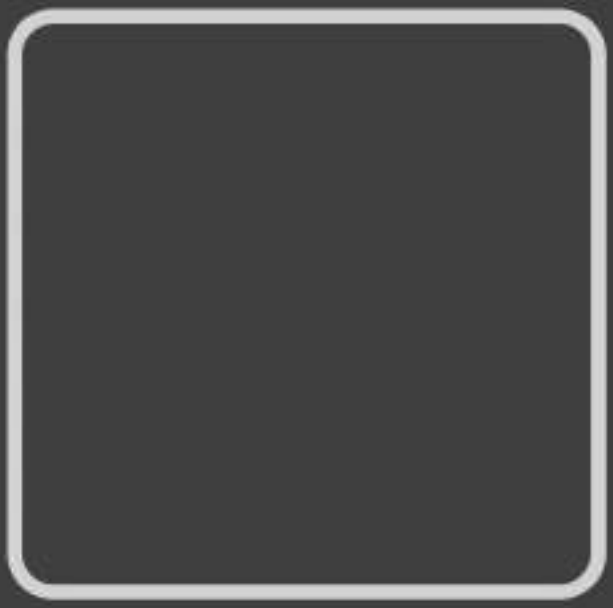
Mikro



X30

COMBINED OVERCURRENT & EARTH FAULT RELAY

user manual

Mikro®

COMBINED OVERCURRENT & EARTH FAULT RELAY

Ver 1.00

Table of Contents

1.0 Introduction

Introduction

Mikro X30 is designed to provide protection of 3 independent phase overcurrent elements and one non-directional earth-fault element. All these elements are connected to protection current transformers that have 5A rated CT on secondary part.

As the name suggest, Mikro X30 provides the user with 2x16 LCD for displaying its various measurement parameter such as: Current Measurement, Fault Records, Event Records, Settings and others.

The relay extends its connectivity by adopting the Modbus-RTU protocol. Through the use of RS485 standard protocol, the user will be able to network the relay with other slave device that links to a center monitoring station.

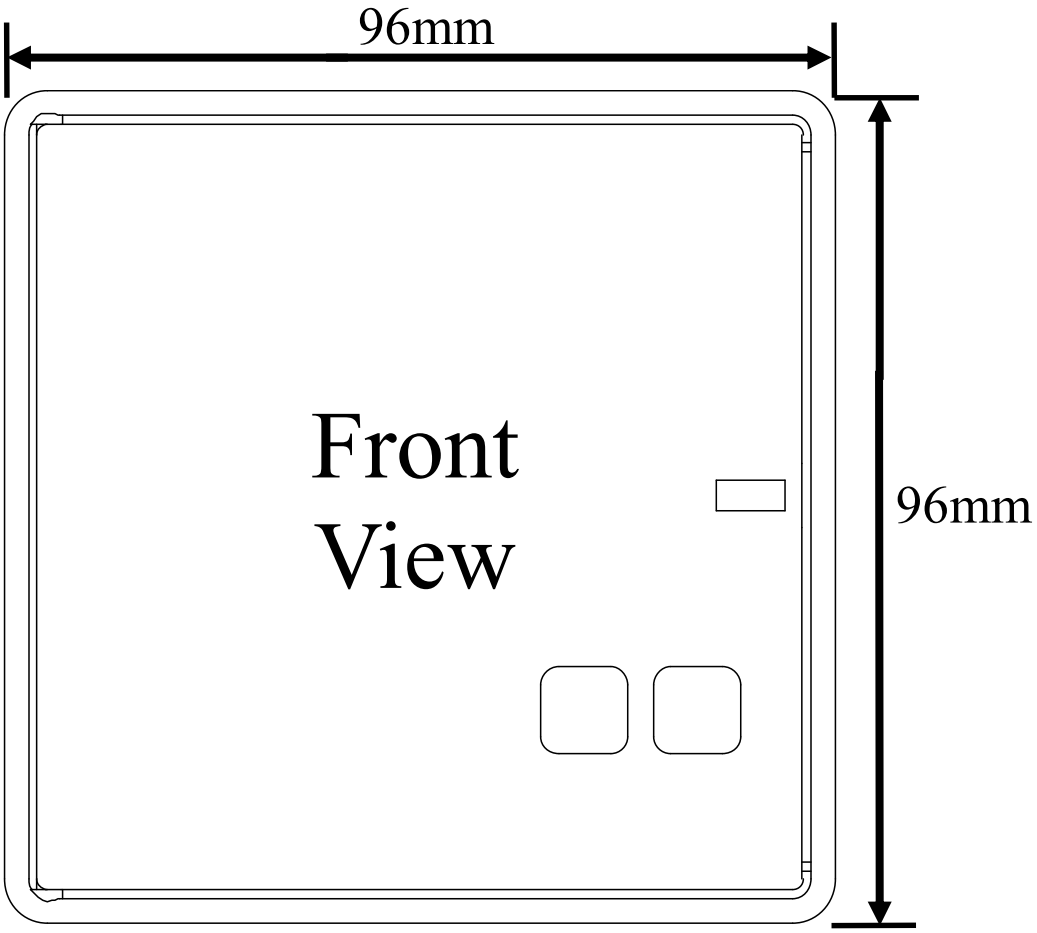
Mikro X30 provides 2 configurable output relays that can be activated by any of the protection functions available in the relay. These output relays are able to be selected for internal fault indication. Besides that, Mikro X30 also provides 1 configuration logic input for various functions.

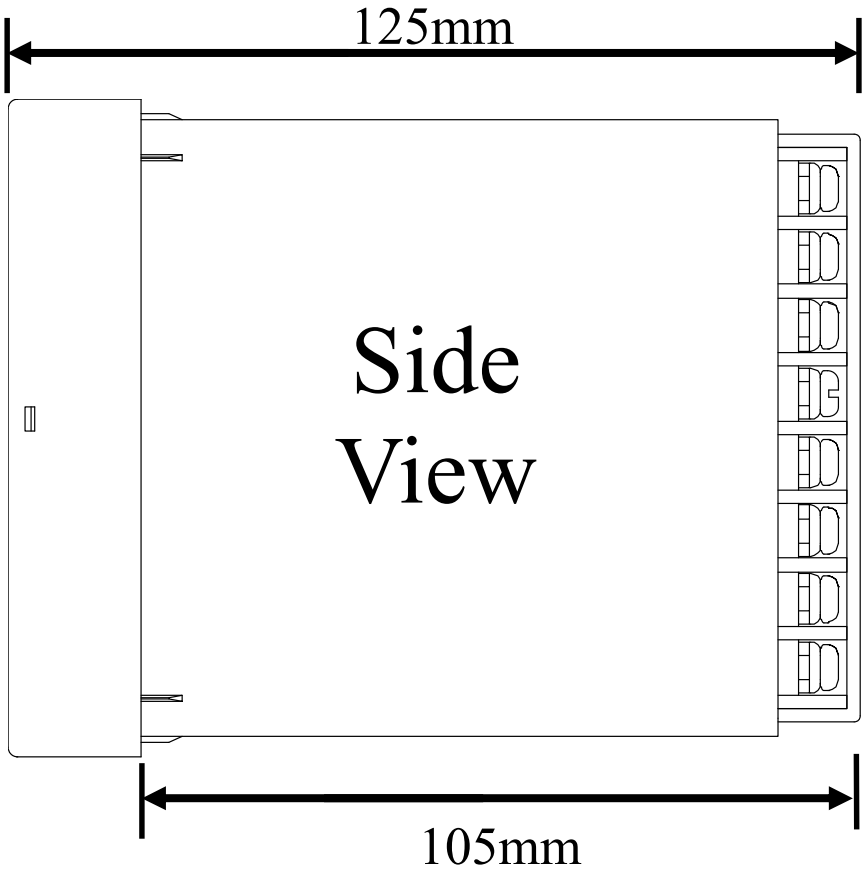
1.1 Symbols and Definitions

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
Gentrl : 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 : Overload
PU : Pickup
RCRD : Record
Rmote : Remote
Rst : Reset
Strt : Start
TCS : Trip Circuit Supervision
Thml : Thermal

1.2 Dimension of X30





2.0 Installation

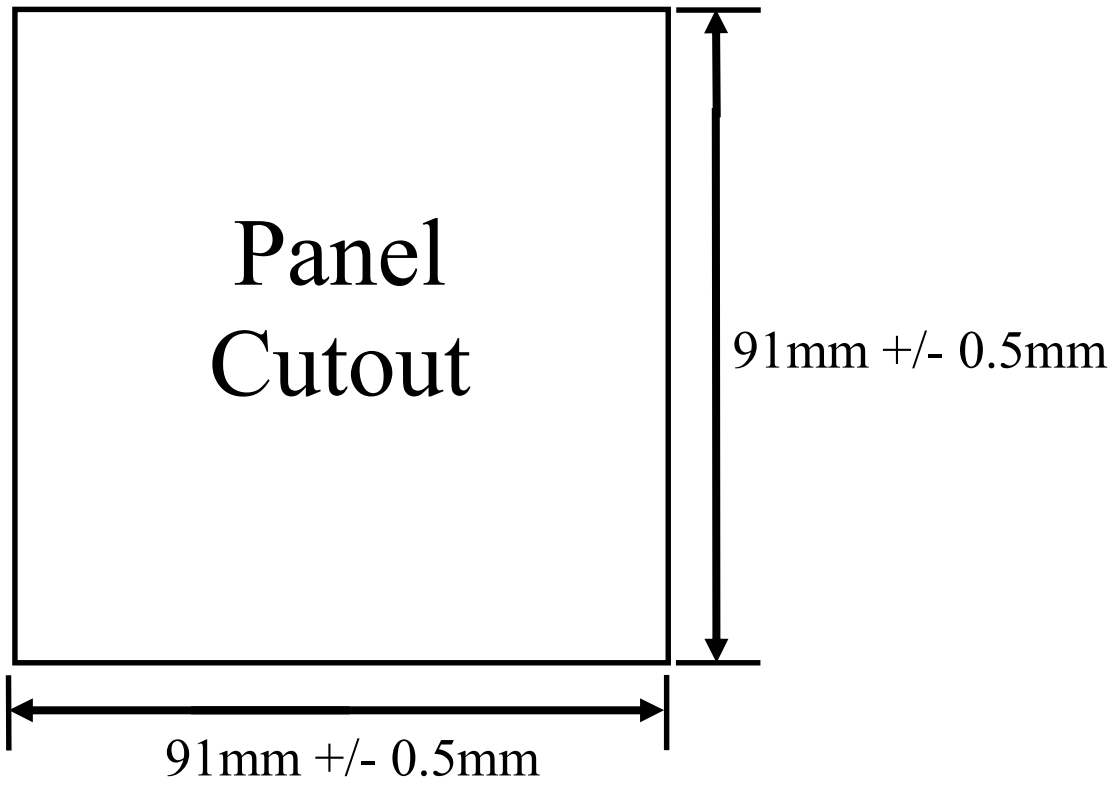
Installation guide

Before installing the X30, please check that the environment meets the following conditions:

