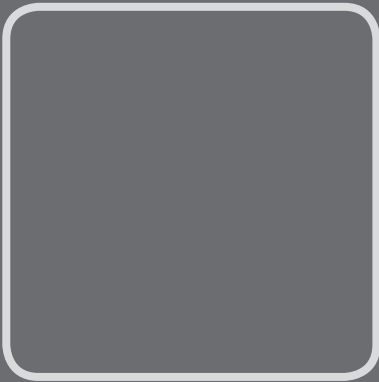


**Mikro**<sup>®</sup>



# X10

EARTH LEAKAGE  
RELAY

USER MANUAL



# PREFACE

## **Before You Start**

Please read this manual thoroughly before installation, operation and maintenance of the device.

## **Disclaimer**

Mikro shall not be liable for errors contained herein including any incidental and/or consequential damages arising from the use of this material. Mikro also reserves the right to vary the product from that described in this material without prior notice.

## **Precautions**

Please observe the following safety precautions before and during the installation of the device:

Only competent and trained personnel should install, operate, service and maintain this device.

Disconnect ALL power sources to the device before performing installation, inspection, tests and maintenance.

Do not perform megger, hi-pot or any high voltage stress test with the device connected to the system.

Install in a suitable enclosure where device connections are inaccessible with sufficient clearance from other live parts.

Please note that incorrect installation may impair the operation or even damage the device. There is no user servicable part in the device. Tampering with it may damage the device, result in injury and also voiding any warranty.

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# 1. Introduction

## 1.1 Introduction



The goal of this manual is to provide information necessary to install, operate and maintain the X10 earth leakage relay.

For earth leakage protection, the device must be connected to a suitable zero phase current transformer or sensor. The sensor is used to measure the vectorial sum of the current passing through it. This current is called earth leakage current. When the leakage current exceeds the pre-set sensitivity threshold, the device will activate the trip contact and update the fault record.

For correct application, the device must operate together with Mikrotech's series of zero phase current transformers.

The device has one programmable trip contact (RL1) dedicated for trip function, one programmable contact (RL2) and one IRF contact (RL3).

The device also has one configurable logic input port. Its main functions are for external reset of alarm, synchronising the real-time clock and selecting protection group.

Using the front panel keys, the user can navigate through the user-friendly menu, read measurements, device status and change the register settings. All these information is displayed on the 2x16 digit backlit LCD.

The device also incorporates three different types of records: alarm records, event records and fault records.

There is a RS485 port located at the rear terminals. Using the MODBUS-RTU protocol, device registers can be read or modified through the serial communication port.

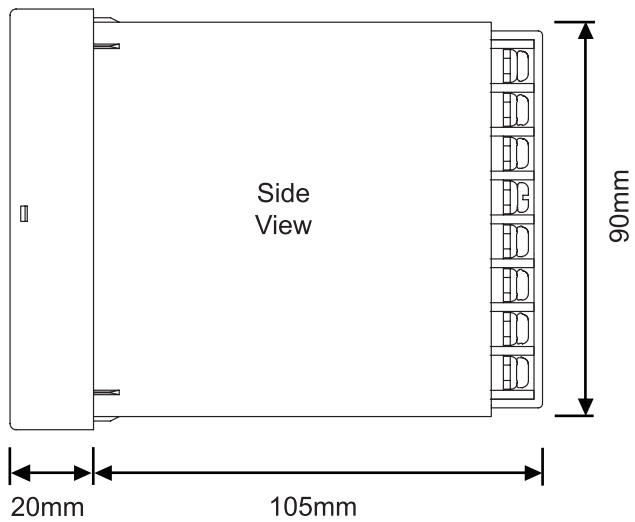
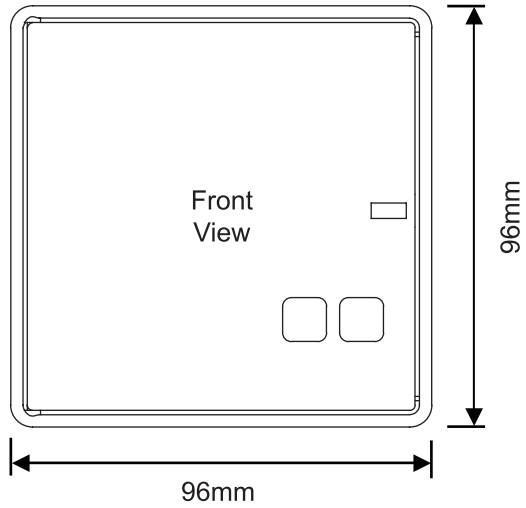
## 1.2 Symbols and Definitions

In this manual and on the device, unless otherwise specified, the following symbols and abbreviations shall apply:-

AC	: Alternating current
Ack	: Acknowledge
ADC	: Analog converter
Addr	: Address
Alrm	: Alarm
Chg	: Change
Chk	: Check
Clr	: Clear
Cmd	: Command
Comm	: Communication
DC	: Direct current
Dly	: Delay
ELR	: Earth Leakage Relay
Err	: Error
Flt	: Fault
Grp	: Group
In1	: Leakage 1
In2	: Leakage 2
Ip	: Input
IRF	: Internal relay fault
LED	: Light emitting diode
Mon	: Monitor
OFL	: Overflow
Pnl	: Panel
Prot	: Protection
Rcrd	: Record
Rem	: Remote
RL	: Relay
Rst	: Reset
RTC	: Real-time clock
Stat	: Status
Tst	: Test
Thres	: Threshold
Wdog	: Watchdog
ZCT	: Zero phase current transformer

### 1.3 Case dimension

The device is designed for front panel flush mounting and has a standard 96mm x 96mm outer dimension.

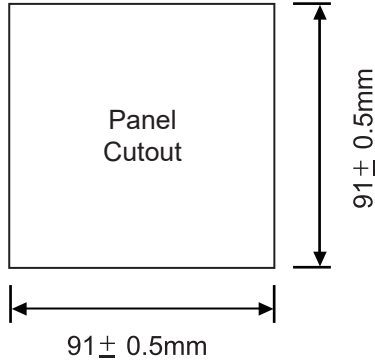




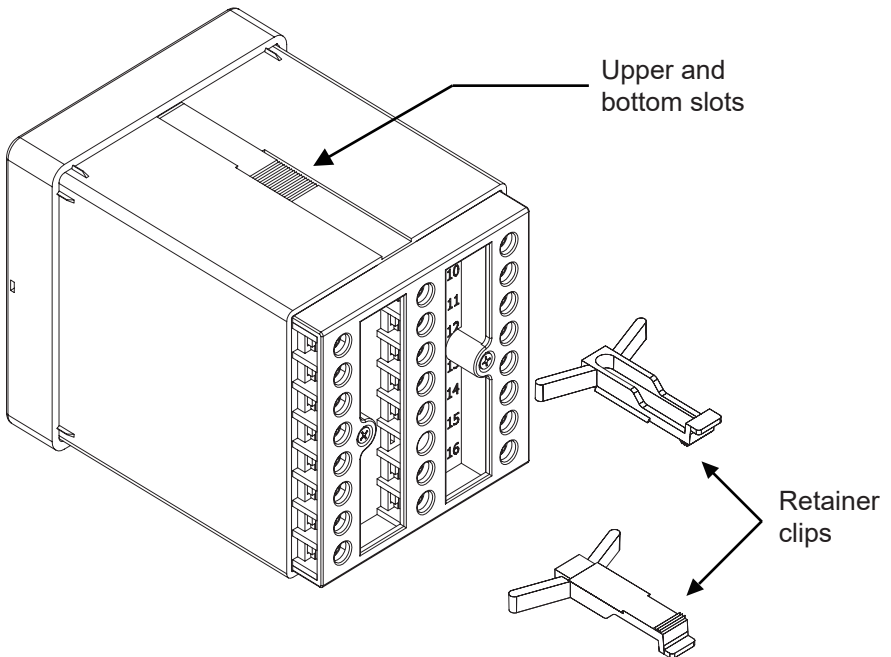
# 2. Installation Guide

## 2.1 Mounting

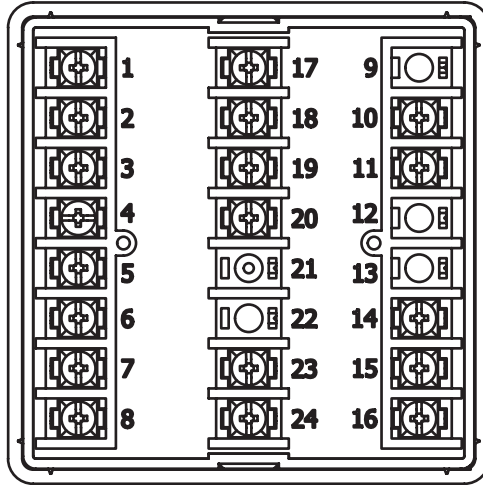
Cut a square hole on the panel. The recommended hole size is 91mm x 91mm. Insert the device through the pre-cut hole.



Slide the retainer clip along the slots on both (top and bottom) sides of the device until the device is tightly secured on the panel. The retainer clips can be removed by lifting the tab lightly at the handle end.



