

MH EF 18D / EF 18D-Pro USER MANUAL

Digital Earth Fault Relay



Document Code: MH-R-EF-18D-UM-B
Revision: B
Date: Sep 2026

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2 Introduction

The MH EF 18D / EF 18D-Pro are Digital Earth Fault Relay for panel mounting. It provides ANSI 51N earth-fault protection with microprocessor-controlled definite-time operation. The relay incorporates an adjustable earth-fault pickup setting, adjustable trip delay, backlit LCD, trip indication, event and operation records, and Modbus-RTU communication over RS485. It also differentiates between an actual protection trip and a test trip and incorporates a Mechanical Trip Button (MTB) associated with ANSI 86 fault indication.

*The enhanced version (**pro series**) is designed and tested for harsh and demanding environments such as marine use, offshores platform, waste water treatment plants, and chemical plants. It is also designed for use in critical facilities such as data centers, semiconductor plants, military installations, hospitals and airport.

This manual provides operating information for installation, front-panel operation, parameter setting, event record review, communication overview and commissioning reference. It is intended to support panel builders, testing engineers, maintenance personnel and system integrators using the EF 18D / EF 18D-Pro relay.

Key Features

Feature	User meaning
Earth fault protection	ANSI 51N earth-fault protection with adjustable pickup range
Definite-time operation	Microprocessor-controlled definite-time delay operation with adjustable trip delay
Local display	Backlit LCD for local viewing of relay information, settings, with red LED for trip indication.
Records	Twenty (20) trip-event records and forty (40) operation logs with date and time information.
Trip identification	Differentiates between actual protection trip and a test trip
Mechanical indication	Mechanical Trip Button provides mechanical fault indication with ANSI 86 functionality
Communication	Modbus-RTU RS485 for supervisory monitoring
Diagnostics	Self-health feature
Physical format	Compact panel-mount construction with a sealable tamper-proof front cover.

2.1 Terms and Abbreviations

Term	Meaning
ANSI 51N	Time-delayed earth-fault overcurrent protection function.
CT	Current transformer. The project-specific CT arrangement shall follow approved design documents.
DTL	Definite-time lag; the configured delay runs after the pickup condition is reached.
LCD	Liquid crystal display.
MTB	Mechanical Trip Button.
N/O	Normally open contact.
PIN	Three-digit numeric password capability.
VAC/DC	Alternating-current or direct-current supply voltage.
RH	Relative humidity.
RTC	Real-time clock used for date and time stamping of records.
RS485	A serial communication interface used for multi-device Modbus networks.
Modbus RTU	A communication protocol used by a computer, BMS, EMS or SCADA system to exchange data with the relay.
Modbus register	A defined data location used to read or write relay information.

3 Technical Data

3.1 Technical Specification

Item	Specification
Protection function	ANSI 51N
Operating characteristic	Definite time
Earth-fault setting	2.0% to 50.0%, adjustable in 0.1% steps
Delay-time setting	0.10 s to 2.00 s, adjustable in 0.01 s steps
Auxiliary supply	85–265 VAC/DC; other voltage available upon request
Power consumption	Below 3.5 VA
Output contacts	Two Normally Open (NO), rated 250 VAC, 2 A
Display	Back lit LCD with setting & delay time value, instantaneous fault current % value, communication status, date & time stamping
LED indication	Red LED for trip indication
Trip event recording	20 trip-event records with fault-current percentage, date and time stamps
Operation logs	40 operation logs with date and time stamps
Communication	Modbus-RTU over RS485
Password access	User-configurable three-digit numeric PIN
Housing material	ABS resin complying with UL94 V-0
Front protection class	IP 31 (front)
Transport and storage temperature	-10 °C to +70 °C
Operating temperature	0°C to 60°C
Operating humidity	Below 95% RH, non-condensing
Overall dimensions	59 mm (W) × 88 mm (H) × 113 mm (D)
Approximate weight	185 g

3.2 Standards and Compliance

Category	Standard / Reference
Mechanical fault indication	ANSI 86 Lockout Relay
Product safety	IEC 60255-27
Vibration, shock and bump	IEC 60255-21-1; IEC 60255-21-2
Climatic environmental tests	IEC 60068-2-2, -2-30, -2-78, referenced with IEC 60255-1
Electromagnetic compatibility	CISPR 11/22; IEC 61000-4-2, -3, -4, -5, -6, -8 and -11, referenced with IEC 60255-26
Marking	CE marking

* The EF 18D-Pro (**pro series**) features an upgraded circuit and material design, including full conformal PCB coating for enhanced environmental protection, and is tested against extreme cold at -25°C, as well as damp heat steady-state test of up to 56-day.

3.3 Protection and Operating Settings

Parameter	Unit / Format	Setting Range	Description
Pickup current setting (I_{F1})	%	2.0 ~ 50.0	Sets the maximum allowable leakage current threshold.
Time delay setting (t_{DL})	s	0.00 - 2.00 (0.01 s step)	Definite time delay before the trip output operates after fault current exceeds the trip setting.
System frequency (F_{rE})	Hz	50 / 60	Select according to the system frequency.
Backlight timeout (t_{F1})	s	0 - 999 (0 = no timer)	Sets the duration of inactivity before the LCD backlight automatically turns off to conserve power.
Input current fine tuning setting (F_{id1})	%	90 ~ 110	Calibrates the input current reading
Password (P_{F5})	NA	000 - 999	Password for relay configuration
Clear trip record command (c_{LE})	NA	0 - 1 (1 = reset)	Command / parameter used to reset trip status through supported control method.
Record clear command (c_{LE})	NA	0 - 1 (1 = clear)	Clears stored event history when required. Use only after records have been reviewed or backed up.
RS485 address (F_{id1})	NA	1 - 255	Modbus slave address for supervisory communication.
Baud rate (b_{F1})	kbps	12 / 24 / 48 / 96 / 192 / 384	Data transmission speed for RS485 communication (12 = 1.2kbps, 24 = 2.4kbps, 48 = 4.8kbps, 96 = 9.6kbps, 192 = 19.2kbps, 384 = 38.4kbps)
RS485 data format (F_{rF1})	data format	n82 / o81 / E81 / n81	n82 = 2 bits, no parity o81 = 1 bit, add parity E81 = 1 bit, even parity n81 = 1 bit, no parity
RTC setting (r_{LE})	YY/MM/DD HH:MM:SS	Year / month / date / hour / minute / second	Date and time used for trip events and operation logs.

