Mikro®

X60

COMBINED OVERCURRENT & EARTH FAULT RELAY

user manual

Mikro®

COMBINED OVERCURRENT & EARTH FAULT RELAY

Ver 1.00

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Revision History

V1.0 Apr 2013 First version.

1.0 Introduction

The purpose of this manual is to provide information necessary to install, operate and maintain the X60 relay.

X60 provides protections for 3 independent phase overcurrent elements and one non-directional earth-fault element. All these elements are connected to the current transformers of the feeders to be protected.

There are 2 sets of current inputs, for 1A and 5A rated CTs.

Using the front panel, the user can easily navigate through the user friendly menu, read measurements and change settings. The relay status and alarm or trip records are displayed on the back-lit LCD also.

There is a RS232 port available on the front panel and a RS485 port on the rear terminals. Using MODBUS RTU protocol, all stored information can be read and settings can be modified with a PC loaded with Mikro setting software.

X60 has 4 configurable output relays. They can be activated by any of the protection functions available in the relay. There is also 1 output relay for internal fault indication. There are 2 configurable logic inputs for various functions.

1.1 Symbols and Definitions

In this manual and on the relay, unless the context otherwise requires, the following symbols and abbreviations shall apply throughout:-

AC : Alternating current
Ack : Acknowledge
Alrm : Alarm
CT : Current transformer
CBFP : Circuit Breaker Failure Protection
Chg : Change
CLPU : Cold Load Pickup
DC : Direct current
Dmnd : Demand
EF : Earth fault
Genrl : General
IDMT : Inverse definite minimum time
IL1 : Phase 1 current
IL2 : Phase 2 current
IL3 : Phase 3 current
Io/IN : Earth (fault) current
Invrse : Inverse
Ip : Input
IRF : Internal Relay Failure
LED : Light emitting diodes
OC : Overcurrent
OL : Overloaded
PU : Pickup
RCRD : Record
Rmote : Remote
Rst : Reset
Strt : Start
TCS : Trip circuit supervision
Thml : Thermal

2.0 Front Panel

Using the front panel, the user can easily navigate through the user friendly menu, read measurements and change settings. The relay status and alarm or trip records are displayed on the back-lit LCD also.

X60 Front panel

2.1 LCD Display

The LCD has 2 lines with 16 characters each. Back light is on when a key is pressed and remains on for a predefined time duration. The brightness can be adjusted to suit the lighting conditions.

2.2 Keypad

There are 6 keys on the front panel.

Up, Down, Enter and Esc are used to navigate through the menus and adjust the settings.

Up	:	Scroll up the menus or increase setting value.
Down	:	Scroll down the menus or decrease setting value.
Esc	:	To exit from menus, submenus or to cancel setting value change. Press and hold for 1.5 seconds to return to default display from any submenu.
Enter	:	To enter submenus or to confirm setting value change.
Clear	:	To reset tripping, reset latched relay. If "CLEAR" Scroll is enabled (under Configurations-> Display menu) and during no alarm status, it can be used to scroll through Phase Overcurrent and Earth Fault settings, and to return to default display from any submenu if pressed and hold for 1.5 seconds.

Record: To display Alarm records. To display successive records, press Record key again.

To display record date and time, press Enter. To exit , press Esc/Enter. To delete individual record, press Clear. To delete all records, go to the end of the records and "Clear all alarm?" will be shown, press Clear to clear.

2.3 LEDs

Trip LED : Indicates tripping
Alarm LED : Blinks to indicate non acknowledge alarm (or tripping). Steady on when the alarm is acknowledged by pressing any key

2.4 RS232 Port

The front panel RS232 port has the same MODBUS RTU protocol as the RS485 port on the rear terminal, though with fixed communication settings: 38400bps, 1 stop bit, even parity, address 1.

All stored information can be read and settings can be modified with a PC loaded with the supplied Mikro setting software.

2.5 Default Display

By default the LCD displays the current value measured for IL1, IL2, IL3 and Io. Input and output status as well as date and time can be shown by pressing Up or Down to change the default display page. Pressing Esc always return to current value display.

As soon as an alarm or trip is detected, the displays jumps to record display to show the latest record.

2.6 Alarm Condition

During an alarm or tripping condition, Alarm LED blinks. Alarm record pops up. Any keypress change the Alarm LED to steady on.

tI> trip 1/2

Example of Alarm record title page, showing record 1 out of total 2 records. Press Enter to enter sub page for this record. Press Record/Down to show next alarm. Press Up to show previous alarm. Press Esc to return to Default Display. Press Clear to clear the alarm. If the condition still persists, the alarm cannot be cleared.

Date: 03/02/2011 Time: 08:23:44am

Alarm record sub page, showing record date and time. Press Esc/Enter/RECORD to return to Alarm Record title page.

Clear all alarm? Clear=CLEAR

Clearing all record menu is shown when Up is pressed during display of Record 1's title page, or RECORD/Down is pressed during display of Last records title page. Press Clear to clear all Alarm record or Esc to cancel.

3.0 Password

Password Protection

Relay settings can be view anytime but locked from being changed. A password is required for changing setting.

The password consists of four digit numbers. The factory default password is set as 0000.

The programming mode is indicated with the letter "P" on the right hand side of the display. The letter "P" remains present as long as the password is active. (2 minutes if there is no key action).

Password Entry

The input of the password is requested as soon as a modification of a parameter is initiated. The user enters each one of the 4 digits by using up or down key and validates each digit with Enter. If Esc is pressed in between, the password entering is terminated.

"Password OK" is shown if correct password is entered. "Password ERROR" is shown if wrong password is entered.

The display returns to the point of the preceding menu. Pressed Enter again to modify the setting.

If no key is pressed after 2 minutes, the settings are locked. A new password request is associated with any subsequent setting change.

Changing Password

To change the password, go to Op Parameter -> Password menu. Enter current password to unlock, after that the display shows current password. Press Enter again to enter the new password.

4.0 Menus

The menu is divided into 8 main menus and their corresponding submenus. To enter Main menu, press Enter during default display.

The menu can be navigated by pressing Up, Down, Enter and Esc keys. There is no need of a password when reading settings and measured values.

4.1 Menu Contents

The Main menu consists of 8 items:

1. MEASUREMENTS, 2. RECORDS, 3. CONFIGURATION, 4. PROTECTION G1,
5. PROTECTION G2, 6. INPUT, 7. OUTPUT, 8. COMMUNICATION

Default Display and Menu Contents

Default Display

Page 1

IL1:0.00 IL2:0.00 IL3:0.00 Io :0.00

Page 2

Output 1 2 3 4 0 0 0 0

Page 3

Input 1 2 0 0

Page 4

Date XX/XX/XXXX Time XX:XX

1.MEASUREMENTS

- IL1
- IL2
- IL3
- Io
- Thermal θ
- Frequency
- IL1 Max
- IL2 Max
- IL3 Max
- Io Max
- IL1 Avg
- IL2 Avg
- IL3 Avg
- Io Avg
- Max & Avg I RST
- Timer Window

2.RECORDS

- **2.1 Fault Rcrds**
- **2.2 Event Rcrds**

3.CONFIGURATION

- **3.1 Op Parameter**
  - Password
  - Description
  - Firmware
  - Frequency
  - Active Group
- **3.2 CT Ratio**
  - Line CT Pri
  - E/Gnd CT Pri
- **3.3 Date & Time**
  - Date
  - Date Format
  - Time
  - Time Format
- **3.4 Group Select**
  - Chg Group by..
  - Setting Group
- **3.5 Display**
  - LCD On Time
  - LCD Brightness
  - "CLEAR" Scroll?
- **3.6 Cold Load PU**
  - CLPU Level
  - CLPU tCL
  - CLPU I>?
  - CLPU I>>?
  - CLPU I>>>?
  - CLPU Io>?
  - CLPU Io>>?
  - CLPU Thml OL?
- **3.7 Demand Alarm**
  - Demand Alarm?
  - Idmnd>
  - tIdmnd>

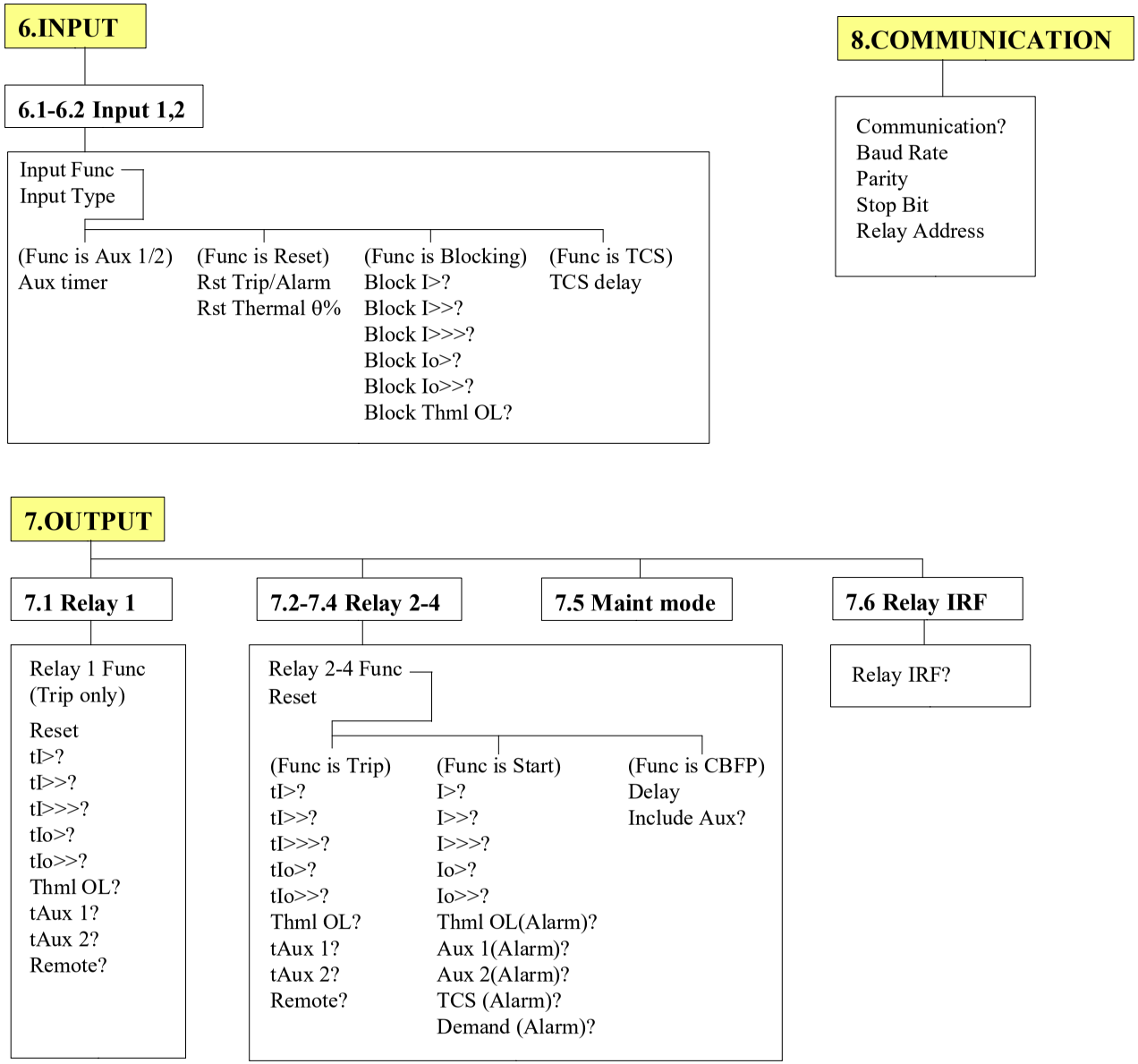
4.PROTECTION G1

- **4.1 Phase OC**
  - I>?
  - I>
  - I> Delay Type
  - I> IDMT Curve
  - ktI>
  - tI>
  - I>>?
  - I>>
  - tI>>
  - I>>>?
  - I>>> Sample
  - I>>>
  - tI>>>
- **4.2 Earth OC**
  - Io>?
  - Io>
  - Io> Delay Type
  - Io> IDMT Curve
  - ktIo>
  - tIo>
  - Io>>?
  - Io>>
  - tIo>>
- **4.3 Thermal OL**
  - Thermal OL?
  - Iθ>
  - Tθ
  - k
  - θ Trip
  - θ Alarm

5.PROTECTION G2

Similar to PROTECTION G1

* Some of the menu items are not shown if relevant functions are disabled



* Some of the menu items are not shown if relevant functions are disabled

MEASUREMENTS Menu

Various measurement values can be read under MEASUREMENTS menu. (The values are shown for illustrative purpose).