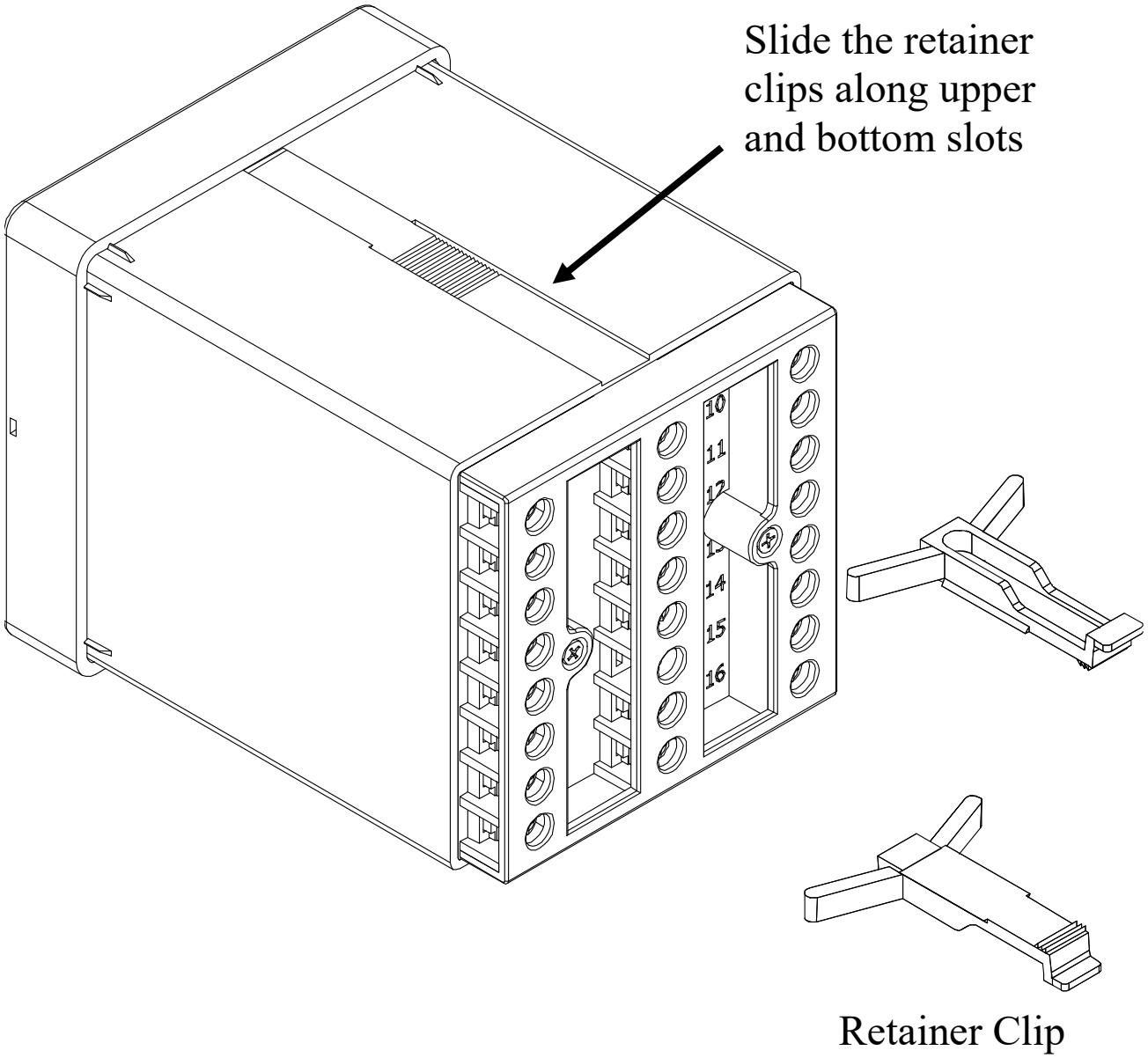
- Operating temperature: -5°C to +55°C
- Humidity: 56 days at 93%, 40°C non-condensing
- Dust free environment away from electrical noise and radiation.

2.1 Mounting

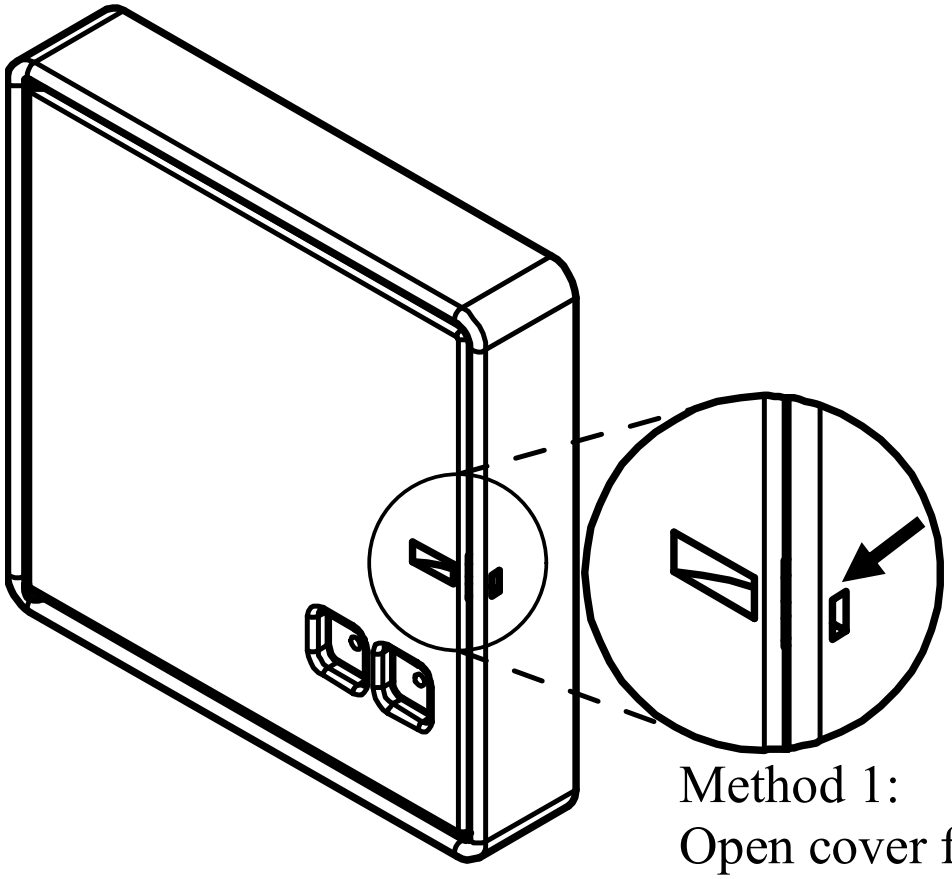
a) Insert the X30 through a 91mm x 91mm switch-gear panel as shown below:



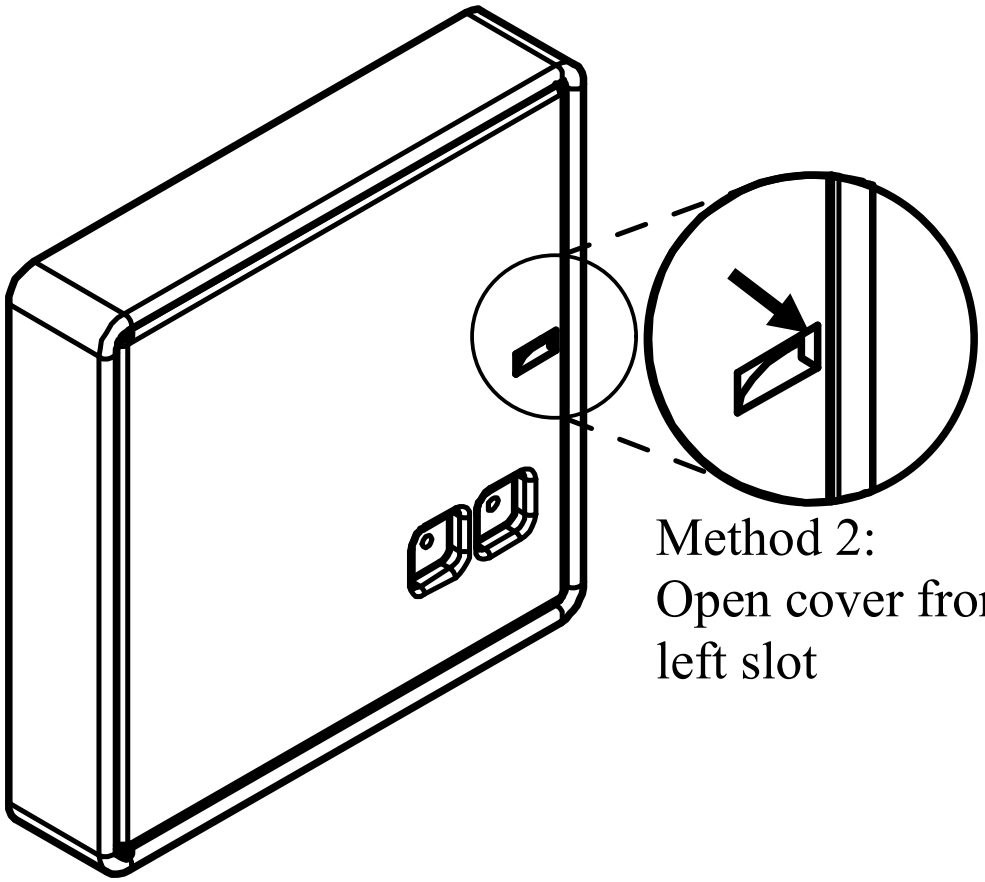
b) Slide the retainer clip along the slots on both sides of the X30 until the device is tightly secured on the switch-gear panel. The retainer clip can be removed by lifting the tab lightly at the handle end.