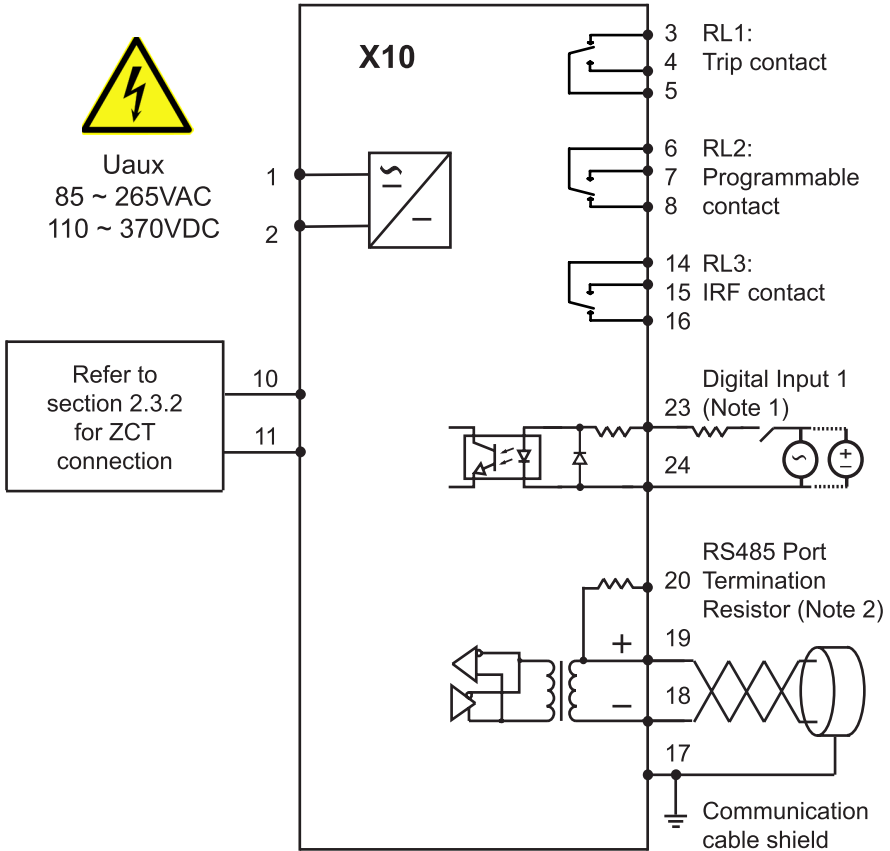
## 2.2 Rear Terminal Description



Terminal	Function Description
1 - 2	Auxiliary supply input
3	Normally closed contact for RL1 Trip contact
4	Normally open contact for RL1
5	Common contact for RL1
6	Common contact for RL2 Programmable contact
7	Normally open contact for RL2
8	Normally closed contact for RL2
9	Not used
10 - 11	ZCT input (no polarity)
12	Not used
13	Not used
14	Common contact for RL3, IRF contact
15	Normally open contact for RL3
16	Normally closed contact for RL3
17	RS485 common terminal
18	RS485 negative terminal
19	RS485 positive terminal
20	Termination resistor for RS485 (by shorting to terminal 18)
21	Reserved
22	Not used
23 - 24	Digital Input (no polarity)

## 2.3 Wiring

### 2.3.1 Overall wiring connection

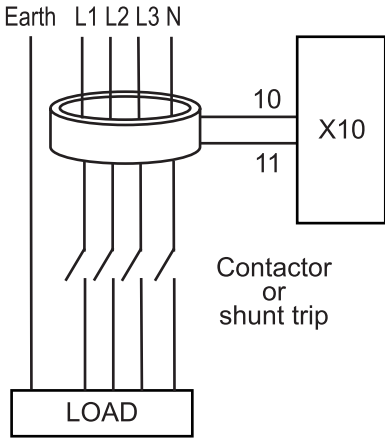


Note 1: External series resistor 18k ohm, 2W is required for input voltage greater than 94Vac or 132Vdc

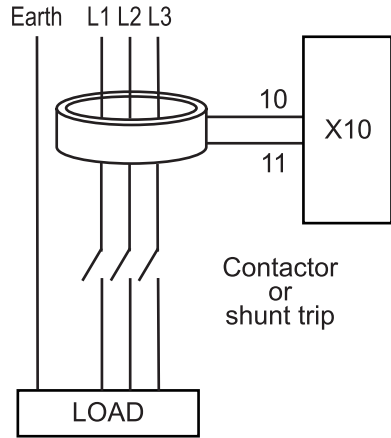
Note 2: Short terminals 18 and 20 for communication data lines termination. Applicable only for devices located at the head and tail ends of the communication lines

### 2.3.2 ZCT Connection

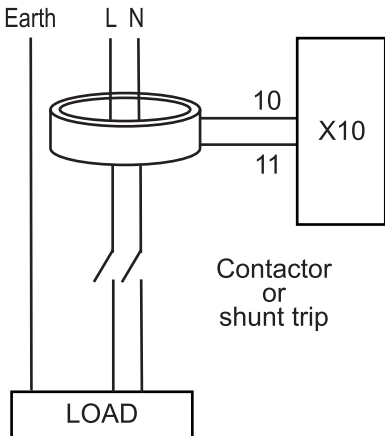
a) 3-Phase 4-Wire System



b) 3-Phase 3-Wire System



c) Single Phase System



#### IMPORTANT NOTE

All applications must comply with the following rules:

1. The device must work together with Mikro's ZCT.
2. The EARTH wire must not pass through the ZCT.

# 3. Front Panel

## 3.1 Description



### Legend

- |   |                       |
|---|-----------------------|
| (A) 2x16-digit LCD with backlight display | (F) "UP" key          |
| (B) Trip LED                              | (G) "DOWN" key        |
| (C) Alarm LED                             | (H) "ENTER" key       |
| (D) Mikro logo and power on indicator     | (J) "CLEAR" key       |
| (E) "ESC" key                             | (K) "TEST/RECORD" key |
|   | (L) Model             |

## 3.2 Keypad

Keypad	Description
ESC	a) To exit from menu and submenu (Note 1) b) To cancel setting value change (Note 3)
UP	a) To scroll up the menu (Note 2) b) To increase the setting value (Note 3)
DOWN	a) To scroll down the menu (Note 2) b) To decrease the setting value (Note 3)
ENTER	a) To enter submenu (Note 2) b) To confirm setting value change (Note 3)
CLEAR	a) To clear/reset the user resettable alarm b) When the alarm record is empty, press to scroll through the dedicated parameters (Note 1)
TEST/ RECORD	a) To display alarm records b) To display successive records, press the RECORD key again c) If there's no alarm, press and hold the RECORD key for 5 seconds to run the test function

Note 1: Press and hold either the ESC or CLEAR keys for 1.5 seconds to return to the default display from any submenu. Subsequently, press the CLEAR key to scroll through the real-time relay status and active group of protection setting. Refer to section 4.3.3.4 for more details.

Note 2: Only applicable when navigating through the menu

Note 3: Only applicable when editing the data.

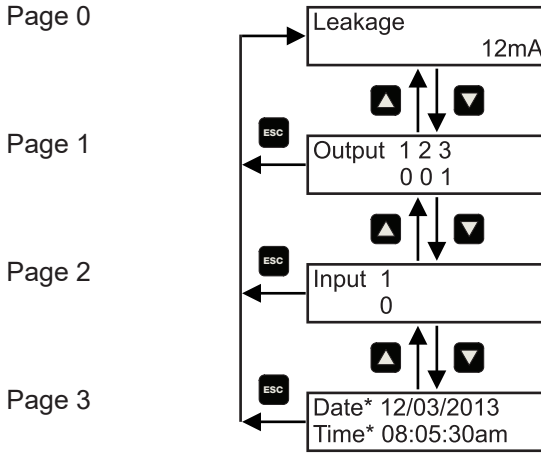
## 3.3 LEDs

Trip LED : Indicates tripping.

Alarm LED : Blinks to indicate unacknowledged alarm and continuous on when the alarm is acknowledged by pressing any key.

# 4. Menu

## 4.1 Default Display



The default display is divided into 4 pages. Its menu can be navigated using the UP or DOWN keys. Press and hold the ESC key for 3 seconds to jump to Page 0.

Page 0: Displays the real-time leakage current. Type of current displayed depends on the sensing parameter set at section 4.3.3.1.

