated according to generic EMC standards EN 61000-6-2 and EN 61000-6-4.
	73/23/EEC	Compliance with the European Commission Low Voltage Directive is demonstrated according to product safety standard EN 60255-27.

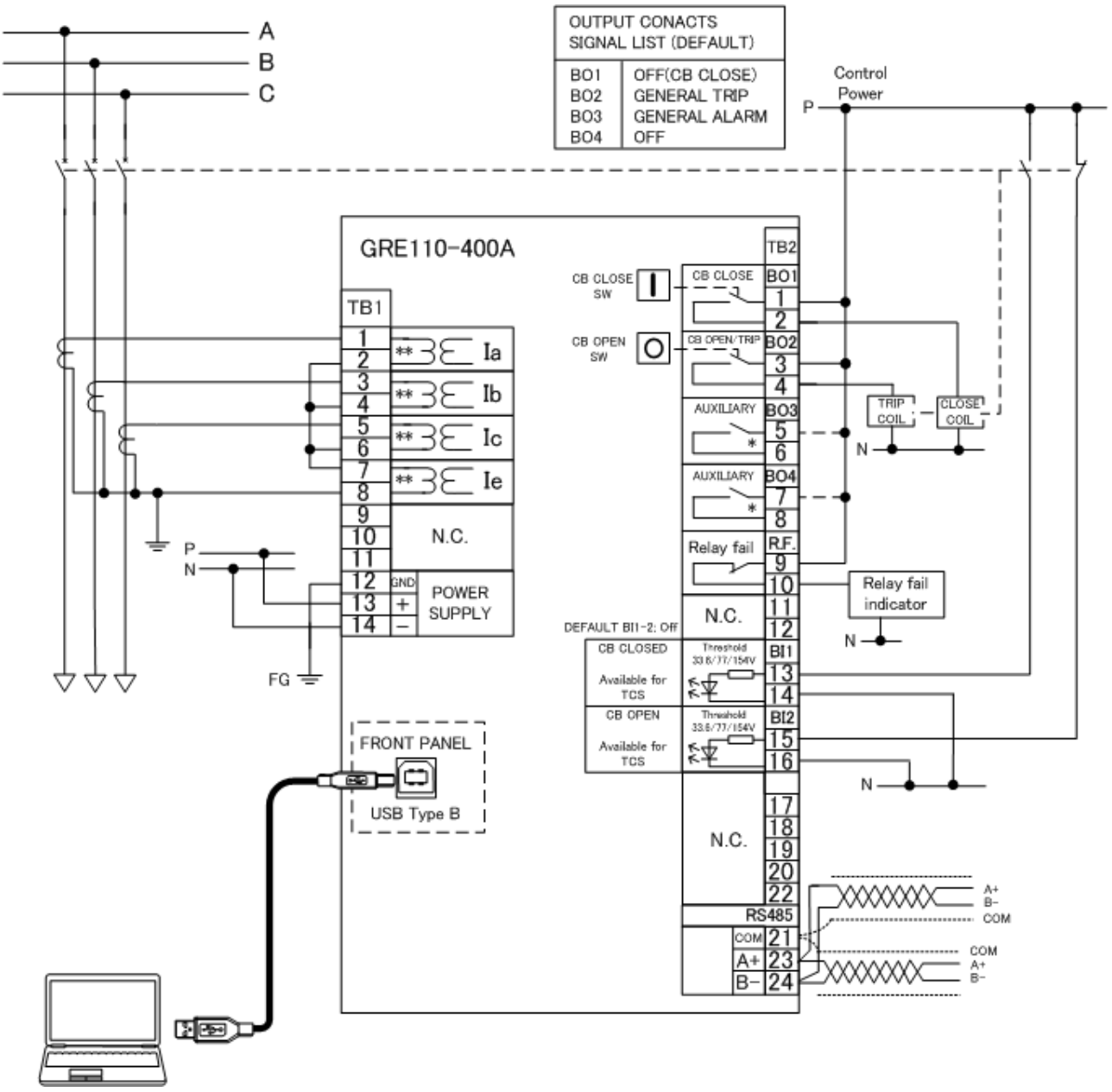
ORDERING

Overcurrent Relay



Type:	
Overcurrent Protection Relay	GRE110
Model:	
- Model 400: Three phase and earth fault	
2 x BIs, 4 x BOs, 1 x Relay fail	400
6 x BIs, 4 x BOs, 1 x Relay fail	401
6 x BIs, 8 x BOs, 1 x Relay fail	402
- Model 420: Three phase and sensitive earth fault	
2 x BIs, 4 x BOs, 1 x Relay fail	420
6 x BIs, 4 x BOs, 1 x Relay fail	421
6 x BIs, 8 x BOs, 1 x Relay fail	422
Rating:	
CT: 1/5A, f: 50/60Hz, 110-250Vdc or 100-220Vac	1
CT: 1/5A, f: 50/60Hz, 48-110Vdc	2
CT: 1/5A, f: 50/60Hz, 24-48Vdc	A
Standard and language:	
IEC (English)	0
ANSI (English)	1
Chinese	2
Communication:	
RS485 1port (Modbus/IEC 60870-5-103)	10
RS485 1port (Modbus/DNP3)	11
Following options can be equipped on Models 402 and 422 only	
100BASE-TX 1port (Modbus/IEC 61850) +RS485 1port (Modbus/IEC 60870-5-103)	A0
100BASE-TX 1port (Modbus/IEC 61850/DNP3) +RS485 1port (Modbus/DNP3)	A1
100BASE-FX 1port (Modbus/IEC 61850) +RS485 1port (Modbus/IEC 60870-5-103)	C0
100BASE-FX 1port (Modbus/IEC 61850/DNP3) +RS485 1port (Modbus/DNP3)	C1