For definite-time operation, the delay begins after the measured earth-fault current reaches the configured pickup condition. A trip output is issued after the configured delay if the pickup condition remains present.

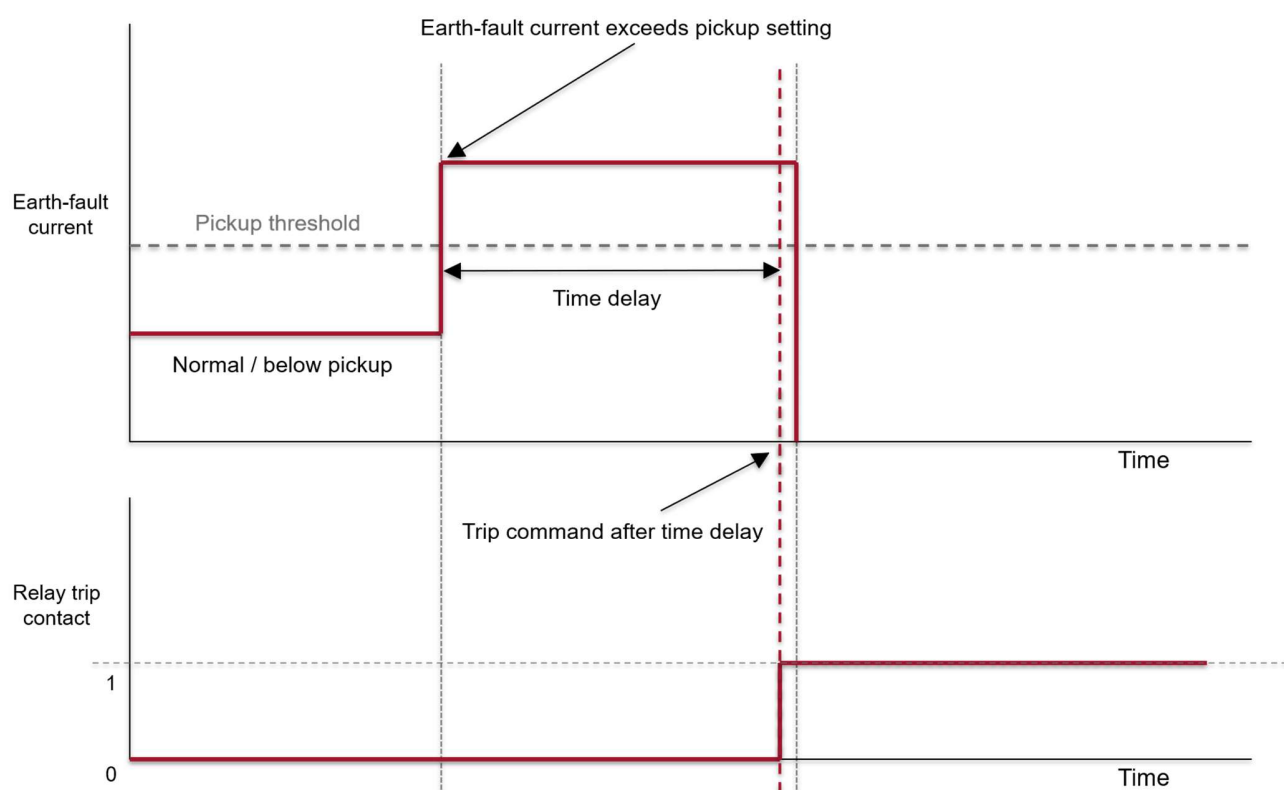


Figure 2 — Definite-time earth-fault operation — conceptual sequence

4 Display and Operation

4.1 Overall Dimensions

The EF 18D / EF 18D-Pro are designed for panel mounting. Use the stated product dimensions when preparing the panel opening. Ensure that sufficient panel space is provided for wiring access, front cover operation and safe termination of auxiliary supply, CT input, RS485 and output contacts.