1.MEASUREMENTS	Heading of MEASUREMENTS menu. Press Enter to enter submenu content.
IL1 52.0A	Phase 1 current value. Taking into account of Line CT Pri ratio.
IL2 88.2A	Phase 2 current value. Taking into account of Line CT Pri ratio.
IL3 64.2A	Phase 3 current value. Taking into account of Line CT Pri ratio.
Io 4.23A	Earth current value. Taking into account of E/Gnd CT Pri ratio.
Thermal θ RST=CLEAR 35%	Thermal % state. Calculated on true RMS current values. Press Clear to clear the % values.
Frequency 50.01Hz	Current frequency calculated from phase 1 currents.
IL1 Max 120A	Peak Phase 1 current value.
IL2 Max 234A	Peak Phase 2 current value.
IL3 Max 1.23kA	Peak Phase 3 current value.
Io Max 1.23kA	Peak Earth current value.
IL1 Avg 323A	Average Phase 1 current value.

IL2 Avg 80.4A	Average Phase 2 current value.
IL3 Avg 78.2A	Average Phase 3 current value.
Io Avg 6.24A	Average Earth current value.
Max & Avg I RST RST=CLEAR	To clear the maximum and average values of the currents. Press Clear to clear these values.
Time Window 10min	Set the value for the time window (rolling) during which maximum and average values are stored. Press Enter to change the value.

RECORDS Menu

2.RECORDS	Heading of RECORDS menu. Press Enter to enter submenu content.

Fault Records Menu

2.1 Fault Rcrds	Heading of Fault Record submenu. Press Enter to enter submenu content.
tI> trip [1] L3	Example of Fault Record title page, showing trip element, source, value and record number 1. Press Up or Down to show another record of Enter to enter sub page for this record. Press Clear to clear this record.
Date: 03/01/2011 Time: 10:19:52am	Fault record sub page 1, showing record date and time. Press down to show next sub page. Press Esc/Enter to return to Fault Record title page.
Active Set Group 1	Fault record sub page 2, showing active protection setting group during fault. Press Up/down to change sub page. Press Esc/Enter to return to Fault Record title page.
IL1 Magnitude 4.86A	Fault record sub page 3, showing L1 current during fault. Press Up/down to change sub page. Press Esc/Enter to return to Fault Record title page.

IL2 Magnitude 4.52A	Fault record sub page 4, showing L2 current during fault. Press Up/down to change sub page. Press Esc/Enter to return to Fault Record title page.
IL3 Magnitude 15.2A	Fault record sub page 5, showing L3 current during fault. Press Up/down to change sub page. Press Esc/Enter to return to Fault Record title page.
Io Magnitude 1.2A	Fault record sub page 6, showing Lo current during fault. Press Up to previous sub page. Press Esc/Enter to return to Fault Record title page.

Clearing all records

Clear all rcrds? Clear=CLEAR	Clearing all record menu is shown when Up is pressed during display of Record 1's title page, or Down is pressed during display of Last records title page. Press Clear to clear all record or Esc to cancel.

Event Records Menu

2.2 Event Rcrds	Heading of Fault Record submenu. Press Enter to enter submenu content.
Genrl strt [1]	Example of Event title page. Press Enter to enter sub page for this record.
Date: 03/02/2011 Time: 08:23:44am	Event record sub page, showing record date and time. Press Esc/Enter to return to Fault Record title page.

Clearing all records

Clear all rcrds? Clear=CLEAR	Clearing all record menu is shown when Up is pressed during display of Record 1's title page, or Down is pressed during display of Last records title page. Press Clear to clear all record or Esc to cancel.

CONFIGURATION Menu

3.CONFIGURATION	Heading of CONFIGURATION menu. Press Enter to enter submenu content.

Op parameter Menu

3.1 Op Parameter	Heading of Op Parameter submenu. Press Enter to enter submenu content.
Password ****	This password is required when changing relay settings. Press Enter to enter a new password. The user needs to enter existing password to unlock, after that the display shows current password. Press Enter again to enter the new password.
Description X60	Model name of this relay
Firmware 1.0	Version of the firmware.
Frequency 50Hz	Set the nominal value of the line frequency. Press Enter to change this value.

CT Ratio Menu

3.2 CT Ratio	Heading of CT Ratio menu. Press Enter to enter submenu content
Line CT Pri 500A	Set the rated primary current of the Line/Phase CT.
E/Gnd CT Pri 200A	Set the rated primary current of the Earth/Ground CT.

Note: The CT secondary should be connected to 5A or 1A CT input terminal of the relay according to Primary CT type. The display current is calculated by the formula:

Current at CT input terminal / CT input terminal type x CT Pri (setting above)

For example if:
Current at CT input terminal = 3A,
CT input terminal type = 5A,
CT Pri = 200A,

The display value = 3/5 x 200 = 120A

Date & Time Menu

3.3 Date & Time	Heading of Date & Time menu. Press Enter to enter submenu content.
Date 16/09/2012	Displays the date. Press Enter to change the date.
Date Format DD/MM/YYYY	Set the date format for display. Press Enter to change between DD/MM/YYYY and MM/DD/YYYY.
Time 10:46:23am	Displays the time. Press Enter to change the time, starts from hour, minute and am/pm (if 12 hour format is selected). Second will be reset to 0 when enter is pressed for any of the digit.
Time Format 12-hour	Set the time format. Press enter to change between 12 and 24 hour.

Group Select Menu

3.4 Group Select	Heading of Group Select menu. Press Enter to enter submenu content.
Chg Group by... Menu	Set whether the protection group setting is change by Menu or Input. One of the input function must be set to 'Select Group' if Input is selected. Press Enter to change.
Setting Group 1	If above is set to Menu, this will set the active protection group. Press Enter to change.

Display Menu

3.5 Display	Heading of Display menu. Press Enter to enter submenu content.
LCD On Time 10min	Set how long the LCD backlight remains on after no key is pressed. Press Enter to change.

LCD Brightness Medium	Set the brightness of the LCD backlight. Press Enter to chage.
“CLEAR” Scroll? No	Set if Clear key can be used (during no alarm or trip state) to scroll through the default display pages, Phase OC and Earth OC settings (for currently selected group), as well as to return to Default Display from Record display. This is useful when Up, Down, Enter and Esc key is inaccessible due to the front panel is covered and locked.

Cold Load Pickup Menu

Cold Load Pickup allows selected settings to be altered to respond to temporary overload conditions that may occur during cold starts. These conditions could be switching on large heating load after a extended cooling period, air conditioning, or inductive loads that draw high starting current like motor.

To use cold load pickup function, one of the input function has to be set to Cold Load PU.

3.6 Cold Load PU	Heading of Cold Load Pickup menu. Press Enter to enter submenu content.
CLPU Level 200%	Scaling value, in percent, for the cold load pick up assigned to the selected thresholds.
CLPU tCL 5.00s	Delay timer setting (tCL) for the Cold Load Pickup function.
CLPU tI>? Yes	Assign the I> time delay threshold with the cold load pick up function.
CLPU tI>>? Yes	Assign the I>> time delay threshold with the cold load pick up function.
CLPU tI>>>? Yes	Assign the I>>> time delay threshold with the cold load pick up function.
CLPU tIo>? Yes	Assign the Io> time delay threshold with the cold load pick up function.

CLPU tIo>>? Yes	Assign the Io>> time delay threshold with the cold load pick up function.
CLPU Thml OL? Yes	Assign the Thermal Overload time delay threshold (Iθ>) with the cold load pick up function.

Demand Alarm Menu

Demand alarm is used to give alarm signal when load current is higher than the threshold. The threshold is set lower than overcurrent for proper functioning.

3.7 Demand Alarm	Heading of Demand Alarm menu. Press Enter to enter submenu content.
Demand Alarm? Yes	Set to Yes to enable demand alarm. Then the following menu is displayed.
Idmnd> 1.50In	Set the value for the current threshold Idmnd>.
tIdmnd> 9.00s	Set the value for the time delay of Idmnd>.

PROTECTION G1 Menu

4.PROTECTION G1	Heading of PROTECTION G1 (Group 1) menu. Press Enter to enter submenu content.

Phase OC Menu

4.1 Phase OC	Heading of Phase OC (Overcurrent) menu. Press Enter to enter submenu content.

I> menu

I>? Yes	Set to Yes to enable first phase overcurrent threshold (I>). Then the following menu is displayed.
I> 2.00In	Set the value for the current threshold I>. NOTE : When delay type is IDMT, the maximum setting recommended should be 2.00In.

I> Delay Type IDMT	Set the time delay type of I>. Setting choices are: IDMT (inverse definite time curve) and Definite Time.

If Definite Time is selected, the following menu is displayed:

tI> 1.00s	Set the value for the time delay of I> definite time.

If IDMT is selected, the following menu is displayed:

I> IDMT Curve Normal Invrse	Set the type of curve.
ktI> 0.20	Set the time multiplier setting value for the curve.

I>> menu

I>>? Yes	Set to Yes to enable second phase overcurrent threshold (I>>). Then the following menu is displayed.
I>> 9.00In	Set the value for the current threshold I>>.
tI>> 100ms	Set the value for the time delay of I>> definite time.

I>>> menu

I>>>? Yes	Set to Yes to enable third phase overcurrent threshold (I>>>). Then the following menu is displayed.
I>>> Sample Yes	Set to yes to enable I>>> operated on current sample base. Otherwise it operates on fundamental value. Sample base method will ensure fast tripping on highly saturated current signal.
I>>> 20.0In	Set the value for the current threshold I>>>.
tI>>> 30ms	Set the value for the time delay of I>>> definite time.

Earth Fault Menu

4.2 Earth Fault	Heading of Earth Fault menu. Press Enter to enter submenu content.

Io> menu

Io>? Yes	Set to Yes to enable first earth fault threshold (Io>). Then the following menu is displayed.
Io> 0.10Ion	Set the value for the current threshold Io>. NOTE : When delay type is IDMT, the maximum setting recommended should be 0.5Ion.
Io> Delay Type IDMT	Set the time delay type of Io>. Setting choices are: IDMT and Definite Time.

