HG

Power System Monitoring and Protection Relays

RELAY

HG Series

Power System Monitoring and Protection Relays

The Best Solution for Protecting Feeder/Incoming Panels.
Optimal Power Monitoring and Protecting Solution with Compact and Convenience.

The HGMAP digital power system monitoring and protection relay series is designed to provide optimized feeder/incoming protection for feeder/incoming loads and medium-small voltage motors, with advanced protective features and graphic based UI.

Compact size

- Easy Installation and Maintenance
- Compact form Factor and Lightweight Unit
- Better Performance in EMC Shielding and Heat Dissipation

Intuitive UI

- Voltage/Current Vector Diagrams
- Shortcut Keys for Measurement Screen
- Status & Alarm LED

Protection and Measurement Functions

- Feeder/Incoming Protection Relay
- Motor Protection Relay
- Measurement of Voltage/Current Negative Sequence, Zero Sequence and Power Factor
- Real-Time Self-Diagnostics Feature

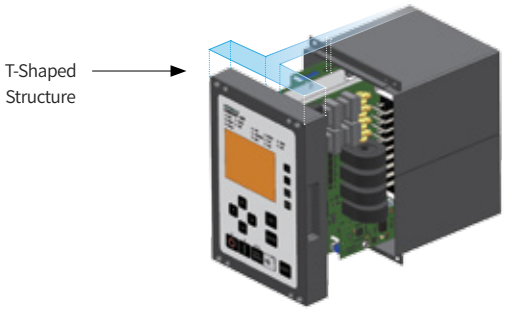
Overview and Characteristics

MCU-Based Controller

- Advanced 32-bit ARM core MCU provides precise measurements and calculations, maximizing relay stability and reliability.

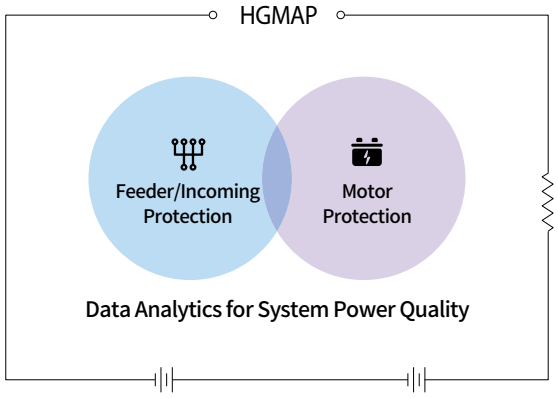
User-Friendly form Factor and Size

- Optimal size and weight for providing system monitoring and protection ensures easy installation and maintenance.
- Internal T-bone structure makes easy replacement of relay unit and components; sturdy modular construction provides greater protection against external shock or noise.



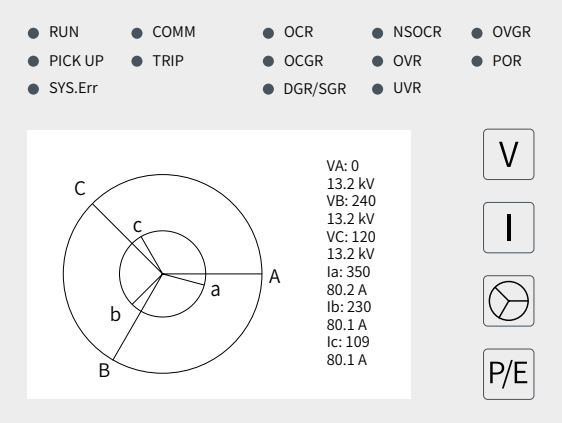
Diverse Protection Features

- Both a feeder/incoming protection model and a motor protection model are offered for a diverse range of protection features suitable for different small and medium systems.
- The feeder/incoming protection relay is designed to provide optimal feeder protection including overcurrent, ground fault, overvoltage, undervoltage, and reverse phase and unbalance protection.
- The motor protection relay includes additional features for protecting small- and medium-sized motors in addition to default feeder/incoming protection features, including thermal overload, short, undercurrent and phase reverse protection.



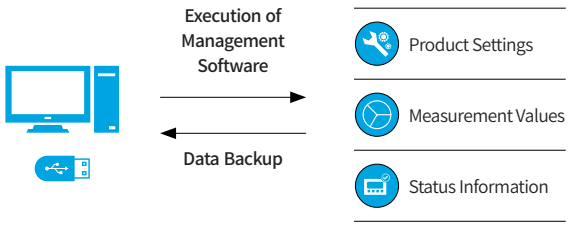
Intuitive HMI

- 128×96 graphic LCD provides three-phase current/voltage measurement checking at a glance, with vector diagram function for easy phase difference analysis.
- Measurement shortcut key allows single-button verification of measurement readings without entering into separate menu screens.
- Separate status LEDs and alarm LEDs provide extra layer of convenience for checking operating status and fault information.



System Management Software

- Connecting the relay and the operator's desktop system via USB link and running the system management software allows relay settings, measurements and status information to be downloaded to the PC, which can be saved into files as backup data.
- Fault waveform information can be converted to IEEE-specification comtrade file for use in any analysis tool to study the fault's waveforms.



Select Before Operation (SBO), Confirm Before Operation (CBO)

- Mandatory select & confirm action before executing relay settings and control commands provides increased relay control reliability and security.

Technical Data

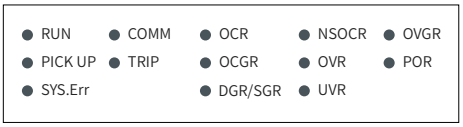
External Structure

Front View

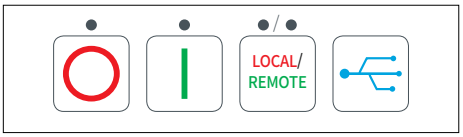
No.	Classification	Description
1	Status LED	Display relay status and trip/pick-up status
2	TRIP Alarm LED	Display the trip alarm for each protection element
3	Pixel Graphic LCD	Display measurements, settings and records
4	Measurement Shortcut Buttons	Shortcuts for each measurement (voltage, current, vector diagram, power)
5	Arrow Keys	Move between screens, change settings values
6	ESC Button	Return to previous screen, cancel save
7	ENTER Button	Enter menu screen, confirm save
8	Breaker Control Button	Control breaker and switch gear
9	Local/Remote Button	Local/Remote control permission toggle
10	USB Connector Port	Mini-B USB port for connection to PC with manager software
11	RESET Button	Cancel trip alarm, LED and DO reset control

LED Status Guide

Classification		LED Status	Description	Notes
Status LED	RUN	●	Normal operation	
	PICKUP	✳ Blinking	Pick-up for protection element	
		●	Trip after pick-up	
	SYS.Err	●	System error	
	COMM	✳ Blinking	Communication to monitor or remote station underway	
	TRIP	●	Protection element trip	
Alarm LED	OCR	●	OCR trip	User settable
	OCGR	●	OCGR trip	User settable
	DGR/SGR	●	DGR/SGR trip	User settable
	NSOCR	●	NSOCR trip	User settable
	OVR	●	OVR trip	User settable
	UVR	●	UVR trip	User settable
	OVGR	●	OVGR trip	User settable
	POR	●	POR trip	User settable

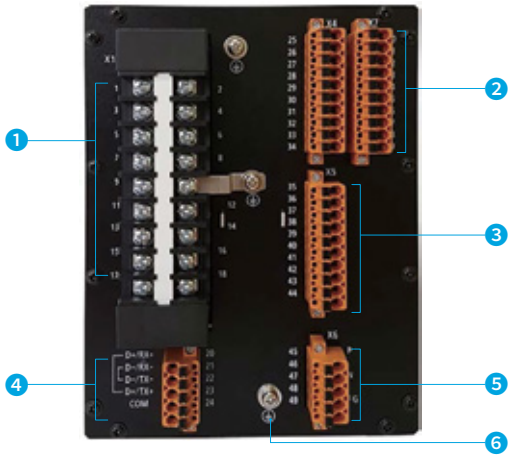


Classification		LED Status	Description
Status LED	O	●	Breaker OPEN
	I	●	Breaker CLOSED
	LOCAL/ REMOTE	●	LOCAL control established
		●	REMOTE control established



Rear View

No.	Classification	Description
1	PT and CT Input Terminals	X1: 1 ~ 8 - PT Terminals (PT1 ~ PT4)
		X1: 11 ~ 18 - CT Terminals (CT1 ~ CT4)
2	DO Output Terminals	X4: 25 ~ 28 - CB Close, Open
		X4: 30 ~ 34 - DO01 ~ DO03
		X7: 52 ~ 59 - DO04 ~ DO08
3	DI Input Terminals	X5: 35 ~ 37 - DI_52a, DI_52b
		X5: 38 ~ 43 - DI01 ~ DI04
4	Communication Terminal	RS-485/Modbus Communication Terminal
5	Power Cable Terminal	Relay Power Input Connector
6	Grounding Terminal	Grounding (X1: 9 ~ 10, X5: 44, X6: 49)



Detailed Terminal Locations

X1			
1	PT1	2	PT1
3	PT2	4	PT2
5	PT3	6	PT3
7	PT4	8	PT4
9	N.C	10	F.G
11	CT1	12	CT1
13	CT2	14	CT2
15	CT3	16	CT3
17	CT4	18	CT4

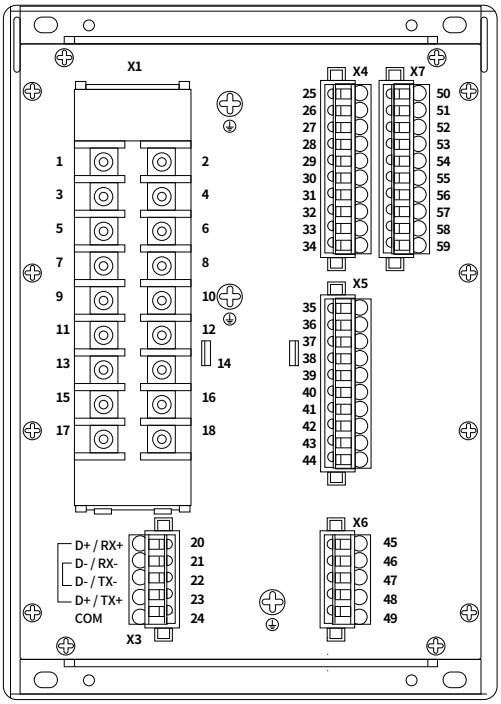
X4	
25	CB CLS+
26	CB CLS-
27	CB OPN+
28	CB OPN-
29	N.C
30	DO 01
31	DO 02
32	DO COM1
33	DO 03
34	DO COM2

X7	
50	N.C
51	N.C
52	DO 04
53	DO COM3
54	DO 05
55	DO 06
56	DO COM4
57	DO 07
58	DO 08
59	DO COM5

X5	
35	DI 52a
36	DI 52b
37	DI COM1
38	DI 01
39	DI 02
40	DI COM2
41	DI 03
42	DI 04
43	DI COM3
44	F.G

X3	
20	D+/RX+
21	D-/RX-
22	D-/TX-
23	D+/TX+
24	COM

X6	
45	P
46	N.C
47	N
48	N.C
49	F.G

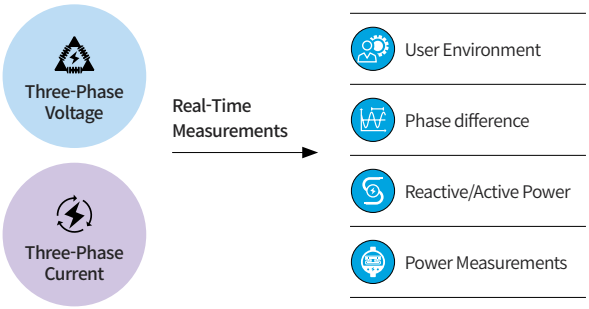


Technical Data

Features

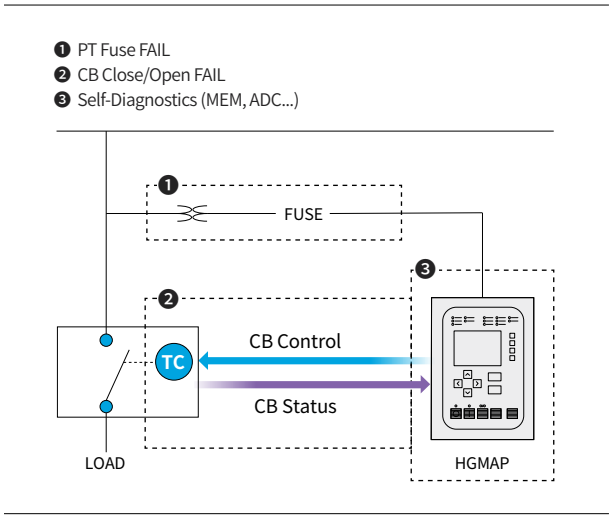
Current Status Monitoring

- Real-time measurement of three-phase voltage and current provides each phase and phase difference and measurement of active power/reactive power and wattage.
- DFT calculations of three-phase voltage and current provides measurements for positive, negative and zero phase sequence as well as power factor and frequency to enable an accurate analysis of power quality.