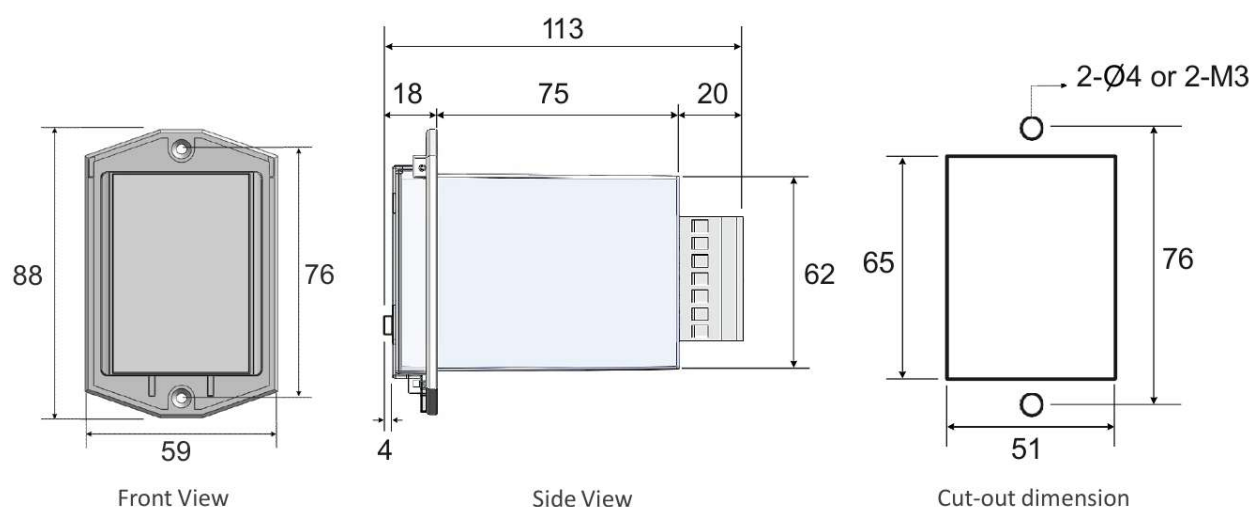
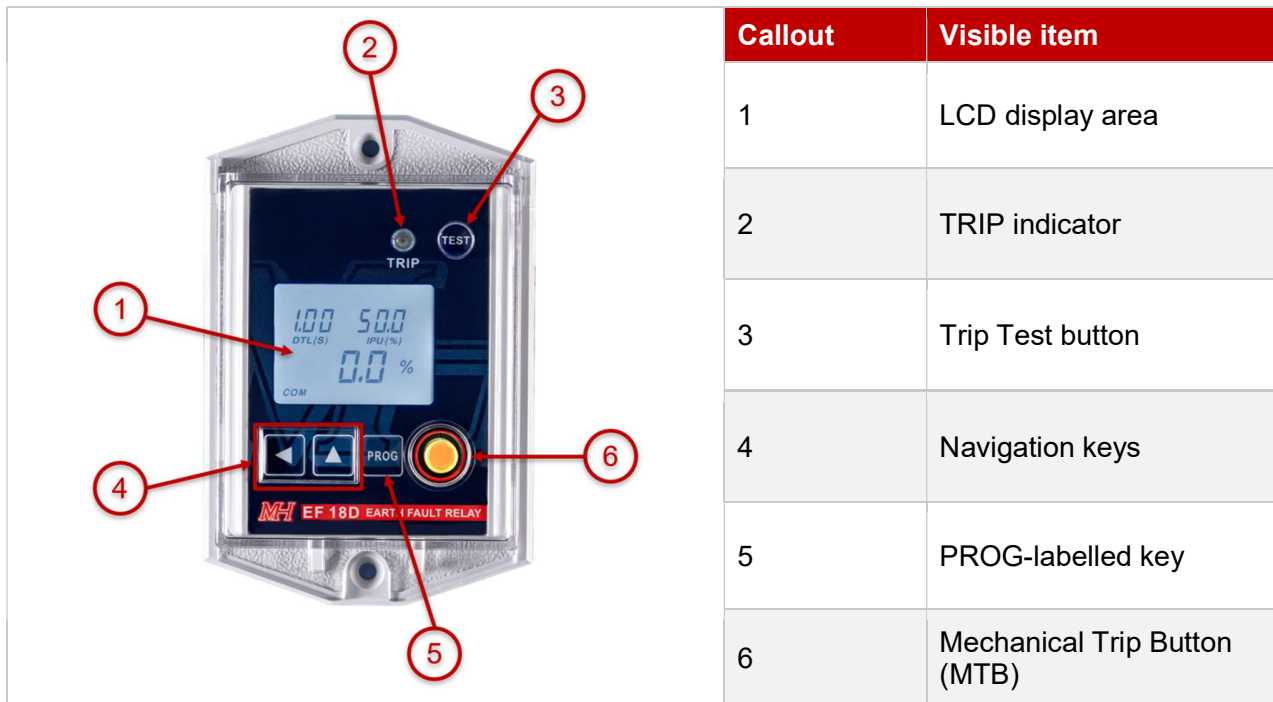


Figure 3 — EF 18D / EF 18D-Pro mechanical views and dimensions

Item	Specification
Overall width	59 mm
Overall height	88 mm
Overall depth	113 mm
Panel cut-out	51 mm × 65 mm
Fixing-hole spacing	76 mm
Approximate weight	185 g
Front protection class	IP 31 (front)

4.2 Front Panel

The front panel provides the LCD display, navigation / programming keys, trip indication, test button and Mechanical Trip Button (MTB). The front panel is used for viewing live monitoring of fault current, checking relay status, entering parameter settings, reviewing event records and performing local test or reset actions.



No.	Item	Function	Description
1	LCD display	Display	Shows set value, delay time, real-time fault current, parameter pages, event records, RTC information and status indication.
2	TRIP indicator	Status	On: relay trip.
3	Navigation / programming keys  	Operation	Used to change pages, enter setting mode, adjust values, confirm settings and exit parameter pages.
4	PROG button 	Parameter adjustment	To access and adjust device parameter

No.	Item	Function	Description
5	Trip Test button 	Trip test	Used to initiate relay test / test trip operation. Typical sequence: press once, then press and hold for 5 seconds to energize trip and turn trip LED on.
6	Mechanical trip button (MTB) 	Trip indicator / Reset	Trip indicator and manual reset button once the fault condition is cleared.
7	Front cover	Protect device screen	Sealable transparent cover to protect and prevent unnecessary contact with buttons

4.3 Rear View and Mounting Identification

The rear photograph shows physical enclosure and terminal-block arrangement. Terminal functions, polarity and wiring shall follow the EF 18D / EF 18D-Pro connection documentation and advice from technical team.