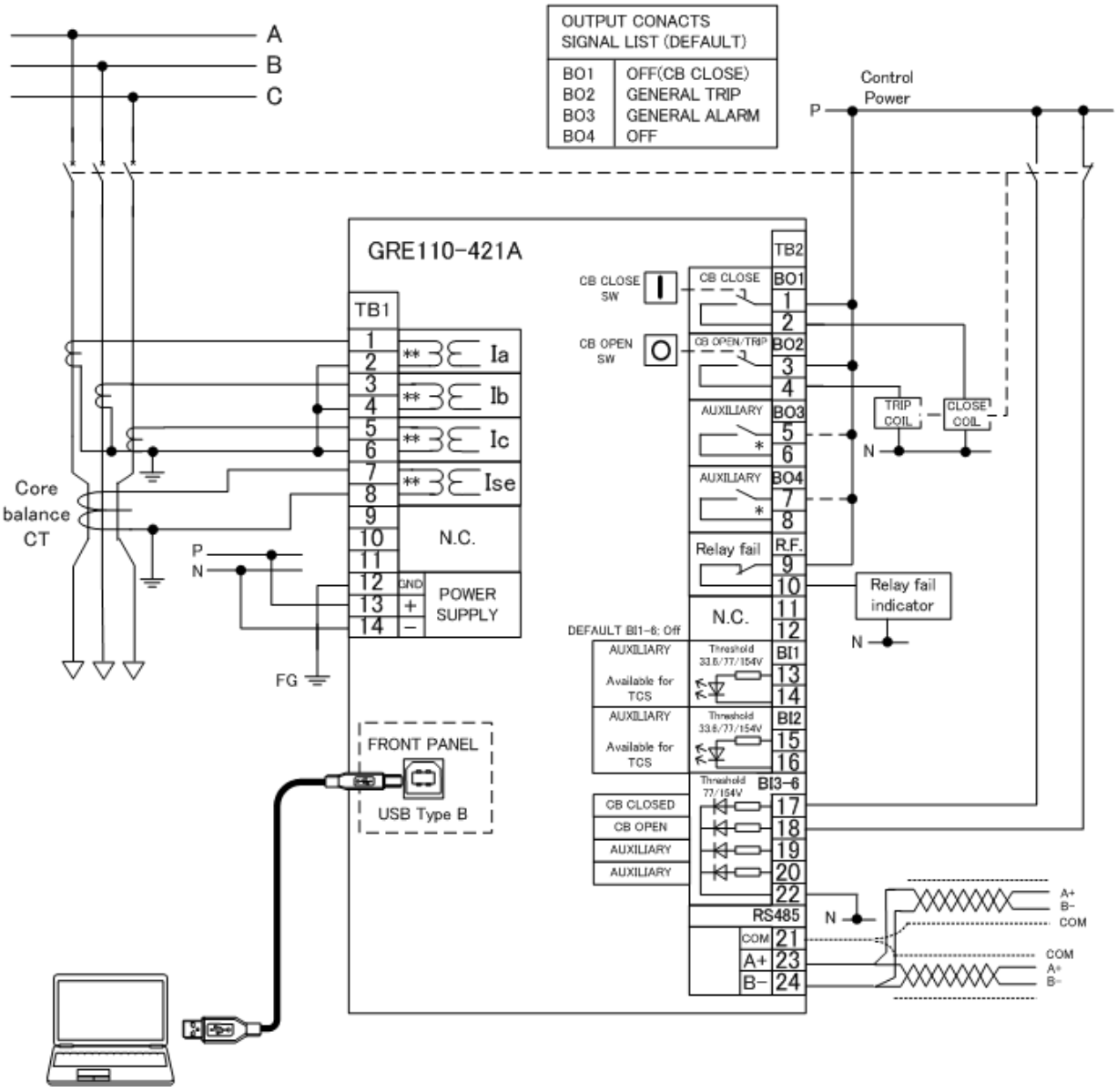
TYPICAL APPLICATIONS / CONNECTIONS



*BO3 and BO4 are NOT applicable for direct CB coil connection.

**Analogue current input ports are shorted when the terminal