If Definite Time is selected, the following menu is displayed:

tIo> 1.00s	Set the value for the time delay of Io> definite time.

If IDMT is selected, the following menu is displayed:

Io> IDMT Curve Normal Invrse	Set the type of curve.
ktIo> 0.20	Set the time multiplier setting value for the curve.

Io>> menu

Io>>? Yes	Set to Yes to enable second earth fault threshold (Io>>). Then the following menu is displayed.
Io>> 1.00Ion	Set the value for the current threshold Io>>.
tIo>> 100ms	Set the value for the time delay of Io>> definite time.

Thermal OL Menu

4.3 Thermal OL	Heading of Thermal OL (Overload) menu. Press Enter to enter submenu content.
Thermal OL? Yes	Set to Yes to enable thermal overload protection. Then the following menu is displayed.
Iθ> 1.50In	Set the value for the thermal overload Iθ>.
Tθ> 10min	Set the value for the thermal time constant.
k> 1.10	Set the value for the k factor.
θ Trip 100%	Set the percentage of the thermal overload trip.
θ Alarm 100%	Set the percentage of the thermal overload alarm. (To disable this alarm, set this value to equal or higher than θ Trip %)

PROTECTION G2 Menu

5.PROTECTION G2 (Group 2) menu has similar content as PROTECTION G1 (Group 1) menu. The Protection G2 settings is applied when Protection Group 2 is activated.

INPUT Menu

6.INPUT	Heading of INPUT menu. Press Enter to enter submenu content.
6.1 Input 1	Heading of Input 1 menu. Press Enter to enter submenu content.

Input 1 Func Aux 1

Set the function of Input 1. Setting choices are: None, Aux 1, Aux2, Reset, Blocking, TCS, Select Group, Cold Load PU (pickup) and Sync Clock.

Aux 1 or Aux 2: The input is used as auxiliary alarm or tripping signal.

If tAux is not assigned to trip output relay (whether it is assigned to a start output relay or not), activation of the input will generate an Aux Alarm signal after time delay.

If tAux is assigned to trip output relay, the input will generate an Aux Trip signal after time delay.

Reset, Blocking, TCS: See below

Select Group: Input deactivated to select Protection Group 1, activated to select Protection Group 2. To enable changing group by input, 3.4 Group Select->Chg Group by.. must be set to Input.

Cold Load PU: Activation of the input starts CLPU timer and increases protection threshold defined by 3.6 Cold Load PU setting.

Sync Clock: An activation of the input will set the clock to the nearest minute.

Input 1 Type Active High

Set how the input 1 is activated. For Active High, energizing the input activates the input. For Active Low, de-energizing the input activates the input.

If Aux 1 or Aux 2 is selected, the following menu is displayed:

Aux timer 500ms

Set the value for the time delay of Aux 1 or 2 definite time.

If Reset is selected, the following menu is displayed:

Rst Trip/Alarm Yes

Set to yes to enable the input to reset trip and alarm.

Rst Thermal θ% No

Set to yes to enable the input to reset thermal %.

If Blocking is selected, the following menu is displayed:

Block I>? No

Set to yes to enable blocking of I>.

Block I>>? No

Set to yes to enable blocking of I>>.

Block I>>>? No	Set to yes to enable blocking of I>>>.
Block Io>? No	Set to yes to enable blocking of Io>.
Block Io>>? No	Set to yes to enable blocking of Io>>.
Block Thml OL? No	Set to yes to enable blocking of Thermal Overload.

If TCS (trip circuit supervision) is selected, the following menu is displayed:

TCS delay 500ms	Set the value for the time delay of TCS. TCS alarm triggers when the input is deactivated for longer than the time delay. TCS function is enabled when the trip contact output (RL1) is not energized.

Input 2 Menu has similar content as Input 1 menu. The settings are applied to input 2.

OUTPUT Menu

7.OUTPUT	Heading of OUTPUT menu. Press Enter to enter submenu content.

Output Relay 1

7.1 Relay 1	Heading of output relay 1 menu. Press Enter to enter submenu content.
Relay 1 Func Trip	Set the function of output Relay 1. Note that Relay 1 function is locked to Trip.
Reset Auto	Set the reset method of relay: Auto (Unlatched), Manual (Latched).

tI>? Yes	Assign I> trip to the output relay.
tI>>? Yes	Assign I>> trip to the output relay.
tI>>>? Yes	Assign I>>> trip to the output relay.
tIo>? Yes	Assign Io> trip to the output relay.
tIo>>? Yes	Assign Io>> trip to the output relay.
Thml OL? Yes	Assign Thermal Overload to the output relay.
tAux 1? Yes	Assign Aux 1 input trip to the output relay.
tAux 2? Yes	Assign Aux 2 input trip to the output relay.
Remote? Yes	Assign Remote trip (by communication) to the output relay.

Output Relay 2 to 4

Output Relay 2 to 4 menu has similar content. The output Relay 2 menu content is shown below:

7.2 Relay 2	Heading of output Relay 2 menu. Press Enter to enter submenu content.
Relay 2 Func Start	Set the function of output Relay 2. Possible settings are: Trip, Start and CBFP .
Reset Auto	Set the reset method of relay: Auto (Unlatched), Manual (Latched).

If relay function is set to Trip, the menu content similar to Relay 1 is shown, please refer to Output Relay 1.

If relay function is set to Start, the following menu is displayed:

I>? Yes	Assign I> start to the output relay.
I>>? Yes	Assign I>> start to the output relay.
I>>>? Yes	Assign I>>> start to the output relay.
Io>? Yes	Assign Io> start to the output relay.
Io>>? Yes	Assign Io>> start to the output relay.
Thml OL(Alarm)? Yes	Assign Thermal Overload Alarm to the output relay.
tAux 1(Alarm)? Yes	Assign Aux 1 input alarm to the output relay.
tAux 2(Alarm)? Yes	Assign Aux 2 input alarm to the output relay.
TCS (Alarm)? Yes	Assign TCS alarm to the output relay.
Demand (Alarm)? Yes	Assign Demand alarm to the output relay.

If relay function is set to CBFP (Circuit Breaker Failure Protection) the following menu is displayed:

Delay 200ms	Set the value for the time delay of CBFP. This output relay is activated, if after the activation of the trip relay, the fault has not been cleared for longer than this delay.

Include Aux? No	Set if Aux 1 or 2 input is included as fault condition. Prolonged activation or latched Aux input could cause the undesirable activation of CBFP relay.

Maintenance Mode Menu

7.5 Maint mode (Prot disabled)	Heading of Maintenance Mode menu. Press Enter to enter submenu content.
Output 1 2 3 4 Test 0 0 0 0	Press Enter once, output 1 blinks, press Up/Down to toggle the output status. Press Enter again to test output 2, and subsequently for output 3 and 4. Press Esc to exit.

Relay IRF

7.6 Relay IRF	Heading of Relay IRF menu. When enabled, relay IRF is on when relay operates normally. If IRF output is not needed, it can be disabled to save some power.
Relay IRF Yes	Set to Yes to enable, No to disable Relay IRF output.

COMMUNICATION Menu

Communication setting is applicable to the RS485 port on the rear terminals of the relay (the front panel RS232 port has fixed communication settings: 38400bps, 1 stop bit, even parity, address 1).

8.COMMUNICATION	Heading of COMMUNICATION menu. Press Enter to enter submenu content.
Communication? Yes	Set to yes to enable MODBUS RTU communication.
Baud Rate 38400bps	Set the baud rate in bit per second (bps).
Parity Even	Set the parity in the data frame.
Stop Bit 1	Set the number of stop bit in the data frame.
Relay Address 1	Set the address of the relay in the MODBUS network.

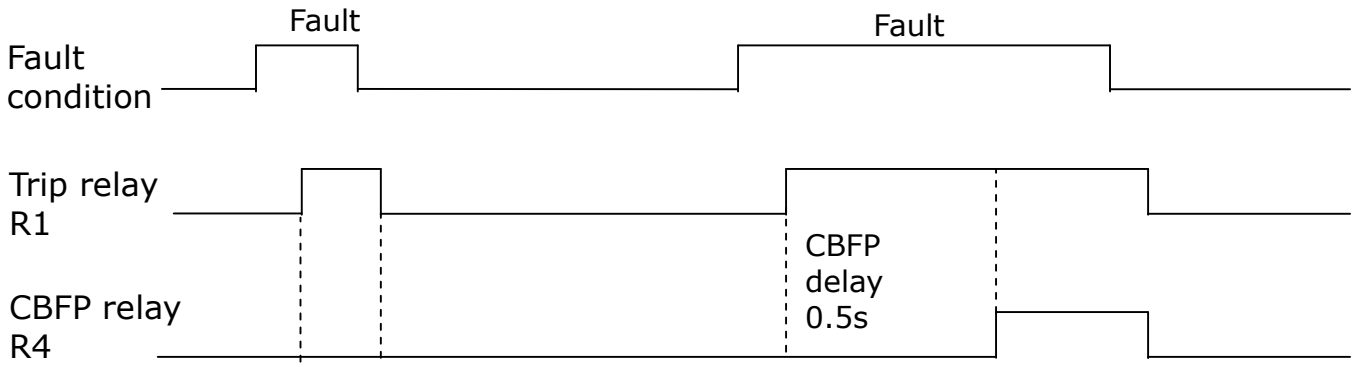
5.1 Circuit Breaker Failure Protection

Circuit breaker failure protection (CBFP) is used to generate a tripping signal via selected output relay after a preset time delay if the fault has not been cleared after the activation of tripping signal through trip contact relay R1. Thermal overload is excluded from fault condition for CBFP.

CBFP output is usually used to trip the upstream circuit breaker or to trip a redundant tripping circuit of the same circuit breaker.

CBFP function can be assigned to relay R2 to R4.

There is an option to enable or disable Aux 1 or 2 as a fault condition (if Aux 1 or 2 is assigned to a digital input as a tripping source). Prolonged activation or latched Aux input could cause the undesirable activation of CBFP relay, in this case set 'Include Aux' to 'No' to disable the condition.



Timing diagram for CBFP. (R4 function set to CBFP, delay 0.5s.)

5.2 Thermal Overload Protection

Thermal overload protection can be used to prevent damages to the equipment of the electrical plant. A prolonged overloading causes excessive heating, which may result in deterioration of the insulation, or in extreme cases, insulation failure.

Load current is used to calculate the heating and cooling effect of the equipment to be protected. The highest phase current is automatically used as input information for the thermal model.
The thermal overload protection can be set with both alarm and trip stages, θ Trip % and θ Alarm %, with 5% below the set % for resetting.

The heating within any plant equipment, such as cables or transformers, is of resistive type (I^2R x t). Thus the thermal time characteristic used in the relay is based on current squared, integrated over time.

Protection equipment is designed to operate continuously at a temperature corresponding to its full load rating, where heat generated is balanced with heat dissipated. Over-temperature conditions occur when currents in excess of rating flow for a certain period of time. It can be shown that temperatures during heating follow exponential time constants and a similar exponential decrease of temperature occurs during cooling.

In order to apply this protection element, the thermal time constant ($T\theta$) of the plant equipment to be protected is therefore required.