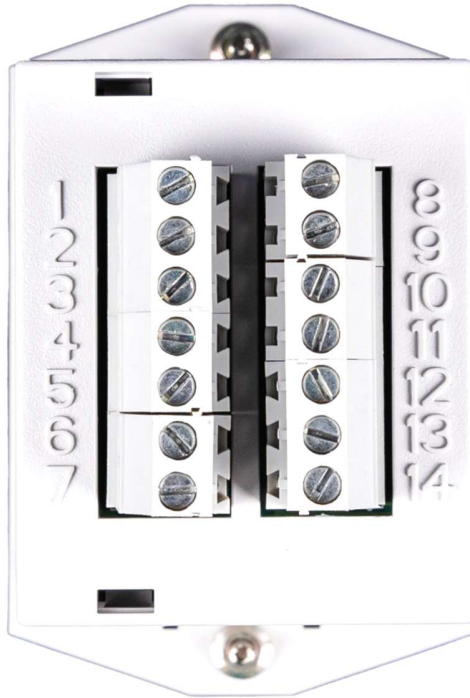


Figure 4 — EF 18D / EF 18D-Pro rear appearance — physical arrangement only

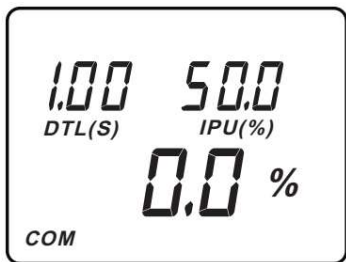
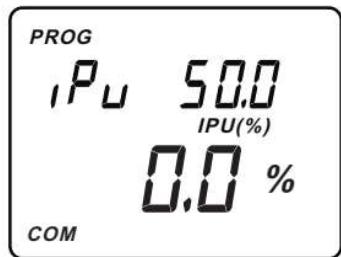
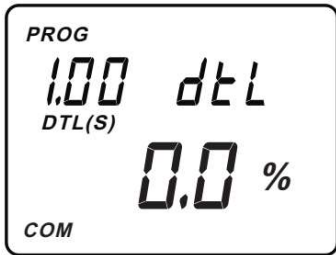
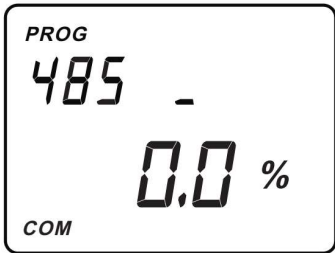
The side identification label states the auxiliary-supply range.

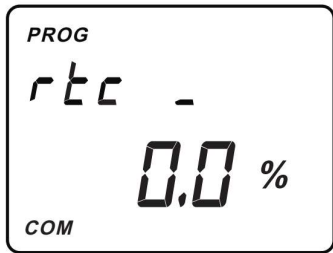
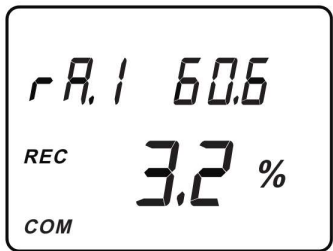


Figure 5 — EF 18D / EF 18D-Pro side identification label

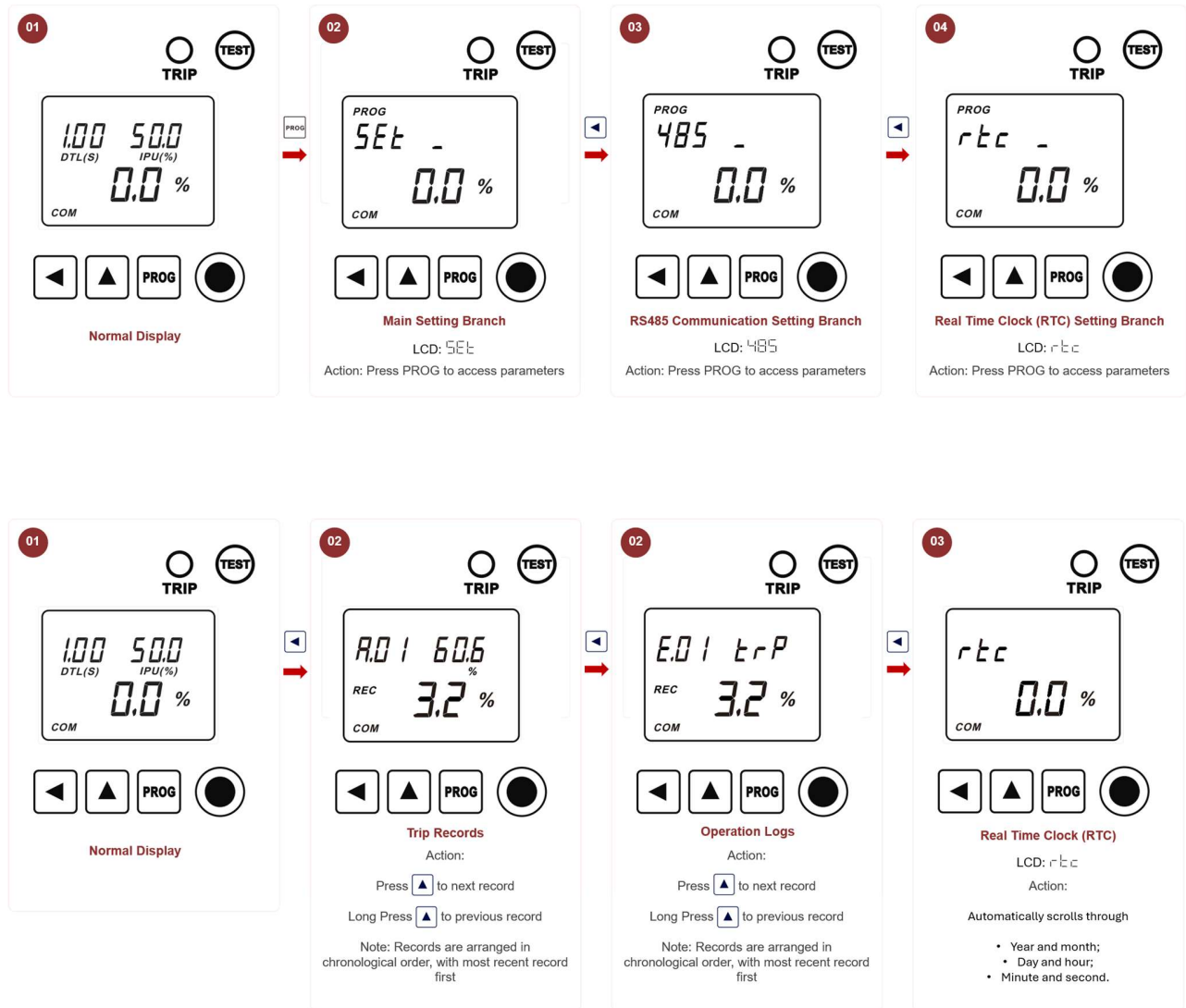
4.4 Display Pages and Menu Navigation

The relay display pages allow the user to view present status, check configured values and access event-related information. The exact displayed abbreviation may vary by firmware version, but the operating purpose of each page is generally as follows.