block is removed. (TB1 1-2, 3-4, 5-6, 7-8)

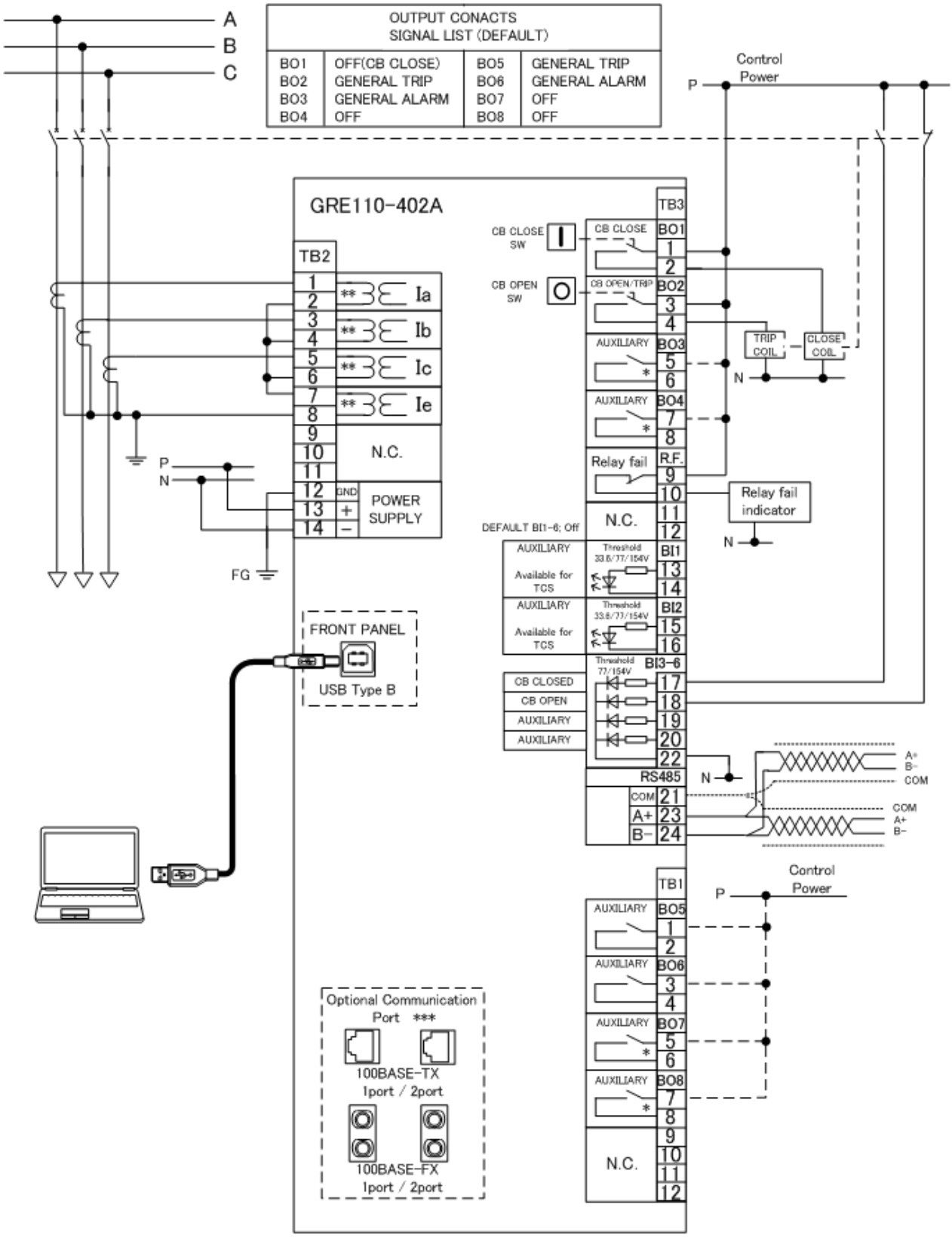
Figure 5 - GRE110-400A Typical Application Diagram



*BO3 and BO4 are NOT applicable for direct CB coil connection.