The calculation of the Time to trip is given by:

$$T_{trip} = T_\theta \ln \left(\frac{\left| K^2 - \theta \right|}{\left| K^2 - \theta_{trip} \right|} \right)$$

T_{trip} = Time to trip (in seconds)
T_θ = Thermal time constant of the protected element (in seconds)

$$K = \frac{I_{eq}}{k.I_\theta >}$$

I_{eq} = Equivalent current corresponding to the RMS value of the largest phase current.
$I\theta >$ = Full load current rating given by the national standard or by the supplier.
k = Factor associated to the thermal state formula.
θ = Initial thermal state. If the initial thermal state = 30% then θ = 0.3
θ_{trip} = Trip thermal state. If the trip thermal state is set at 100%, then θtrip = 1

The settings of these parameters are available in the menus:
PROTECTION G1/G2 – Thermal OL

The calculation of the thermal state is given by the following formula:

$$\theta_{\tau+1} = K^2 \left(1 - e^{\frac{-t}{T\theta}}\right) + \theta_\tau \, e^{\frac{-t}{T\theta}}$$

θ being calculated every 20ms.

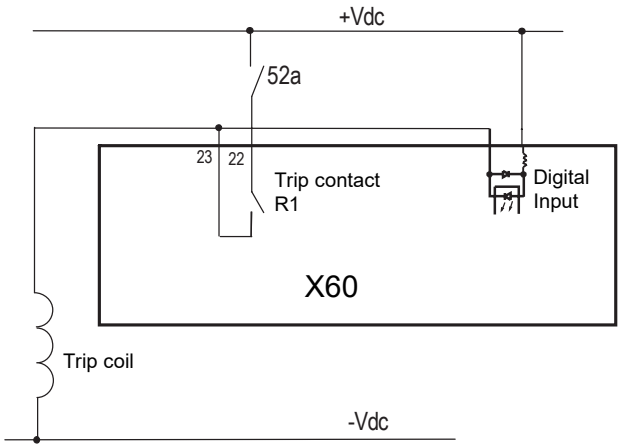
5.3 Trip Circuit Supervision

Trip Circuit Supervision (TCS) enables the trip circuit to be monitored. To enable TCS function, set one of the Digital Input function to TCS (at the INPUT Menu), Input Type as Active High and set the appropriate TCS delay time.

The continuity of trip circuit is monitor when Trip contact R1 is not energized. When the input detects no signal for a time longer than the TCS delay time, TCS alarm pops up to warn the failure of trip circuit. Three examples

Example 1: Trip Coil Monitoring

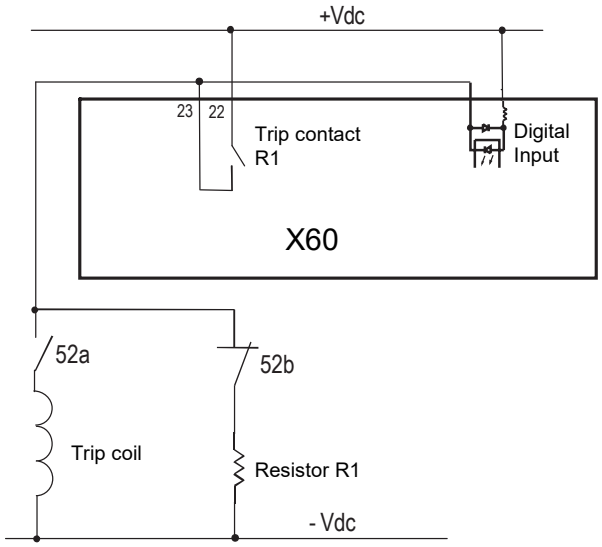
In this example only 52a auxiliary contact is available, the trip coil is monitored when the CB is open or closed.



Example 2: Trip Coil and Auxiliary Contacts Monitoring

In this example both 52a and 52b auxiliary contacts are available. The complete trip circuit is monitored when the CB is closed and a part of the trip circuit when the CB is open (excluding Trip coil).

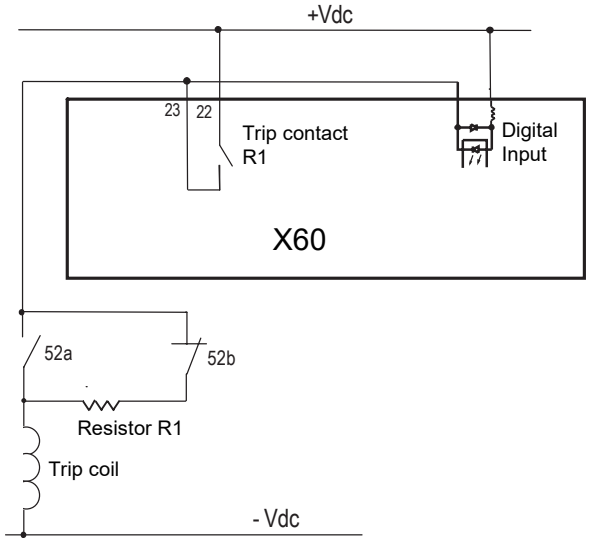
It is necessary to insert resistor R1 in series with 52b, if the Trip contact R1 is latched or it stays involuntarily closed.



Examples 3: Trip Coil and Auxiliary Contacts Monitoring when CB is open or closed

In this example both 52a and 52b auxiliary contacts are available, the complete trip circuit is monitored when the CB is open or closed.

In this case it is necessary to insert resistor R1, if the Trip contact R1 is latched or it stays involuntarily closed.



Recommended Resistor R1 Value

The recommended maximum resistor R1 value for various auxiliary voltage is shown:

Auxiliary Voltage, Ua	24Vdc	36Vdc	48Vdc	60Vdc	72Vdc	110Vdc	132Vdc
Maximum R1 value (Ohm)	4.7k	9.1k	13k	16k	22k	43k	62k
Power rating (W)	1/4	1/4	1/2	1/2	1/2	1	1

Auxiliary Voltage, Ua	220Vdc	264Vdc
Maximum R1 value (Ohm)	82k	91k
Power rating (W)	2	2

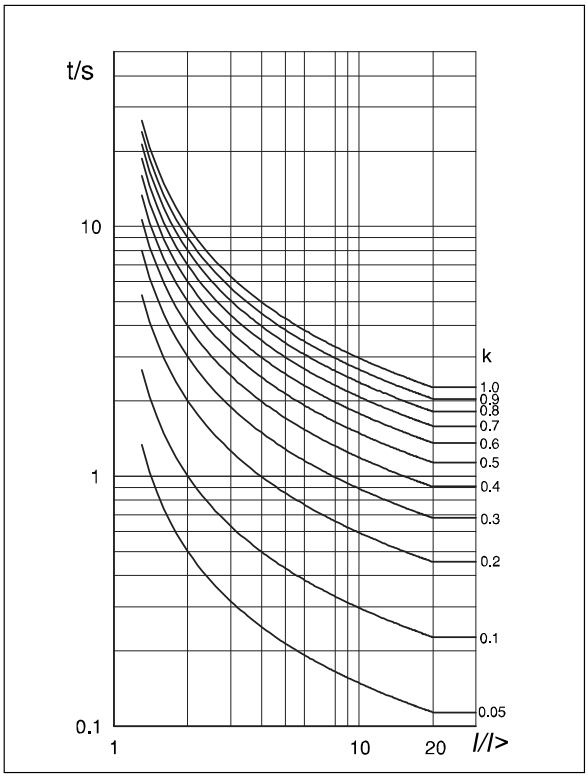
For the case of example 3, the maximum R1 value should be deducted by Trip coil resistance (insignificant in most cases).

The Power rating of the resistor R1 is calculated as:

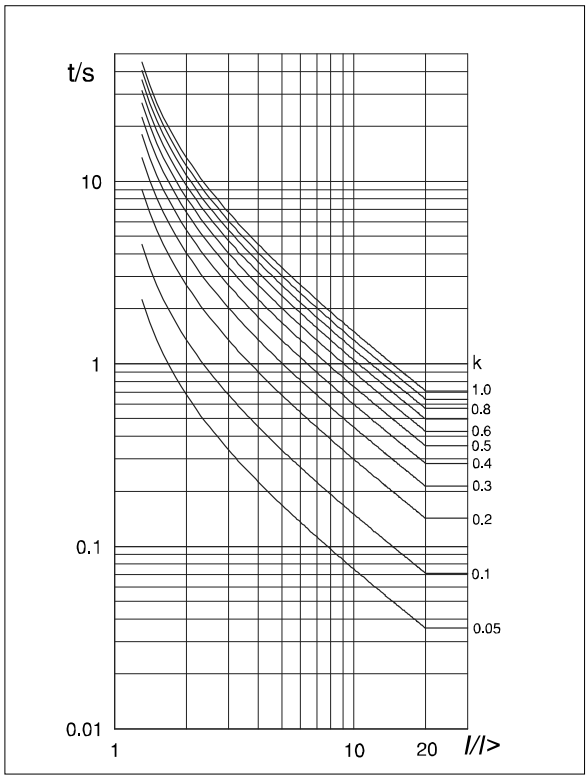
$$P_{R1} > 2 \times \frac{Ua^2}{R1} \text{ Watt}$$