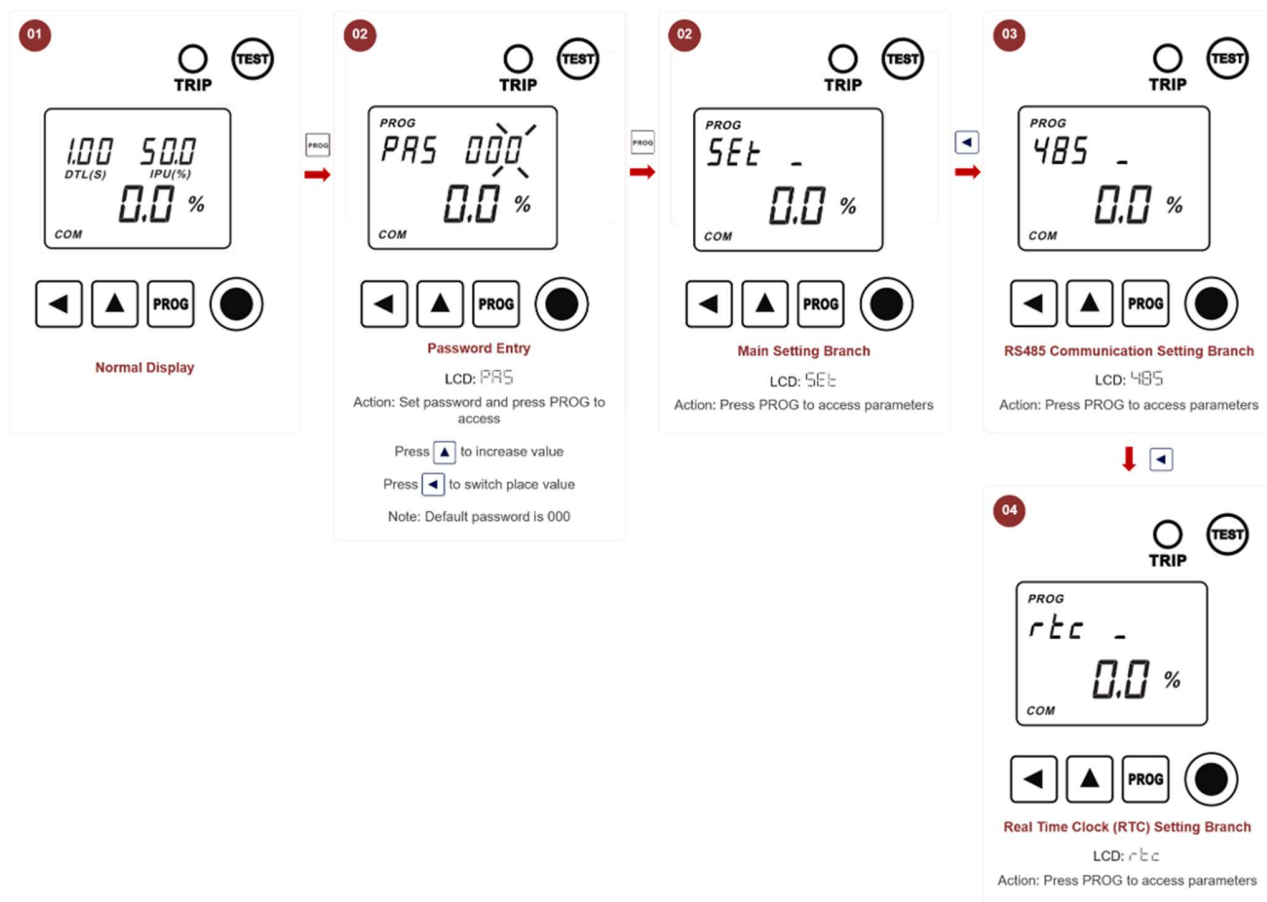
Display Page	Purpose
Main page display 	Displays the real-time measured earth fault current (in percentage) alongside protection settings (IPU) and DTL time delay) and communication status (COM).
Pickup current setting page 	Displays the configured earth fault pickup current threshold (IPU). Used to verify or adjust protection parameters.
Definite time delay (DTL) setting page 	Displays the configured definite time delay (in seconds) required for the relay to trip after a fault is detected.
Communication setting page 	Displays the RS-485 slave address and baud rate configuration settings for Modbus communication.

Display Page	Purpose
Real-time clock (RTC) setting page 	Displays and configures the date and time to ensure accurate time-stamping for event and fault records.
Trip records page 	Displays stored trip event logs, including fault current magnitude (in percentage), event index, and corresponding date/time stamp.
Operation logs page 	Displays logged system events and operational history, including trips, resets, test operations, and setting changes.