c) There are two methods to open door cover, refer below:



Method 1:
Open cover from
right slot



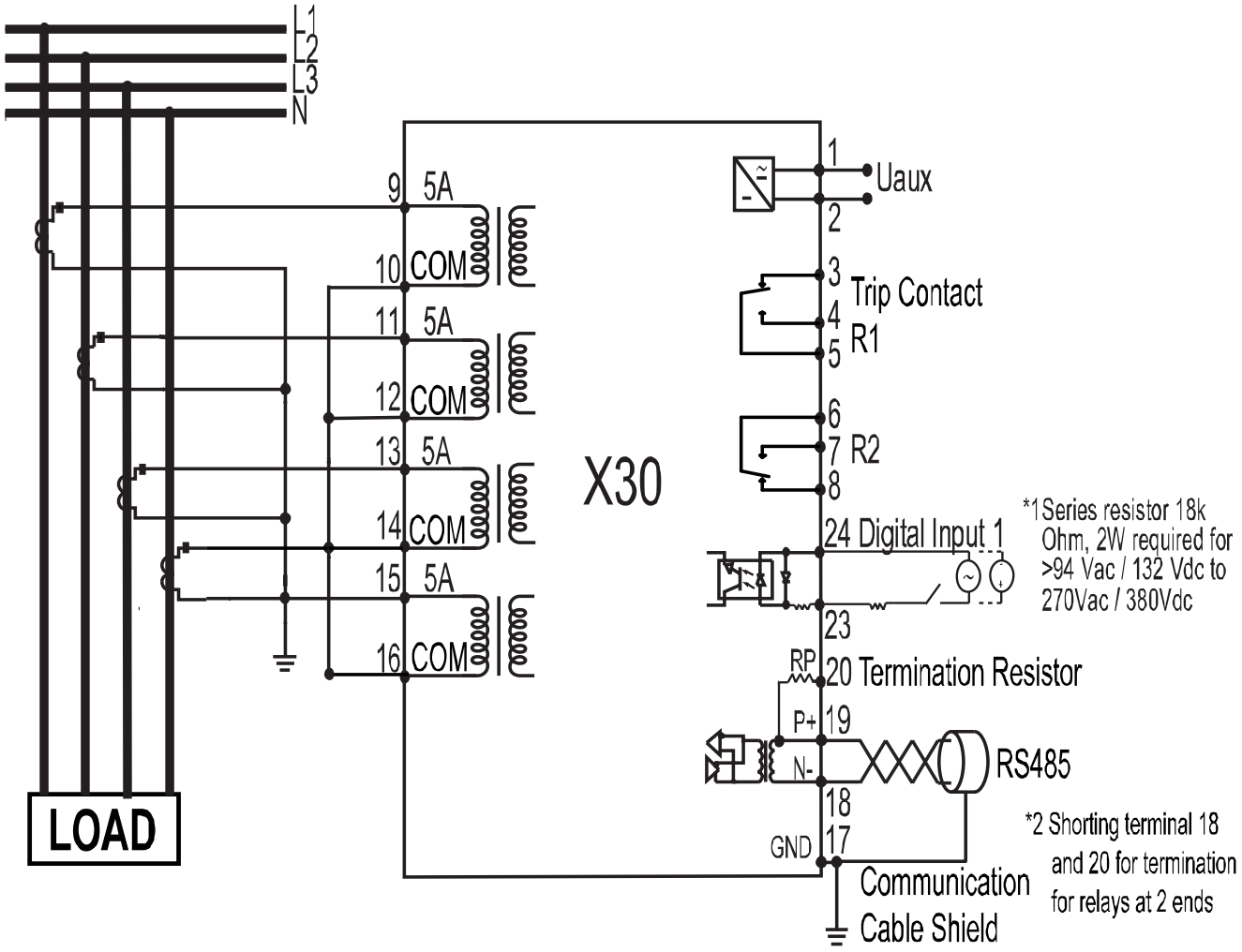
Method 2:
Open cover from
left slot

2.2 Terminal Connection

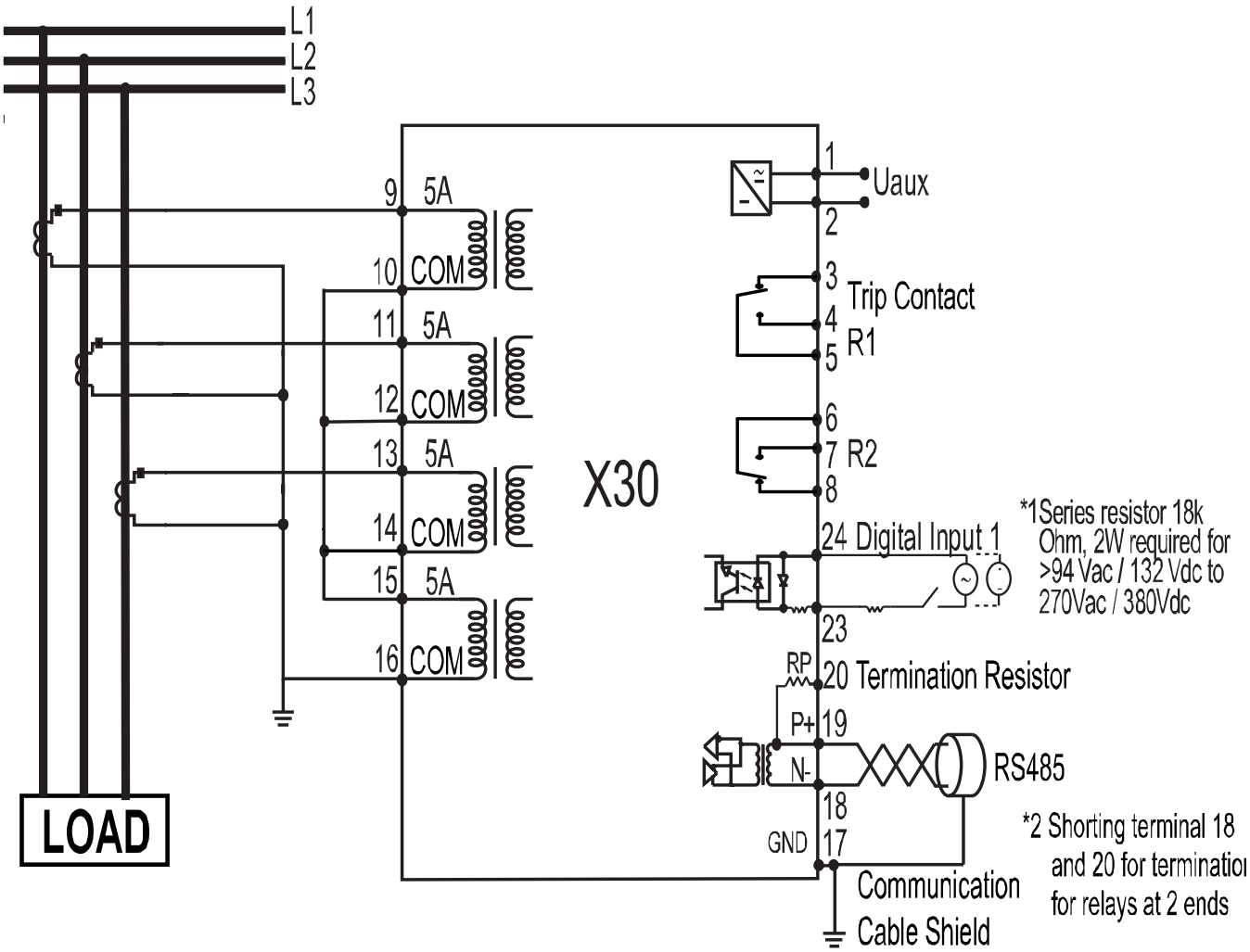
Connection Terminal	Function Description
1	Auxiliary supply input
2	Auxiliary supply input
3	Normally close contact for tripping contact R1
4	Normally open contact for tripping contact R1
5	Common contact for tripping contact R1
6	Common contact for tripping contact R2
7	Normally open contact for tripping contact R2
8	Normally close contact for tripping contact R2
9	5A CT input for IL1
10	5A common CT input for IL1
11	5A CT input for IL2
12	5A common CT input for IL2
13	5A CT input for IL3
14	5A common CT input for IL3
15	5A CT input for ILo
16	5A common CT input for ILo
17	RS485 common terminal
18	RS485 negative terminal
19	RS485 positive terminal
20	Termination resistor for RS485
21-22	Reserved
23-24	Digital input (no polarity)

2.3 Wiring

With 3 phase 4 wires



With 3 phase 3 wire



3.0 Display

a) Auxiliary LED Indication
b) Trip LED Indication
c) Alarm LED Indication
d) 2x16 LCD Display
e) “ESC” Button
f) “UP” Button
g) “DOWN” Button
h) “ENTER” Button
i) “CLEAR” Button
j) “RECORD” Button

3.1 Keypad

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

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.

UP : Scroll up the menus or increase setting value.

Down : Scroll down the menus or decrease setting value.

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 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.