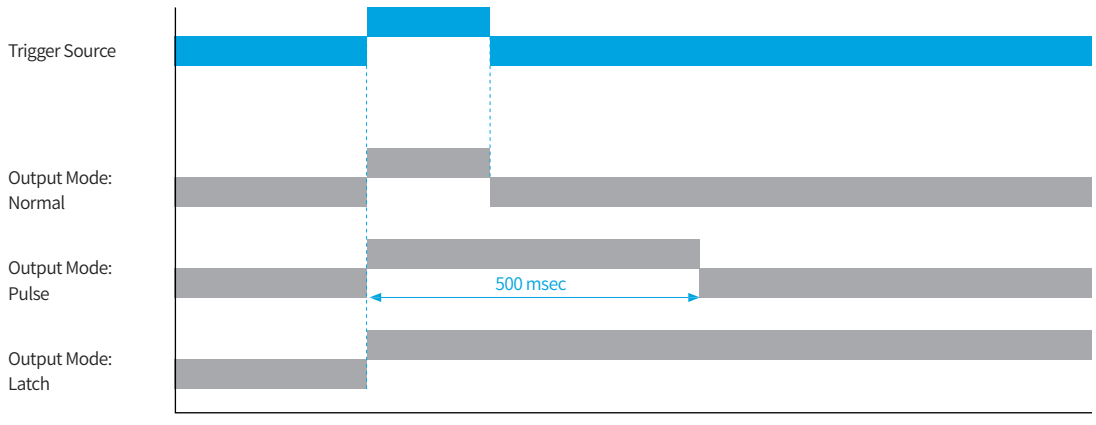
PT Fuse Monitoring and Breaker Monitoring

- Monitors for shorts in the fuse wired to the power system's PT secondary winding.
- When the relay controls (Close, Trip) the breaker, breaker control status is monitored using the breaker status information inputted into the system.



Customized DO Output

- DO output mode can be customized by the user to normal, latch and pulse.
- Additional DO output trigger source settings such as each phase pickup trip, TO input and other alarm functions can be selected in addition to the default trip signal for each protection element.



Self-Diagnostics

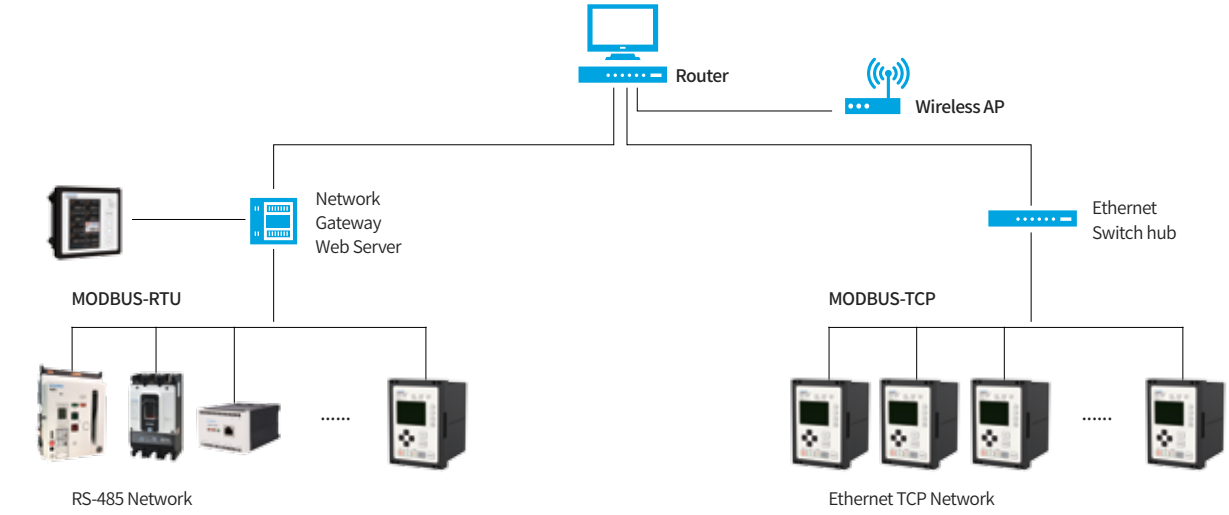
- Extensive self-diagnostics feature ensures reliability and prevents errors.
- Diagnostics feature enables error detection of internal memory, control power, analogue circuits and communication components, and monitoring of external power input.

Extensive Record-Keeping

- Internal non-volatile memory provides a recording feature for each element.
- A maximum number of 256 records can be saved for relay status, settings change, and operation of monitoring and protective functions.
- In the event of a breaker being tripped due to a protection element, the fault information and relevant measurements are recorded for up to 64 faults.
- To ensure accurate event diagnostics, a breaker trip triggers the storage of event information and waveforms, storing up to ten waveforms.

Communication Function

- Supports universal industrial communication protocol RS-485/Modbus to enable easy integration into the user's management network.
- Optional Ethernet TCP communication module provides RJ45 and fiberoptic communication for use in conjunction with a high-speed network. 1)



※ 1) To be issued

Technical Data

Main Functions

Overcurrent Relay, OCR : 50/51

Overcurrent relay detects a load current that is greater than the setting value, and is classified into an instantaneous element (50) without a time delay and a time overcurrent element (51) that operate after a delay.
The instantaneous element is set to operate in less than 40 msec in the event of a massive current such as a load side short circuit, designed to minimize the damages caused by a fault.
Time delay is further classified into definite time and indefinite time characters; the definite time element fires the relay within a designated period of time after an overcurrent event regardless of the size of the current, with a delay ranging from 50 msec to 60 seconds. Inverse time characteristics is inversely proportional to the size of the current—smaller the ratio of the overcurrent to the pickup current, longer the delay, and vice versa.
The inverse time relay curves are categorized as standard inverse (SI), very inverse (VI), extremely inverse (EI) and long inverse (LI) as defined by IEC specifications.

Overcurrent Ground Relay, OCGR : 50/51N [1)]

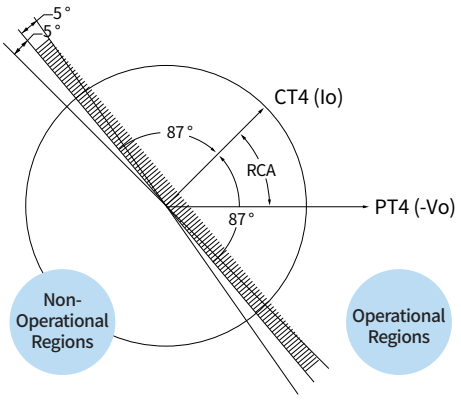
The ground overcurrent relay detects a zero sequence current larger than the setting value caused by a ground fault event in the grounding system, and is classified into the instantaneous element without a delay (50N) and time overcurrent relay with a time delay (51N).
The relay timing is identical to the overcurrent relay; however, while the OCR recognizes a fault by the size of the phase current, the OCGR receives input from the current transformer that measures the zero sequence current and measures the latter current to determine if a fault has occurred.
The OCGR Block function can be used to prevent a malfunction caused by irregular current, such as the operation current from a circuit breaker insertion.
The inverse time relay curves are categorized as standard inverse (SI), very inverse (VI), extremely inverse (EI) and long inverse (LI) as defined by IEC specifications.

Directional Ground Overcurrent Relay, DGR : 67N [1)]

The DGR determines the operation of the relay by selecting the faulted circuit in the grounded system (bus event, load event) based on the size or phase of the zero sequence voltage and current. Relay operation is by definite time characteristics, with a delay from 100 msec up to 60 sec.

Selective Ground Overcurrent Relay, SGR : 67G [2)]

The SDR determines the operation of the relay by selecting the faulted circuit in the ungrounded system (Bus Event, Load Event) based on the based on the size or phase of the zero sequence voltage and current.
Relay operation is by definite time characteristics, with a delay from 100 msec up to 60 sec.



※ 1) SF-N and SM-N can use either OCGR or DGR as a ground current protection element.
2) SF-N and SM-N can use only SGR as a ground current protection element.

Negative Sequence Overcurrent Relay, NSOCR : 46

The NSOCR calculates the negative sequence current passing through the system's CT circuit to detect a negative sequence short, phase loss or phase unbalance in the system under load, and is operated on a time delay.
Time delay is further classified into definite time and indefinite time characters; the definite time element fires the relay within a designated period of time after an overcurrent event regardless of the size of the current, with a delay ranging from 50 msec to 60 seconds. Inverse time characteristics is inversely proportional to the size of the current—smaller the ratio of the overcurrent to the pickup current, longer the delay, and vice versa.
The inverse time relay curves are categorized as standard inverse (SI), very inverse (VI), extremely inverse (EI) and long inverse (LI) as defined by IEC specifications.

Overvoltage Relay, OVR : 59

The OVR detects a voltage higher than the setting value in the PT secondary circuitry in the system, and is operated on a time delay. An overvoltage occurs in the event of an unbalance fault in the system, failure to control the generation voltage, max load dropoff from the generator for low load, or in the transformer circuits.
Relay operation is by definite time characteristics, with a delay from 100 msec up to 60 sec.

Undervoltage Relay, UVR : 27

The UVR detects a voltage lower than the setting value in the PT secondary circuitry in the system, and is operated on a time delay. Relay operation is by definite time characteristics, with a delay from 100 msec up to 60 sec. The UVR is employed to detect a bus outage, protect from low voltage, load switching, condenser protection, and interlock other system elements.
In order to prevent malfunction due to momentary low voltage detection during system startup, the UV Block function can be set to activate the low voltage relay after normal voltage application.
The UVR should be linked with the PT fuse failure (PTF) feature in order to prevent an error caused by a short in the PT secondary side fuse.

Technical Data

Main Functions

Overvoltage Ground Relay, OVGR : 64

The OVGR measures zero sequence voltage in the event of a ground fault by detecting an overvoltage in the tertiary circuitry of the GPT, and is operated on a time delay.
As the OVGR by itself cannot make a completely accurate determination of a ground fault event, the OVGR is generally used to signal an alert while the DGR and SGR elements are used to trip the circuit after detecting a ground fault.
Relay operation is by definite time characteristics, with a delay from 100 msec up to 60 sec.

Phase Open Relay, POR : 47P

The POR detects a disparity between the phase and line voltage in the three-phase system or between the phase angle and the condition of balance, or in the event of a single phase voltage loss from the system.
The voltage unbalance is detected by receiving the three-phase voltage input from the system's PT and using the formula below to determine if the percentage value is larger than the setting value. Relay operation is by definite time characteristics, with a delay from 100 msec up to 60 sec.
The voltage unbalance rate formula of HGMAP-S is as follows.

$$V_{unbal}\ (\%) = \left(\frac{V_{max} - V_{min}}{V_{avg}} \right) \times 100$$

Vunbal : Unbalance Rate
Vmax : Highest of Three-Phase Voltage
Vmin : Lowest of Three-Phase Voltage
Vavg : Average of Three-Phase Voltage

Thermal Relay, THR : 49

The THR provides protection against motor overload and measures the heat buildup in the current inflowing via the system's CT circuit to check if the thermal load is larger than the setting value.
Relay operation is by inverse time characteristics with time delay characteristics of the cold and hot curves as outlined by IEC60255-8.
The cold curve is based on the thermal state and the time constant, and the hot curve operate based on the cold curve plus prior thermal accumulation.

Undercurrent Relay, UCR : 37

The UCR determines whether the current from the CT circuit is lower than the setting value, and is operated on a time delay.
Relay operation is by definite time characteristics, with a delay from 100 msec up to 60 sec.

Negative Sequence Overvoltage Relay, NSOVR : 47N

The NSOVR calculates the negative sequence voltage inflow via the system's PT circuit to detect the motor's reverse phase, open phase or phase unbalance, and is operated on a time delay.
Relay operation is by definite time characteristics, with a delay from 100 msec up to 60 sec.

Stall/Lock Relay : 48/51LR

Stall refers to a state when the torque load on a running motor exceeds the motor's maximum torque, reducing the rotational speed or stopping the motor altogether; a lock is caused by excessive torque on the motor before it operate, preventing startup.
The Stall/Lock Relay protects the motor from these events, detecting a similar set of conditions on the motor albeit during motor operation for stall and before motor startup for lock.
Both the stall and lock relay are operated on a time delay, with the stall relay operation on definite time characteristics and lock relay operation on inverse time (VI, EI) characteristics.

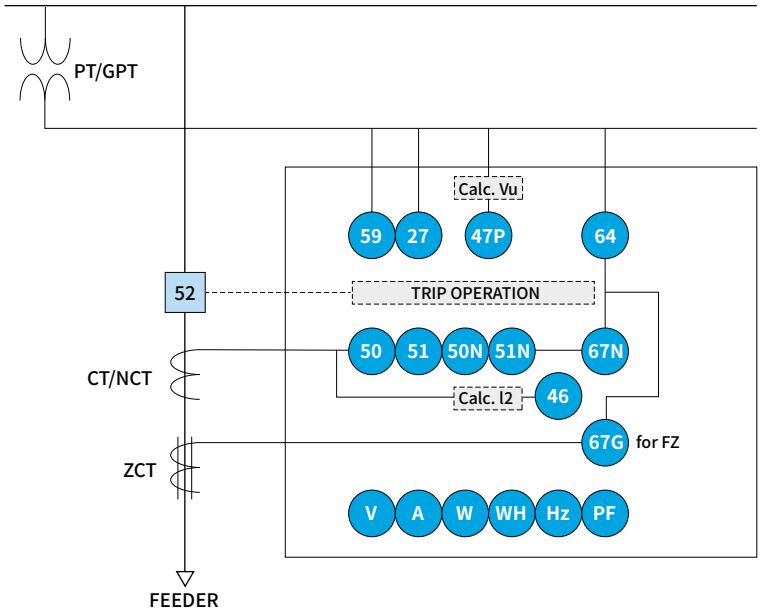
Notching Relay, NCH : 66

The NCH protects the motor from the large startup current occurring at initial motor operation which can put thermal and mechanical stress on the motor.
The NCH limits the number of operations during a set period of time, setting the interval between operations to prevent the motor from being started up immediately after powering down.
The relay can be linked with the THR element to limit operation when the residual heat is greater than the heat level setting.