5.4 Characteristic Curves

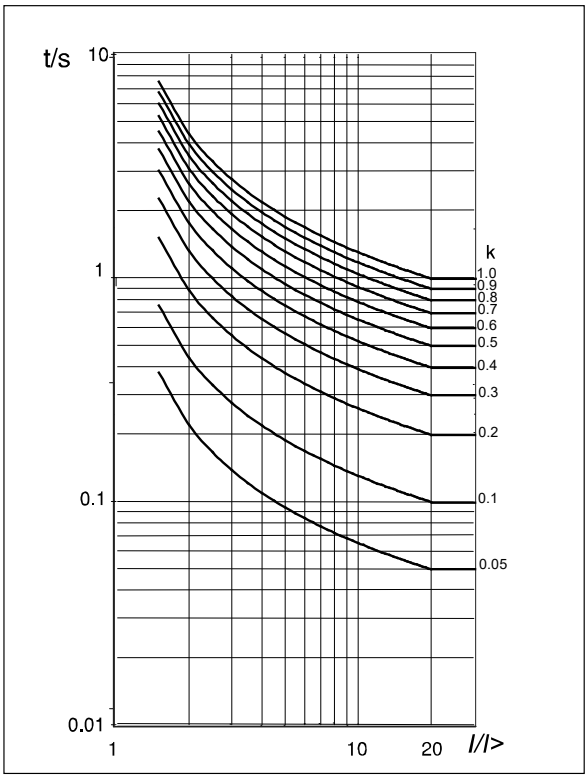
Normal Inverse



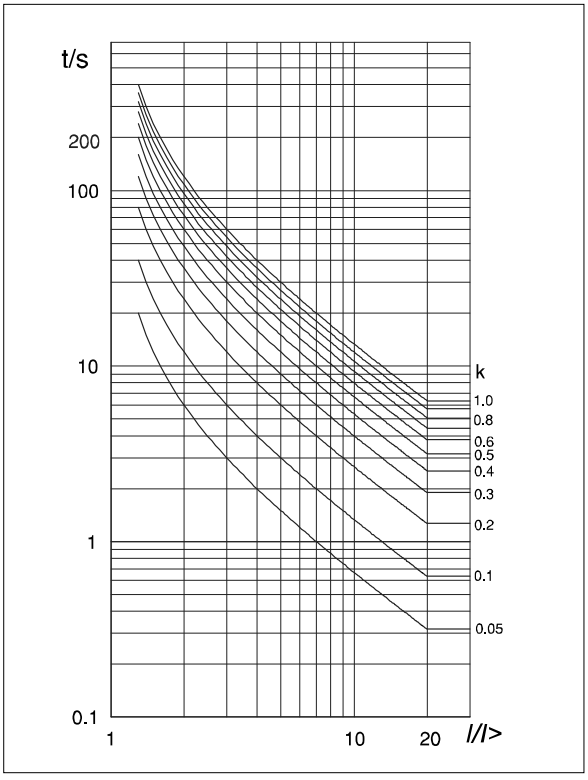
Very Inverse



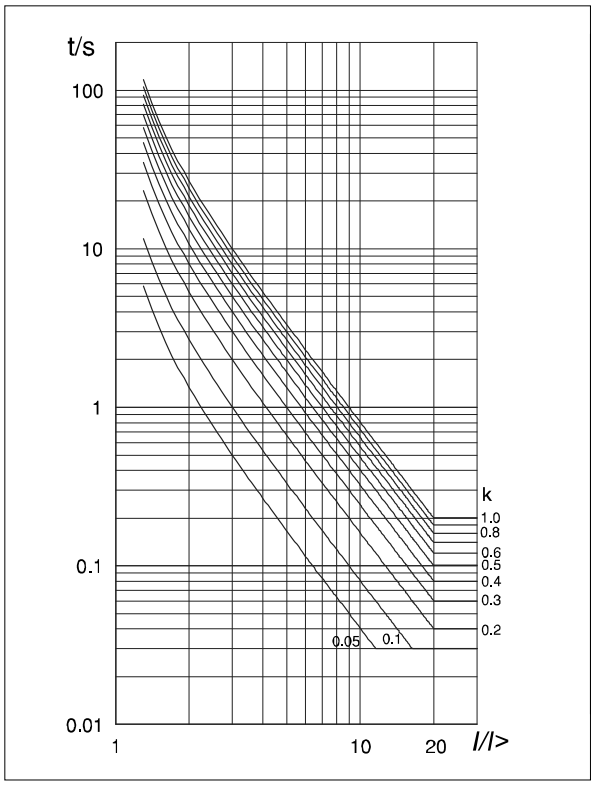
Normal Inverse 1.3/10



Long-time Inverse

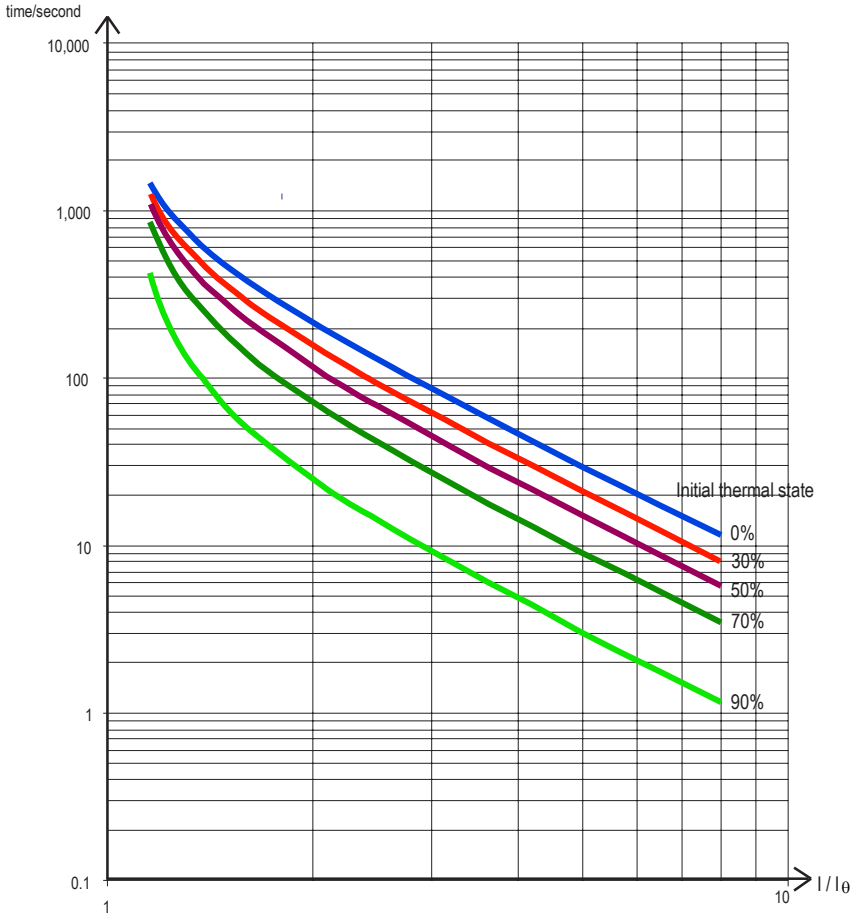


Extremely Inverse

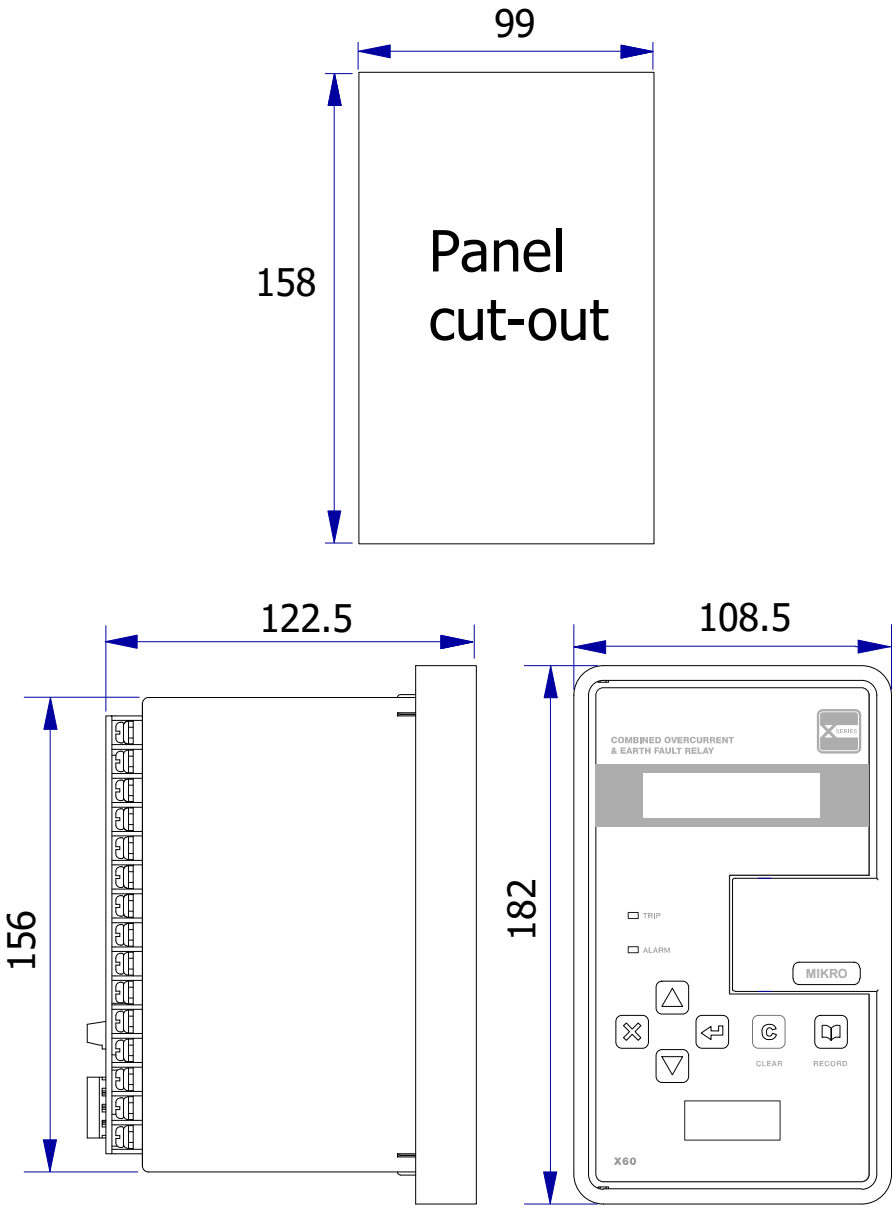


Thermal Overload Curves

(k=1.1, T_θ=10minutes)