3.2 LEDs

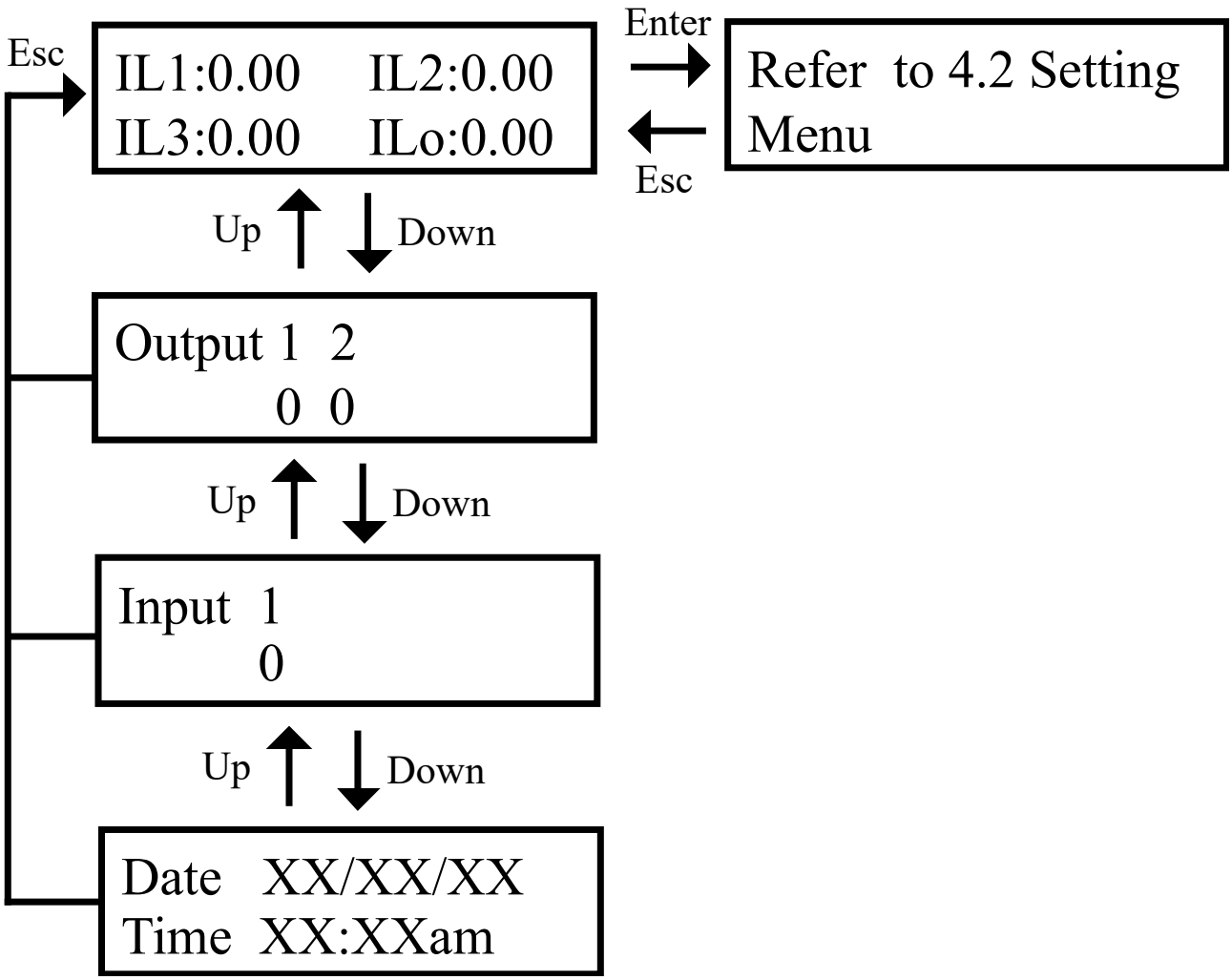
Trip LED : Indicates tripping

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

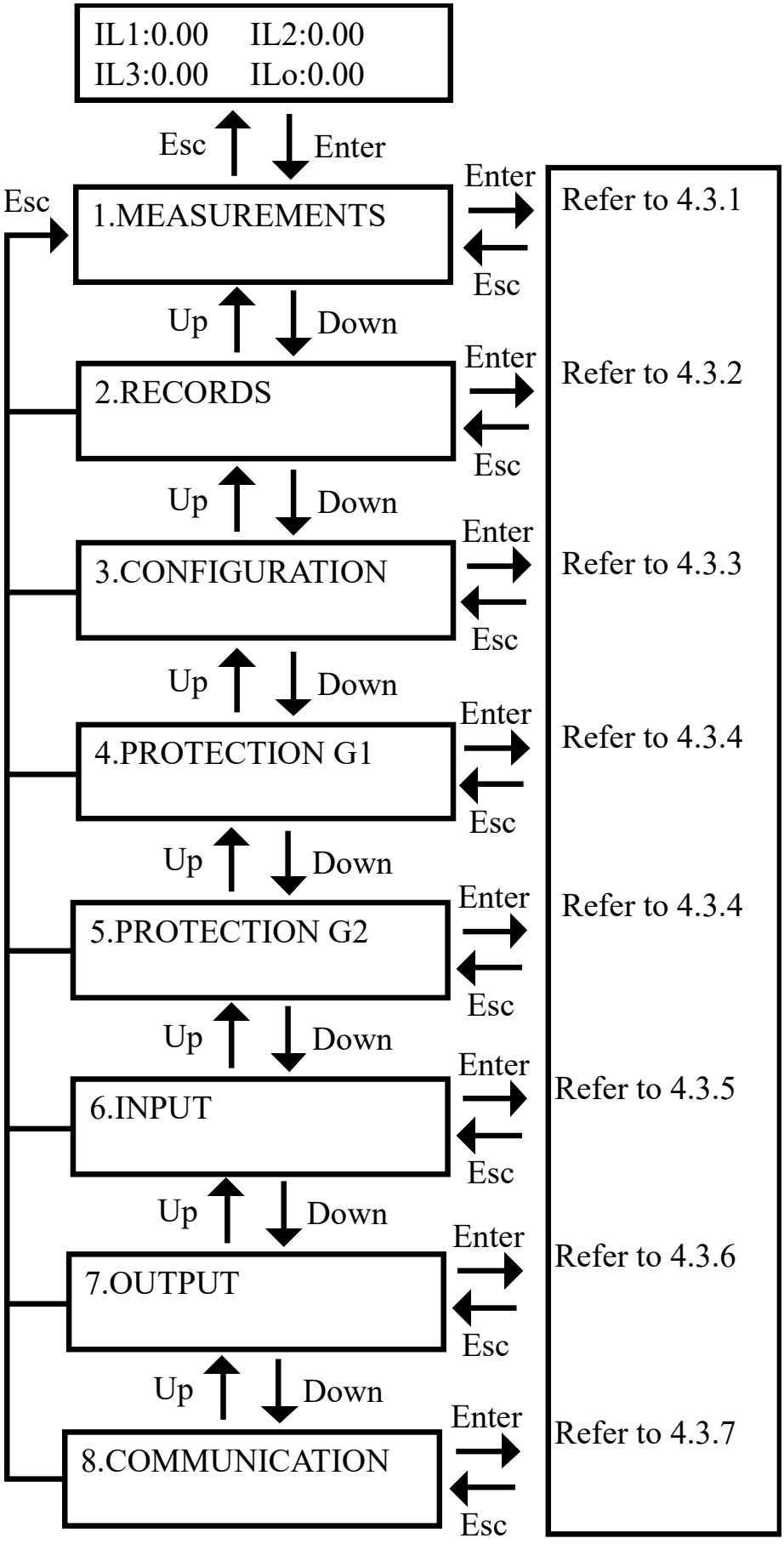
4.0 Function

Figure below shows menu map for X30. It includes the setting, input status, output status and measurement display for X30. These menus can be accessed by pressing ESC, UP, DOWN, ENTER, CLEAR and RECORD buttons.

4.1 Main Page



4.2 Menu


IL1:0.00 IL2:0.00
IL3:0.00 ILo:0.00
Esc
Enter
Esc
1.MEASUREMENTS
Enter
Esc
Refer to 4.3.1
Up
Down
2.RECORDS
Enter
Esc
Refer to 4.3.2
Up
Down
3.CONFIGURATION
Enter
Esc
Refer to 4.3.3
Up
Down
4.PROTECTION G1
Enter
Esc
Refer to 4.3.4
Up
Down
5.PROTECTION G2
Enter
Esc
Refer to 4.3.4
Up
Down
6.INPUT
Enter
Esc
Refer to 4.3.5
Up
Down
7.OUTPUT
Enter
Esc
Refer to 4.3.6
Up
Down
8.COMMUNICATION
Enter
Esc
Refer to 4.3.7

4.3 Sub Menu

4.3.1 Measurement Menu

LCD Display	Description
IL1	Phase 1 current value. Taking into account of Line CT Pri Ratio.
IL2	Phase 2 current value. Taking into account of Line CT Pri Ratio.
IL3	Phase 3 current value. Taking into account of Line CT Pri Ratio.
Ilo	Earth current value. Taking into account of Line CT Pri Ratio.
Thermal θ	Thermal % state. Calculated on true RMS current values. Press Clear button to clear the % values.
Frequency	Current frequency calculated from phase 1 currents.
IL1 Max	Peak Phase 1 current value.
IL2 Max	Peak Phase 2 current value.
IL3 Max	Peak Phase 3 current value.
Ilo Max	Peak Earth current value.
IL1 Avg	Average Phase 1 current value.
IL2 Avg	Average Phase 2 current value.
IL3 Avg	Average Phase 3 current value.
Ilo Avg	Average Earth current value.
Max&Avg I RST	To clear the maximum and average values of the currents. Press Clear button to clear these values.

4.3.2 Records Menu

4.3.2.1 Fault Records

Whenever any trip fault happens in X30, information of trip value, element, source, date, time and all phase current magnitude values will be stored in fault records. There is total 50 fault records storage available in X30.

4.3.2.2 Event Records

Whenever any event has done in X30, information of type event, date and time will be stored in event records. As examples of type events are like setting change, Aux power start, clear trip fault and others more. There is total 250 event records storage available in X30.

4.3.3 Configuration Menu

4.3.2.1 Op parameter Menu

LCD Display	Description
Password	This password is required when changing relay settings.
Description	Model name of this relay
Firmware	Version of the firmware
Frequency	Set the nominal value of the line frequency

4.3.2.2 CT Ratio Menu

LCD Display	Description
Line CT Pri	Set the rated primary current of the line/Phase CT.
E/Gnd CT Pri	Set the rated primary current of the Earth/Ground CT.

Note: The CT secondary should be connected to 5A 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

*If user request to change setting, press Enter button.

4.3.2.3 Date & Time Menu

LCD Display	Description
Date	Set the date.
Date Format	Set the date format for display
Time	Set the time.
Time Format	Set the time format for display.