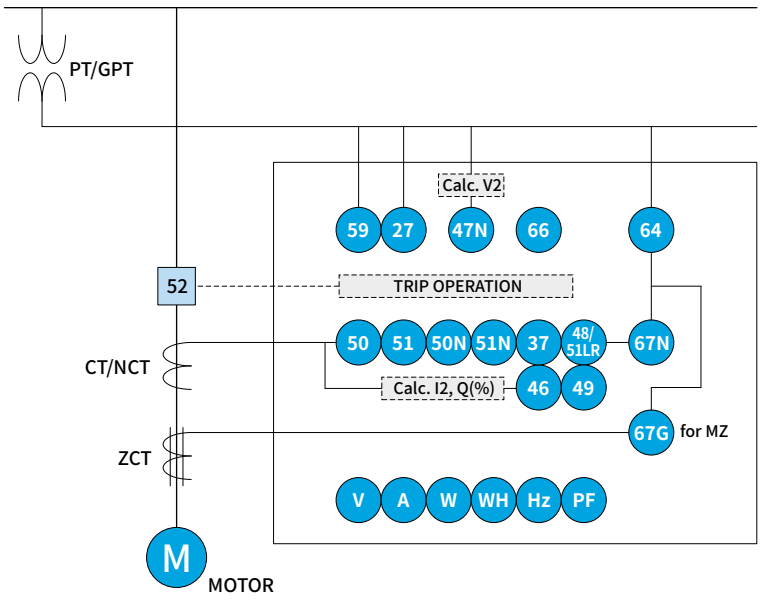
Technical Data

Function Block Diagram

HGMAP-SF

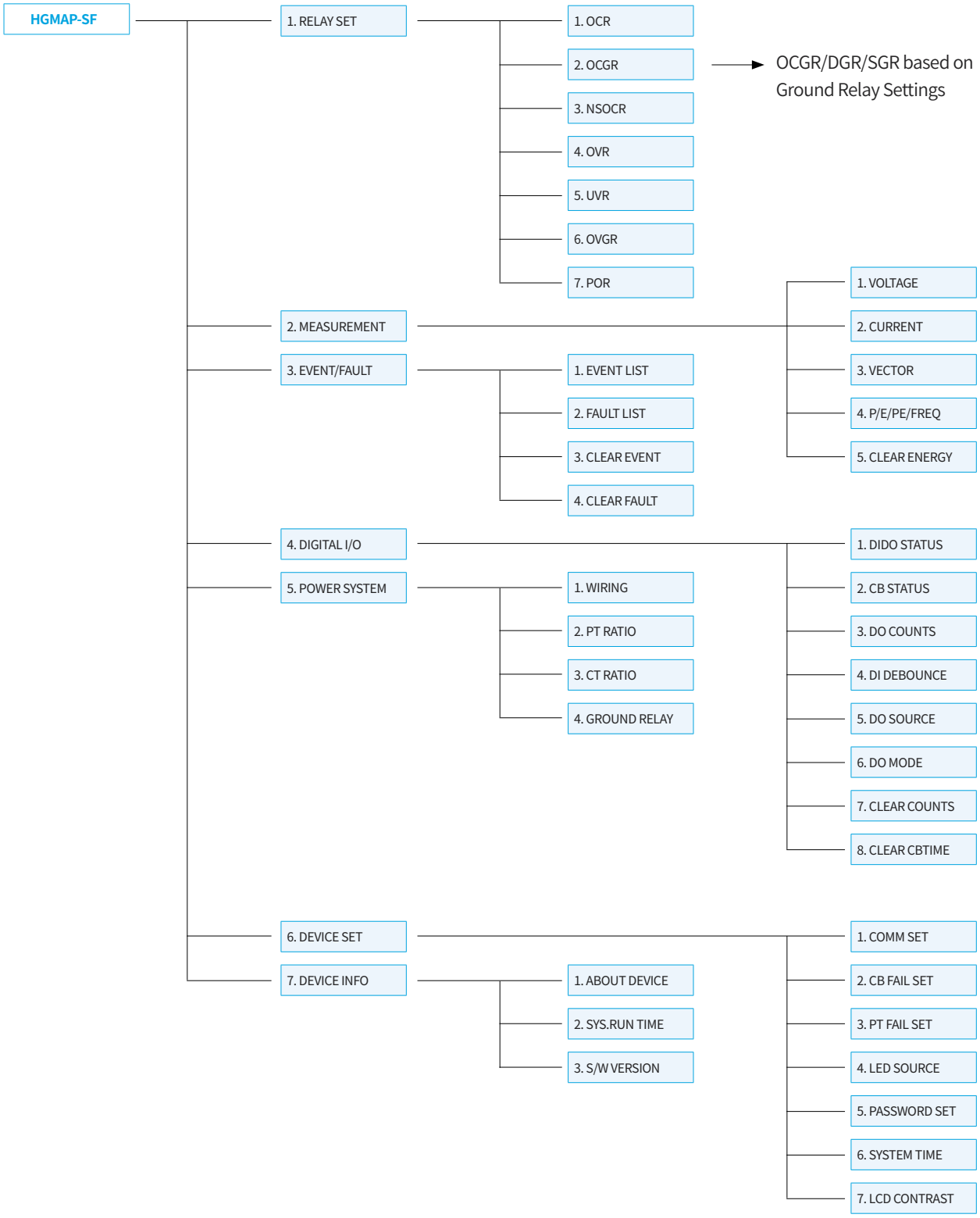


HGMAP-SM



Controls and Settings

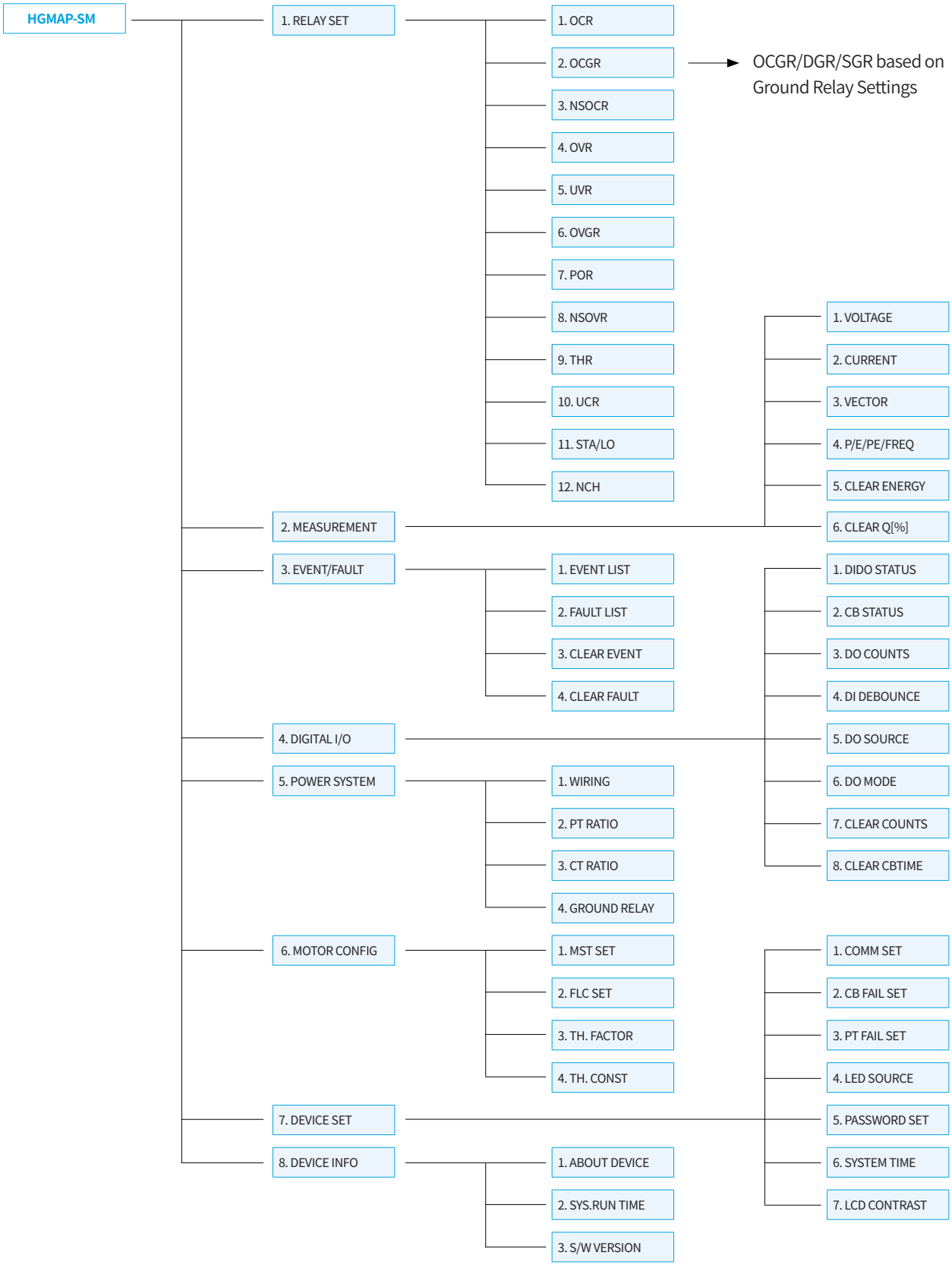
HGMAP-SF Menu Tree



Technical Data

Controls and Settings

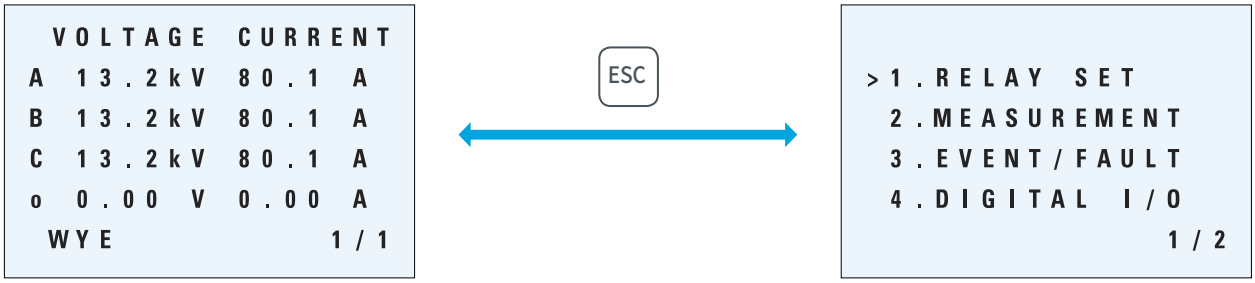
HGMAP-SM Menu Tree



HMI Basic Controls

1. Switching to Settings Menu

Pressing the ESC button from the default measurement screen switches to the settings menu.
Pressing the ESC button again returns to the Measurement screen.



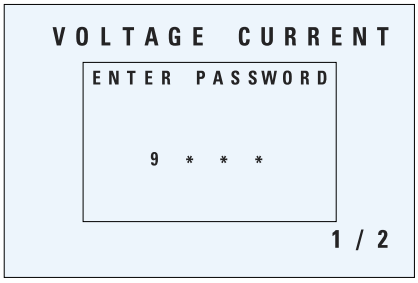
2. Password Input

The password must be entered for changing the relay's settings values or controlling the breaker.
The popup window shown below will appear for actions that require a password.

< > Buttons can be pressed to move the cursor.

∨ ∧ Buttons can be pressed to increase/decrease each value.

Press the ENTER key after entering the four-digit password. Unlocked state will be maintained for 2 minutes when entering password.



The default password is 9999. Change the password to a unique password to ensure safe and secure electrical panel control.
The password can be changed in **6. DEVICE SET** ▷ **5. PASSWORD** SET in the settings menu.

Technical Data

Controls and Settings

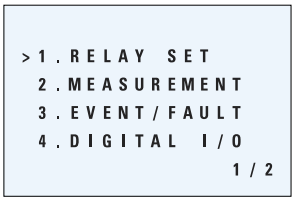
HMI Basic Controls

3. Protective Relay Settings

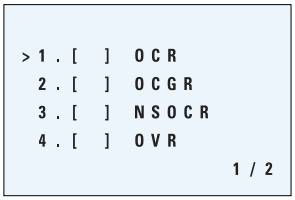
The protection element settings include settings for activating or deactivating a protective relay and entering the index setting value for each relay.

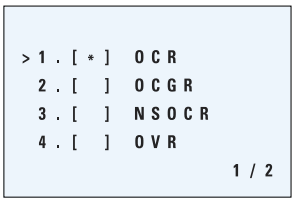
Activating a Protection Element

This is the basic settings menu screen.
1. Select the RELAY SET and press ENTER button to enter into the protective relay setting display.