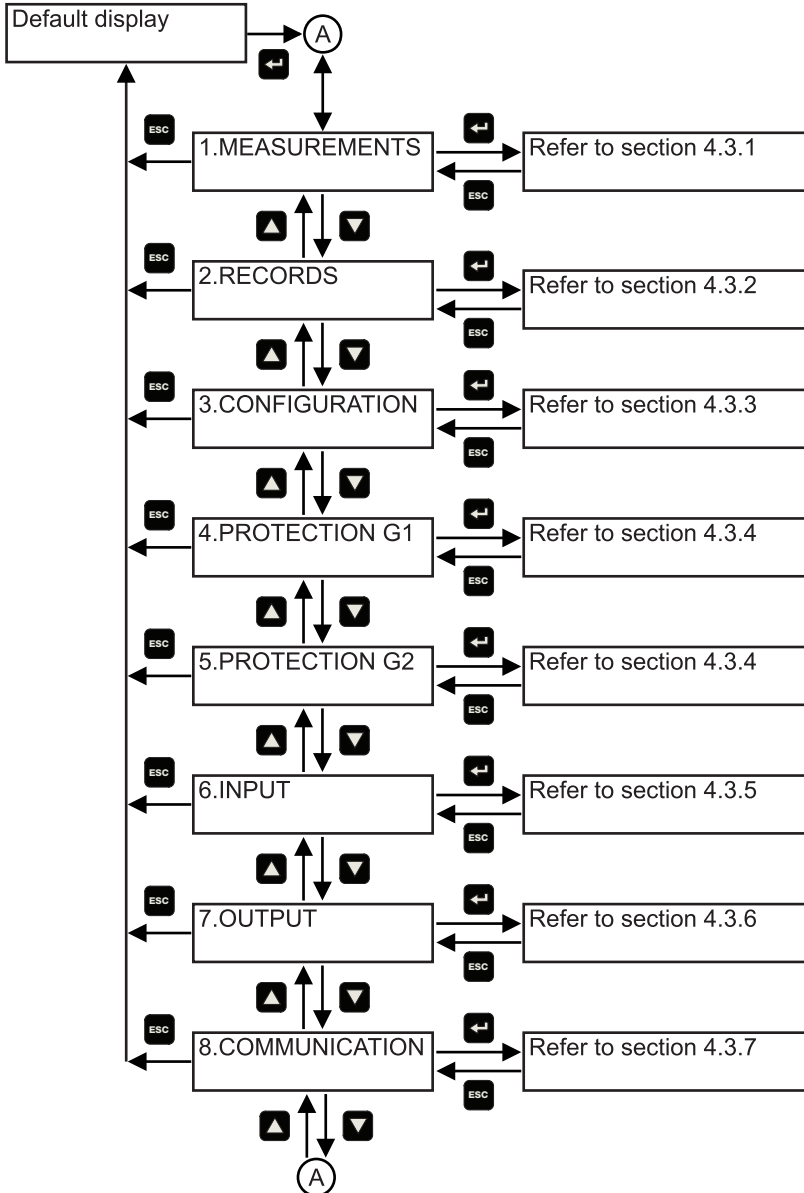
Page 1: Displays the real-time output contact physical status.  
Output 1 is the trip contact  
Output 2 is the programmable contact  
Output 3 is the IRF contact  
0=Output contact is de-activated  
1=Output contact is activated

Page 2: Displays the real-time input port physical status.  
0=Input port is open  
1=Input port is energised

Page 3: Displays the real-time date and time. Date and time format is configurable. Refer to section 4.3.3.2 for more information.

## 4.2 Main Menu

From the default display, the main menu can be reached by pressing the ENTER key. To return back to default display, press the ESC key once.

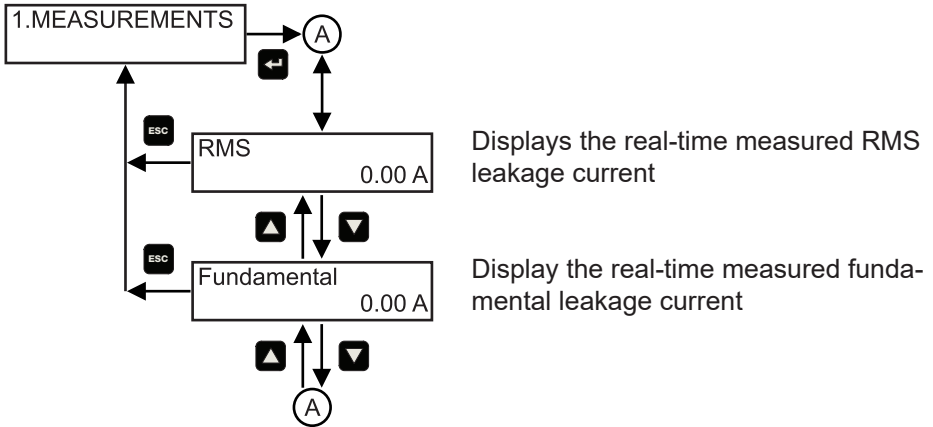




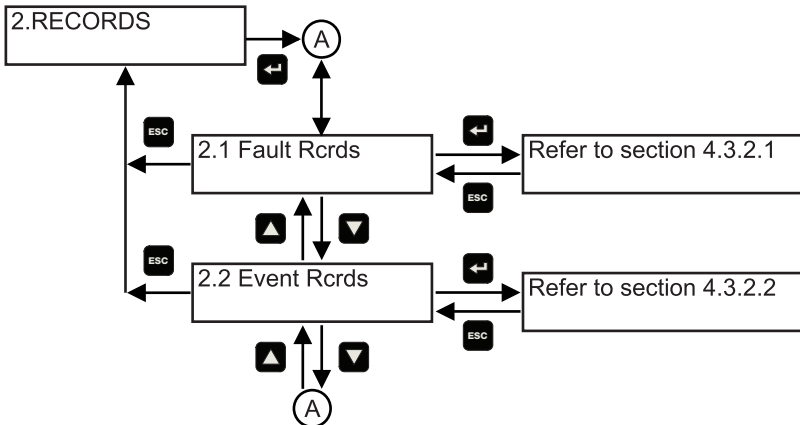
## 4.3 Sub Menu

### 4.3.1 MEASUREMENTS Menu

Shows the real-time measured leakage current.



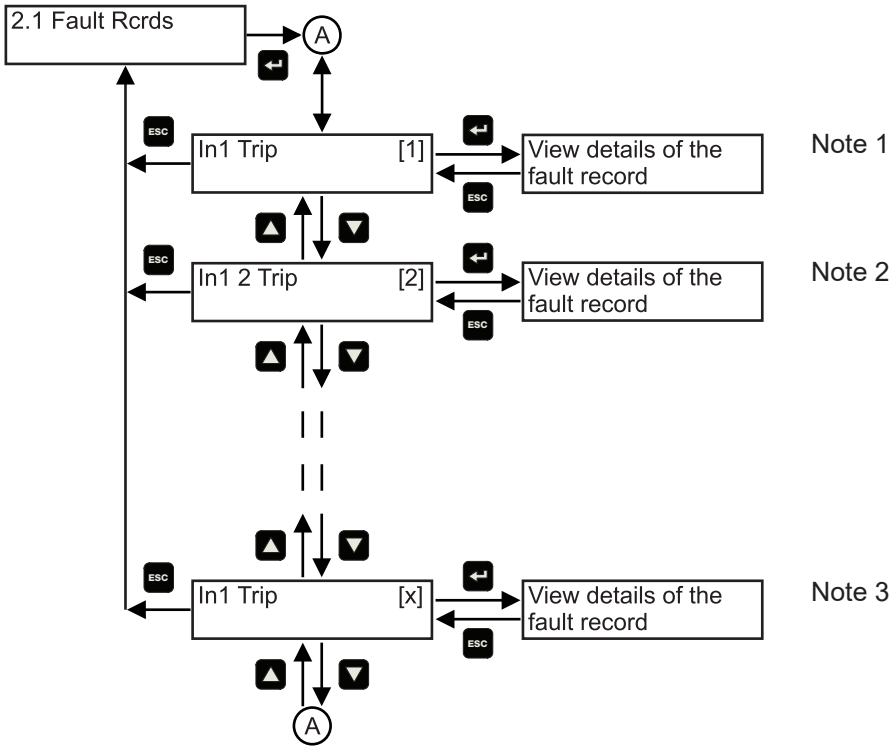
### 4.3.2 RECORDS Menu



### 4.3.2.1 Fault Record

Whenever a leakage fault trips, the fault details are recorded in the fault record. The information about the fault type, fault current, date, time and protection setting at the time of trip is recorded.

The user can use the UP or DOWN key to navigate through the fault records.

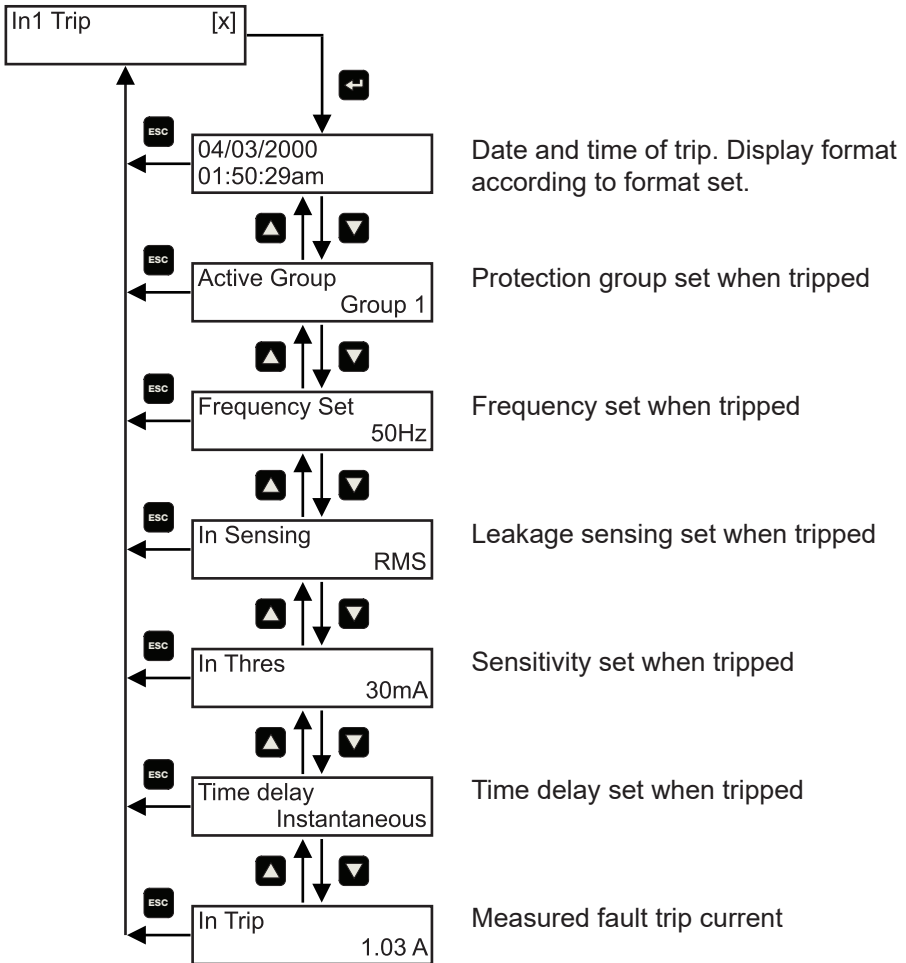


Note 1: [1] indicates displaying the first record.