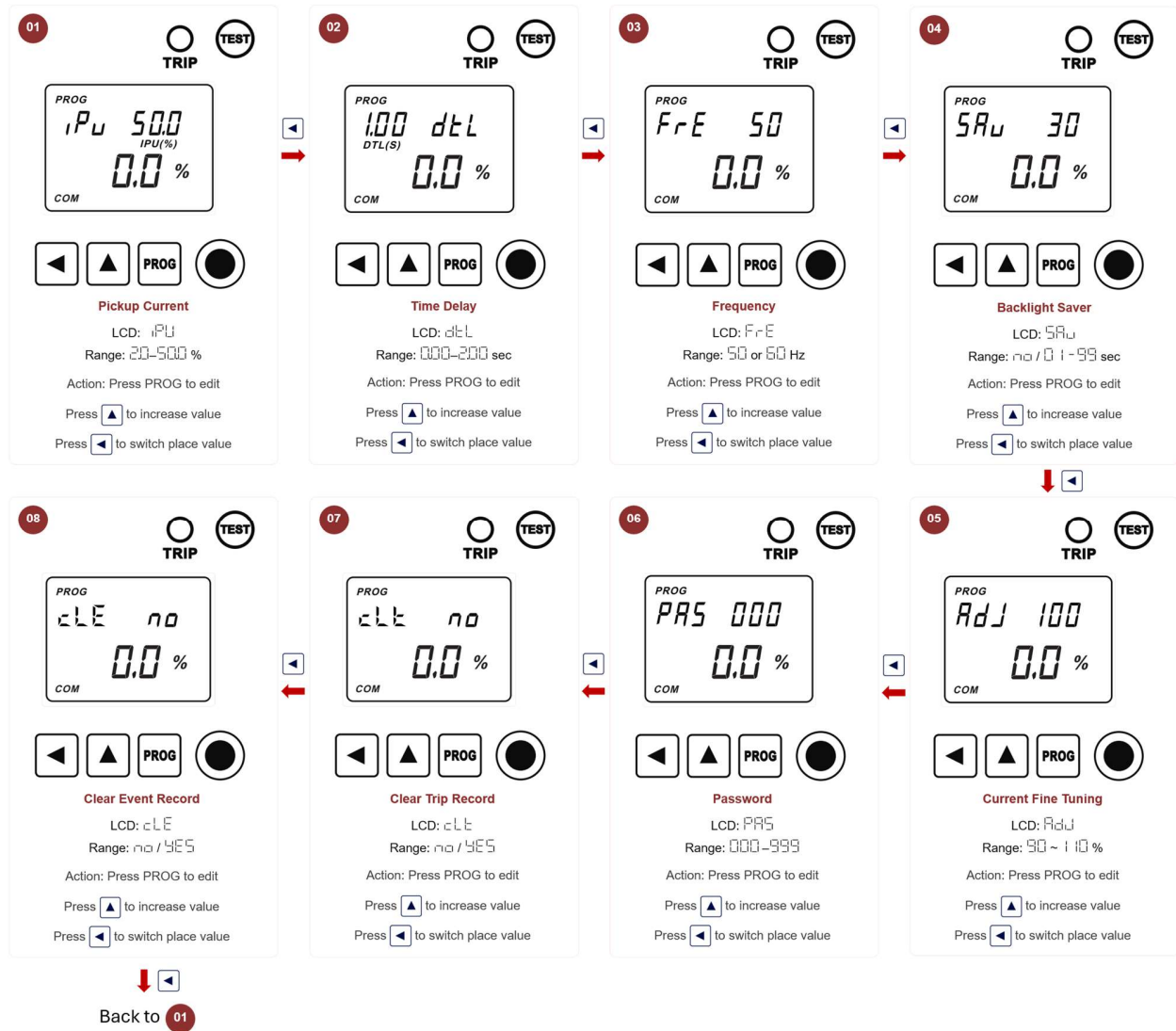
Quick Navigation Overview



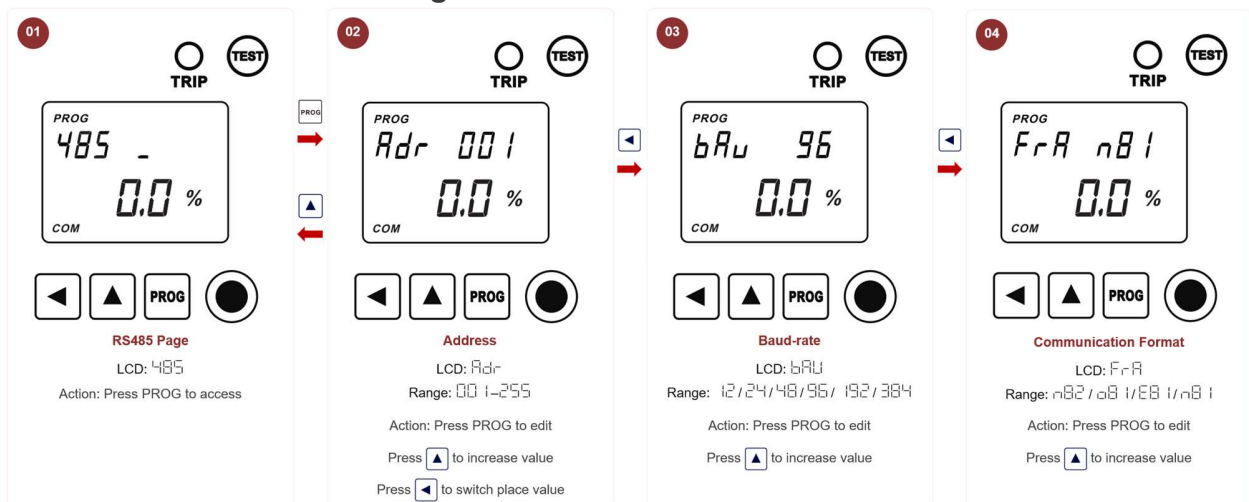
With password:



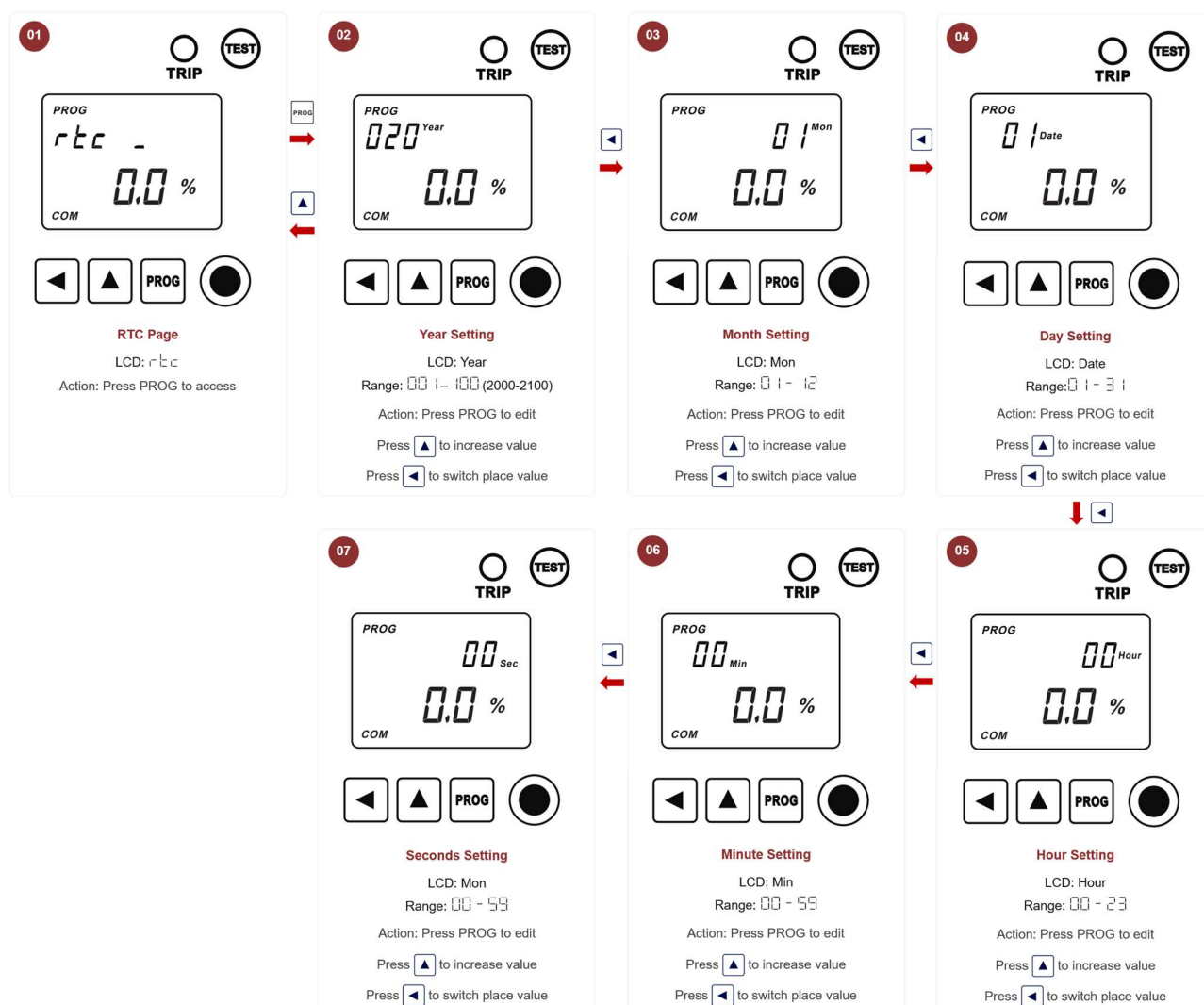
Main Setting Branch Menu



RS485 Communication Setting Branch Menu



Real Time Clock (RTC) Setting Branch Menu



General Navigation Method

1. From the normal display page, use the navigation keys to move between viewing pages.
2. Enter the setting page using the programming / confirm key as required by the parameter page.
3. Use the navigation keys to select the parameter or adjust the displayed value.
4. Confirm the setting after the value has been reviewed.
5. Exit the setting page and verify that the displayed setting matches the intended commissioning value.

5 Event Records and Operation Logs

The EF 18D / EF 18D-Pro stores trip events and operation logs to support maintenance, troubleshooting and commissioning review. Records should be checked after a trip, pre-alarm, test operation or suspected wiring / communication abnormality.

Record Type	Capacity	Typical Information Stored
Trip event records	20 records	Trip current value, event type and date/time stamp. Used for fault review and investigation.
Operation logs	40 records	Operation events such as reset, test, setting change, RS485 related activity and internal diagnostic events.

5.1 Event Categories

Code / Display	Meaning	Typical Use / Description
trP	Trip event	Relay tripped because fault current exceeded the pickup setting (IPU) for longer than the configured time delay (DTL).
oc	Over pick-up event	Measured current exceeded the configured pickup threshold (IPU).
nor	Fault cleared / Normalization event	Measured current dropped below the pickup threshold, returning the relay to normal operating state.
rSt	Manual reset event	Relay reset via the MTB button.
rS4	RS485 reset event	Relay reset command issued remotely via RS-485 / Modbus communication.
tSt	Test event	Relay trip test operation performed.
clt	Clear trip event records	Trip event records cleared.
cle	Clear operation logs	Operation logs cleared.
cl4	Clear trip event records through RS485	Trip event records cleared through RS485 / Modbus.
FF I	Fatal error - setting value error	Internal severe error relating to setting value. The relay must be sent to the manufacturer for inspection.

Code / Display	Meaning	Typical Use / Description
FF2	Fatal error - calibration value error	Internal severe error relating to calibration value. The relay must be sent to the manufacturer for inspection.
FF3	Fatal error - setting and calibration value error	Internal severe error relating to setting and calibration values. The relay must be sent to the manufacturer for inspection.
EE1	Non-critical error - Trip records checksum error	EEPROM data corruption or checksum mismatch in trip records. Protection remains operational.
EE2	Non-critical error - Operation logs checksum error	EEPROM data corruption or checksum mismatch in operational logs. Protection remains operational.
EE3	Non-critical error - MCU error / auto-reboot	MCU fault or unexpected reset event. The relay successfully recovered and rebooted automatically.
EE4	Non-critical error - RTC error event	Real-time clock error event.
EE5	Non-critical error – abnormal trip event	Unexpected trip detected during operation without an active fault condition present.
EE6	Non-critical error – power on tripped event	Mechanical Trip Button (MTB) was already in the tripped position when auxiliary power was energized.

5.2 Clearing Records

Clearing trip event records and operation logs is not recommended. Retaining this history is critical for diagnosing intermittent faults, recurring trips, unauthorized parameter changes, and wiring anomalies.

5.3 Event Record Use Cases

- Investigating repeated fault current trips on the same feeder.
- Confirming whether a trip was caused by test operation or actual fault condition.
- Reviewing whether parameters were changed after commissioning.
- Providing evidence for maintenance reports and handover documentation.

6 Modbus and Register Overview

The EF 18D / EF 18D-Pro supports Modbus-RTU communication over RS485 for monitoring and integration into supervisory systems. The communication section in this manual provides operating guidance only. The detailed Modbus address list should be confirmed using the official EF 18D / EF 18D-Pro register document or verified through project communication testing.