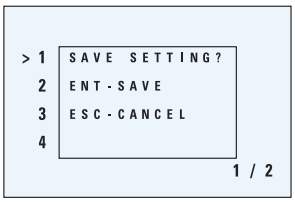


The unit's main protection elements are displayed.
Select the relay to activate.
Press the ∨ ∧ buttons to move the cursor to the intended relay.
Press the < > buttons to select or deselect a relay for operation.
[*]: Activate
[ ]: Deactivate
After selecting the intended relay, press ENTER.

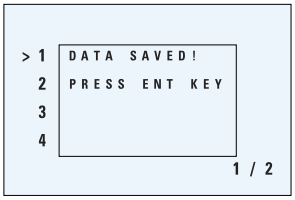




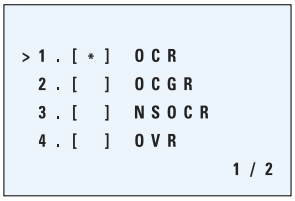
A popup will ask to confirm the new settings.
Press ENTER to save the new settings.



Protection element settings have been changed.
Press the ENTER or ESC button to close the pop-up window.

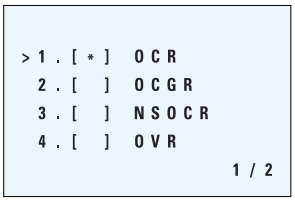


Pressing the ESC button will return to the menu screen.



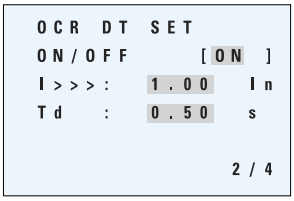
Checking Measurement Values

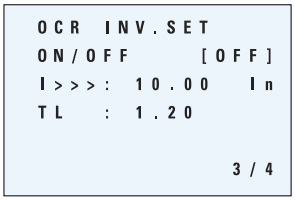
Press the ENTER button with the protection element highlighted and Operated.
1. [*] OCR is illustrated below.

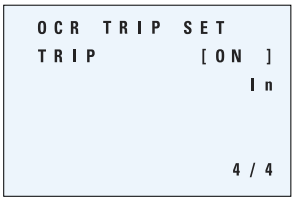


The page for the protection elements consists of how to activate/deactivate functions, how to change the setting, and how to trip on/off.
Press the V Λ buttons to toggle between parameters.

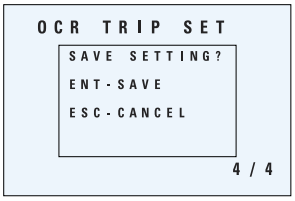
Current stored settings are displayed.
Press the < > buttons to increase/decrease each value.
Repeat the process for any parameters that need to be changed.
Once all entries for relay values are complete, press the ENTER button.



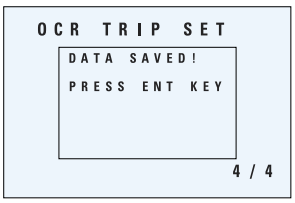




A popup will ask to confirm the new settings.
Press ENTER to save the new settings.



The setting of the protection elements has been changed.
Press the ENTER or ESC button to close the pop-up window.
Press the ESC button after the pop-up window is closed to move to the menu at the top.



※ Please refer to the separate list of items for setting the protection elements for the range and unit for setting each protection element in detail.

Technical Data

Controls and Settings

HMI Basic Controls

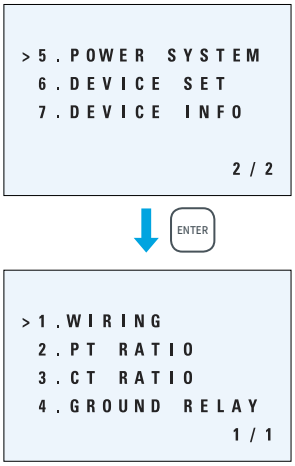
4. System Settings

System settings can be classified into POWER SYSTEM settings for the electrical panel environment and the DEVICE SET settings for the relay's own operational conditions.

POWER SYSTEM Settings

No.	Classification	Description	Setting Values
1	WIRING	PT Secondary Wiring Type	WYE, DELTA
2	PT RATIO	PT Primary Rating	110 ~ 345,000 V
		PT Secondary Rating	110 V, 110/√3 V
		GPT Tertiary Rating	110 V, 190 V
3	CT RATIO	CT/NCT Primary Rating	5 ~ 6,000 A (5 step)
4	GROUND RELAY	Ground Fault Current Detection Element	OCGR, DGR (SF-N, SM-N) SGR (SF-Z, SM-Z)

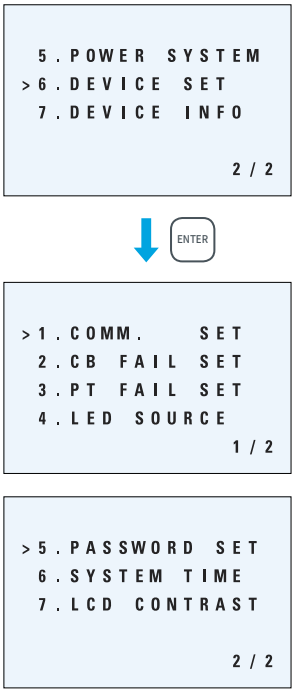
※ PT Primary Raiting is based on Line-to-Line voltage, and PT Secondary Rating is based on Phase Voltage.



DEVICE SET Settings

No.	Classification	Description	Setting Values
1	COMM. SET	RS-485 communication	
		- ADDR : comm. Address	1 ~ 247
		- BAUD : comm. Speed (bps)	9600, 19200, 38400
		- SWAP : Float Data Swap Feature [1)]	ON, OFF
2	CB FAIL SET	Breaker Control Status Monitoring	
		- CB CLOSE [ON/OFF] TIME	100 ~ 200 ms (5 step)
		- CB OPEN [ON/OFF] TIME	100 ~ 200 ms (5 step)
3	PT FAIL SET	PT Secondary Fuse Fail Monitoring	
		- PT FAIL [ON/OFF] TIME	100 ~ 200 ms (5 step)
4	LED SOURCE	User set LED 01 ~ 08 Source	Select among the pickup, operation, and DI status of protection elements.
5	PASSWORD SET	User Password Setting	-
6	SYSTEM TIME	System Clock Setting	-
7	LCD CONTRAST	LCD Display Contrast Setting	-

※ 1) The SWAP function applies only to the float data and operates with SWAP WORD.
Example) Float value 1234.57 is converted to hex value as follows:
- 3D 52 9A 44 (without SWAP)
- 9A 44 3D 52 (with SWAP)

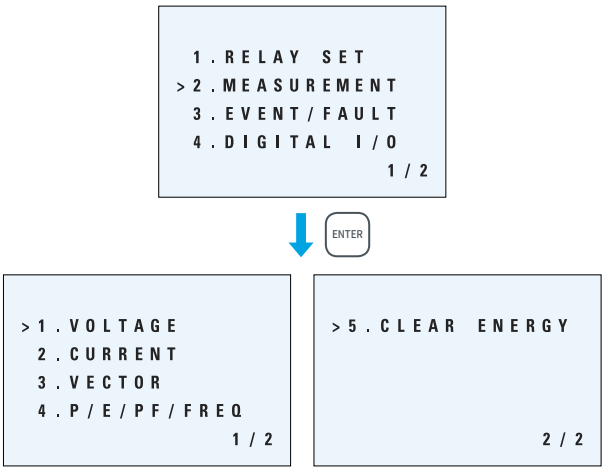


5. Measuring And Monitoring Screens

Checking Measurement Values

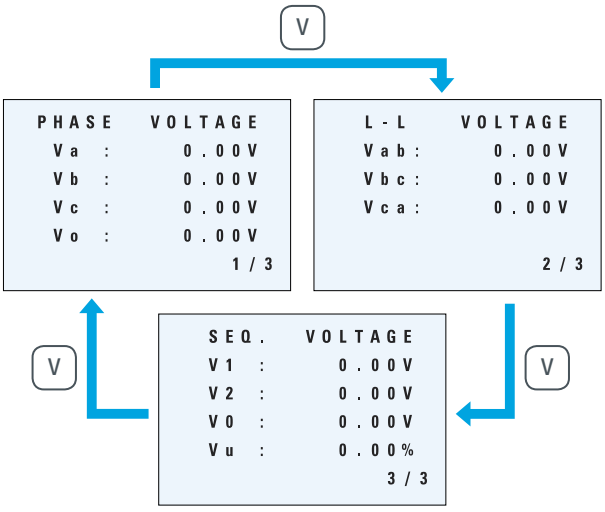
Measurement values including voltage, current, vector, power and energy, power factor and frequency can be verified in the **2. MEASUREMENT** menu item in the main menu screen.

Pressing the shortcut buttons at the right of the LCD screen immediately displays the relevant measurement value in any situation.



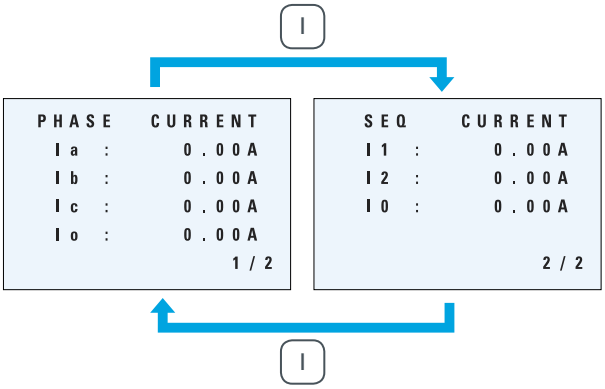
① VOLTAGE

- Displays the phase sequence voltage, line voltage, positive sequence voltage, negative voltage, and zero sequence voltage.
- Pressing the V shortcut button immediately displays the voltage measurement screen, with each press of the button toggling through the voltage category displays.



② CURRENT

- Displays the phase current, positive current, negative sequence current and zero sequence current.
- Pressing the I shortcut button immediately displays the current measurement screen, with each press of the button toggling through the current category displays.

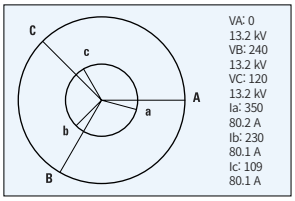


Technical Data

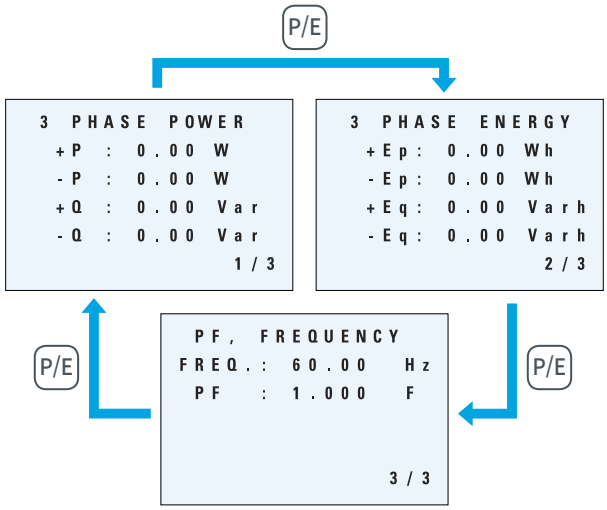
Controls and Settings

HMI Basic Controls

③ VECTOR
- Displays the magnitude, phase angle and vector diagram of voltage and current in each phase.
- Pressing the shortcut button immediately displays the vector measurement screen.



④ P/E/PF/FREQ
- Displays the active/reactive power, energy, power factor and frequency.
- Pressing the P/E shortcut button immediately displays the power measurement screen, with each press of the button toggling through the power category displays.



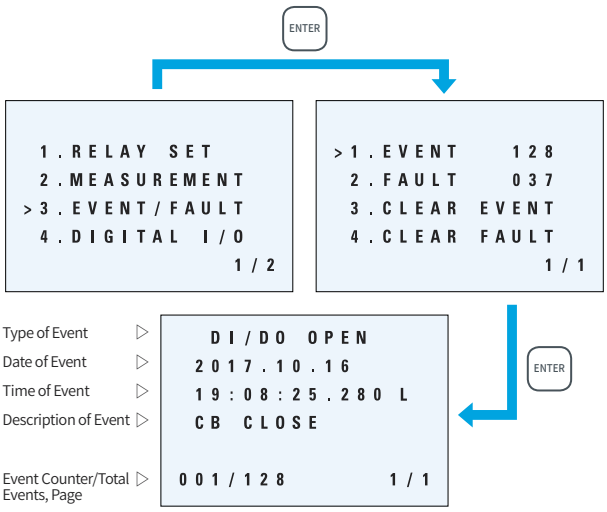
⑤ CLEAR ENERGY
- The CLEAR ENERGY menu can be selected to reset the relay's accumulated energy value.

6. Viewing Event and Fault History

The relay's event records and fault records can be viewed by accessing **3. EVENT/FAULT** in the main menu screen.