Note 2: [2] indicates displaying the second record.

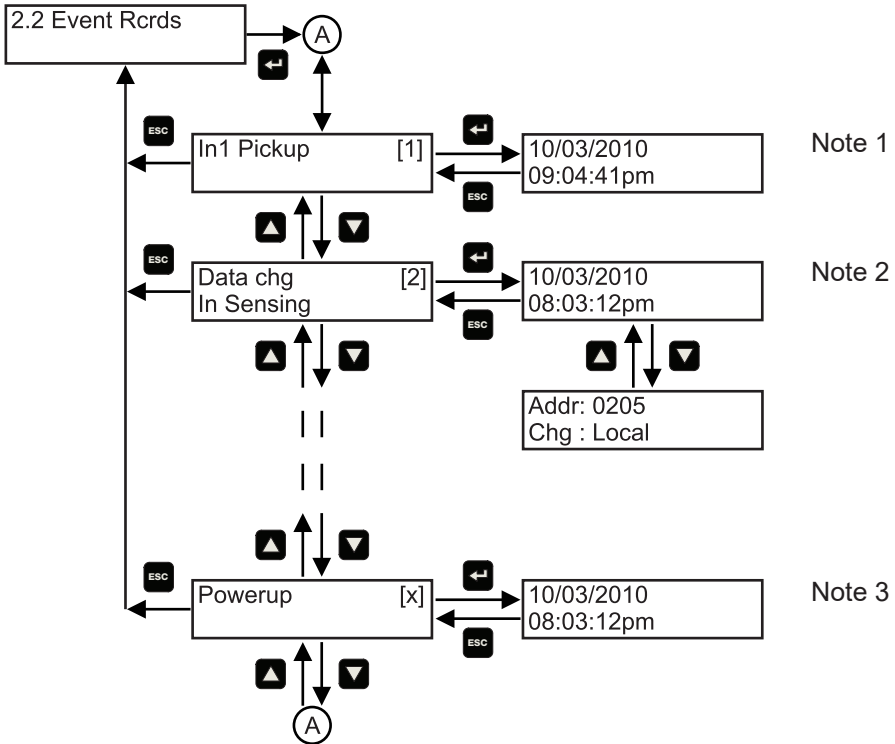
Note 3: [x] indicates the record number. The smaller number indicates the later record, e.g. [1] is the latest record.

The user also can view the details of the fault record by navigating to the desired record and pressing the ENTER key, followed by the UP or DOWN key to scroll through the details of the record or the ESC key back to the fault display.



### 4.3.2.2 Event Record

Whenever any event has been triggered in the device, it is logged in the event record. The information about the type of event, event status, event date and time is recorded.

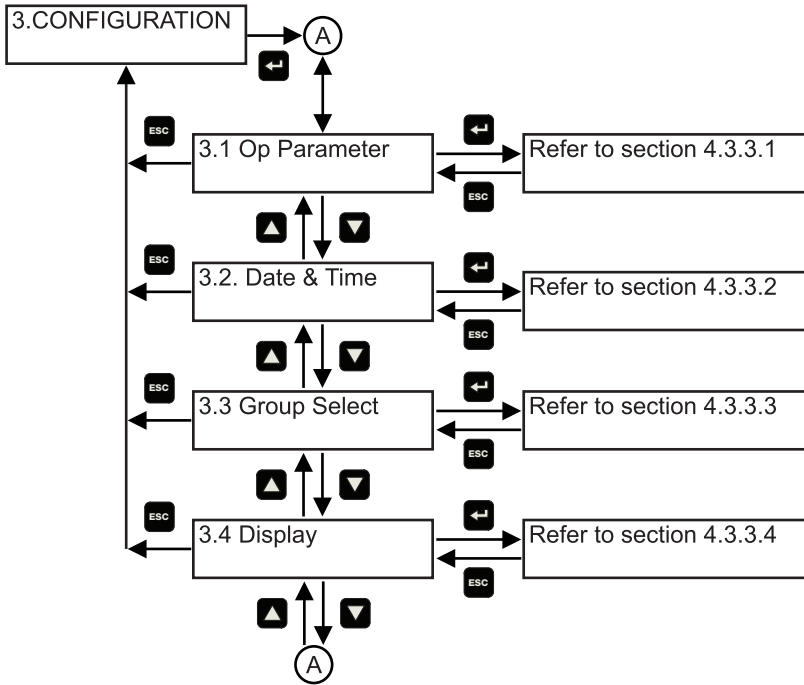


Note 1: [1] indicates displaying the first record. For most records, the user can view the event date and time by pressing the ENTER key or press the ESC key to return back to the event record display.

Note 2: [2] indicates displaying the second record. For setting data changes, the first line indicates the data has been changed and the second line shows the description of data being changed. Besides showing the date and time, additional information is also recorded and the user can view these changes at the relay front panel (local) or through the remote communication at the corresponding Modbus register address.

Note 3: [x] indicates the record number. The smaller number indicates the later record, e.g. [1] is the latest record.

### 4.3.3 CONFIGURATION Menu



#### 4.3.3.1 Op Parameter Menu

Display	Address	Description
Password	0215	Password to unlock the setting of parameters. Refer to section 5.0 for explanation
Description	0000	Model name for relay. This item is not editable
Firmware	0004-0007	Firmware version for the device. This item is not editable
Frequency	0204	Sets the nominal value of the line frequency
Sensing	0205	Sets the leakage current sensing method
Active Group	020C	Shows the current active protection group. Refer to section 4.3.3.3 for setting the active protection group.

### 4.3.3.2 Date and Time Menu

Display	Address	Description
Date	0206 - 0207	Sets the date
Date Format	020A	Sets the date format for display - DD/MM/YYYY or MM/DD/YYYY
Time	0208 - 0209	Sets the time (hh:mm:ss)
Time Format	020A	Sets the time format for display. For the 12-hours format, am/pm is added immediately after the seconds digit

### 4.3.3.3 Group Select Menu

Display	Address	Description
Chg Group by..	020B	Sets whether the protection group setting is changed by Menu or Input. Select either Menu or Input. If Input is selected, the input function must be set to 'Select Group', otherwise the "Setting Conflict" alarm will be shown
Setting Group	020C	Only configurable if Chg Group by... is set to Menu. Select either 1 or 2 for the active protection group

### 4.3.3.4 Display Menu

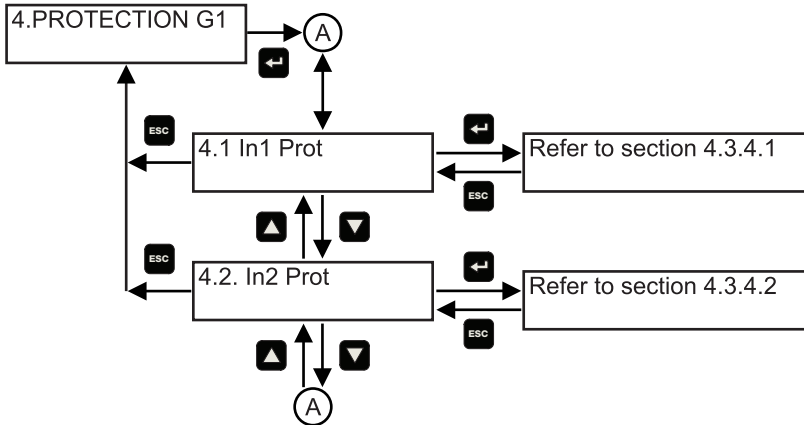
Display	Address	Description
LCD On Time	020D	Sets how long the LCD backlight remains on after no key is pressed
LCD Brightness	020E	Sets brightness of the LCD backlight
"CLEAR" Scroll?	020F	Set to allow the CLEAR key to scroll through a list of real-time status and current protection setting parameters. Refer to section 4.3.3.6 for the list. To initiate the scrolling, press and hold the CLEAR key for 3 seconds to reset the display to page 0. Subsequent press will scroll through the display. This function is only accessible when the alarm record is empty.

#### 4.3.3.5 Parameter Displayed During Display Scroll

Display	Description
Leakage	Real-time protection current display
Output	Real-time output contact physical status
Input	Real-time input port physical status
Date, Time	Real-time current date and time display
Frequency	Nominal frequency setting
Sensing	Protection sensing current setting
Active Group	Active protection group setting
In1 Prot?	In1 protection enable status setting
In1 Trip Rst	In1 protection trip reset method setting
In1 Thres	In1 protection threshold setting
In1 Time Dly	In1 time delay setting
In1 Alm?	In1 protection alarm enable status setting
In1 Alm Rst	In1 alarm reset method setting
In1 Alm Thres	In1 alarm threshold setting
In2 Prot?	In2 protection enable status setting
In2 Trip Rst	In2 protection trip reset method setting
In2 Thres	In2 protection threshold setting
In2 Time Dly	In2 time delay setting
In2 Alm?	In2 protection alarm enable status setting
In2 Alm Rst	In2 alarm reset method setting
In2 Alm Thres	In2 alarm threshold setting

### 4.3.4 PROTECTION G1/G2 Menu

This menu configures the earth leakage protection function. Each protection group consists of two sets of protection. The content for PROTECTION G1 menu and PROTECTION G2 menu are identical except the addresses are 03xx for PROTECTION G1 and 04xx for PROTECTION G2. The selection of Protection G1 or G2 is determined by the protection group setting. Refer to sections 4.3.3.3 and 4.3.5 for more details.