Please refer to EF 18D/ EF 18D-Pro Modbus address list for full details of communication registers

6.1 Modbus Transmission Parameters

Category	Value / Guidance
Interface	RS485
Protocol	Modbus-RTU
Device address	001 - 255
Baud rate	1.2 / 2.4 / 4.8 / 9.6 / 19.2 / 38.4 kbps
Function code field	03, 04, 06
Parity bit	No parity, odd parity, even parity
Stop bits	1, 2
Recommended cable type	Shielded twisted pair where practical

6.2 Typical Register Groups

Register Group	Typical Contents	Application
Measurement values	Real-time measured earth fault current and related display values	Used for live remote monitoring, data logging and trend analysis.
Relay status	Trip status and reset status	Integrated into BMS/SCADA system for real-time alarm aggregation and status monitoring.
Setting values	Pickup threshold (IPU), time delay (DTL), communication parameters	Used for remote parameter configuration, setpoint verification, and system setup.
Event records	Trip event records and operation logs information	Used for maintenance review and fault tracing.
RTC values	Date and time information	Used to align event time stamps.

6.3 Integration Notes

- Use one unique address for each relay on the same RS485 network.
- Match baud rate, parity and stop bit configuration between the relay and Modbus master.
- Confirm RS485 polarity A+ / B- during commissioning.
- Use shielded twisted pair cable where practical, especially for longer communication runs.
- Confirm register function codes and addresses against the approved Modbus address list before writing to any parameter.
- For BMS integration, agree the required points list before commissioning.

7 Connection Diagram and Installation Notes

This section summarises the connection arrangement for EF 18D / EF 18D-Pro relay. Final wiring shall follow the terminal diagram supplied with the relay and the approved panel schematic.

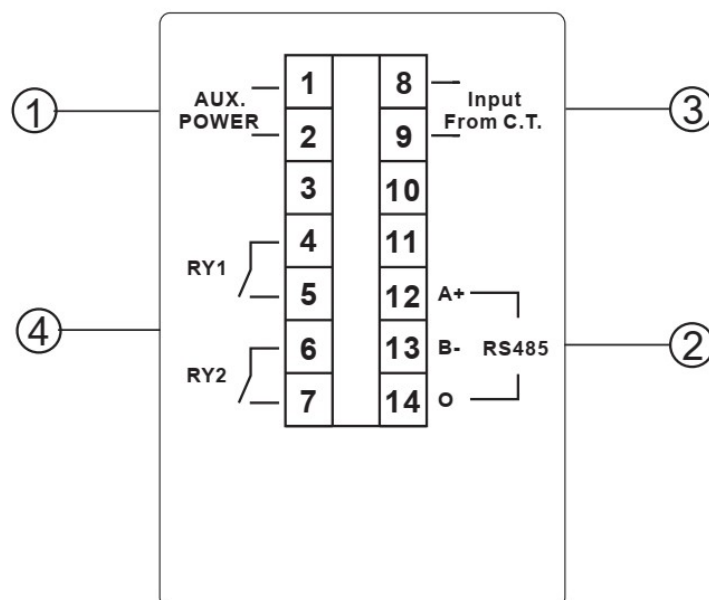


Figure 6. EF18D terminal arrangement

7.1 Typical Wiring Functions

Terminal	Notes
Terminals 1 - 2	Auxiliary power supply
Terminals 4 – 5, 6 - 7	Potential free relay output contact, NO (normally open)
Terminals 8 - 9	Current input
Terminals 12 - 14	Modbus RTU over RS485. A+, B- and reference/common terminal according to the communication wiring requirement.

8 Commissioning and Troubleshooting

The following checklist is intended to support practical site checks. It does not replace the approved commissioning procedure, test plan or project-specific requirements.

8.1 Pre-Energization Checks

- Confirm relay model and auxiliary power supply type before wiring terminals 1 - 2.
- Confirm auxiliary power supply voltage is within the range.
- Confirm CT wiring is connected to terminals 8 - 9.
- Confirm trip output wiring to shunt trip / UV release / indication circuit is correct.
- Confirm RS485 wiring polarity and shield arrangement where communication is used.
- Confirm all terminals are tightened and labelled.

8.2 Commissioning Checks

Check	Description
Power-on check	Energize auxiliary supply and verify LCD display and status indication.
RTC check	Set and verify date and time before performing event or trip testing.
Setting check	Confirm pickup threshold (IPU), delay time (DTL), and communication settings.
MTB check	Perform manual trip test only when connected circuits are safe to operate.
Trip output check	Verify trip output contact operation and connected circuit response.
RS 485 check	(If RS 485 is connected) Verify address, baud rate, parity / stop bits and successful communication polling.
Event record check	Confirm test and trip events are correctly recorded with accurate date/time stamp.

8.3 Typical Troubleshooting Guide

Symptom	Possible Cause	Recommended Check
Relay does not power on	Auxiliary supply absent or incorrect; loose terminal; wiring error	Verify terminals 1 - 2 supply voltage and terminal tightness.
Unexpected trip during operation	Actual fault current, wiring error, trip setting too low for load fault	Check fault level, conductor routing through CT and event record.

RS485 communication failed	Incorrect address, baud rate, serial format, wiring polarity or network issue	Check A+ / B- wiring, address and Modbus master settings.
Event time incorrect	RTC not set or time lost	Set RTC and confirm date/time before commissioning handover.

8.4 Maintenance Recommendations

- Periodically verify relay display status and event logs.
- Review recurring trip event records and investigate root causes.
- Verify relay settings against the approved setting record after maintenance works.
- Inspect wiring terminal connections for tightness during scheduled switchboard maintenance.
- Verify RS485 communication status where remote monitoring is deployed.
- Do not clear trip event records and operation logs before saving information required for maintenance or incident analysis.

9 Disclaimer

9.1 Safe Operation

Reviewing the information provided for the device is essential for safe operation and achieving the specified performance and features. The EF 18D / EF 18D-Pro shall be installed, wired, tested and operated only by competent personnel familiar with the applicable electrical safety requirements.

9.2 Copyright Notice

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9.3 Technical Changes

- Please ensure that the device is installed in accordance with the installation manual and approved project wiring diagram.
- Please carefully read and understand the documents provided with the product before use.
- Keep these documents accessible for the entire service life of the product and pass them on to any future users, if applicable.
- Technical data and functions may be subject to change according to relay version, firmware or product revision.

9.4 Comments on the Manual

We appreciate your feedback. If you find anything in this manual unclear, please let us know by emailing us at:

munheansing@munhean.com.sg