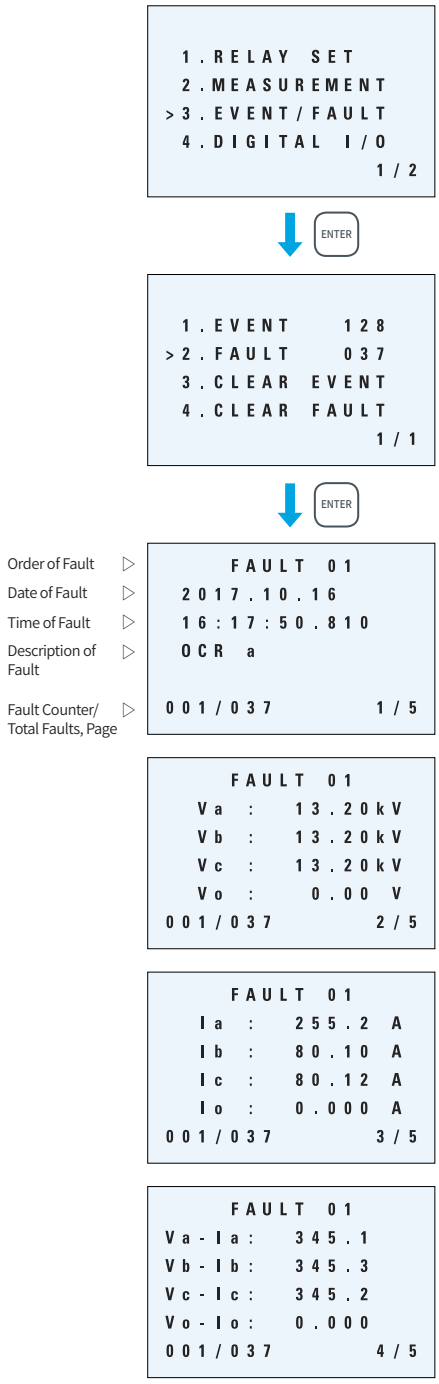
View Events

- The relay unit's various status changes, settings and event history of protection/monitoring operations can be viewed in the **1. EVENT** option in the **3. EVENT/FAULT** menu.
- Each event's details and time of occurrence can be verified.
- Up to 256 event records are stored, after which the oldest record is erased to store new event data.
- **3. CLEAR EVENT** can be selected to erase event history.



Fault History

- The relay's protective trip history can be viewed in the **2. FAULT** option from the **3. EVENT/FAULT** menu.
- The protection element responsible for triggering the trip as well as the current, voltage, phase, negative sequence voltage and current and phase unbalance rate at the moment of the fault can be viewed to facilitate analysis.
- Waveforms recorded at the time of the fault can be viewed and analyzed using the **HG Manager** software.
- Up to 64 fault records are stored, after which the oldest record is erased to store new fault data.
- **4. CLEAR FAULT** can be selected to erase event history.



Technical Data

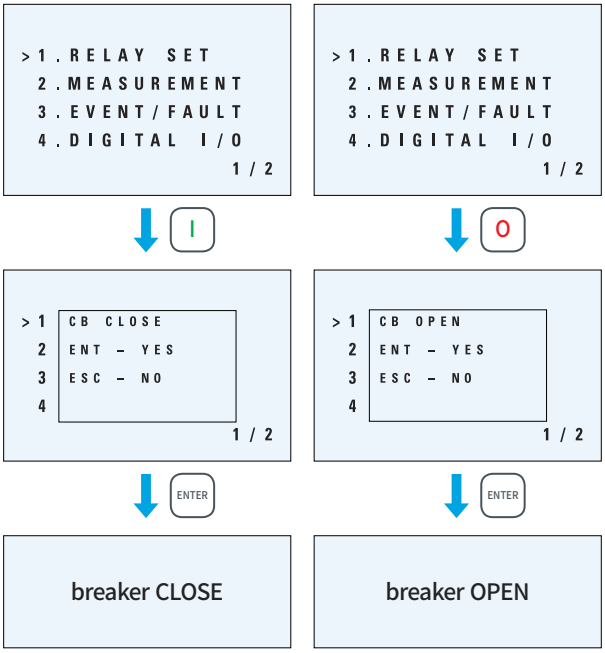
Controls and Settings

HMI Basic Controls

7. Circuit Breaker Control

The **1. RELAY SET** option can be used to directly open or close the circuit breaker.

To enable this action, the control command permission should be set to LOCAL (LED indicator of the LOCAL/ REMOTE button must be red).

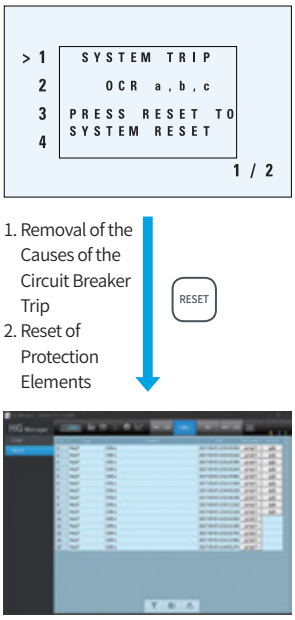


8. Fault Reset

Press the RESET button to initialize the DO status (when DO mode is latched) and LED status of the relay after the relay is operated due to fault in power system and the circuit breaker is tripped. The protection elements are operated, the TRIP LED is turned on, and the pop-up window indicating the operated elements appears.

Remove the causes of the circuit breaker trip or close the pop-up window and deactivate the operated protection elements first, and then press the RESET button to return the relay to the normal operating mode.

※ If any of the protection elements is deactivated without removing the causes, the causes can have a lasting impact and ultimately damage the system.
※ The RESET function does not operate if any of the activated protection elements falls into the causes of the circuit breaker trip.

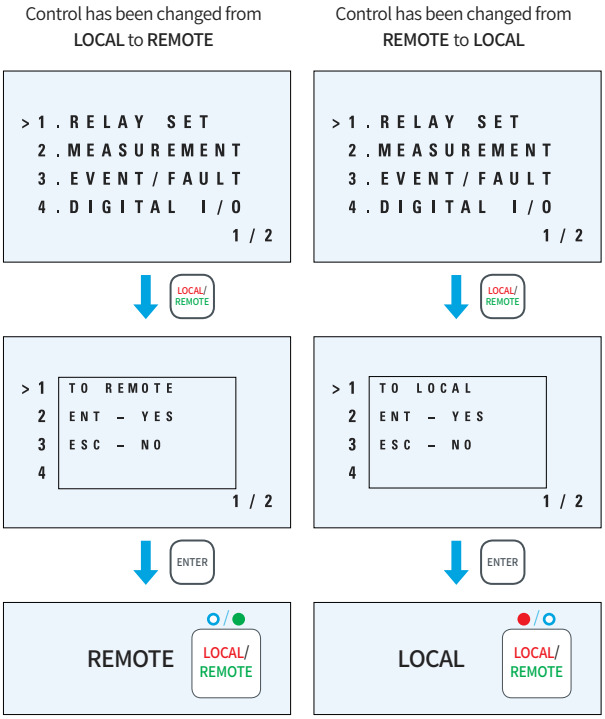


9. Control Setting

Control can be converted to LOCAL or REMOTE using the LOCAL/REMOTE button on the optional menu display.
In order to control the relay remotely, the product's control must be converted to REMOTE.

Changing the setting of the protection elements and product and controlling the circuit breaker using buttons are restricted when control is set at REMOTE.

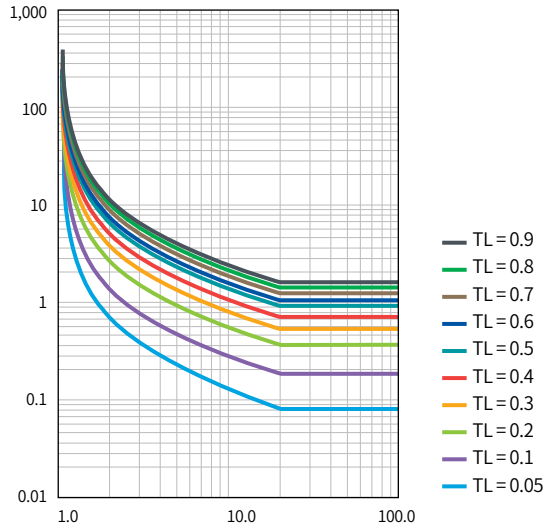
If control remains LOCAL, the red LED above LOCAL/REMOTE is turned on. If it remains REMOTE, the green LED above LOCAL/REMOTE is turned on.



Technical Data

Time Characteristic Curves

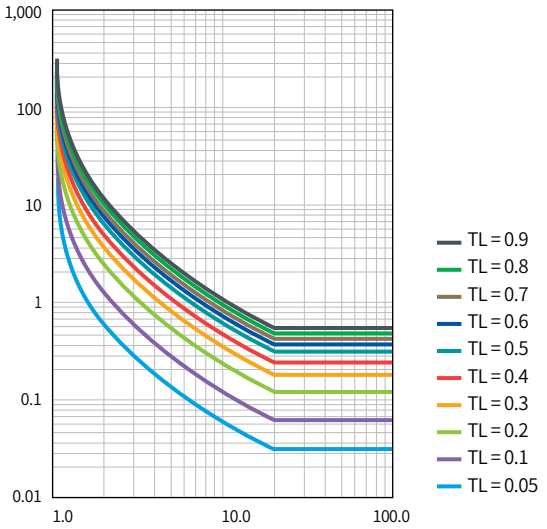
Inverse Curve : IEC_SI



$$T_{SI} = \left(\frac{0.14}{\left(\frac{I}{Is}\right)^{0.02} - 1} \right) \times T_L$$

Unit : sec
I : Fault Current
Is : Setting Current
T_L : Time Lever

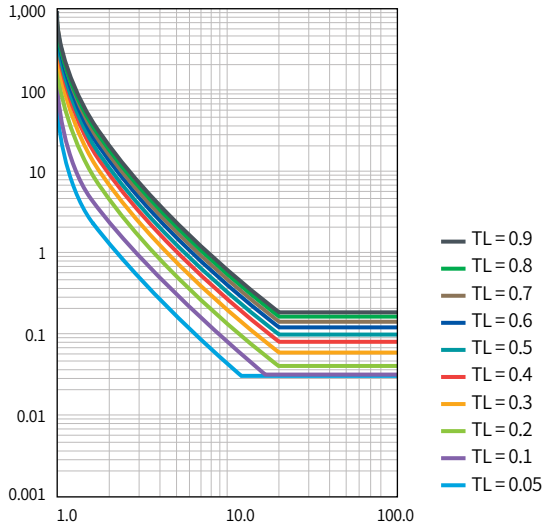
Inverse Curve : IEC_VI



$$T_{VI} = \left(\frac{13.5}{\left(\frac{I}{Is}\right) - 1} \right) \times T_L$$

Unit : sec
I : Fault Current
Is : Setting Current
T_L : Time Lever

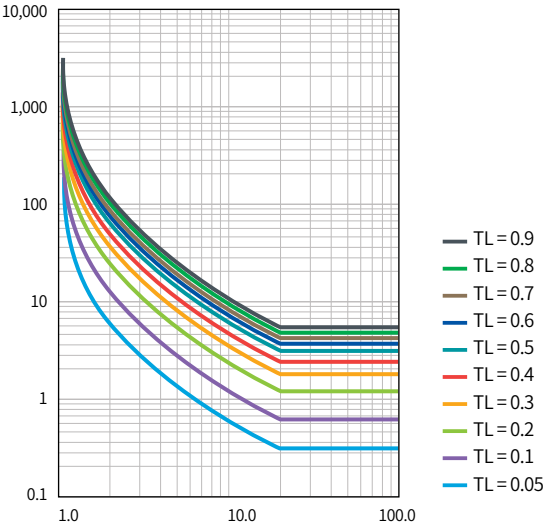
Inverse Curve : IEC_EI



$$T_{EI} = \left(\frac{80}{\left(\frac{I}{Is}\right)^{2} - 1} \right) \times T_L$$

Unit : sec
I : Fault Current
Is : Setting Current
T_L : Time Lever

Inverse Curve : IEC_LI

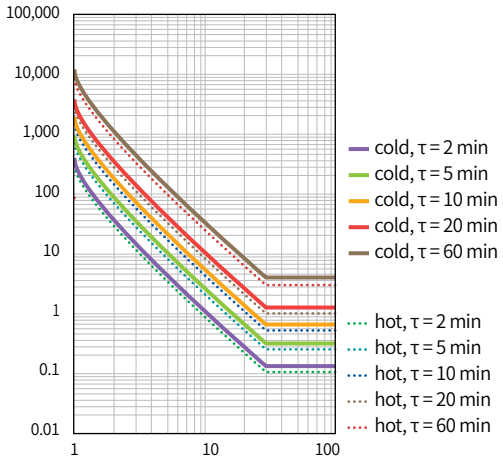


$$T_{LI} = \left(\frac{120}{\left(\frac{I}{Is}\right) - 1} \right) \times T_L$$

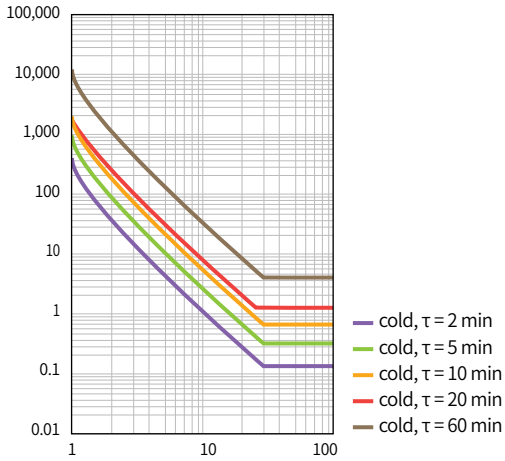
Unit: sec
I : Fault Current
Is : Setting Current
T_L : Time Lever