4.3.2.4 Group Select Menu

LCD Display	Description
Chg Group by…	Set whether the protection group setting is changed by Menu or Input. One of the input functions must be set to 'Select Group" if Input is selected
Setting Group1	If above is set to Menu, this will set the active protection group

4.3.2.5 Display Menu

LCD Display	Description
LCD On Time	Set how long the LCD backlight remains on after no key is pressed.
LCD Brightness	Set the brightness of the LCD backlight.
"CLEAR" Scroll?	Set if Clear key can be used to scroll throught the default display pages, Phase OC and Earth OC settings

*If user request to change setting, press Enter button.

4.3.2.6 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 an 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.

LCD Display	Description
CLPU Level	Scaling value in percent for the cold load pick up assigned to the selected thresholds.
CLPU tCL	Delay timer setting for the Cold Load Pickup function.
CLPU tI>?	Assign the I> time delay threshold with the cold load pick up function
CLPU tI>>?	Assign the I>> time delay threshold with the cold load pick up function
CLPU tI>>>?	Assign the I>>> time delay threshold with the cold load pick up function
CLPU to>?	Assign the Io> time delay threshold with the cold load pick up function
CLPU to>>?	Assign the Io>> time delay threshold with the cold load pick up function
CLPU Thml OL?	Assign the Thermal Overload time delay threshold with the cold load pick up function

*If user request to change setting, press Enter button.

4.3.2.7 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.

LCD Display	Description
Demand Alarm?	Set to YES to enable demand alarm.
Idmnd>	Set the value for the current threshold Idmnd>.
TIdmnd>	Set the value of the time delay of Idmnd>.

4.3.4 Protection G1 & G2 Menu

4.3.4.1 Phase OC Menu

LCD Display	Description
I>?	Set to Yes to enable first phase overcurrent threshold.
I>	Set the value for the current threshold I>.
I> Delay Type	Set the time delay type of I>.
tI>	Set the value for the time delay of I> definite time if delay type of I> is set definite time.
I> IDMT Curve	Set the type of curve if delay type of I> is set IDMT.
KtI>	Set the time multiplier setting value for the curve if delay type of I> is set IDMT
I>>?	Set to Yes to enable second phase overcurrent threshold.

*If user request to change setting, press Enter button.

I>>	Set the value for the current threshold I>>.
tI>>	Set the value for the time delay of I>> definite time.
I>>>?	Set to Yes to enable third phase overcurrent threshold.
I>>> Sample	Set to Yes to enable I>>> operated on current sample base. Otherwise it operates on fundamental value.
I>>>	Set the value for the current threshold I>>>.
tI>>>	Set the value for the time delay of I>>> definite time.

4.3.4.2 Earth Fault Menu

LCD Display	Description
Io>?	Set to Yes to enable first phase earth fault threshold.
Io>	Set the value for the current threshold Io>.
Io> Delay Type	Set the time delay type of Io>.
tIo>	Set the value for the time delay of Io> definite time if delay type of Io> is set definite time.
Io> IDMT Curve	Set the type of curve if delay type of Io> is set IDMT.
KtIo>	Set the time multiplier setting value for the curve if delay type of Io> is set IDMT
Io>>?	Set to Yes to enable second phase earth fault threshold.
Io>>	Set the value for the current threshold Io>>.
tIo>>	Set the value for the time delay of Io>> definite time.

*If user request to change setting, press Enter button.

4.3.4.3 Thermal OL Menu

LCD Display	Description
Thermal OL?	Set to Yes to enable thermal overload protection.
Iθ>	Set the value for the thermal overload Iθ>.
Tθ>	Set the value for the thermal time constant.
k>	Set the value for the k factor
θ Trip	Set the percentage of the thermal overload trip.
θ Alarm	Set the percentage of the thermal overload alarm. To disable this alarm, set this value equal to or higher than θ than Trip %.

4.3.5 Input Menu

LCD Display	Description
Input 1 Func	Set the function of Input 1. Setting choices are included None, Aux1, Reset, Blocking, TCS, Select Group, Cold Load PU and Sync Clock.
Input 1 Type	Set how the input 1 is activated. For Active High, a voltage to the input activates the input, For Active Low, opening of the input activates the input.
Aux 1 Type	
Aux timer	Set the value for the time delay of Aux 1 definite time.
Reset Type	
Rst Trip/Alarm	Set to Yes to enable the input to reset trip and alarm.
Rst Thermal θ%	Set to Yes to enable the input to rest thermal %.

*If user request to change setting, press Enter button.

Blocking Type	
Block I>?	Set to Yes to enable blocking of I>
Block I>>?	Set to Yes to enable blocking of I>>
Block I>>>?	Set to Yes to enable blocking of I>>>
Block Io>?	Set to Yes to enable blocking of Io>
Block Io>>?	Set to Yes to enable blocking of Io>>
Block Thml OL?	Set to Yes to enable blocking of Thermal Overload.
TCS Type	
TCS delay	Set the value for the time delay of TCS.

Aux 1

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.

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.

*If user request to change setting, press Enter button.

Sync Clock

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

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.

4.3.6 Output Menu

4.3.6.1 Relay 1 Menu

LCD Display	Description
Relay 1 Func	Set the function of output Relay 1. Note that Relay 1 function is locked to Trip
Reset	Set reset method of relay, Auto is unlatched or Manual is latched.
tI>?	Assign I> trip to the output relay.
tI>>?	Assign I>> trip to the output relay.
tI>>>?	Assign I>>> trip to the output relay.
tIo>?	Assign Io> trip to the output relay.
tIo>>?	Assign Io>> trip to the output relay.
Thml OL?	Assign Thermal Overload to the output relay.
tAUX 1?	Assign Aux 1 input trip to the output relay.
Remote?	Assign Remote trip to the output relay.

*If user request to change setting, press Enter button.

4.3.6.2 Relay 2 Menu

LCD Display	Description
Relay 2 Func	Set the function of output Relay 2. Settings are included Trip, Start, CBFP and IRF.
Reset	Set reset method of relay, Auto is unlatched or Manual is latched.
Trip Function	
tI>?	Assign I> Trip to the output relay.
tI>>?	Assign I>> Trip to the output relay.
tI>>>?	Assign I>>> Trip to the output relay.
tIo>?	Assign Io> Trip to the output relay.
tIo>>?	Assign Io>> Trip to the output relay.
Thml OL?	Assign Thermal Overload to the output relay.
tAUX 1?	Assign Aux 1 input trip to the output relay.
Remote?	Assign Remote trip to the output relay.
Start Function	
I>?	Assign I> Start to the output relay.
I>>?	Assign I>> Start to the output relay.
I>>>?	Assign I>>> Start to the output relay.
Io>?	Assign Io> Start to the output relay.
Io>>?	Assign Io>> Start to the output relay.
Thml OL (Alarm)?	Assign Thermal Overload alarm to the output relay.
tAux 1 (Alarm)?	Assign Aux 1 input alarm to the output relay.
TCS (Alarm)?	Assign TCS alarm to the output relay
Demand (Alarm)?	Assign Demand alarm to the output relay.
CBFP (Circuit Breaker Failure Protection) Function	
Delay	Set the value for the time delay of CBFP.

*If user request to change setting, press Enter button.

Include Aux?	Set if Aux 1 input is included as fault condition. Prolonged activation or latched Aux input could cause the undesirable activation of CBFP relay.

4.3.6.3 Maintenance Mode Menu

In maintenance mode, user is able to do trip simulation test for each output relay contact. For testing output contacts, press Enter once and then number '0' at the column of output 1 will start blinking. Press Up or Down to toggle the output contact. For output 2 contact testing, press Enter again and then number '0' at the column of output 2 will start blinking. Press Up or Down to toggle the output contact.

4.3.7 Communication Menu

LCD Display	Description
Communication?	Set to Yes to enable MODBUS RTU communication.
Remote set?	Set to Yes to enable Read/Write register function. Set to No to disable Write register function but allow to Read register.
Baud Rate	Set the baud rate in bit per second (bps)
Parity	Set the parity in the data frame
Stop Bit	Set the number of stop bit in the data frame.
Relay Address	Set the address of the relay in the MODBUS network.

5.0 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. Press 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.

6.0 Technical Data

6.1 Ratings

Auxiliary Supply	
Rate voltage	100-240V AC / 140-340V DC
Operation voltage	85-265V AC / 110-370V DC
Rate frequency	50 or 60 Hz
Operating frequency	45 - 65 Hz
Power consumption	6 VA max

Current Inputs	
Rated current In	5A by connections
Frequency	50 or 60 Hz nominal
Burden	<0.3VA(5A)
Thermal withstand	4x In continuous 25x In for 10s

Logic Input	
Input type	Optically isolated
Rated voltage	20 - 380V DC 50 - 270V AC

Output Relay	
Rated voltage	250V AC/DC
Contact arrangement	Change-over
Continuous carry	5A
Expected electrical life	100,000 Operations at rated load
Expected mechanical life	5x10^6 operations

6.2 Records

Type Records	
Fault Record	Up to 50 records
Event Record	Up to 250 records
Alarm Record	Up to 30 records

6.3 Setting Ranges

Phase Overcurrent	
I>?	Yes or No
I>	0.1 to 20 x In
I> Delay type	IDMT or Definite Time
tI>	0 to 100s
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 20x In
tI>>	0 to 100s
I>>>?	Yes or No
I>>>	0.5 to 20x In
I>>> Sample	Yes or No
tI>>>	0 to 100s

Earth Fault	
Io?	Yes or No
Io>	0.02 to 2 x In
Io> Delay type	IDMT or Definite Time
tIo>	0 to 100s
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 10x In
tIo>>	0 to 100s

Thermal Overload	
Thermal OL?	Yes or No
Iθ >	0.1 to 3.00 x In
Tθ	1 to 200 minutes
k	1 to 1.5
θ Trip	50% to 200%
θ Alarm	50% to 200%

Cold Load Pickup	
CLPU Level	100% to 500%
CLPU tCL	0.1 to 600s

Input	
Aux timer	0 to 600s
TCS delay	0.1 to 10s

Output	
Aux timer	0 to 600s

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

6.4 Measurement Range

Measurement Range	
Phase and Earth Current Display	0 to 999 kA
Phase Current Secondary 5A input	0 to 100A