**Analogue current input ports are shorted when the terminal block is removed. (TB1 1-2, 3-4, 5-6, 7-8)

Figure 6 - GRE110-421A Typical Application Diagram



*BO3, BO4, BO7 and BO8 are NOT applicable for direct CB coil connection.

**Analogue current input ports are shorted when the terminal block is removed. (TB2 1-2, 3-4, 5-6, 7-8)

*** Available at one of the communication function is selected.

Figure 7 - GRE110-402A Typical Application Diagram

RELAY OUTLINE

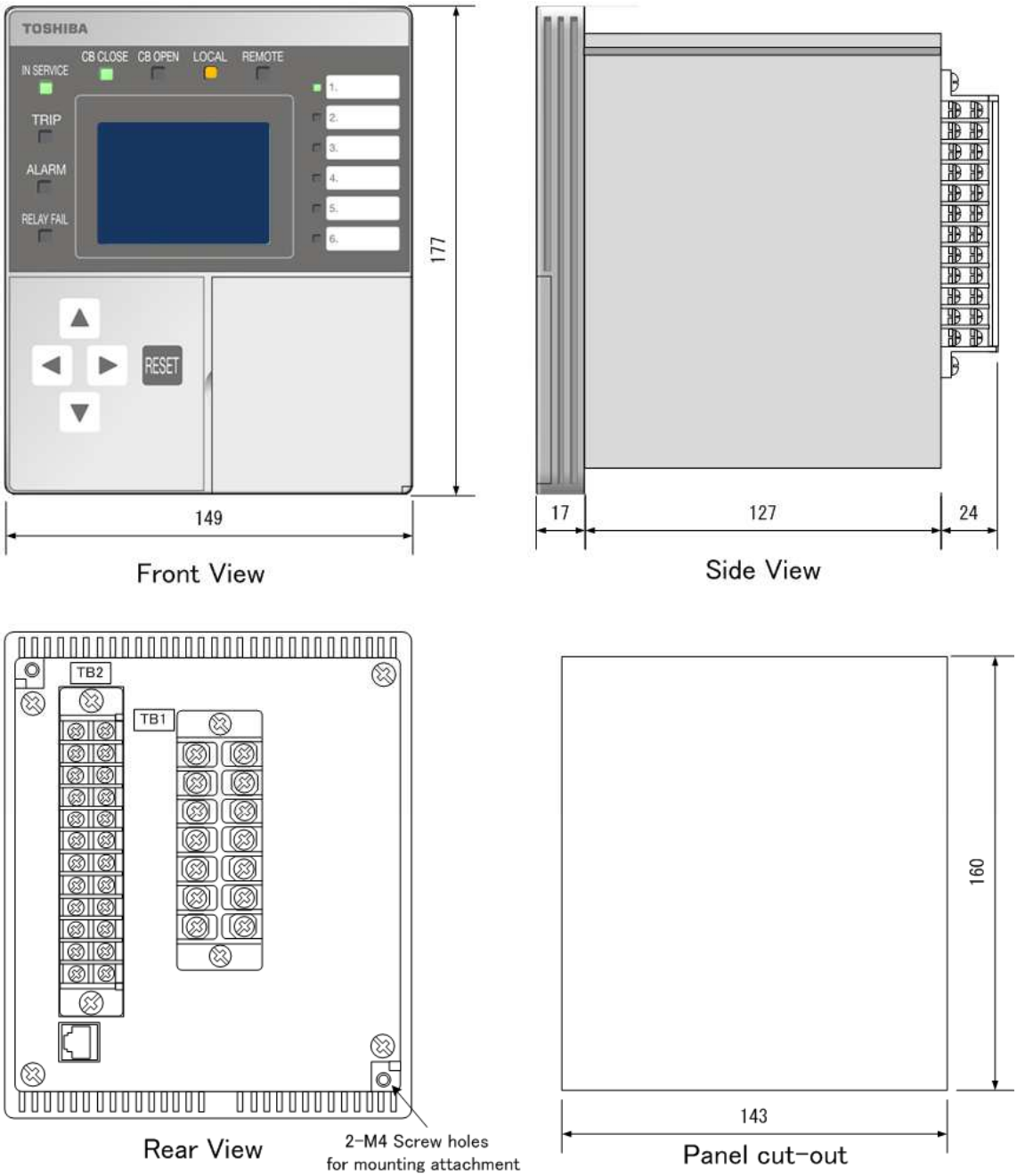


Figure 8 - GRE110 Outline Diagram – Model 400/401/420/421

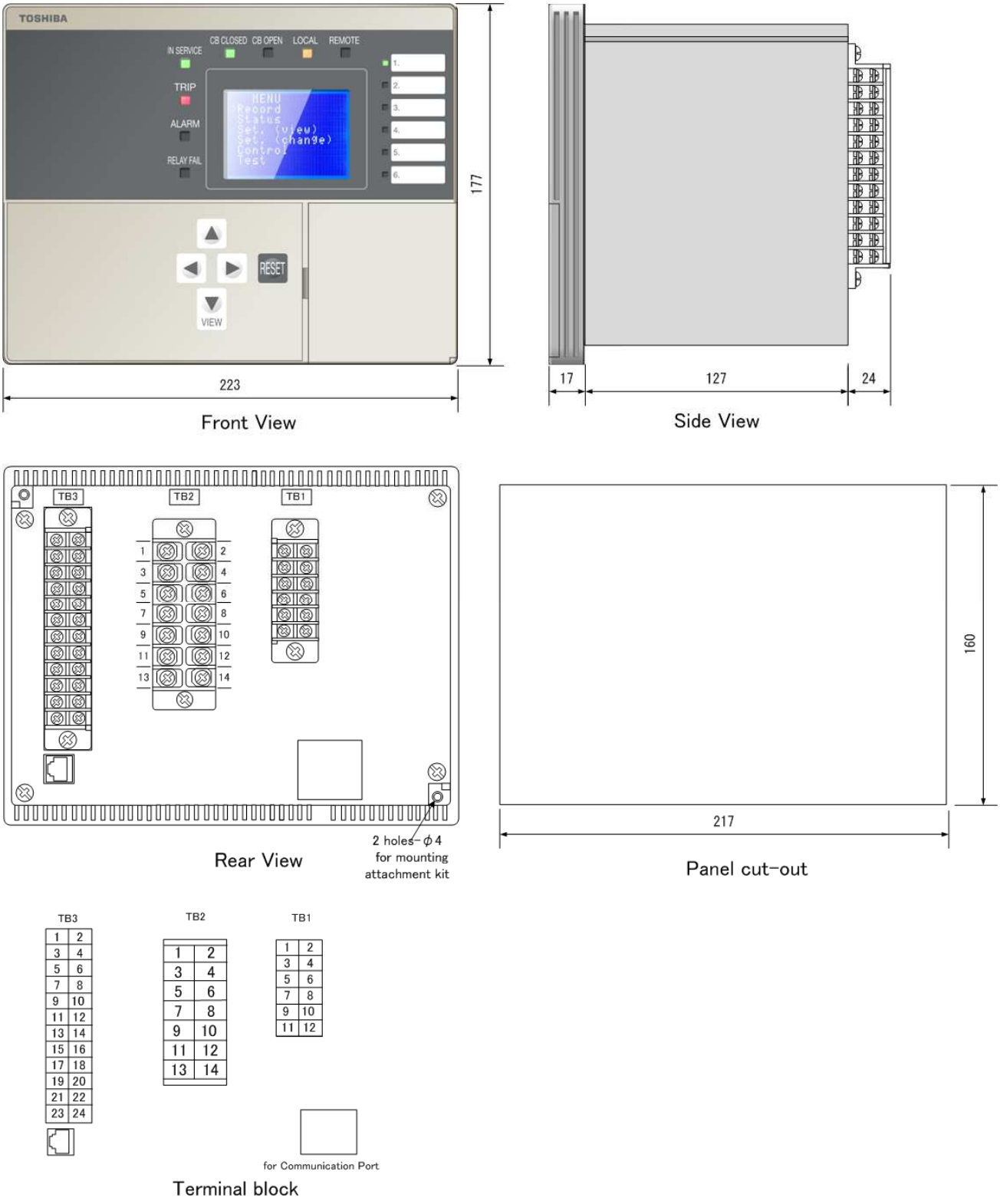


Figure 9 - GRE110 Outline Diagram – Model 402/422

TOSHIBA

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