Thermal Curve Cold vs Hot

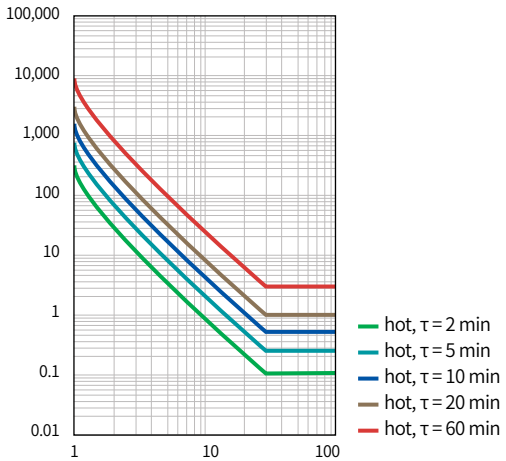
Cold vs Hot



Cold (FLC 0 %)



Hot (FLC 50 %)



$$t = \tau \times ln \frac{I^2 - I_p^2}{I^2 - (k \times I_B)^2}$$

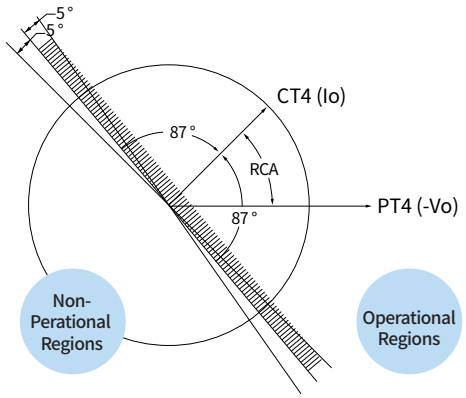
t : Trip Time (sec)
τ : Time Constant
I_P : Load Current Prior to Fault
I_B : Rated Load Current
k : Overload Constant (FLC×SVC×O/C)
I : Fault Current

- X axis : I/I_B (%)
- Y axis : Trip Time (sec)
- I_P=0 When Cold

DGR/SGR Operational Regions

- The DGR and SGR operational regions are within ± 87 ° of the pre-set RCA
- Wiring should be connected to “-Vo” when connecting PT4 terminal to GPT tertiary
- Phase deviation is within ± 5 ° of the index angle

Example) RCA : when set to 45 °
Operational angle (-Vo) : - 42 ° ~ 87 °
Phase deviation : 82 ° ~ 92 °, - 47 ° ~ -37 °



Technical Data

HG Manager

HG Manager Software

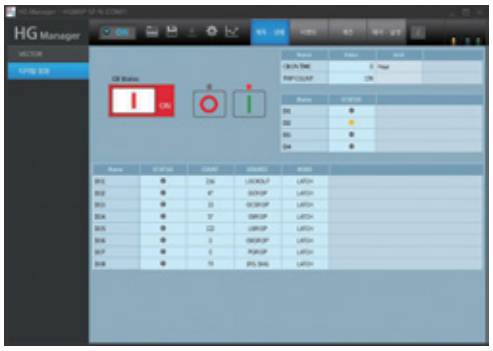
HG Manager is HGMAP dedicated management software.
The HGMAP relay includes the HG Manager software that provides additional convenience for initial settings for the relay's protection features. The software also provides a GUI for easy status monitoring, verification of events and comtrade analysis.

System Requirement

- OS : Microsoft Windows® 7/8/8.1/10
- RAM : 2 GB or higher
- Monitor : 1,366×768 resolution and color mode of 16 bits or higher
- Supports USB 2.0 or higher

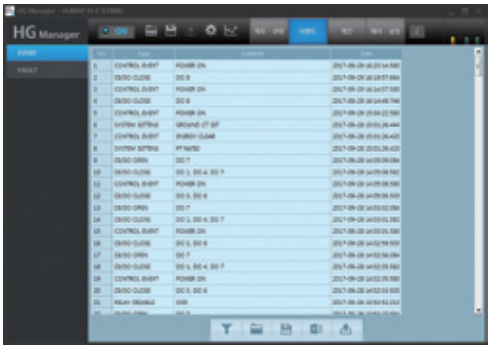
1. Check Measured Values and Contact Status

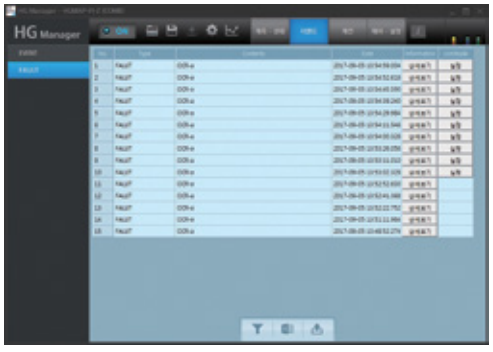
- Verify voltage, current vector diagram, power and wattage, power factor and frequency values at a glance.
- Check breaker open/close status and the various digital I/O contact values.



2. View Event and Fault History

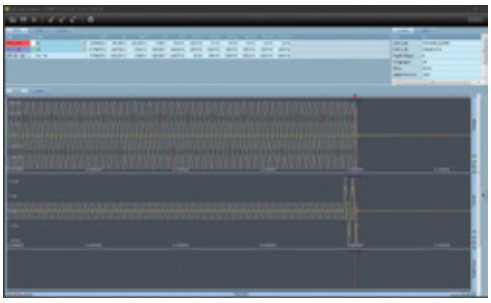
- Verify relay event logs.
- Various measured values as well as the protective relay that caused the trip can be examined closely, with the comtrade event waveform available for immediate analysis if necessary.

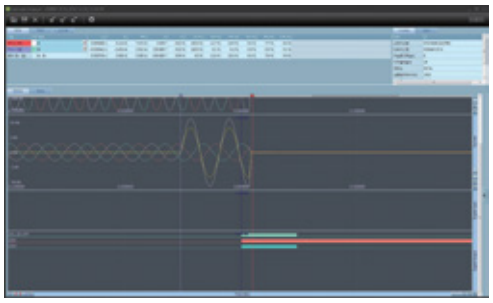




3. Comtrade Analysis

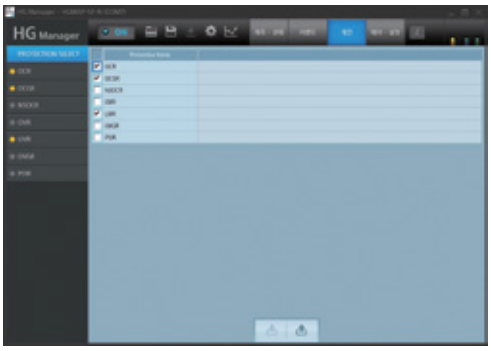
- Current, voltage, and contact status recorded in wave form at the time of an incident are converted into the form of comtrade. Wave form can be checked by setting Comtrade Viewer or other types of viewer software.
- Harmonics, difference between two times can also be analyzed.

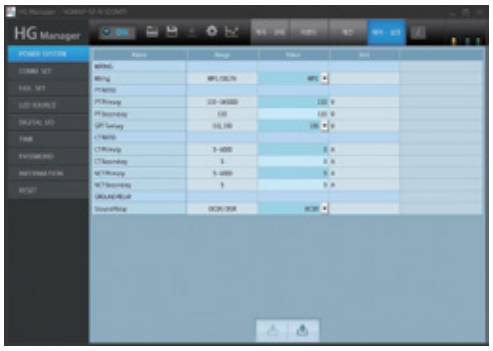




4. Protection Element Setting

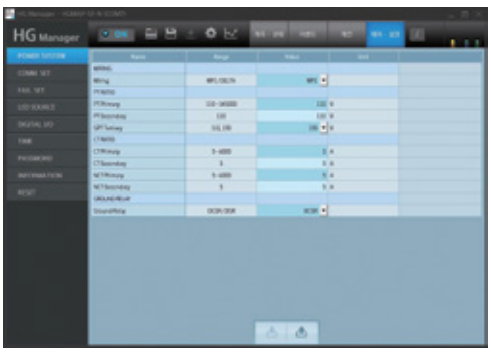
- The activation/deactivation of the protection elements can be set, as well as detailed operational characteristics.
- For elements with an inverse time characteristic, the inverse time characteristic curve can be checked.
- The current setting status can be saved to apply it to other devices (Saved as the system setting).

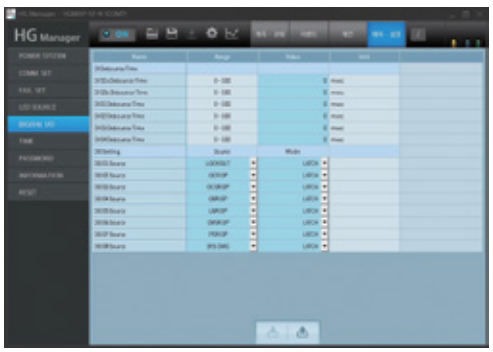




5. System Setting

- The Protection functions of PTF and CBF for HGMAP can be set, as well as predetermined values regarding communication, DO sources and operational characteristics, and LED sources.
- The system time information of HGMAP and time information on the user's desktop computer are synchronized.
- The product counter and accumulated records can be initialized and the product's current operational status can be reset.





Model Selection Table

Ratings and Specifications

Classification		Specifications
General Specifications		
Main Feature		Protects distribution panel feeder/incoming loads and motors, metering a variety of electrical information and monitoring and controlling input and output contacts.
		Supports remote control via communication link with monitoring station and provides real-time system protection status information
Operational Environment	Ambient Temperature Rating	25 [°C]
	Operating Temperature	-10 ~ 55 [°C]
	Storage Temperature	-20 ~ 75 [°C]
	Humidity	Below 80 [%] (Must be Free of Condensation)
	Installation Environment	Below 2,000 m Elevation
		No exposure to Snow, Rain, Direct Sunlight, Wind
		No exposure to Dust, Corrosion, Explosive Gases
General Features		
Input	Control Power	DC 110 V
	Analogue Input	PT 4 Channels, CT 4 Channels
Protection Relays	Feeder, Grounded (SF-N)	OCR (50/51), OCGR (50/51N), DGR (67N), NSOCR (46)
		OVR (59), UVR (27), OVGR (64), POR (47P)
	Feeder, Ungrounded (SF-Z)	OCR (50/51), SGR (67G), NSOCR (46)
		OVR (59), UVR (27), OVGR (64), POR (47P)
	Motor, Grounded (SM-N)	OCR (50/51), OCGR (50/51N), DGR (67N), NSOCR (46), THR (49), UCR (37), POR (47P)
		OVR (59), UVR (27), OVGR (64), NSOVR (47N), Stall/Lock (48/51L), NCH (66)
	Motor, Ungrounded (SM-Z)	OCR (50/51), SGR (67G), NSOCR (46), THR (49), UCR (37), POR (47P)
		OVR (59), UVR (27), OVGR (64), NSOVR (47N), Stall/Lock (48/51L), NCH (66)
Measurement		Voltage, Current, Power, Electrical Energy, Phase, Power Factor, Frequency
Display		128×96 Graphic LCD
		Status & Alarm LEDs×17
Data Records		Event Record×256
		Fault Record×64
		Fault Wave Record (64 cycles, 32 samples/cycle)×10 (IEEE C37.111 Comtrade Format)
External Specifications	Dimension	148×208×188 mm (W×H×D)
	Total Weight	3.5 kg (Including Box and Accessories)