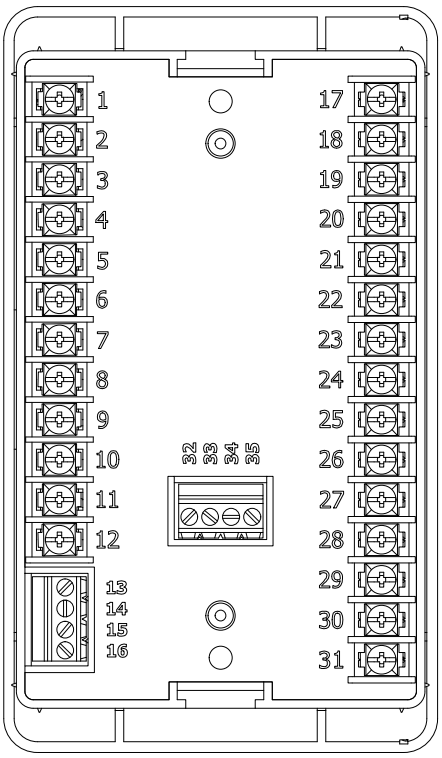


6.0 Case Dimensions



7.0 Connection Diagram and Terminal

7.1 Terminal Connection at Rear View

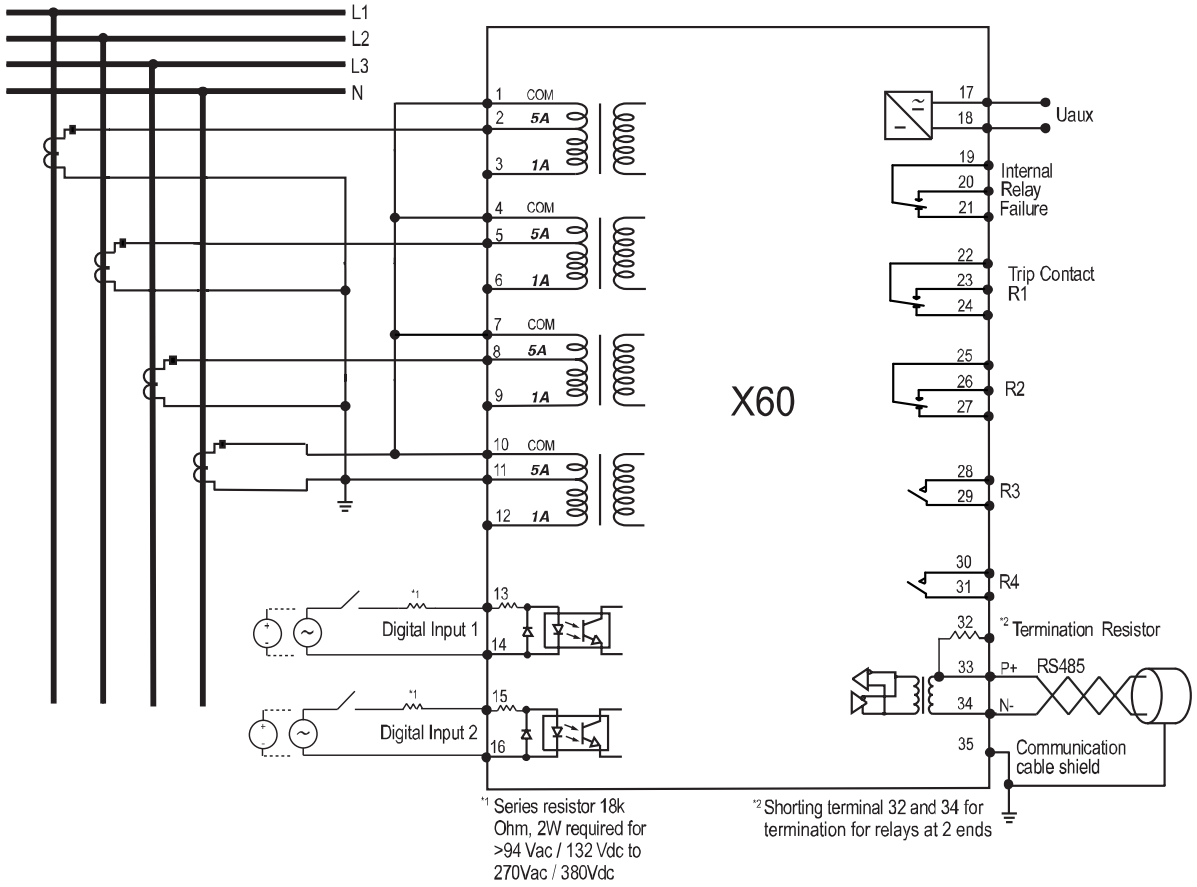


Connection terminal	Function Description
1	5A / 1A common CT input for IL1
2	5A CT input for IL1
3	1A CT input for IL1
4	5A / 1A common CT input for IL2
5	5A CT input for IL2
6	1A CT input for IL2
7	5A / 1A common CT input for IL3
8	5A CT input for IL3
9	1A CT input for IL3
10	5A / 1A common CT input for I0
11	5A CT input for I0
12	1A CT input for I0
13-14	Digital Input 2 (no polarity)
15-16	Digital Input 1 (no polarity)
17	Auxiliary supply input
18	Auxiliary supply input
19	Common contact for IRF
20	Normally open contact for IRF

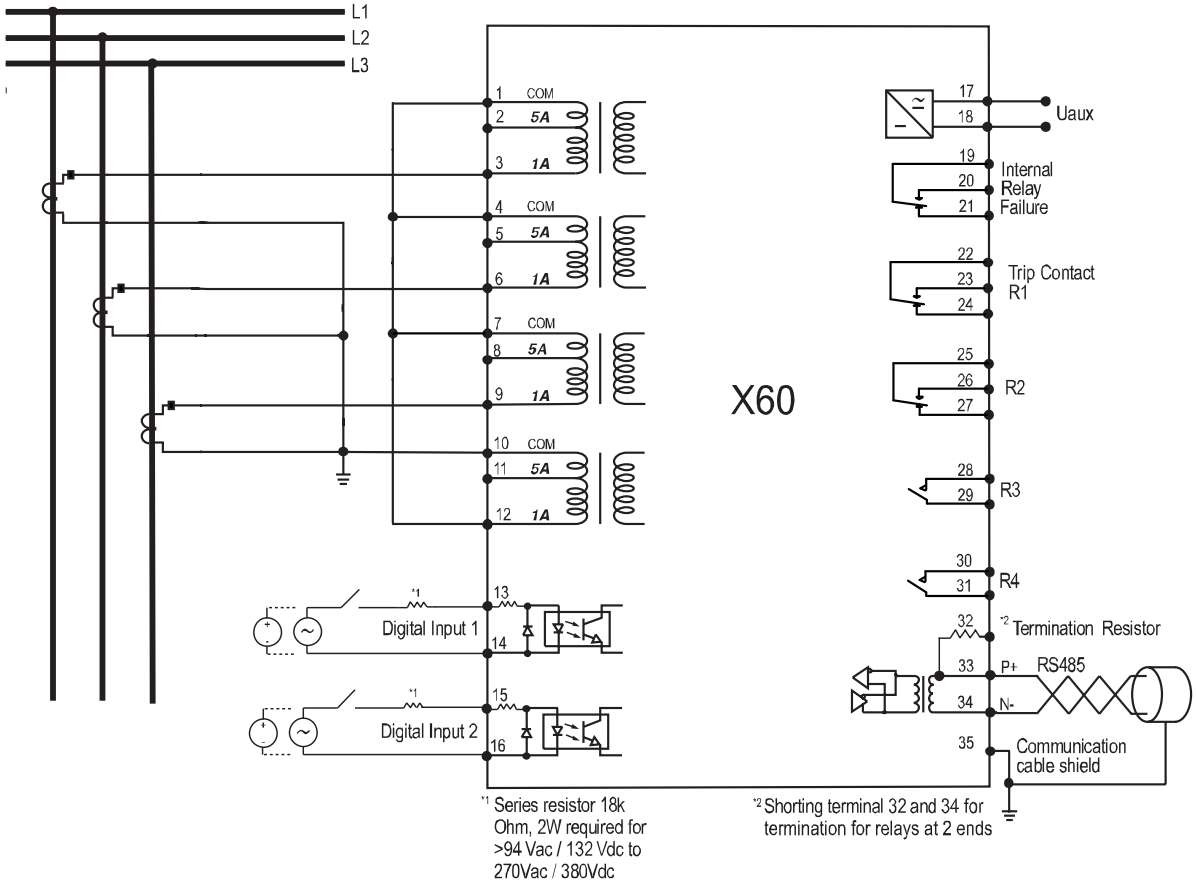
21	Normally closed contact for IRF
22	Common contact for tripping contact R1
23	Normally open contact for tripping contact R1
24	Normally closed contact for tripping contact R1
25	Common contact for output contact R2
26	Normally open contact for output contact R2
27	Normally closed contact for output contact R2
28	Normally open contact for output contact R3
29	Common contact for output contact R3
30	Normally open contact for output contact R4
31	Common contact for output contact R4
32	Termination resistor for RS485 (shorting to 34 for termination)
33	RS485 positive terminal
34	RS485 negative terminal
35	RS485 common terminal

7.2 Typical Connection Diagram

Example 1: With 3 phase 4 wires system. CT secondary 5A.



Example 2: With 3 phase 3 wires system. CT secondary 1A.



8.0 Technical Data

RATINGS

Auxiliary Supply

X60-150D

Rated voltage	:	30 ~ 120 V DC
Operating voltage	:	24 ~ 150 V DC

X60-240AD

Rated voltage	:	100 ~ 240 V AC or 140 ~ 340 V DC
Operating voltage	:	85 ~ 265 V AC or 110 ~ 370 V DC
Rated frequency	:	50 or 60Hz
Operating frequency	:	45 ~ 65 Hz

Power consumption	:	8 VA max

Current Inputs

Rated current In	:	1 or 5 A by connection
Frequency	:	50 or 60 Hz nominal
Burden	:	< 0.025 VA (1A)
	:	< 0.3 VA (5A)
Thermal withstand	:	4 x In continuous
	:	40 x In for 2s
	:	100 x In for 1s

Logic Inputs

Input type	:	Optically isolated
Rated voltage	:	20 ~ 380 V DC
	:	50 ~ 270 V AC
	:	(Series resistor 18k Ohm, 2W required for >94 V AC / 132 V DC direct input)

Output Relay

Trip Contact Relay (R1), R2, IRF Relay

Rated voltage	:	250 V AC/DC
Contact arrangement	:	Change-over
Continuous carry	:	5 A
Expected electrical life	:	100,000 operations at rated load
Expected mechanical life	:	5 x 10^6 operations

R3, R4

Rated load (resistive)	:	5 A at 250 V AC
	:	3 A at 30 V DC
Expected electrical life	:	100,000 operations at rated load
Expected mechanical life	:	5 x 10^6 operations

RECORDS

Fault Record	:	Up to 50 records.
Event Record	:	Up to 250 records
Alarm Record	:	Up to 30 records

SETTING RANGES

General

Line CT primary	: 1 to 10000 A. 1 to 1000: step 1; 1000 to 10000: step 5
Earth CT primary	: 1 to 10000 A. 1 to 1000: step 1; 1000 to 10000: step 5
Frequency	: 50 or 60 Hz

Phase Overcurrent

I>?	: Yes or No
I>	: 0.1 to 25 x In. *Variable steps. NOTE : When delay type is IDMT, the maximum setting recommended should be 2.00 x In.
I> Delay type	: IDMT or Definite Time
tI>	: 0 to 100 s. *Variable steps
I> IDMT curve	: Normal Inverse, Very Inverse, Extremely Inverse, Long-time Inverse, Normal Inverse 1.3/10
ktI	: 0.01 to 1.00
I>>?	: Yes or No
I>>	: 0.5 to 40 x In. *Variable steps
tI>>	: 0 to 100 s. *Variable steps
I>>>?	: Yes or No
I>>>	: 0.5 to 40 x In. *Variable steps
I>>> Sample	: Yes or No
tI>>>	: 0 to 100 s. *Variable steps

Earth Fault

Io?	: Yes or No
Io>	: 0.02 to 2 x Ion. *Variable steps NOTE : When delay type is IDMT, the maximum setting recommended should be 0.5 x Ion.
Io> Delay type	: IDMT or Definite Time
tIo>	: 0 to 100 s. *Variable steps
Io> IDMT curve	: Normal Inverse, Very Inverse, Extremely Inverse, Long-time Inverse, Normal Inverse 1.3/10
ktIo	: 0.01 to 1.00
Io>>?	: Yes or No
Io>>	: 0.1 to 10 x Ion. *Variable steps
tIo>>	: 0 to 100 s. *Variable steps

Thermal Overload

Thermal OL?	: Yes or No
Iθ>	: 0.1 to 3.00 x In. *Variable steps
Tθ	: 1 to 200 minutes. Step 1
k	: 1 to 1.5. Step 0.01
θ Trip	: 50 to 200%. Step 1%
θ Alarm	: 50 to 200%. Step 1%

Demand Alarm

Demand Alarm?	: Yes or No
Idmnd>	: 0.10 to 20 x In. *Variable steps
tIdmnd>	: 0.03 to 100 s. *Variable steps

Cold Load Pickup

CLPU Level	: 100 to 500%.
CLPU tCL	: 0.1 to 600 s

Input

Aux timer	: 0 to 600 s
TCS delay	: 0.1 to 10 s. *Variable steps

Output
CBFP Delay : 0.05 to 10.0 s. *Variable steps.