Earth Current Secondary 5A input	0 to 50A
Thermal θ	0 to 9999%
Frequency	20 to 80Hz

6.5 Accuracy

Phase Overcurrent I>,I>> and I>>>	
Measuring Range	0.1 to 20 x In
Accuracy of pickup current	±2% of set value or 20mA whichever is greater
Accuracy of DFT time	±2% or 30ms whichever is greater
Accuracy of IDMT time	±5% or 30ms whichever is greater

Earth Fault Overcurrent Io> and Io>>	
Measuring Range	0.02 to 10 x Ion
Accuracy of pickup current	±2% of set value or 20mA whichever is greater
Accuracy of DFT time	±2% or 30ms whichever is greater
Accuracy of IDMT time	±5% or 30ms whichever is greater

Thermal Overload Iθ>	
Measuring Range	0.1 to 3 x In
Accuracy of operate time	±5%

6.6 Insulation Test

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

6.7 EMC Standard Test

IEC60255-26 standard Test	
Electrical fast transient IEC61000-4-4, Power Supply	4kV, 5 kHz
Electrical fast transient IEC61000-4-4, other inputs	2kV, 5 kHz
Surge IEC6100-4-5, IEC 60255-22-5	4kV Common mode 2kV Differential mode
Electrostatic discharge IEC61000-4-2, air discharge	8kV
Electrostatic discharge IEC61000-4-2, contact discharge	6kV
1MHz burst disturbance IEC60255-22-1	2kV Common mode 1kV Differential mode
Conducted immunity IEC61000-4-6	10Vrms@1kHz 80%AM, 0.15 to 80MHz
Radiated immunity IEC61000-4-3	10V/m 80MHz to 1GHz @1kHz 80%AM
Conducted emissions	EN55011 Group 1 class B
Radiated EM field emission	CISPR 11 Group 1 class B

6.8 Environmental Conditions

Environmental Conditions	
Temperature	-5°C to 55°C
Humidity	56 days at 93% RH and 40°C non-condensing
Enclosure protection	IP54 when panel mounted

7.0 MODBUS Protocol

7.1 MODBUS Functions

0x03/0x04 Read Input/Holding Registers

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
Register value	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

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

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

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

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 the entire slave. The slave will not respond with a broadcast command.

7.2 MODBUS Register

Address (HEX)	Parameter	Format	Unit	Range
Read only. Function 03h or 04h				
0000	Device type - main	F1	ASCII	'00'
0001		F1	ASCII	'02'
0002		F1	ASCII	'04'
0003	Device type - sub	F1	ASCII	'00'
0004	Version number - main	F1	ASCII	'XX'
0005		F1	ASCII	'XX'
0006	Version number - sub	F1	ASCII	'XX'
0007		F1	ASCII	'XX'
0008-000F	Reserved	--	--	--
Measurements and relay status. Read only. Function 03h or 04h				
0010	Relay status	F2	Bit field	Bit 0 - 15
0011	Relay LED status	F3	Bit field	Bit 0 - 3
0012	Input status	F4	Bit field	Bit 0
0013	Output status	F5	Bit field	Bit 0 - 15
0014	Active group	F6	--	0=Group 1, 1=Group 2
0015	Thermal state	F7	%	0 - 9999
0016	IL1 high word	F8	0.01 Ampere	0-9.99X10^7 (999kA)
0017	IL1 low word			
0018	IL2 high word	F8	0.01 Ampere	0-9.99X10^7 (999kA)
0019	IL2 low word			
001A	IL3 high word	F8	0.01 Ampere	0-9.99X10^7 (999kA)
001B	IL3 low word			
001C	ILo high word	F8	0.01 Ampere	0-9.99X10^7 (999kA)
001D	ILo low word			
001E	IL1 Max high word	F8	0.01 Ampere	0-9.99X10^7 (999kA)
001F	IL1 Max low word			
0020	IL2 Max high word	F8	0.01 Ampere	0-9.99X10^7 (999kA)
0021	IL2 Max low word			

Address (HEX)	Parameter	Format	Unit	Range
Measurements and relay status. Read only. Function 03h or 04h				
0022	IL3 Max high word	F8	0.01 Ampere	0-9.99X10^7 (999kA)
0023	IL3 Max low word			
0024	ILo Max high word	F8	0.01 Ampere	0-9.99X10^7 (999kA)
0025	ILo Max low word			
0026	IL1 Avg high word	F8	0.01 Ampere	0-9.99X10^7 (999kA)
0027	IL1 Avg low word			
0028	IL2 Avg high word	F8	0.01 Ampere	0-9.99X10^7 (999kA)
0029	IL2 Avg low word			
002A	IL3 Avg high word	F8	0.01 Ampere	0-9.99X10^7 (999kA)
002B	IL3 Avg low word			
002C	ILo Avg high word	F8	0.01 Ampere	0-9.99X10^7 (999kA)
002D	ILo Avg low word			
002E	Line Frequency	F7	0.01 Hz	0- 10000 (100Hz)
Remote command. Write only. Function 06h				
0100	Remote Command	F9	Bit field	--
Settings. Read/Write. Function 03h,04h, 06h, 10h				
0200	Line CT Primary	F7	Ampere	1-3000
0201	Reserved	--	--	--
0202	Earth/Ground CT Primary	F7	Ampere	1-10000
0203	Reserved	--	--	--
0204	Frequency	F6	Hz	0-50Hz, 1=60Hz
0205	Time Window for Average and Maximum Current	F7	minute	1-60
0206	Year	F7	year	0-199 (2000 - 2199)
0207	Month, Day	F10	month,day	0-12, 0-31
0208	Hour, Minute	F11	hour,minute	0-23, 0-59
0209	Miliseconds	F7	ms	0-59999
020A	Date & time format	F12	--	0-1, 0-1
020B	Change Group by…	F13	--	0-1

Address (HEX)	Parameter	Format	Unit	Range
Settings. Read/Write. Function 03h,04h, 06h, 10h				
020C	Setting Group	F6	--	0=Group 1, 1=Group 2
020D	LCD backlight on duration	F7	minute	1-60
020E	LCD backlight brightness	F6	--	0=low, 1=medium, 2=high
020F	Clear key to scroll settings	F6	--	0=Disable, 1=Enable
0210	Communication?	F6	--	0=Disable, 1=Enable
0211	Communication Baud Rate	F6	--	0=2400, 1=4800, 2=9600, 3=19200, 4=38400
0212	Communication Parity	F6	--	0=None, 1=Odd, 2=Even
0213	Communication Stop Bit	F6	--	0=1bits, 1=2bits
0214	Communication Address	F7	--	1-255
0215	Password	F7	--	0
0216-021F	Reserved	--	--	--
0220	Demand Alarm	F6	--	0-=Disable, 1=Enable
0221	Idemand> threshold	F14	0.01 In	10-2000
0222	tIdemand> delay time	F14	0.01s	0-10000 (100s)
0223-022F	Reserved	--	--	--
0230	Cold Load Pickup Level	F7	%	100-500%

Address (HEX)	Parameter	Format	Unit	Range
Settings. Read/Write. Function 03h,04h, 06h, 10h				
0231	Cold Load Pickup tCL	F14	0.01s	10-60000 (600s)
0232	Cold Load Pickup element	F15	Bit field	Bit 0-5
0233-023F	Reserved	--	--	--
0240	Input 1 Function	F6	--	0=None, 1=Aux1, 2=Reserved, 3=Reset, 4=Blocking, 5=Trip, 6=Group select, 7=CLPU, 8=Sync clock. Bit7: 0=Active high, 1=Active low
0241	Input 1 Reset Option	F16	Bit field	Bit 0-1
0242	Input 1 Blocked element	F17	Bit field	Bit 0 -5
0243	Input 1 Aux delay	F14	0.01s	0-60000 (600s)
0244	Input 1 TCS delay	F14	0.01s	0-1000 (10s)
0245-026E	Reserved	--	--	--
026F	IRF Option	F6	--	0=Disable, 1=Enable
0270	Relay 1 Function (read only)	F6	--	0=None, 1=Start/alarm, 2=Trip, 3=Upstream trip

Address (HEX)	Parameter	Format	Unit	Range
Settings. Read/Write. Function 03h,04h, 06h, 10h				
0271	Relay 1 Reset option	F6	--	0=Manual, 1=Auto
0272	Relay 1 Linked element	F18	Bit field	Bit 0-10
0273-0274	Reserved	--	--	--
0275	Relay 2 Function	F6	--	0=None, 1=Start/alarm, 2=Trip, 3=Upstream trip
0276	Relay 2 Reset option	F6	--	0=Manual, 1=Auto
0277	Relay 2 Linked element	F18	Bit field	Bit 0-10
0278	Relay 2 CBFP option	F6	--	0=exclude Aux input, 1=include Aux input
0279	Relay 2 CBFP delay	F14	0.01s	5-1000 (10s)
Protection Group 1. Read/Write. Function 03h, 04h, 06h, 10h				
0300	Thermal Overload	F6	--	0=Disable, 1=Enable
0301	Thermal Full Load Current Iθ	F14	0.01 In	10-300 (3)
0302	Thermal Time Constant, Tθ	F7	minute	1-200
0303	Thermal Factor, k	F14	0.01	100-150 (1.5)
0304	Thermal Trip Threshold	F7	%	50-200
0305	Thermal Alarm Threshold	F7	%	50-200
0306-030F	Reserved	--	--	--
0310	I>	F6	--	0=Disable, 1=Enable
0311	I> Threshold	F14	0.01 In	10-2000 (20)