Classification			Specifications
Rated Input/Output			
Control Power	Rated Input		110 Vdc
	Input Voltage Range		88 ~ 132 Vdc
	Instantaneous Power Failure Duration		100 msec (at 110 Vdc)
	Power Consumption		Standby : less than 10 W, Active : less than 15 W
CT Input	CT Primary Rating Range		5 ~ 6,000 A
	CT Secondary Rating		5 A (= 1 In)
	Maximum Burden		1.0 VA at 1 In
	Input Range		0 ~ 40 In
	Overload Capacity		2 In (continue), 20 In (for 2 sec), 40 In (for 50 msec)
ZCT Input	ZCT Primary Rating		200 mA
	ZCT Secondary Rating		1.5 mA (= 1 Ion)
	Maximum Burden		1.0 VA at 1 In
	Input Range		0 ~ 40 In
	Overload Capacity		2 In (continue), 20In (for 2 sec), 40 In (for 50 msec)
PT Input	PT Primary Rating Range		110 ~ 345,000 V
	PT Secondary Rating		110 V, 110/$\sqrt{3}$ V (= 1 Vn)
	Maximum Burden		0.5 VA at 1 Vn
	Input Range		0 ~ 2.0 Vn
	Overload Capacity		1.2 Vn (continue), 2 Vn (for 1 hour)
Digital Input (DI)	Rated Input		110 Vdc
	Threshold Voltage		Turn-On : 80 Vdc, Turn-off : 70 Vdc
	Input Delay		Less than 10 msec
	Maximum Burden		2 mA at 110 V
Digital Output (DO) (Control)	Contact Type		Dry Contact
	Contact Rating		Resistive Load : 10 A at 250 Vac/30 Vdc
			Inductive Load : 5 A at 250 Vac/30 Vdc
	Operation Speed		Less than 10 msec
Digital Output (DO) (Signal)	Contact Type		Dry Contact
	Contact Rating		Resistive Load : 5 A at 250 Vac/30 Vdc
			Inductive Load : 2 A at 250 Vac/30 Vdc
	Operation Speed		Less than 10 msec
Communication	RS-485	Wiring Types	2 Wire (D+, D-), 4 Wire (Rx+, Rx-, Tx-, Tx+)
		Communication Speed	9600, 19200, 38400 bps
		Protocol	Modbus/RTU
	Ethernet (Option)	Wiring Types	UTP (RJ45), Fiber Optic (SFP-MM)
		Communication Speed	10/100 Mbps
		Protocol	Modbus/TCP
	PC	Connection	USB Mini-B Port
		Protocol	Dedicated Protocol
Type Test			
CoC	Korea		KEMC1120-0579 ; 2008-06-26
EMC	RF Immunity		IEC61000-4-3/IEC60255-26
	Conducted RF		IEC61000-4-6/IEC60255-26
	ESD		IEC61000-4-2/IEC60255-26
	Fast Transient		IEC61000-4-4/IEC60255-26
	Surge Immunity		IEC61000-4-5/IEC60255-26
	Power Magnetic		IEC61000-4-8/IEC60255-26
	Voltage Dips, Interruptions		IEC61000-4-11/IEC60255-26, IEC61000-4-29/IEC60255-26
	RF Emission		CISPR 11,22/IEC60255-26
Mechanical	Vibration		IEC60255-21-1/IEC60255-27
	Shock/Bump		IEC60255-21-2/IEC60255-27
	Seismic		IEC60255-21-3/IEC60255-27
Environment	Dry heat		IEC60068-2-2/IEC60255-27
	Cold		IEC60068-2-1/IEC60255-27
	Damp-heat		IEC60068-2-78/IEC60255-27
	Cyclic Temperature		IEC60068-2-30/IEC60255-27
Withstand	Insulation Resistance		IEC60255-5/IEC60255-27
	Dielectric		
	Impulse Voltage		

Operational Characteristics

Relay Protection Characteristics

Relay	Input Signal	Classification	Setting Range	Time Characteristics	Time Delay	Notes
OCR (50/51)	CT1 ~ CT3	I >>>	OFF, 1.0 ~ 20.0 In (0.1 step)	Instantaneous	Less than 40 msec	
		I >>	OFF, 0.20 ~ 10.00 In (0.02 step)	Definite	0.05 ~ 60.00 sec (0.01 step)	
		I >	OFF, 0.20 ~ 10.00 In (0.02 step)	Inverse	0.05 ~ 1.20 (0.01 step)	SI, LI, VI, EI
OCGR (50/51N) N Type Only	CT4	I >>>	OFF, 0.50 ~ 8.00 In (0.02 step)	Instantaneous	Less than 40 msec	
		(50/51N)	OFF, 0.10 ~ 2.00 In (0.01 step)	Definite	0.05 ~ 60.00 sec (0.01 step)	
		I >	OFF, 0.10 ~ 2.00 In (0.01 step)	Inverse	0.05 ~ 1.20 (0.01 step)	SI, LI, VI, EI
		OCGR Block time: Delaying relay operation within block time additionally to prevent immediate trip after closing the breaker, or set-up the system.			0.05 ~ 60.00 sec (0.0 1 step)	
DGR (67N) N Type Only	PT4, CT4	Io >>	0.02 ~ 2.00 In (0.01 step)	Definite	0.10 ~ 60.00 sec (0.01 step)	Limit Angle: RCA ± 87
		Vo >>	0.10 ~ 0.40 Von (0.02 step)			
		RCA	0 ~ 90 ° (1 step)			
SGR (67G) Z Type Only	PT4, CT4	Io >>	0.6 ~ 4.0 Ion (0.2 step)	Definite	0.10 ~ 60.00 sec (0.01 step)	Limit Angle: RCA ± 87
		Vo >>	0.10 ~ 0.40 Von (0.02 step)			
		RCA	0 ~ 90 ° (1 step)			
NSOCR (46)	Calc. I2	I2 >>	OFF, 0.10 ~ 1.00 In (0.02 step)	Definite	0.05 ~ 60.00 sec (0.01 step)	
		I2 >	OFF, 0.10 ~ 1.00 In (0.02 step)	Inverse	0.05 ~ 1.20 (0.01 step)	SI, LI, VI, EI
OVR (59)	PT1 ~ PT3	DT1 V >>	OFF, 0.80 ~ 1.60 Vn (0.02 step)	Definite	0.10 ~ 60.00 sec (0.01 step)	
		DT2 V >>	OFF, 0.80 ~ 1.60 Vn (0.02 step)	Definite	0.10 ~ 60.00 sec (0.01 step)	
UVR (27)	PT1 ~ PT3	DT1 V >>	OFF, 0.20 ~ 0.90 Vn (0.02 step)	Definite	0.10 ~ 60.00 sec (0.01 step)	
		DT2 V >>	OFF, 0.20 ~ 0.90 Vn (0.02 step)	Definite	0.10 ~ 60.00 sec (0.01 step)	
		UV Block : Blocking relay operation when the voltage on the secondary PT is below 15 V in all three-phase.				
OVGR (64)	PT4	DT1 Vo >>	OFF, 0.10 ~ 0.40 Von (0.02 step)	Definite	0.10 ~ 60.00 sec (0.01 step)	
		DT2 Vo >>	OFF, 0.10 ~ 0.40 Von (0.02 step)	Definite	0.10 ~ 60.00 sec (0.01 step)	
POR (47P)	Calc. Vu (%)	DT1 Vu >>	OFF, 5 ~ 100 % (1 step)	Definite	0.10 ~ 60.00 sec (0.01 step)	V_{unbal} (%) = $(V_{max} - V_{min})/V_{avg}$
		DT2 Vu >>	OFF, 5 ~ 100 % (1 step)	Definite	0.10 ~ 60.00 sec (0.01 step)	
NSOVR (47P) (M-Type)	Calc. V2	DT1 V2 >>	OFF, 0.10 ~ 1.00 Vn (0.02 step)	Definite	0.10 ~ 60.00 sec (0.01 step)	
		DT2 V2 >>	OFF, 0.10 ~ 1.00 Vn (0.02 step)	Definite	0.10 ~ 60.00 sec (0.01 step)	
THR (49) (M-Type)	Calc. Q	INV1 >	OFF, 50 ~ 100 % (1 step)	Inverse		
		INV2 >	OFF, 50 ~ 100 % (1 step)	Inverse		
UCR (37) (M-Type)	CT1 ~ CT3	DT1 I >>	OFF, 0.10 ~ 0.90 In (0.02 step)	Definite	0.10 ~ 60.00 sec (0.01 step)	
		DT2 I >>	OFF, 0.10 ~ 0.90 In (0.02 step)	Definite	0.10 ~ 60.00 sec (0.01 step)	
STALL/LOCK (48/51LR) (M-Type)	CT1 ~ CT3	STALL>>	OFF, 0.50 ~ 10.00 FLC (0.02 step)	Definite	0.50 ~ 60.00 sec (0.01 step)	
		LOCK >>	OFF, 0.50 ~ 10.00 FLC (0.02 step)	Definite	0.50 ~ 60.00 sec (0.01 step)	
		LOCK >	OFF, 0.50 ~ 10.00 FLC (0.02 step)	Inverse	0.05 ~ 1.20 (0.01 step)	VI, EI
NCH (66) (M-Type)	Number of Starts	Ns	OFF, 1 ~ 5 (1 step)			
		Tbase	1 ~ 60 min (1 step)			
	Start and Stop Interval	Tss	1 ~ 60 min (1 step)			
	Residual Heat	Qr	10 ~ 80 % (1 step)			

※ Vn : PT secondary-circuit rated voltage (110 V)
Von: GPT tertiary-circuit rated voltage (110 V or 190 V)

In: CT secondary-circuit rated current (5 A)
Ion: ZCT secondary-circuit rated current (1.5 mA)

MOTOR Characteristics Settings

Classification		Setting Range
Motor Start Time	MST	1.00 ~ 60.00 sec (0.01 step)
Full Load Current	FLC	0.20 ~ 2.00 In (0.01 step)
(S/F: Service Factor, O/C: Overload Constant)	S/F	1.00 ~ 1.20 (0.05 step)
	O/C	0.80 ~ 1.20 (0.05 step)
Thermal Time Constant	Th	2 ~ 60 min (1 step)
	Tc	2 ~ 60 min (1 step)

Product Features

Key Measurement and Communication Functions

Item	Classification	Display Range	Accuracy	Notes
Voltage	Phase	0.000 ~ 999.99 [kV]	± 1 %	Va (PT1), Vb (PT2), Vc (PT3)
	Zero Phase	0.000 ~ 999.99 [kV]	± 1 %	Vo (PT4)
	Line [1)]	0.000 ~ 999.99 [kV]	± 1 %	Vab, Vbc, Vca
	Positive Sequence	0.000 ~ 999.99 [kV]	± 2.5 %	V1
	Negative Phase	0.000 ~ 999.99 [kV]	± 2.5%	V2
	Zero Sequence	0.000 ~ 999.99 [kV]	± 2.5 %	V0
	Voltage Unbalance Rate	0.00 ~ 100.0 [%]	± 2.5 %	Vu
Current	Phase	0.000 ~ 999.99 [kA]	± 1 %	Ia (CT1), Ib (CT2), Ic (CT3)
	Zero Phase	0.000 ~ 999.99 [kA]	± 1 %	Io (CT4)
	Positive Sequence	0.000 ~ 999.99 [kA]	± 2.5 %	I1
	Negative Phase	0.000 ~ 999.99 [kA]	± 2.5 %	I2
	Zero Sequence	0.000 ~ 999.99 [kA]	± 2.5 %	I0
Phase	Phase	0.0 ~ 360.0 °	± 2 °	Marked in three-phase voltage based on phase-A voltage Refer to "Vector" menu
Power	Forward Active Power	0.000 ~ 999.99 [MW]	± 2.5 %	+P
	Reverse Active Power	0.000 ~ 999.99 [MW]	± 2.5 %	-P
	Forward Reactive Power	0.000 ~ 999.99 [MVar]	± 2.5 %	+Q, Inductive load (L-Load)
	Reverse Reactive Power	0.000 ~ 999.99 [MVar]	± 2.5 %	-Q, Capacitive load (C-Load)
	Forward Active Energy	0.000 ~ 9999.99 [MWh]	± 2.5 %	+Ep
	Reverse Active Energy	0.000 ~ 9999.99 [MWh]	± 2.5 %	-Ep
	Forward Reactive Energy	0.000 ~ 9999.99 [MVarh]	± 2.5 %	+Eq
	Reverse Reactive Energy	0.000 ~ 9999.99 [MVarh]	± 2.5 %	-Eq
	Power Factor	-1.00 ~ 1.00 [F/R]	± 2.5 %	+: LEAD, - : LAG F: Forward direction, R: Reverse direction
	Frequency	45.000 ~ 65.000 [Hz]	± 0.005 Hz	Frequency for A phase

※ 1) As for delta wiring, voltage approved for PT is marked in line voltage.

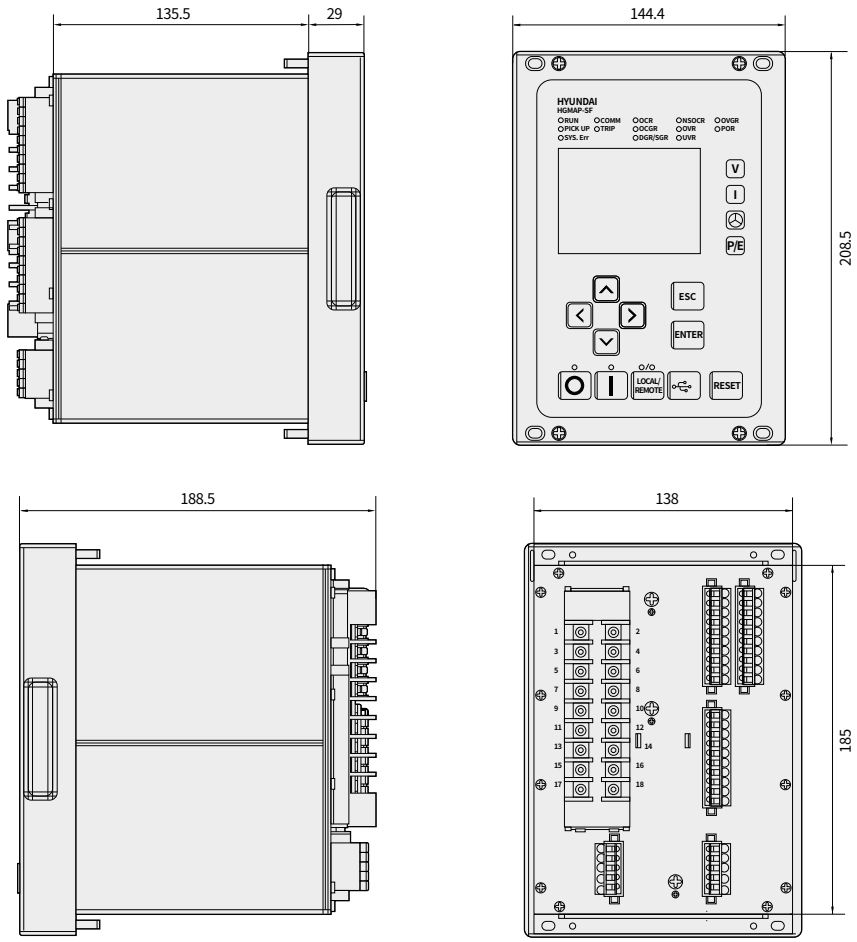
Monitoring Functions

Item	Classification	Parameters	Description
CB Failure (CBF)	Time Delay	100 ~ 200 msec	Measures time after breaker control (on/off) to receiving breaker status input signal, operating when the duration is greater than the preset parameters.
	Output Method	User Set LED, DO	
PT Fuse Failure (PTF)	Time Delay	100 ~ 200 msec	Feature for checking a PT circuit fuse short, operated when the three phase current is greater than 10% and less than 100% of rated current and voltage is 0.
	Output Method	User Set LED, DO	
Power Fail	Operating Voltage	Control Power below 75 Vdc	A system error occurs when external power voltage is less than default voltage, limiting protective relay and DO output from the unit.
	Recovery Voltage	Control Power above 80 Vdc	
	Output Method	Sys.Err LED Flash, User Set LED, DO	
Counter	Trip Counter	0 ~ 65,535 Events	Cumulative counter of CB open and DO close events.
	DO Counter	0 ~ 65,535 Events	Cumulative counter for DO1 to DO8 close events.
	CB On Time	0 ~ 4,294,697,295 hrs	Cumulative time after CB ON
	Sys. Run Time	0 ~ 4,294,697,295 hrs	Cumulative normal system run time