#### 4.3.4.1 In1 Prot Menu

Display	Address	Description
In1 Prot?	0300	Set Yes to enable the protection
In1 Trip Rst	0301	Sets the trip reset method. Set Manual for user reset and set Auto for internal self-reset. The self-reset is carried out if the leakage current drops to 50% below the sensitivity setting. It only self-resets both the trip function and trip alarm. For output contact to synchronise with the trip function, the reset method for the output contact must be set to Auto. Refer to sections 4.3.6.1 and 4.3.6.2 for details.
In1 Thres	0302	Sets the sensitivity setting. Protection pickup is at 85% of the sensitivity setting
In1 Time Dly	0303	Sets the trip time delay setting
In1 Alm?	0304	Set Yes to enable the alarm function
In1 Alm Rst	0305	Sets the alarm resetting method. The alarm can only be reset if the leakage current drops to 5% below the alarm threshold setting
In1 Alm Thres	0306	Sets the alarm threshold



#### 4.3.4.2 In2 Prot Menu

The In2 Prot menu has a similar content as the In1 Prot menu. It is applicable to the second set of the protection settings except the addresses are different.

Display	Address	Description
In2 Prot?	0308	Set Yes to enable the protection
In2 Trip Rst	0309	Sets the trip reset method. Set Manual for user reset and set Auto for internal self-reset. The self-reset is carried out if the leakage current drops to 50% below the sensitivity setting. It only self-resets both the trip function and trip alarm. For output contact to synchronise with the trip function, the reset method for the output contact must be set to Auto. Refer to sections 4.3.6.1 and 4.3.6.2 for details.
In2 Thres	030A	Sets the sensitivity setting. Protection pickup is at 85% of the sensitivity setting
In2 Time Dly	030B	Sets the trip time delay setting
In2 Alm?	030C	Set Yes to enable the alarm function
In2 Alm Rst	030D	Sets the alarm resetting method. The alarm can only be reset if the leakage current drops to 5% below the alarm threshold setting
In2 Alm Thres	030E	Sets the alarm threshold

## 4.3.5 INPUT Menu

### 4.3.5.1 Input 1

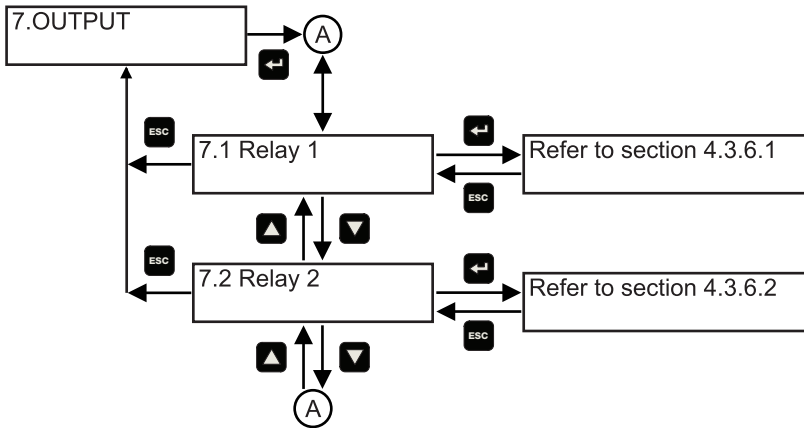
Display	Address	Description
Ip1 Func	0240	Sets function of Input 1. Refer to section 4.3.5.2 for details
Ip1 Type	0240	Selects the Input 1 activation logic. Active High is when voltage is applied to the input terminals. Active Low is when the input terminals are open
Rst Alarm	0241	Sets the option to reset the alarm (Note 1)
Rst Trip	0241	Sets the option to reset the trip (Note 1)
Rst Rly	0241	Sets the option to reset the output contacts (Note 1)
Aux timer	0242	Sets the auxiliary tripping timer. Only shown and configurable if the Ip1 Func is set to Aux timer

Note 1: Items only shown and configurable if the Ip1 Func is set to Reset

### 4.3.5.2 Input Function

Option	Description
None	Nothing is selected
Aux	If Aux is assigned, the input will generate an Aux Trip signal after the Aux time delay
Test	Tests the earth leakage function through the input port
Sync Clock	Sets the real-time clock to the nearest second
Select Group	Refer to section 4.3.3.3 for details
Blocking	Enables the external blocking signal to block the leakage protection function from running
Reset	Selects the alarm reset options among: (a) protection alarm, (b) protection trip, and/or (c) unlatch output contacts

### 4.3.6 OUTPUT Menu



#### 4.3.6.1 Relay 1

Display	Address	Description
Failsafe	0270	Sets the relay activation logic: No (Normal), Yes (Inverse)
Reset	0270	Sets the relay reset method: Manual (latched), Auto (Unlatched)
Trip function		
ZCT fault?	0271	Assigns the ZCT fault trip to RL1 (Note 1)
In1 trip?	0271	Assigns the In1 trip to RL1 (Notes 2, 3)
In2 trip?	0271	Assigns the In2 trip to RL1 (Notes 2, 3)
Pnl tst trip?	0271	Assigns the front panel test trip to RL1 (Note 2)
Ip tst trip?	0271	Assigns the input test trip to RL1 (Note 2)
Rem trip?	0271	Assigns the remote command trip to RL1 (Note 2)
Aux trip?	0271	Assigns the Aux input trip to RL1 (Note 2)

Note 1: Item not editable. Permanently set to “No”.

Note 2: Item not editable. Permanently set to “Yes”

Note 3: Once triggered, it is only resettable when the measured leakage current drops below 50% of the sensitivity setting.

### 4.3.6.2 Relay 2

Display	Address	Description
Failsafe	0275	Sets the relay activation logic: No (Normal), Yes (Inverse)
Reset	0275	Sets the relay reset method: Manual (latched), Auto (Unlatched)
Trip function		
ZCT fault?	0276	Assigns the ZCT fault trip to RL2
In1 trip?	0276	Assigns the In1 trip to RL2 (Note 1)
In2 trip?	0276	Assigns the In2 trip to RL2 (Note 1)
Pnl tst trip?	0276	Assigns the front panel test trip to RL2
Ip tst trip?	0276	Assigns the input test trip to RL2
Rem trip?	0276	Assigns the remote command trip to RL2
Aux trip?	0276	Assigns the Aux input trip to RL2
Alarm function		
In1 alm?	0277	Assigns the In1 alarm to RL2
In2 alm?	0277	Assigns the In2 alarm to RL2
Block alm?	0277	Assigns the blocking alarm to RL2
Setting conflict?	0277	Assigns the setting conflict alarm to RL2. Triggered when the protection group setting is set to input but the input port is not assigned to this function. Refer to sections 4.3.3.3 and 4.3.5.1 for more details

Note 1: Once triggered, it is only resettable when the measured leakage current drops below 50% of the sensitivity setting

### 4.3.7 COMMUNICATION Menu

Display	Address	Description
Communication?	0210	Set Yes to enable MODBUS RTU communication
Remote Set?	0216	Set Yes to enable remote read and write to the device. Set No to allow only remote read of the device
Baud Rate	0211	Sets the baud rate in bits per second (bps)
Parity	0212	Sets the parity in the data frame
Stop Bits	0213	Sets the number of stops bit in the data frame
Relay Address	0214	Sets the address of device in the MODBUS network

## 4.4 Menu Test

### 4.4.1 Leakage Test

When the alarm record is empty, press and hold the TEST/RECORD key for 5s to run the leakage test on the device.

# 5. Password

## Password Protection

Device settings can be viewed anytime but locked from being changed. A password is required for changing the settings. The password consists of four digits. The factory default password is 0000.

The programming mode is indicated with the letter “P” on the right hand side of the display. The letter “P” remains displayed as long as the password is active. This mode is exited if no key is pressed for 2 minutes.

## Password Entry

The password is requested as soon as the modification of a parameter is initiated. The user enters each one of the 4 digits by using the UP or DOWN key and validates each digit by pressing the ENTER key. If the ESC key is pressed in between, the password entry is terminated.

“Password OK” is shown if the correct password is entered. “Password ERROR” is shown if the wrong password is entered.

The display returns to the point of the preceding menu. Press the ENTER key again to modify the setting. If no key is pressed after 2 minutes, the settings are locked. A new password request must be initiated for any subsequent setting change.

## Changing Password

To change the password, go to the Op Parameter → Password menu.

Enter the current password to unlock, after which the display shows the current password. Press the ENTER key again to enter the new password.

# 6. Alarm

## Alarm Type

Alarms are divided into two types: user resettable alarms and non-resettable alarms.

For non-resettable alarms, the alarm are self reset by the relay once the alarm condition is removed.

For resettable alarms, the user must ensure the cause of the alarm is removed before the alarm can be cleared.

Eg: To clear “ZCT fault” alarm, the user must resolve the hardware ZCT connection problem before the alarm can be cleared.