Address (HEX)	Parameter	Format	Unit	Range
Protection Group 1. Read/Write. Function 03h, 04h, 06h, 10h				
0312	I> Delay Type	F6	--	0=Definite time, 1=IDMT
0313	tI> Definite Time	F14	0.01s	0-10000 (100s)
0314	I> IDMT Curve	F6	--	0=NI, 1=VI, 2=EI, 3=LTI, 4=NI1
0315	ktI> IDMT time multiplier	F14	0.01	1-100 (1)
0316-031F	Reserved	--	--	--
0320	I>>	F6	--	0=Disable, 1=Enable
0321	I>> Threshold	F14	0.01 In	50-2000 (20)
0322	tI>> Definite time	F14	0.01s	0- 10000 (100s)
0323-0329	Reserved	--	--	--
032A	I>>>	F6	--	0=Disable, 1=Enable
032B	I>>> Sample	F6	--	0=No, 1=Yes
032C	I>>> Threshold	F14	0.01 In	50-4000 (40)
032D	tI>>> Definite time	F14	0.01s	0-10000 (100s)
032E-032F	Reserved	--	--	--
0330	Earth Fault Low Set Io>	F6	--	0=Disable, 1=Enable
0331	Earth Fault Low Set Io> Threshold	F14	0.01 Ion	2-200 (2)
0332	Earth Fault Low Set Io> Delay Type	F6	--	0=Definite time, 1=IDMT

Address (HEX)	Parameter	Format	Unit	Range
Protection Group 1. Read/Write. Function 03h, 04h, 06h, 10h				
0333	Earth Fault Low Set Definite Time tIo>	F14	0.01s	0-10000 (100s)
0334	Earth Fault Low Set IDMT Curve	F6	--	0=NI, 1=VI, 2=EI, 3=LTI, 4=NI1
0335	Earth Fault Low Set IDMT Multiplier k	F14	0.01	1-100 (1)
0336-0339	Reserved	--	--	--
0340	Earth Fault High Set Io>> Threshold	F6	--	0=Disable, 1=Enable
0341	Earth Fault High Set Io>>	F14	0.01 Ion	10-1000 (10)
0342	Earth Fault High Set tIo>>	F14	0.01s	0-10000 (100s)
Protection Group 2. Read/Write. Function 03h, 04h, 06h, 10h				
0400-0442	Same as Protection Group1 except addresses are 04xx instead of 03xx			
Fault Records. Read only. Function 03h, 04h				***(Refer page 48)**
1000-1031	Fault Record 1-50			
Event Records. Read only. Function 03h, 04h				***(Refer page 49)**
2000-20F9	Event Record 1-250			
Alarm Records. Read only. Function 03h, 04h				***(Refer page 49)**
3000-301D	Alarm Record 1-30			

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: Reserved
12: TCS

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

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: Reserved
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 change
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

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

7.3 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: Reserved
	Bit 13: 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)
F5	Unsigned integer – Output relay status
	Bit 0: Output 1 (0=off, 1=on)
	Bit 1: Output 2 (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: Reserved
	Bit 8: TCS
	Bit 9: Idemand
	Bit 10: Remote trip

Appendix A

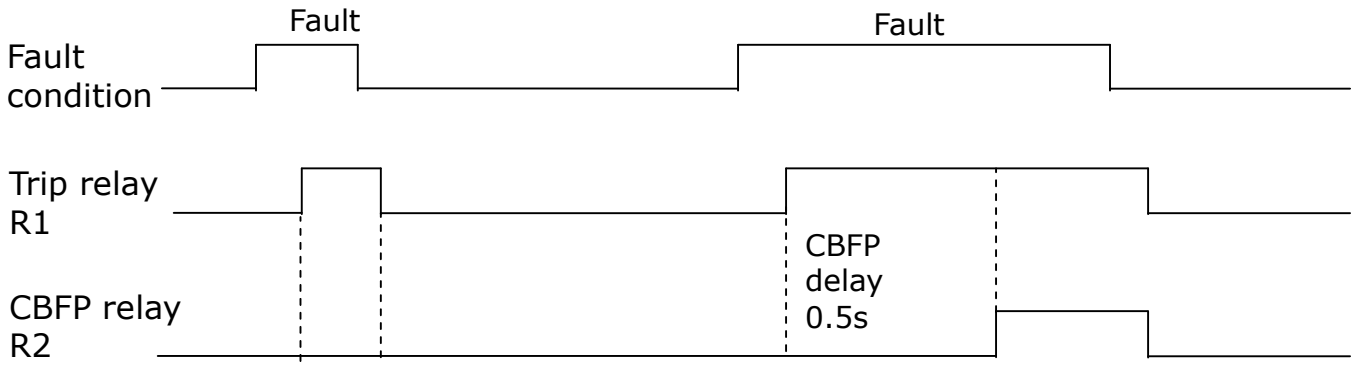
Circuit Breaker Failure Protection

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.

There is an option to enable or disable Aux 1 as a fault condition (if Aux 1 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. (R2 function set to CBFP, delay 0.5s.)

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:

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

Ttrip = Time to trip (in seconds)

Tθ = Thermal time constant of the protected element (in seconds)

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

Ieq = Equivalent current corresponding to the RMS value of the largest phase current.

Iθ > = 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

θtrip = Trip thermal state. If the trip thermal state is set at 100%, then θtrip = 1

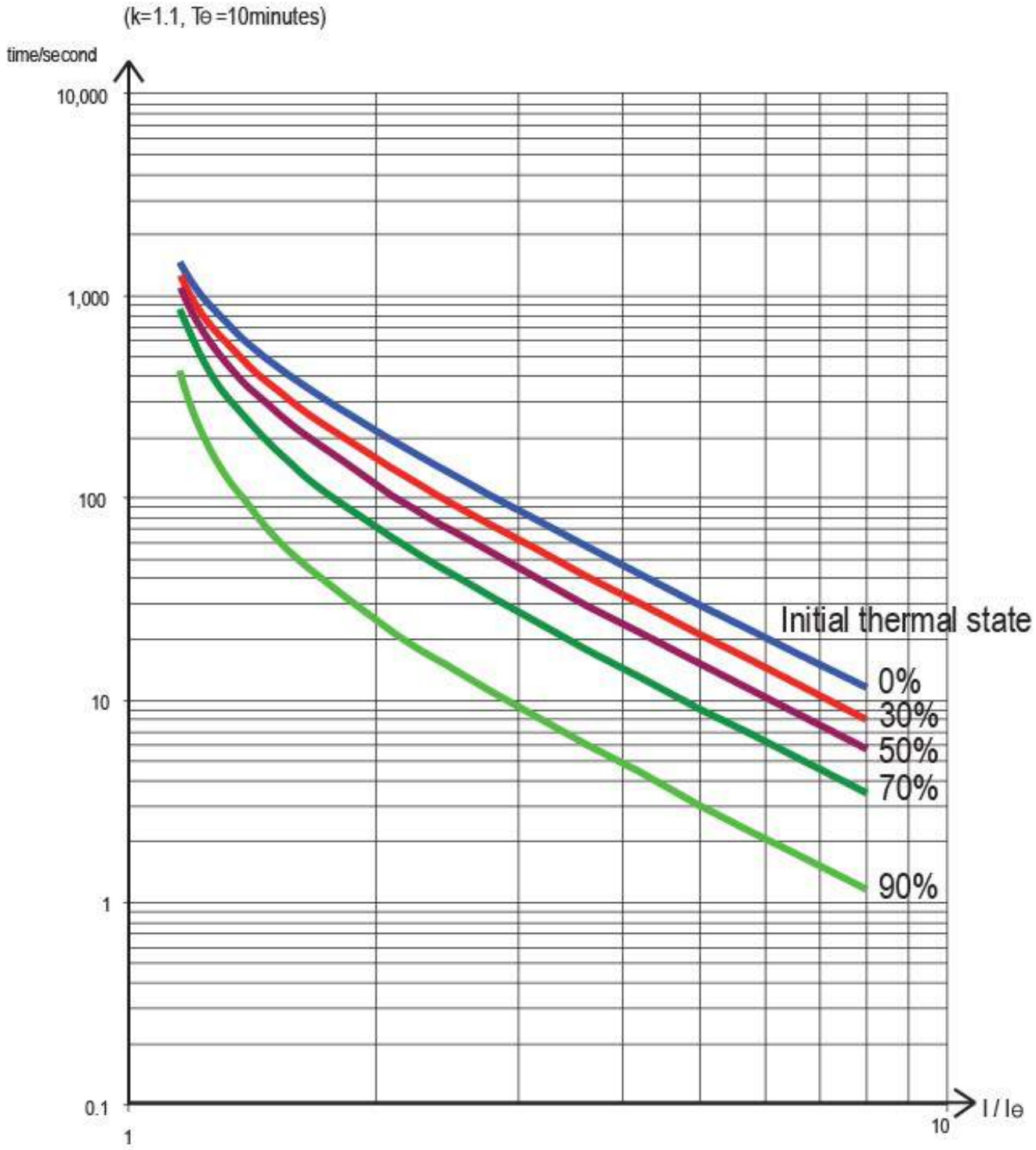
The settings of these parameters are available in the menus:
PROTECTION G1/G2 – Thermal OL

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.