Dimensions

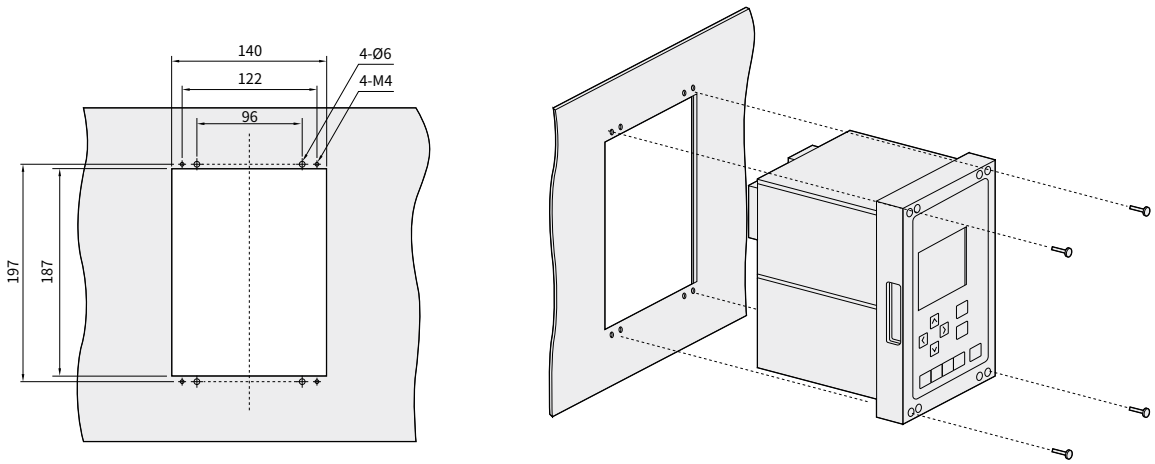
External Dimensions

Unit : mm



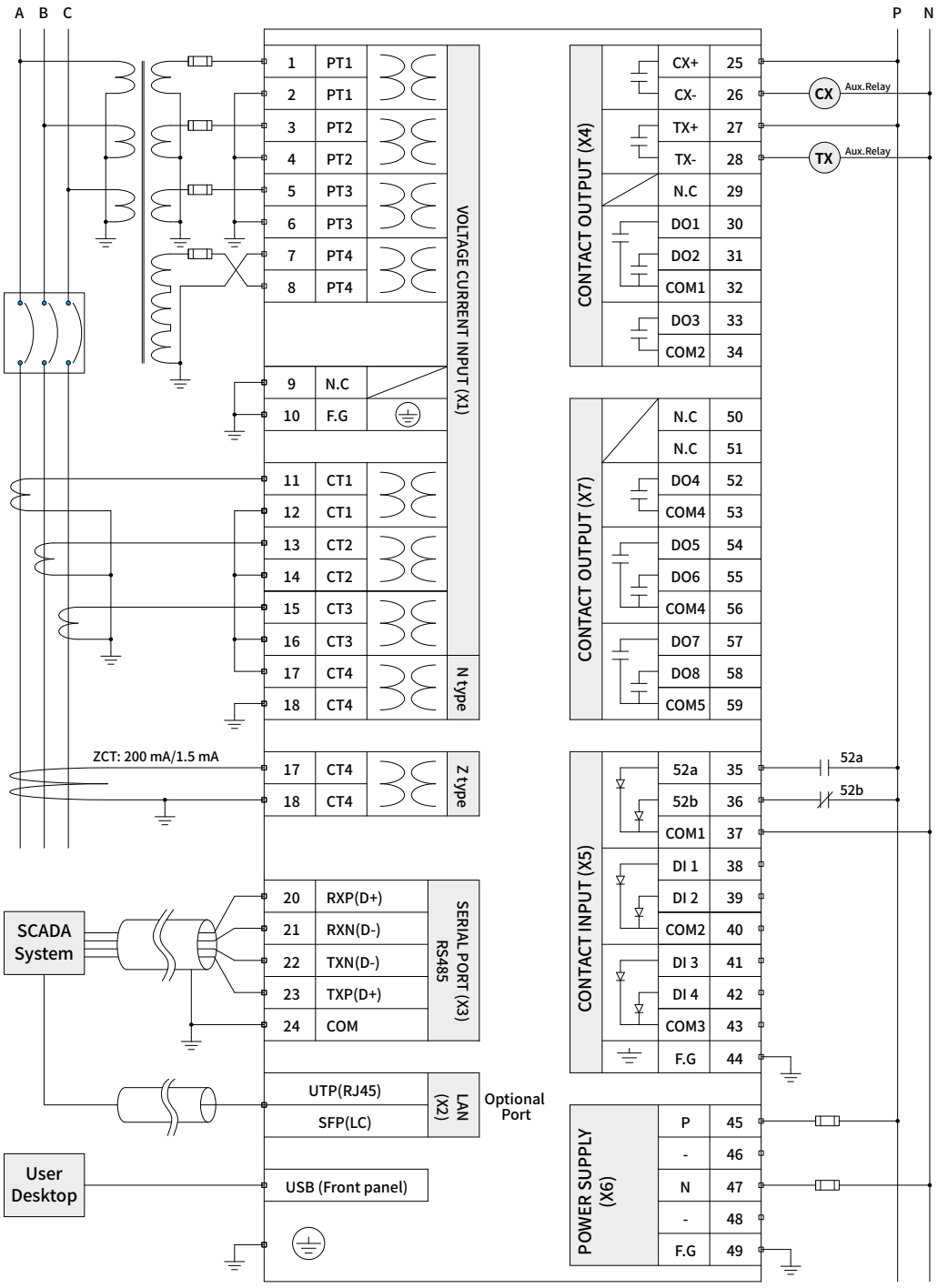
Panel Cutout Dimensions and Installation

Unit : mm



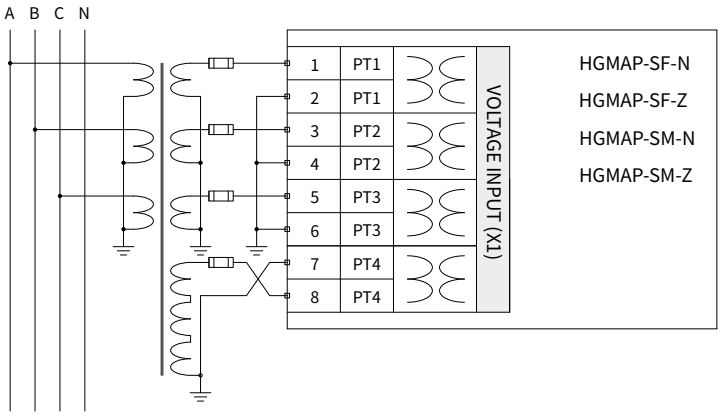
Wiring Diagram

Three Phase Wiring

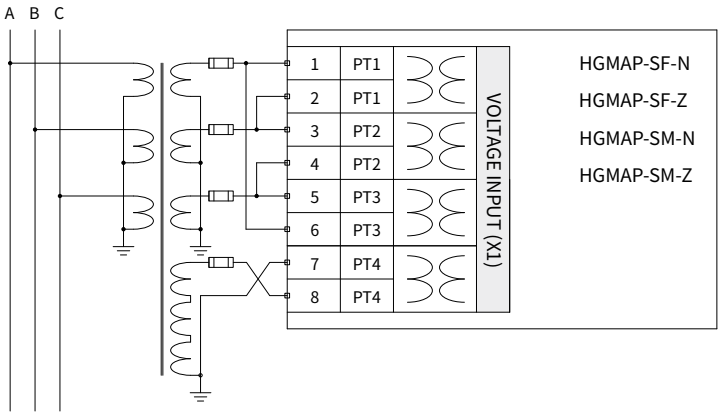


PT Wiring

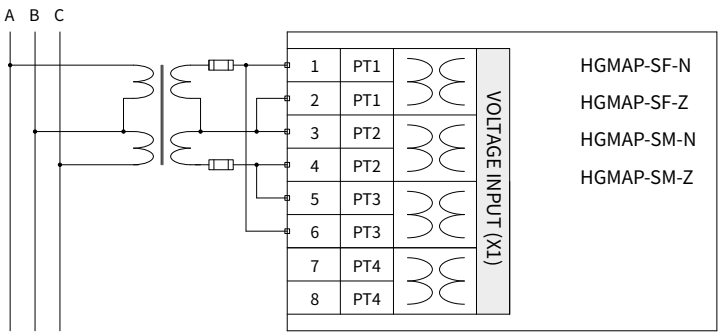
3P4W Wiring



3P3W 3PT Wiring

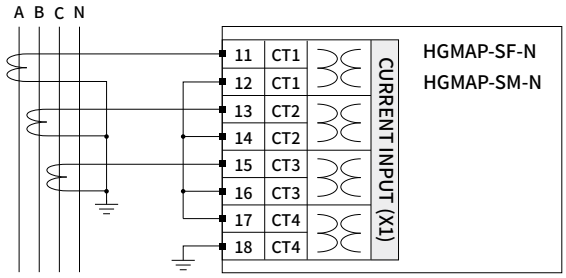


3P3W 2PT Wiring

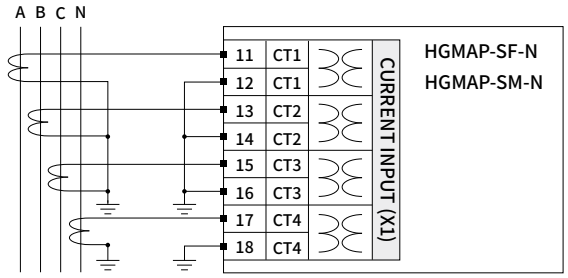


CT Wiring

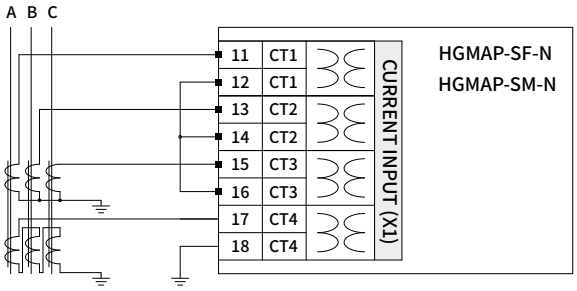
3P4W Residual Circuit Wiring



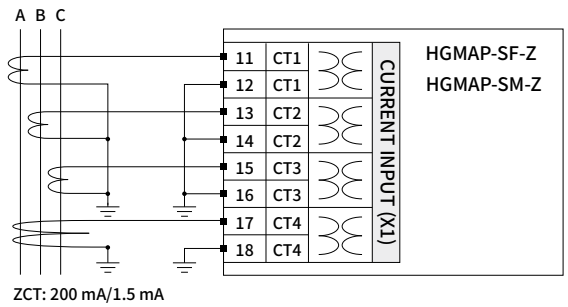
3P4W NCT Wiring



3P3W Tertiary Coil CT Wiring



3P3W ZCT Wiring



Order Code

Order Process

MAP	S	F	N	V	C1
Product Type	Model	Protection Purpose	Current Transformer Type	Mounting Type	Communication Options

MAP	HGMAP Digital Protection Relay	S	Standard Type	F	Feeder / Incoming	N	NCT
				M	Motor	Z	ZCT

V	Vertical Type	C1	MODBUS/RTU, RS485

※ NCT : OCFR, DFR Transformer [Grounded System]
ZCT : SGR Transformer [Ungrounded System]
Standard Type : Applied to mid- and low-voltage systems and power distribution for buildings and industries

D1	F6	A1	A5	NO
Control Power	Frequency	PT Secondary Rating	CT Secondary Rating	Optional Modules
D1 DC 110V	**F6** 60Hz	**A1** AC 110V	**A5** AC 5A	**NO** No Option