## Alarm Condition

During an alarm condition, the alarm LED blinks and the alarm record shows up. Press any key to acknowledge the alarm. Once acknowledged, the alarm LED will be changed to continuous on.

## Alarm Viewing

Press the TEST/RECORD key once to go to the alarm display menu.

Press the TEST/RECORD key again to view successive records. Alternatively, in the alarm display menu, press the UP or DOWN key to scroll through the records.

## Alarm Clearing

To clear a single alarm, use the TEST/RECORD key to navigate to the desired alarm and press the CLEAR key.

To clear all records, use the TEST/RECORD key to navigate until the display shows “Clear all alarm?” and press the CLEAR key.

# 7. Technical Data

<i>PROTECTION</i>	
Setting group	Group 1 or Group 2
Setting sub-group	In1 or In2
Frequency	50Hz or 60Hz
Current sensing	True RMS or Fundamental
<i>EARTH LEAKAGE PROTECTION</i>	
Leakage?	Yes or No
Sensitivity setting	30mA, 0.05 to 1.00A (step=0.05A), 1.00 to 10.0A (step=0.25A)
Time delay setting	Instantaneous, 0.1s to 3.0s (step=0.1s)
<i>EARTH LEAKAGE ALARM</i>	
Alarm?	Yes or No
Alarm reset	Manual or Auto
Alarm threshold	50% to 80% (step=5%)
<i>EARTH LEAKAGE TEST</i>	
Test In	Panel key, input port, remote command
<i>MISCELLANEOUS PROTECTION</i>	
Blocking logic	Yes or No
Auxiliary trip	Yes or No
Auxiliary timer	0 to 600s (step=0.01s)
<i>RECORDS</i>	
Alarm records	Up to 30 records
Event records	Up to 250 records
Fault records	Up to 50 records
Recording resolution	1 ms
<i>COMMUNICATION</i>	
Hardware interface	Isolated RS485
Protocol	Modbus-RTU
Device ID	1 to 255
<i>REAL-TIME LEAKAGE CURRENT DISPLAY</i>	
Range	10mA to 12.0A
<i>ZERO PHASE CURRENT TRANSFORMER (ZCT)</i>	
ZCT type	Mikro standard type ZCT



<i>AUXILIARY POWER SUPPLY</i>	
Rated voltage	100~240VAC or 140~340VDC
Operating voltage	85~265VAC or 110~370VDC
Rated frequency	50 or 60Hz
Power consumption	6VA max
<i>INDICATORS</i>	
Display	2x16-digit LCD
Trip	Red indicator
Alarm	Yellow indicator
<i>LOGIC INPUT</i>	
Input type	Optically isolated
Rated voltage	50-270VAC or 20-380VDC External series resistor 18k ohm, 2W required for voltage greater than 94VAC or 132VDC
<i>OUTPUT CONTACT</i>	
Rated voltage	240VAC
Contact arrangement	Change-over
Continuous carry	5A, AC1
Expected electrical life	50,000 operations at rated load
Expected mechanical life	5,000,000 operations
<i>MECHANICAL</i>	
Mounting type	Front panel flush mounting
Dimension (mm)	96W x 96H x 125L
Enclosure protection	IP63 at panel. IP30 at body
Approximate weight	0.6kg (excluding ZCT)
<i>TEMPERATURE</i>	
Pollution degree	2
Operating temperature	-10°C to +55°C
Storage temperature	-20°C to +70°C
Humidity	5% to 95%, non condensing

<i>PRODUCT REFERENCE STANDARD</i>	
IEC 60947-2	Annex M
<i>ELECTROMAGNETIC COMPATIBILITY</i>	
IEC 61000-4-2 Electrostatic discharge	8kV, air discharge 8kV, contact discharge
IEC 61000-4-3 Radiated RF immunity	10V/m, 80MHz to 1GHz
IEC 61000-4-4 Electrical fast transient	4kV power port 2kV signal port
IEC 61000-4-5 Surge	4kV power port 2kV signal port
IEC 61000-4-6 Conducted RF immunity	10Vrms, 0.15 to 80MHz
IEC 61000-4-8 Power frequency magnetic	100A/m, 1s
IEC 61000-4-11 Voltage interruption	100% 200ms
IEC 61000-4-18 Damped oscillatory wave	2.50kV common mode 1.25kV differential mode
CISPR 11 Conducted emission	0.15-30MHz, 56-66dB
CISPR 11 Radiated emission	30-230MHz, 30dB, 10m 230-1000MHz, 37dB, 10m
<i>SAFETY TEST</i>	
IEC 60255-5 Insulation	2kV high voltage dielectric test 5kV high voltage impulse test
<i>ENVIRONMENT</i>	
IEC 60068-2-6	

# 8 MODBUS

## 8.1 MODBUS Protocol

The RS485 port is located at the rear terminals and uses the MODBUS-RTU protocol.

The communication setting is set in the COMMUNICATION Menu from the front panel or RS485 port. When changes are made through the RS485 port, modifications are restricted to the communication protocol registers or addresses ranging from 0211h to 0214h. The changes take place immediately after the acknowledge message is sent.

Most of the MODBUS database registers can be modified through the RS485 port except the following:

- a) relay status registers, address ranging from 0000h to 001Fh.
- b) communication function enable/disable register, address=0210h.
- c) front panel access password register, address=0215h
- d) RL1 or relay 1 trip option, address=0270h.

Items (b) & (c) can only be modified through the front panel. Reading the password register will always return 0000h.

Prior to writing data to the database, the user **MUST** ensure that the device front panel access password is not active. Otherwise, the data write is void. The front panel access password status can be checked by reading the database interlocking bit of the device status register or bit 10 of address 0010h. Reading of the database registers is not affected.

## 8.2 MODBUS Message Format

The MODBUS protocol defines the format for the master's query and the slave's response.

The query contains the device address, a function code defining the requested action, any data to be sent, and an error-checking field.

The response contains fields confirming the action taken, any data to be returned, and an error-checking field. If an error occurred in receipt of the message, or if the slave is unable to perform the requested action, the slave will construct an error message and send it as its response.

The MODBUS communication address 0 is a broadcast command to all slave devices. The slave devices will not respond to a broadcast command.

## 8.3 MODBUS Functions

### 8.3.1 Function 03h or 04h - Reading Input/Holding Register(s)

This function code is used to read from 1 to 125 contiguous input registers in the device. The master specifies the starting register address and the number of registers to be read.

The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Request:

Communication address	1 byte	1 to 255 (0xFF)
Function code	1 byte	0x03 or 0x04
Starting address	2 bytes	0x0000 to 0xFFFF
Quantity of registers	2 bytes	1 to 125 (0x7D)
CRC	2 bytes	2-byte CRC

Response:

Communication address	1 byte	1 to 255 (0xFF)
Function code	1 byte	0x03 or 0x04
Byte count	1 byte	2 x N (Note 1)
Value of registers	Nx2 bytes	Value
CRC	2 bytes	2-byte CRC

Note 1: N = Quantity of registers and ranges from 1 to 125.

Error:

Communication address	1 byte	1 to 255
Error code	1 byte	0x83 or 0x84
Exception code	1 byte	0x01, 0x02 or 0x03
CRC	2 bytes	2-byte CRC

### 8.3.2 Function 06h - Write Single Register

This function code is used to write a single holding register in the device. The master specifies the address of the register to be written.

The normal response is an echo of the request, returned after the register contents have been written.

Request:

Communication address	1 byte	0 to 255 (Note 1)
Function code	1 byte	0x06
Register address	2 bytes	0x0000 to 0xFFFF
Register value	2 bytes	Value
CRC	2 bytes	2-byte CRC

Note 1: 0 is a broadcast command to all slave devices. The slave devices will not respond to a broadcast command.

Response:

Communication address	1 byte	1 to 255 (0xFF)
Function code	1 byte	0x06
Register address	2 bytes	0x0000 to 0xFFFF
Register value	2 bytes	Value
CRC	2 bytes	2-byte CRC

Error:

Communication address	1 byte	1 to 255 (0xFF)
Error code	1 byte	0x86
Exception code	1 byte	0x01, 0x02, 0x03 or 0x04
CRC	2 bytes	2-byte CRC

### 8.3.3 Function 10h - Write Multiple Registers

This function code is used to write a block of contiguous registers (1 to 123 registers) in the device. The requested written values are specified in the request data field. Data is packed as two bytes per register. The normal response returns the function code, starting address, and quantity of registers written.

Request:

Communication address	1 byte	0 to 255 or 0xFF (Note 1)
Function code	1 byte	0x10
Starting address	2 bytes	0x0000 to 0xFFFF
Quantity of registers	2 bytes	1 to 123 (0x7B)
Byte count	1 byte	2 x N (Note 2)
Register value	N x 2 bytes	Values
CRC	2 bytes	2-byte CRC

Note 1: 0 is a broadcast command to all slave devices. The slave devices will not respond to a broadcast command.

Note 2: N = Quantity of registers and it ranges from 1 to 123.