Communication
Communication? : Yes or No
Baud Rate : 2400, 4800, 9600, 19200 or 38400bps
Parity : None, Even or Odd
Stop Bit : 1 or 2
Relay Address : 1 to 255

*Variable steps: 0.1-1.00: step 0.01; 1.00-20: step 0.1; >20: step 1

MEASUREMENT RANGE

Phase and Earth current Display
: 0 to 999 kA. (Taking into account of CT Pri ratio)

Phase Current Secondary
5A input : 0 to 200 A
1A input : 0 to 40 A

Earth Current Secondary
5A input : 0 to 50A
1A input : 0 to 10A

Thermal θ : 0 to 9999%

Frequency : 20 to 80 Hz

ACCURACY

Is: I>, I>> or I>>>
Ios: Io> or Io>>

Element	Range	Trigger	Reset	Time deviation
Phase overcurrent I>, I>>, I>>>	0.1 to 40 x In	Is ± 2%	0.95 x Is ± 2%	DT: ±2% +30ms IDMT: ±5% +30ms (>1.2 x Is)
Earth fault overcurrent Io>, Io>>	0.02 to 10 x Ion	Ios ± 2%	0.95 x Ios ± 2%	DT: ±2% +30ms IDMT: ±5% +30ms (>1.2 x Is)
Thermal overload Iθ>	0.1 to 3 x In			±5%

INSULATION

High voltage dielectric withstand test IEC60255-5 : 2kV rms, 1 minute
High voltage impulse test IEC60255-5 : 5kV, 1.2/50us

STANDARDS

Complies with IEC 60255-26 standard
Electrical fast transient IEC61000-4-4, power supply : 4kV, 5kHz
Electrical fast transient IEC61000-4-4, other inputs : 2kV, 5kHz
Surge IEC61000-4-5, IEC 60255-22-5 : 4kV common mode
: 2kV differential mode
Electrostatic discharge IEC61000-4-2, air discharge : 8 kV

Electrostatic discharge IEC61000-4-2, contact discharge	: 6 kV
1MHz burst disturbance IEC60255-22-1	: 2kV Common mode
	: 1kV Differential mode

Conducted Immunity IEC61000-4-6	: 10V rms @ 1kHz 80%AM, 0.15 to 80MHz
Radiated Immunity IEC61000-4-3	: 10V/m 80Mhz to 1GHz @1kHz 80% am
Conducted emissions	: EN 55011 Group 1 Class B
Radiated EM Field emission	: CISPR 11 Group 1 Class B

ENVIRONMENTAL CONDITIONS

Temperature	: -5ºC to 55ºC
Humidity	: 56 days at 93% RH and 40ºC non-condensing

9.0 MODBUS Protocol

Both of the RS232 port on the front panel and the RS485 port on the rear terminals uses MODBUS RTU protocol.

The RS232 front panel port is fixed to 38400bps, even parity, 1 stop bit, relay address 1.
The RS485 rear port communication setting is set by the COMMUNICATION Menu from the front panel.

9.1 MODBUS Functions

The MODBUS functions described below are used:

0x03/0x04 Read Input/Holding Registers

These 2 commands have the same function

Request	Communication address	1 byte	0* to 255
	Function code	1 byte	0x03/0x04
	Starting Address	2 bytes	0x0000 to 0xFFFF
	Quantity of Registers	2 bytes	0x0001 to 0x007d (N)
	CRC	2 bytes	2 bytes CRC

Response	Communication address	1 byte	1 to 255
	Function code	1 byte	0x03/0x04
	Byte count	1 bytes	2 X N
	Quantity of Registers	N X 2 bytes	Value
	CRC	2 bytes	2 bytes CRC

Error	communication address	1 byte	1 to 255
	Error code	1 byte	0x83/0x84
	Exception code	1 bytes	0x01 or 02 or 03 or 04
	CRC	2 bytes	2 bytes CRC

0x06 Write Single Register

Request	Communication address	1 byte	0* to 255
	Function code	1 byte	0x06
	Register Address	2 bytes	0x0000 to 0xFFFF
	Register value	2 bytes	Value
	CRC	2 bytes	2 bytes CRC

Response	Communication address	1 byte	1 to 255
	Function code	1 byte	0x06
	Register value	2 bytes	value
	CRC	2 bytes	2 bytes CRC

Error	Communication address	1 byte	1 to 255
	Error code	1 byte	0x86
	Exception code	1 bytes	0x01 or 02 or 03 or 04
	CRC	2 bytes	2 bytes CRC

0x10 Write Multiple Registers

Request	Communication address	1 byte	0* to 255
	Function code	1 byte	0x10
	Starting Address	2 bytes	0x0000 to 0xFFFF
	Quantity of Registers	2 bytes	0x0001 to 0x007b (N)
	Byte count	1 byte	2 X N
	Register value	N X 2 bytes	Value
	CRC	2 bytes	2 bytes CRC

Response	Communication address	1 byte	1 to 255
	Function code	1 byte	0x10
	Quantity of Registers	2 bytes	0x0001 to 0x007b (N)
	CRC	2 bytes	2 bytes CRC

Error	Communication address	1 byte	1 to 255
	Error code	1 byte	0x90
	Exception code	1 bytes	0x01 or 02 or 03 or 04
	CRC	2 bytes	2 bytes CRC

*Note: communication address 0 is a broadcast command to all the slave. The slave will not respond with a broadcast command.

9.2 MODBUS Register

Address		Parameter	Format	Units and Scale	Range
Dec	Hex				
Product information. Read only. Function 03h or 04h					
0	0000	Device type - main*	F1	ASCII	'00'
1	0001		F1	ASCII	'02'
2	0002		F1	ASCII	'00'
3	0003	Device type - sub*	F1	ASCII	'10'
4	0004	Version number -main	F1	ASCII	'XX'
5	0005		F1	ASCII	'XX'
6	0006	Version number -sub	F1	ASCII	'XX'
7	0007		F1	ASCII	'XX'
8	0008	Serial Number - High word	F7	--	0-99999999
9	0009	Serial Number - Low word	F7	--	
10-15	000A-000F	Reserved	--	--	--
Measurements and relay status. Read only. Function 03h or 04h					
16	0010	Relay status	F2	Bit field	Bit 0 - 15
17	0011	Relay LED status	F3	Bit field	Bit 0 - 3
18	0012	Input status	F4	Bit field	Bit 0 - 1
19	0013	Output status	F5	Bit field	Bit 0 - 3
20	0014	Active group	F6	--	0=group 1, 1=group 2
21	0015	Thermal State	F7	%	0-9999
22	0016	IL1 high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
23	0017	IL1 low word			
24	0018	IL2 high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
25	0019	IL2 low word			
26	001A	IL3 high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
27	001B	IL3 low word			
28	001C	Io high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
29	001D	Io low word			
30	001E	IL1 Max high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
31	001F	IL1 Max low word			
32	0020	IL2 Max high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
33	0021	IL2 Max low word			
34	0022	IL3 Max high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
35	0023	IL3 Max low word			
36	0024	Io Max high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
37	0025	Io Max low word			
38	0026	IL1 Avg high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
39	0027	IL1 Avg low word			
40	0028	IL2 Avg high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
41	0029	IL2 Avg low word			
42	002A	IL3 Avg high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
43	002B	IL3 Avg low word			
44	002C	Io Avg high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
45	002D	Io Avg low word			
46	002E	Line Frequency	F7	0.01 Hz	0-10000 (0-100Hz)
Remote command. Write only. Function 06h					
256	0100	Remote Command	F9	Bit field	--
Settings. Read/Write. Function 03h, 04h, 06h, 10h					
512	0200	Line CT Primary	F7	Ampere	1 - 10000
513	0201	Reserved			
514	0202	Earth/Ground CT Primary	F7	Ampere	1 - 10000
515	0203	Reserved			
516	0204	Frequency	F6	--	0=50Hz, 1=60 Hz
517	0205	Time Window for Average and Maximum Current	F7	minute	1 - 60
518	0206	Year	F7	year	0 - 199 (as 2000 - 2199)
519	0207	month, day	F10	month,day	0 - 12, 0 - 31
520	0208	hour, minute	F11	hour, minute	0 - 23, 0 - 59
521	0209	Milliseconds	F7	ms	0 - 59999

*Note: For X60, Device type – main is 00 02 00. Device type –sub is 00.

Address		Parameter	Format	Units and Scale	Range
Dec	Hex				
522	020A	Date & time format (for relay display only)	F12	--	0-1, 0-1
523	020B	Change Group by…	F13	--	0 - 1
524	020C	Setting Group	F6	--	0 = Group 1, 1 = Group 2
525	020D	LCD backlight on duration	F7	minute	1 - 60
526	020E	LCD backlight brightness	F6	--	0=low, 1=medium, 2=high
527	020F	Clear' key to scroll settings	F6	--	0=Disable, 1=Enable
528	0210	Communication? (Unused)	F6	--	0=Disable, 1=Enable
529	0211	Communication Baud Rate	F6	--	0=2400, 1=4800, 2=9600, 3=19200, 4=38400, 5=57600
530	0212	Communication Parity	F6	--	0=None, 1=Odd, 2=Even
531	0213	Communication Stop Bit	F6	--	0=1bit, 1=2bits
532	0214	Communication Address	F7	--	1 - 255
533	0215	Password	F7	--	0
534-543	0216-021F	Reserved - read as 0, write to void			
544	0220	Demand Alarm	F6	--	0=Disable, 1=Enable
545	0221	Idemand> threshold	F14	0.01 In	10-2000 (0.1 - 20)
546	0222	tIdemand> delay time	F14	0.01s	0 - 10000 (0 - 100s)
547-559	0223-022F	Reserved - read as 0, write to void			
560	0230	Cold Load Pick-up Level	F7	%	100-500%
561	0231	Cold Load Pick-up tCL	F14	0.01s	10-60000 (0.1-600s)
562	0232	Cold Load Pick-up element	F15	Bit field	Bit 0-5
563-575	0233-023F	Reserved - read as 0, write to void			
576	0240	Input 1 Function	F6	--	0=None, 1=aux1, 2=aux2, 3=Reset, 4=Blocking, 5=Trip, 6=Grp select, 7=CLPU, 8=Sync clock. Bit 7: 0=Active high, 1=Active low
577	0241	Input 1 Reset Option	F16	Bit field	Bit 0 - 1
578	0242	Input 1 Blocked element	F17	Bit field	Bit 0 - 5
579	0243	Input 1 Aux delay	F14	0.01s	0 - 60,000 (600s)
580	0244	Input 1 TCS delay	F14	0.01s	0 - 1000 (10s)
581	0245	Input 2 Function	F6	--	0=None, 1=aux1, 2=aux2, 3=Reset, 4=Blocking, 5=Trip, 6=Grp select, 7=CLPU, 8=Sync clock. Bit 7: 0=Active high, 1=Active low
582	0246	Input 2 Reset Option	F16	Bit field	Bit 0 - 1
583	0247	Input 2 Blocked element	F17	Bit field	Bit 0 - 5
584	0248	Input 2 Aux delay	F14	0.01s	0 - 60,000 (600s)
585	0249	Input 2 TCS delay	F14	0.01s	0 - 1000 (10s)
586-622	024A-026E	Reserved - read as 0, write to void			
623	026F	IRF Option	F6	--	0=Disable, 1=Enable
624	0270	Relay 1 Function (read only)	F6	--	0=none, 1=start/alarm, 2=trip, 3=upstream trip
625	0271	Relay 1 Reset option	F6	--	0=manual (latched), 1=auto reset (unlatched)
626	0272	Relay 1 Linked element	F18	Bit field	Bit 0 -10
627-628	0273-0274	Reserved - read as 0, write to void			
629	0275	Relay 2 Function	F6	--	0=none, 1=start/alarm, 2=trip, 3=upstream trip
630	0276	Relay 2 Reset option	F6	--	0=manual (latched), 1=auto reset (unlatched)
631	0277	Relay 2 Linked element	F18	Bit field	Bit 0 - 10
632	0278	Relay 2 CBFP option	F6	--	0=exclude Aux input, 1=include Aux input
633	0279	Relay 2 CBFP delay	F14	0.01s	5 - 1000 (50ms - 10s)
634	027A	Relay 3 Function	F6	--	0=none, 1=start/alarm, 2=trip, 3=upstream trip
635	027B	Relay 3 Reset option	F6	--	0=manual (latched), 1=auto reset (unlatched)
636	027C	Relay 3 Linked element	F18	Bit field	Bit 0 - 10
637	027D	Relay 3 CBFP option	F6	--	0=exclude Aux input, 1=include Aux input
638	027E	Relay 3 CBFP delay	F14	0.01s	5 - 1000 (50ms - 10s)
639	027F	Relay 4 Function	F6	--	0=none, 1=start/alarm, 2=trip, 3=upstream trip
640	0280	Relay 4 Reset option	F6	--	0=manual (latched), 1=auto reset (unlatched)
641	0281	Relay 4 Linked element	F18	Bit field	Bit 0 - 10
642	0282	Relay 4 CBFP option	F6	--	0=exclude Aux input, 1=include Aux input
643	0283	Relay 4 CBFP delay	F14	0.01s	5 - 1000 (50ms - 10s)