Response:

Communication address	1 byte	1 to 255 (0xFF)
Function code	1 byte	0x10
Starting address	2 bytes	0x0000 to 0xFFFF
Quantity of registers	2 bytes	1 to 123 (0x7B)
CRC	2 bytes	2-byte CRC

Error:

Communication address	1 byte	1 to 255 (0xFF)
Error code	1 byte	0x90
Exception code	1 byte	0x01, 0x02, 0x03 or 0x04
CRC	2 bytes	2-byte CRC

#### 8.4 MODBUS Exception Code

Exception Code	Name	Description
01	Illegal Function	The function code is not supported by the product
02	Illegal Data Address	Attempt to read or write an invalid address
03	Illegal Data Value	Attempt to write the non-allowable value to the slave.
04	Slave Device Failure	An unrecoverable error occurred while the slave was attempting to perform the requested action

## 8.5 MODBUS Registers

### 8.5.1 Product Information (Read only)

Function code: 03h or 04h

Addr (hex)	Parameter	*Format	Unit	Range	Default (hex)
0000	Device type - main	F1	ASCII	'00'	3030
0001		F1	ASCII	'06'	3036
0002		F1	ASCII	'00'	3030
0003	Device type - sub	F1	ASCII	'00'	3030
0004	Version number - main	F1	ASCII	'XX'	3030**
0005		F1	ASCII	'XX'	3031**
0006	Version number - sub	F1	ASCII	'XX'	3030**
0007		F1	ASCII	'XX'	3030**
0008-000F	Reserved	---	---	---	0000

\* Refer to section 8.6 for the mapping format

\*\* Default value changes according to the firmware release

### 8.5.2 Measurement and Device Status (Read only)

Function code: 03h or 04h

Addr (hex)	Parameter	*Format	Unit	Range	Default (hex)
0010	Device status	F2	Bit field		---
0011	LED status	F3	Bit field	Bit: 0-1	---
0012	Input status	F4	Bit field	Bit 0	---
0013	Output status	F5	Bit field	Bit: 0-2	---
0014	Active group	F6	---	0=Group1, 1=Group2	---
0015	Leakage current	F7	mA	0-12000 (0-12.0A) or 0x7FFF for values greater than 12.0A	---
0016	Alarm status	F15	Bit field	Bit: 0-3	---
0017	Trip status	F16	Bit field	Bit: 0-6	---
0018-001F	Reserved	---	---	---	---

\* Refer to section 8.6 for the mapping format

### 8.5.3 Remnote Command (Write only)

Function code: 06h

Addr (hex)	Parameter	*Format	Unit	Range	Default (hex)
0100	Remote cmd	F19	Integer	---	---

\* Refer to section 8.6 for the mapping format

### 8.5.4 General Setting (Read/Write)

Function code: 03h, 04h, 06h or 10h

Addr (hex)	Parameter	*Format	Unit	Range	Default (hex)
0200-0203	Reserved	---	---	---	0000
0204	Frequency	F6	---	0=50Hz, 1=60Hz	0000
0205	Sensing	F6	---	0=RMS, 1=Fundamental	0000
0206	Year	F7	year	0-199 (as 2xxx)	0000
0207	Month, Day	F10	month, day	1-12, 1-31	0101
0208	Hour, Minute	F11	hour, minute	0-23, 0-59	0000
0209	Milliseconds	F7	ms	0-59999 (0 - 59.999s)	0000
020A	Date & time format	F12	date, time	0-1, 0-1	0000
020B	Change group by...	F13	---	0=menu, 1=input	0000
020C	Setting group	F6	---	0=Group1, 1=Group2	0000
020D	LCD backlight on time	F7	minute	1-60	0001
020E	LCD backlight brightness	F6	---	0=low, 1=medium, 2=high	0001
020F	Clear key to scroll setting	F6	---	0=No, 1=Yes	0000
0210	Communication?	F6	---	0=No, 1=Yes	0001
0211	Baudrate	F7	bps	0=2400, 1=4800, 2=9600, 3=19200, 4=38400	0003

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Addr (hex)	Parameter	*Format	Unit	Range	Default (hex)
0212	Parity	F6	---	0=none, 1=0dd, 2=even	0001
0213	Stop bits	F6	---	0=1-bit, 1=2-bits	0000
0214	MODBUS address	F6	---	1-255	0001
0215	Password	F1	---	0000	0000
0216	Remote set parameters	F6	---	0=No, 1=Yes	0001
0217-023F	Reserved	---	---	---	0000
0240	Input 1 function	F14	level, option	0-1, 0-6	0100
0241	Input 1 reset option	F18	Bit field	Bit: 0-2	0000
0242	Input 1 Aux delay	F8	1/100 sec	0-60000 (0-60.000s)	0001
0243-026F	Reserved	---	---	---	0000
0270	RL1 function	F17	Bit field	Bit: 0-1	0000
0271	RL1 trip options	F16	Bit field	Bit: 0-6	007E
0272-0274	Reserved	---	---	---	0000
0275	RL2 function	F17	Bit field	Bit: 0-1	0000
0276	RL2 trip options	F16	Bit field	Bit: 0-6	0000
0277	RL2 alarm options	F15	Bit field	Bit: 0-4	0000
0278-027F	Reserved	---	---	---	0000

\* Refer to section 8.6 for the mapping format

Addresses 0210, 0215, 0216 and 0271 are read-only registers. Writing on them has no effect.

**8.5.5 Protection Group 1 (Read/Write)**  
**Function code: 03h, 04h, 06h or 10h**

Addr (hex)	Parameter	*Format	Unit	Range	Default (hex)
0300	Leakage 1 (In1)	F6	---	0=Disable, 1=Enable	0001
0301	In1 trip reset	F6	---	0=Manual, 1=Auto	0000
0302	In1 sensitivity	F9	mA	30-10000 (0.03-10A)	001E (30mA)
0303	In1 time delay	F8	ms	0-5000 (step=100)	0000
0304	In1 alarm?	F6	---	0=Disable, 1=Enable	0001
0305	In1 alarm reset	F6	---	0=Manual, 1=Auto	0000
0306	In1 alarm threshold	F7	%	50-80 (step=5)	0032 (50%)
0307	Reserved	---	---	---	0000
0308	Leakage 2 (In2)?	F6	---	0=Disable, 1=Enable	0000
0309	In2 trip reset	F6	---	0=Manual, 1=Auto	0000
030A	In2 sensitivity	F9	mA	30-10000 (0.03-10A)	001E (30mA)
030B	In2 time delay	F8	ms	0-5000 (step=100)	0000
030C	In2 alarm?	F6	---	0=Disable, 1=Enable	0001
030D	In2 alarm reset	F6	---	0=Manual, 1=Auto	0000
030E	In2 alarm threshold	F7	%	50-80 (step=5)	0032 (50%)
030F- 031F	Reserved	---	---	---	0000

\* Refer to section 8.6 for the mapping format

**8.5.6 Protection Group 2 (Read/Write)**  
**Function code: 03h, 04h, 06h or 10h**

Addr (hex)	Parameter	Format	Unit	Range	Default
0400- 041F	Same as Protection Group 1 except the addresses are 04xx instead of 03xx				

**8.5.7 Fault Record (Read only)**  
**Function code: 03h or 04h**

Addr (hex)	Parameter	Format	Unit	Range	Default
1000	Fault record 1				---
1001	Fault record 2				---
:	:				
1031	Fault record 50				---

**8.5.8 Event Record (Read only)**  
**Function code: 03h or 04h**

Addr (hex)	Parameter	Format	Unit	Range	Default
2000	Event record 1				---
2001	Event record 2				---
:	:				
20F9	Event record 250				---

**8.5.9 Alarm Record (Read only)**  
**Function code: 03h or 04h**

Addr (hex)	Parameter	Format	Unit	Range	Default
3000	Alarm record 1				---
3001	Alarm record 2				---
:	:				
301D	Alarm record 30				---

## 8.6 MODBUS Mapping Format

Code	Description
F1	2 bytes ASCII character
F2	Unsigned integer - Device status. Bit 0: EEPROM data failure Bit 1: Calibration data failure Bit 2: RTC data lost Bit 3: RTC error Bit 4: ADC error Bit 5: Watchdog reset Bit 10: Modbus database registers interlocking status Bit 11: Rear port (RS485) unread fault record Bit 14: Rear port (RS485) unread alarm record
F3	Unsigned integer - LED status. Bits 0-1: Trip LED (1=ON, 2=blink) Bits 2-3: Alarm LED (1=ON, 2=blink)
F4	Unsigned integer - Input status. Bit 0: Input 1 (0=Open, 1=Close)
F5	Unsigned integer - Output status. Bit 0: Relay 1 or Trip contact (0=Off, 1=On) Bit 1: Relay 2 or Programmable contact (0=Off, 1=On) Bit 2: Relay 3 or IRF contact (0=Off, 1=On)
F6	Unsigned integer - Miscellaneous. A numeric value representation of certain options or functions. Refer to the 'range' column of the register for details
F7	Unsigned integer - A numeric value of certain units. Refer to the individual register 'Unit' and 'Range' for details E.g. 50 may represent 50% or 50 seconds
F8	Unsigned integer - A scaled numeric of certain units Refer to the individual register 'Unit' and 'Range' for details E.g. 125 may represent 1.25A or 12.5s
F9	Unsigned integer - Sensitivity setting and the unit is mA. Valid data: 30, 50-1000 (step=50), 1000-10000 (step=250) E.g. 500 is 500mA or 2000 is 2.0A
F10	Unsigned integer. High byte: month Low byte: day

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Code	Description
F17	Unsigned integer - Relay operation status. Bit 0: Latch status (0>manual/latched, 1=auto/unlatched) Bit 1: Failsafe function (0=No, 1=Yes)
F18	Unsigned integer - Input reset option. Bit 0: Alarm reset Bit 1: Trip reset Bit 2: Output contact reset
F19	Unsigned integer - remote command. High byte: 1: Reset alarm/trip 2: Acknowledge alarm/trip 3: Remote set the display to default display page 6: Remote trip 7: Remote reset panel password 10: Delete alarm record  Low Byte: For high byte=3, set to display page 0-4. Refer to section 4.1 for the page assignments, . For high byte=10, 0=delete all record, n=delete record n

# 9 Records

The device has three types of data records: (a) Alarm records, (b) Event records and (c) Fault records. Time resolution for the records is 1ms.

To access the records, user can view the records from the device front panel (see section 4.3.2) or through the MODBUS-RTU communication.

## 9.1 Alarm Record

There are two different types of alarm records in the device - user resettable alarm records and non-resettable alarm records.

For non-resettable alarms, the alarm are self reset by the device once the alarm condition is removed.

### 9.1.1 MODBUS Alarm Record Format

Each alarm record consists of 6 words and the format is shown below :

Word	Description	Format	Units	Range
1	Year	F7	year	0-199 (as 2000-2199)
2	Month,day	F10	month, day	1-12, 1-31
3	Hour, minute	F11	hour, minute	0-23, 0-59
4	Milliseconds	F7	ms	0-59999 (0-59.999s)
5	Record code	See section 9.1.2		
6	Record data	See section 9.1.2		

### 9.1.2 Alarm Record Codes and Data

Word number 5		Word number 6
Code	Code Description	Data Description
1	In1 alarm	---
2	In2 alarm	---
3	ZCT fault	---
4	In1 trip	Trip fault current
5	In2 trip	Trip fault current

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Word number 5		Word number 6
Code	Code Description	Data Description
6	Panel button test trip	---
7	Input test trip	---
8	Remote command trip	---
9	Aux trip	---
10	Blocking alarm	---
20	Relay 1 ON	---
21	Relay 1 latched	---
22	Relay 2 ON	---
23	Relay 2 latched	---
24	IRF relay OFF	---
25	Watchdog reset	---
26	Calibration data error	---
27	ADC error	---
28	EEPROM error	---
29	RTC data lost	---
30	RTC error	---
31	Firmware updated	---
32	Default data	---
33	Setting conflict	---

Alarm codes 32 and 33 are for non-resettable alarms. The alarm is self reset by the device once the alarm condition is removed.

### 9.1.3 Example of Reading Single Alarm Record

Request:

Field name	Code	Description
Communication address	01	Slave address is 1
Function code	04	Reading input register
Starting address high	30	Reads a single alarm record - Alarm record 3
Starting address low	02	
Quantity of register high	00	An alarm record consist of 6 words
Quantity of register low	06	
CRC high	DE	Error checking code
CRC low	C8	



Response:

Field name	Code	Description
Communication address	01	Slave address is 1
Function code	04	Reading input register
Byte count	0C	12 bytes
Year high	00	Word 1: Year
Year low	11	
Month	0B	Word 2: Month, day.
Day	03	
Hour	10	Word 3: Hour, minute
Minute	16	
Milliseconds high	C1	Word 4: Milliseconds
Milliseconds low	26	
Record code high	00	Word 5: Record code
Record code low	06	
Record data high	00	Word 6: Record data
Record data low	00	
CRC high	2F	Error checking code
CRC low	44	

The above example data shows:

Alarm date: 3-November-2017

Alarm time: 16:22:49.446 or 4:22:49.446pm

Alarm type: Device front panel key pressed test trip

Error:

Field name	Code	Description
Communication address	01	Slave address is 1
Error code	84	Reading input register
Exception code	02	0x01, 02, 03 or 04
CRC high	C2	Error checking code
CRC low	C1	

### 9.1.4 Example of Reading Multiple Consecutive Alarm Records

Request:

Field name	Code	Description
Communication address	01	Slave address is 1
Function code	04	Reading input register
Starting address high	30	Note 1
Starting address low	00	
Quantity of register high	00	Note 2
Quantity of register low	30	
CRC high	DE	Error checking code
CRC low	C8	

Response:

Field name	Code	Description
Communication address	01	Slave address is 1
Function code	04	Reading input register
Byte count	60	96 bytes
Word 1 to Word 6		Alarm record 1 (Note 3)
Word 7 to Word 12		Alarm record 2 (Note 3)
:		
:		
Word 43 to Word 48		Alarm record 8 (Note 3)
CRC high	XX	Error checking code
CRC low	XX	

Note 1: For reading multiple consecutive records, the starting address is the address for the first record. In the example, the starting address is 0x3000 and it is Alarm record 1.

Note 2: Each alarm record consists of 6 words. Therefore, the quantity of registers = 6 x number of records to read  
The above example reads 8 consecutive records and the quantity of registers read is 48 or 0x30.

Note 3: Refer to section 9.1.1 for the alarm record format

## 9.2 Event Record

The event record (also referred to as event logging) operates continuously and records status changes of the protection functions, MODBUS registers, input port, output ports and etc.

Up to 250 events can be stored in the cyclic buffer. When the buffer is full, the oldest event is overwritten as new events occur.

The MODBUS access on the event record is similar to reading the alarm record by replacing the starting address of the alarm record with the starting address of the event records.

### 9.2.1 MODBUS Event Record Format

Each event record consists of 6 words and the format is shown below :

Word	Description	Format	Units	Range
1	Year	F7	year	0-199 (as 2000-2199)
2	Month,day	F10	month, day	1-12, 1-31
3	Hour, minute	F11	hour, minute	0-23, 0-59
4	Milliseconds	F7	ms	0-59999 (0-59.999s)
5	Record code	See section 9.2.2		
6	Record data	See section 9.2.2		

### 9.2.2 Event Record Codes and Data

Word number 5		Word number 6	
Code	Code Description	Data Description	
1	In1 alarm status	0=Alarm reset	1=Alarm pickup
2	In2 alarm status	0=Alarm reset	1=Alarm pickup
3	ZCT fault status	0=Fault reset	1=Fault pickup
4	In1 protection status	0=Protection drop off	1=Protection pickup
5	In2 protection status	0=Protection drop off	1=Protection pickup
6	In1 trip status	0=Trip reset	1=Leakage trip
7	In2 trip status	0=Trip reset	1=Leakage trip
8	Panel button test trip	0=Trip reset	1=Test trip

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Word number 5		Word number 6	
Code	Code Description	Data Description	
9	Input test trip	0=Trip reset	1=Test trip
10	Remote command trip	0=Trip reset	1=Rem cmd trip
11	Aux trip	0=Trip reset	1=Aux trip
12	Blocking alarm	0=Alarm reset	1=Block alarm
13	Relay 1 status	0=De-energise	1=Energise
14	Relay 1 latch status	0=Unlatch	1=Latch
15	Relay 2 status	0=De-energise	1=Energise
16	Relay 2 latch status	0=Unlatch	1=Latch
17	IRF relay status	0=De-energise	1=Energise
18	Input 1 status	0=Switch open	1=Switch close
19	Powerup	---	---
20	Watchdog startup	0=Alarm cleared	1=Alarm pickup
21	Firmware updated	0=Alarm cleared	1=Alarm pickup
22	Default data	0=Alarm cleared	1=Alarm pickup
23	Setting conflict	0=Alarm cleared	1=Alarm pickup
24	Calibration data error	0=Alarm cleared	1=Alarm pickup
25	ADC error	0=Alarm cleared	1=Alarm pickup
26	EEPROM error	0=Alarm cleared	1=Alarm pickup
27	RTC data lost	0=Alarm cleared	1=Alarm pickup
28	RTC error	0=Alarm cleared	1=Alarm pickup
29	Synchronise clock	---	---
30	Group change	0=Active group 1	1=Active group 2
31	Frequency change	0=50Hz	1=60Hz
32	Panel data change	Address of setting being changed	
33	Remote data change	Address of setting being changed	
34	Password reset	0=Local	1=Remote
35	Acknowledge alarm	0=Local	1=Remote

Refer to section 9.1.3 for the example of reading single record and section 9.1.4 for the example of reading multiple consecutive records.

## 9.3 Fault Record

The fault record only pertains to the leakage fault trip. It records the device operation setting, protection setting and the fault current. The fault record data is captured at the instance when the device trips.

Up to 50 faults can be stored in the cyclic buffer. When the buffer is full, the oldest fault is overwritten as new faults occur.

The MODBUS accessing the fault records is similar to reading the alarm record by replacing the starting address and quantity of the registers of the alarm record with the starting address of the fault records and the quantity of registers for the fault records.

### 9.3.1 MODBUS Fault Record Format

Each fault record consists of 10 words and the format is shown below:

Word	Description	Format	Units	Range
1	Year	F7	year	0-199 (as 2000-2199)
2	Month, day	F10	month, day	1-12, 1-31
3	Hour, minute	F11	hour, min	0-23, 0-59
4	Milliseconds	F7	ms	0-59999
5	Record code	F6	---	0=None 1=In1 trip 2=In2 trip
6	Protection group set	F6	---	0=Group 1 1=Group 2
7	High byte: Frequency set	F6	---	0=50Hz 1=60Hz
	Low byte: Sensing set	F6	---	0=RMS 1=Fundamental
8	Sensitivity set	F9	mA	30-10000 (0.03-10.0A)
9	Time delay set	F8	ms	0-3000 (0-3.0s)
10	In trip	F7	mA	0-12000 (0-12.0A) or 0x7FFF for values greater than 12.0A

Refer to section 9.1.3 for the example of reading single record and section 9.1.4 for the example of reading multiple consecutive records.







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