Address		Parameter	Format	Units and Scale	Range
Dec	Hex				
Protection Group 1					
768	0300	Thermal Overload	F6	--	0=Disable, 1=Enable
769	0301	Thermal Full Load Current, Iθ	F14	0.01 In	10 - 300 (0.1-3)
770	0302	Thermal Time Constant, Tθ	F7	minute	1 - 200
771	0303	Thermal Factor, k	F14	0.01	100-150 (1-1.5)
772	0304	Thermal Trip Threshold	F7	%	50 - 200
773	0305	Thermal Alarm Threshold	F7	%	50 - 200
774-783	0306-030F	Reserved - read as 0, write to void			
784	0310	I>	F6	--	0=Disable, 1=Enable
785	0311	I> Threshold	F14	0.01 In	10-2500 (0.1 - 25)
786	0312	I> Delay Type	F6	--	0=definite time, 1=IDMT
787	0313	tI> Definite Time	F14	0.01s	0 - 10000 (0 - 100s)
788	0314	I> IDMT Curve	F6	--	0=NI,1=VI,2=EI, 3=LTI, 4=NI1
789	0315	ktI> IDMT time multiplier	F14	0.01	1 - 100 (0.01 - 1)
790-799	0316-031F	Reserved - read as 0, write to void			
800	0320	I>>	F6	--	0=Disable, 1=Enable
801	0321	I>> Threshold	F14	0.01 In	50 - 4000 (0.5-40)
802	0322	tI>> Definite time	F14	0.01s	0 - 10000 (0 - 100s)
803-809	0323-0329	Reserved - read as 0, write to void			
810	032A	I>>>	F6	--	0=Disable, 1=Enable
811	032B	I>>> Sample	F6	--	0=No, 1=Yes
812	032C	I>>> Threshold	F14	0.01 In	50 - 4000 (0.5-40)
813	032D	tI>>> Definite time	F14	0.01s	0 - 10000 (0 - 100s)
814-815	032E-032F	Reserved - read as 0, write to void			
816	0330	Earth Fault Low Set Io>	F6	--	0=Disable, 1=Enable
817	0331	Earth Fault Low Set Io> Threshold	F14	0.01 Ion	2-200 (0.02 - 2)
818	0332	Earth Fault Low Set Io> Delay Type	F6	--	0=definite time, 1=IDMT
819	0333	Earth Fault Low Set Definite Time tIo>	F14	0.01s	0 - 10000 (0 - 100s)
820	0334	Earth Fault Low Set IDMT Curve	F6	--	0=NI,1=VI,2=EI, 3=LTI, 4=NI1
821	0335	Earth Fault Low Set IDMT Multiplier kto>	F14	0.01	1 - 100 (0.01 - 1)
822-831	0336-0339	Reserved - read as 0, write to void			
832	0340	Earth Fault High Set Io>>	F6	--	0=Disable, 1=Enable
833	0341	Earth Fault High Set Io>> Threshold	F14	0.01 Ion	10 - 1000 (0.1-10)
834	0342	Earth Fault High Set tIo>>	F14	0.01s	0 - 10000 (0 - 100s)

Address		Parameter	Format	Units and Scale	Range
Dec	Hex				
Fault Records. Read only. Function 03h or 04h					
4096	1000	Fault Record 1			
4097	1001	Fault Record 2			
:	:				
:	:				
4145	1031	Fault Record 50			

Each Fault Record consists of 16 words:

Word Number	Description	Format	Units and scale	Range
1	Year	F7	year	0 - 199 (as 2000 - 2199)
2	month, day	F10	month,day	0 - 12, 0 - 31
3	hour, minute	F11	hour, minute	0 - 23, 0 - 59
4	Milliseconds	F7	ms	0 - 59999
5	setting group	F7	--	0 - 1 (as group 1 - 2)
6	source & threshold	See below	source, threshold	0 - 12, 0 - 10
7	Value high word	F8	0.01 Ampere or 0.1% thermal	0-9.99x10^7 (999kA) or 500-2000
8	Value low word			
9	IL1 high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
10	IL1 low word			
11	IL2 high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
12	IL2 low word			
13	IL3 high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
14	IL3 low word			
15	Io high word	F8	0.01 Ampere	0-9.99x10^7 (999kA)
16	Io low word			

Word number 6:
High byte: Fault record source code
Bit 0: IL1
Bit 1: IL2
Bit 2: IL3
8: Io
9: Thermal
10: Aux 1
11: Aux 2
12: TCS
13: Remote

Low byte: Fault record threshold
0: tI>
1: tI>>
2: tI>>>
3: tIo>
4: tIo>>
5: Thermal Overload
6: tAux 1
7: tAux 2
8: Reserved
9: Reserved
10: Remote trip

Address		Parameter	Format	Units and Scale	Range
Dec	Hex				
Event Records. Read only. Function 0x03 or 0x04					
8192	2000	Record 1			
8193	2001	Record 2			
:	:				
:	:				
8441	20F9	Record 250			
Alarm Records. Read only. Function 0x03 or 0x04					
12288	3000	Record 1			
12289	3001	Record 2			
:	:				
:	:				
12317	301D	Record 30			

Each Event or Alarm Record consists of 6 words:

Word Number	Description	Format	Units and scale	Range
1	Year	F7	year	0 - 199 (as 2000 - 2199)
2	month, day	F10	month,day	0 - 12, 0 - 31
3	hour, minute	F11	hour, minute	0 - 23, 0 - 59
4	Milliseconds	F7	ms	0 - 59999
5	Record code	See below	record code	
6	Record value	See below	record value	

Word number 5:
Event and Alarm Record code
0: None
1: I> start
2: tI> trip
3: I>> start
4: tI>> trip
5: I>>> start
6: tI>>> trip
7: Io> start
8: tIo>> trip
9: Io>> start
10: tIo>> trip
11: Remote trip
12: Remote acknowledge
13: Remote reset
14: Setting change
15: Remote thermal state reset
16: Maintenance mode
17: Thermal alarm
18: Thermal overload
19: TCS alarm
20: Group change
21: tAux 1
22: tAux 2
23: tI> reset
24: tI>> reset
25: tI>>> reset
26: tIo> reset
27: tIo>> reset
28: Relay latching
29: Relay unlatching
30: Input activate
31: Input deactivate
32: Idemand alarm
33: General starting
34: Cold load function starting

Word number 6:
Event and Alarm Record value
If code is I> start, tI> trip, I>> start, tI>> trip, I>>> start, tI>>> trip, Demand alarm:
Bit 0: IL1
Bit 1: IL2
Bit 2: IL3

If code is Setting chage
Value is the register address of setting being changed

If code is thermal alarm, thermal overload
Value is the % of thermal alarm or overload threshold

If code is Group change
0: group 1
1: group 2

If code is output relay latching, output relay unlatching:
Bit 0: Output relay 1
Bit 1: Output relay 2
Bit 2: Output relay 3
Bit 3: Output relay 4

If code is input activate, input deactivate:
Bit 0: Input 1
Bit 1: Input 2

9.3 MODBUS Mapping Format

CODE	DESCRIPTION
F1	2 bytes ASCII character
F2	Unsigned integer – Relay status Bit 0: Eeprom data failure Bit 1: Calibration failure Bit 2: Clock loss Bit 3: Clock error Bit 4: Adc error Bit 11: Back port (RS485) unread fault record Bit 12: Front panel (RS232) unread fault record Bit 13: Front panel/Back port communication Bit 14: Back port unread alarm record Bit 15: Front panel unread alarm record
F3	Unsigned integer – Relay LED status Bit 0 and Bit 1: Trip LED. 1=on, 2=blink Bit 2 and Bit 3: Alarm LED. 1=on, 2=blink
F4	Unsigned integer – Input status Bit 0: Input 1 (0=off, 1=on) Bit 1: Input 2 (0=off, 1=on)
F5	Unsigned integer – Output relay status Bit 0: Output 1 (0=off, 1=on) Bit 1: Output 2 (0=off, 1=on) Bit 2: Output 3 (0=off, 1=on) Bit 3: Output 4 (0=off, 1=on)
F6	Unsigned integer – Miscellaneous A numeric value representation of certain options or functions. Refer to 'range' column of the register for detail.
F7	Unsigned integer A numeric value of certain units Eg. 12 may represent 12% or 12minutes Refer to individual resisger's 'Units and Scale' and 'range' for detail
F8	Unsigned long integer – Current value in multiples of 0.01 Ampere
F9	Unsigned integer – Remote command High byte: 1: Reset alarm/trip (also acknowledge and delete alarm record) 2: Acknowledge alarm/trip 3: Reset display to main page 4: Reset thermal state 5: Reset maximum and average measurement value 6: Remote trip 7: Reset panel password 8: Delete fault record 9: Delete event record 10: Delete alarm record Low byte: For high byte=3: set to main display page 0-3 For hight byte=8,9 and 10: 0=Delete all record, n: delete record n

F10	Unsigned integer High byte: month Low byte: day
F11	Unsigned integer High byte: hour (24 hour format) Low byte: minute
F12	Unsigned integer – Date and time format for relay display only High byte: Date format, 0=DD/MM/YYYY, 1=MM/DD/YYYY Low byte: Time format, 0=12 hour, 1=24 hour
F13	Unsigned integer – Change Group by... 0=Change group by menu, 1=change group change by level of digital input
F14	Unsigned integer A scaled numeric value of certain units Eg. 123 may represent 1.23A or 1.23s Refer to individual resisger's 'Units and Scale' and 'range' for detail
F15	Unsigned integer – Cold Load Pick-up element Bit 0: tI> Bit 1 tI>> Bit 2: tI>>> Bit 3: tIo> Bit 4: tIo>> Bit 5: Thermal overload
F16	Unsigned integer – Input n reset option (For input function set as reset) Bit 0: 0= Not to reset trip/alarm, 1=to reset trip/alarm Bit 1: 0= Not to reset thermal state, 1=to reset thermal state
F17	Unsigned integer – Input n Blocked element (For input function set as blocking) Bit 0: tI> Bit 1 tI>> Bit 2: tI>>> Bit 3: tIo> Bit 4: tIo>> Bit 5: Thermal overload
F18	Unsigned integer – Relay n link element Bit 0: I> Bit 1 I>> Bit 2: I>>> Bit 3: Io> Bit 4: Io>> Bit 5: Thermal overload Bit 6: Aux 1 Bit 7: Aux 2 Bit 8: TCS Bit 9: Idemand Bit 10: Remote trip