Thermal Overload Curves



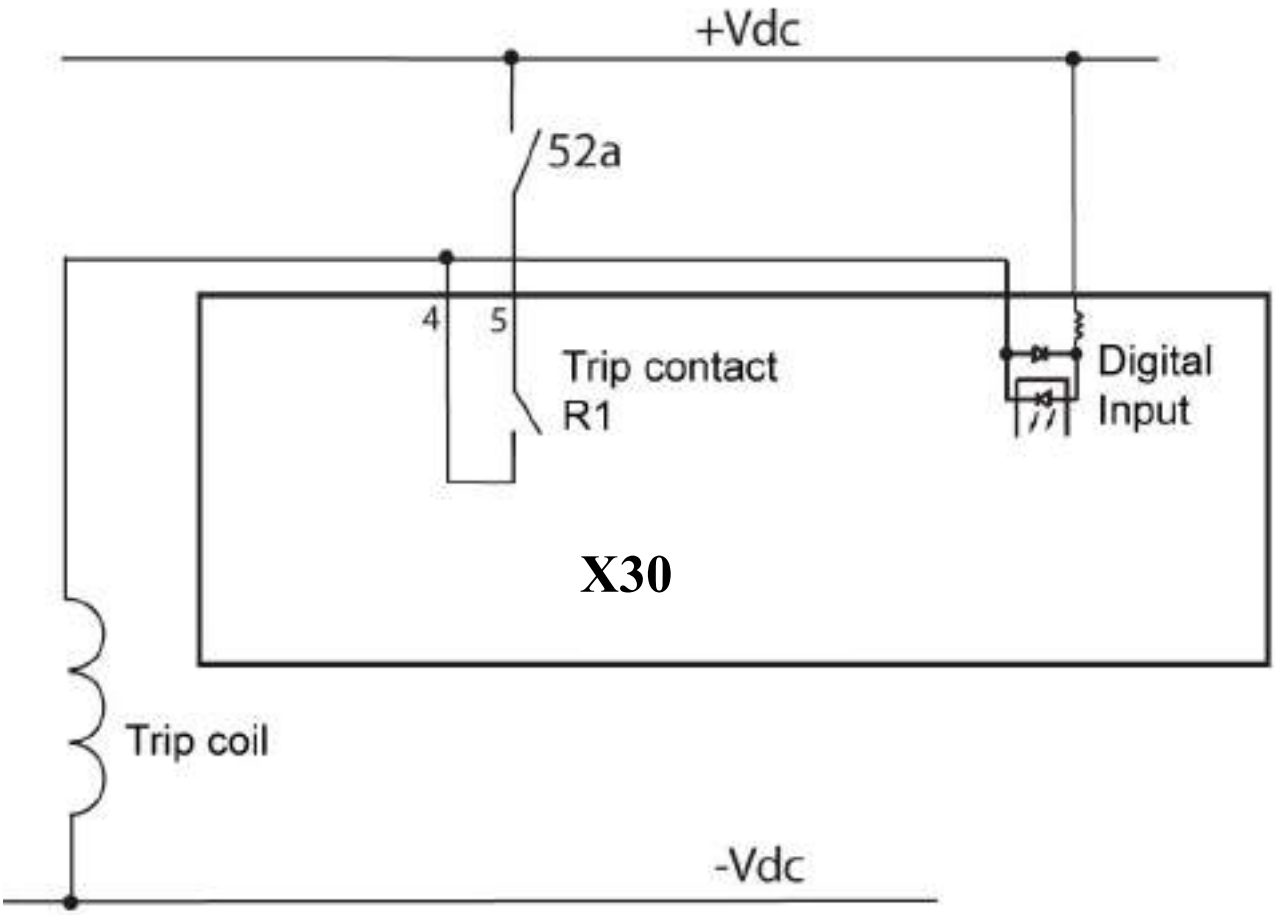
Trip Circuit Supervision

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

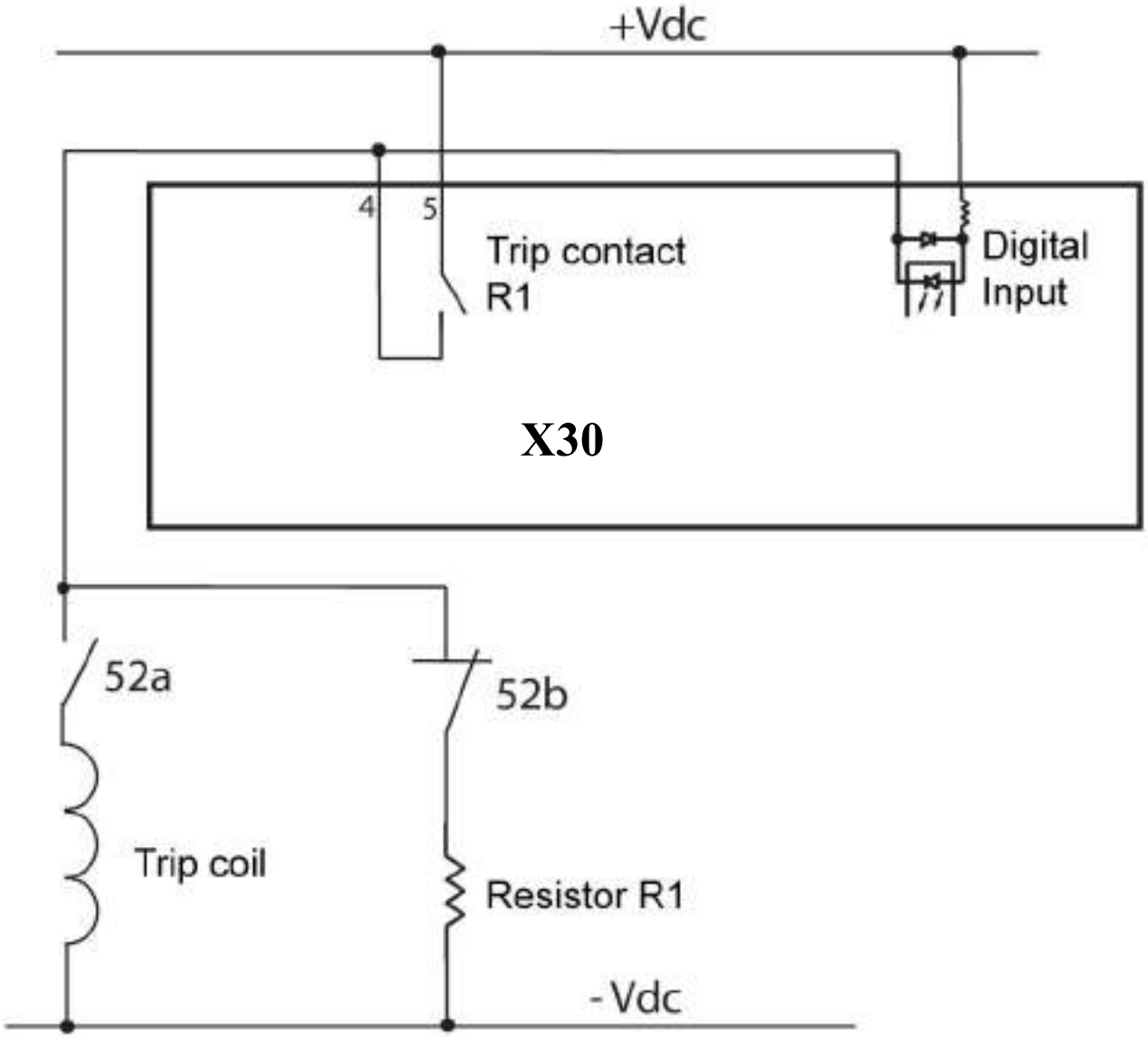
In this example only 52a auxiliary contact is available, the trip coil is monitored when the CB is open or closed.



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).

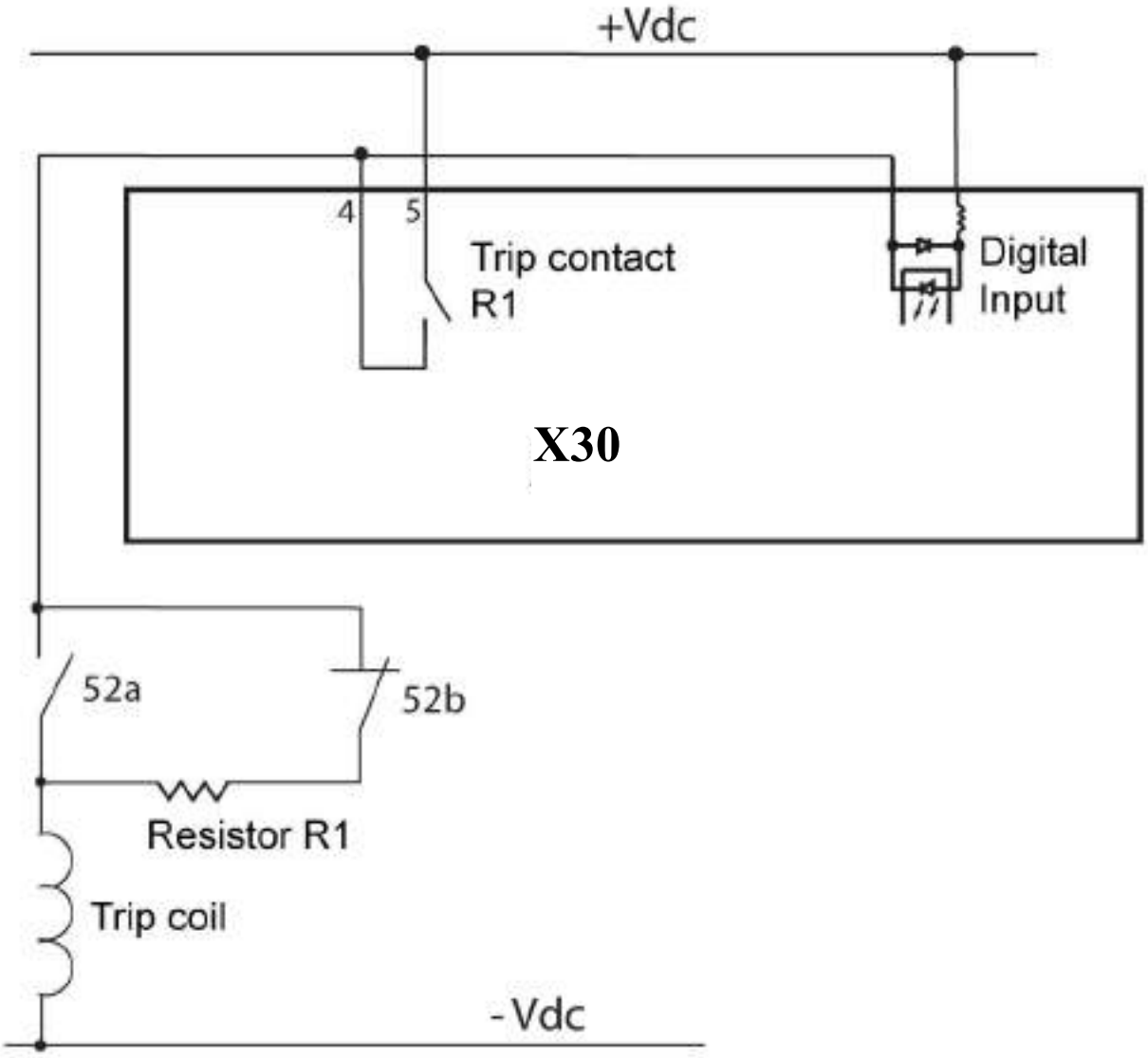
It is necessary to insert resistor R1 in series with 52b, if the Trip contact R1 is latched or it stays involuntarily closed.



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

In this exmple 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

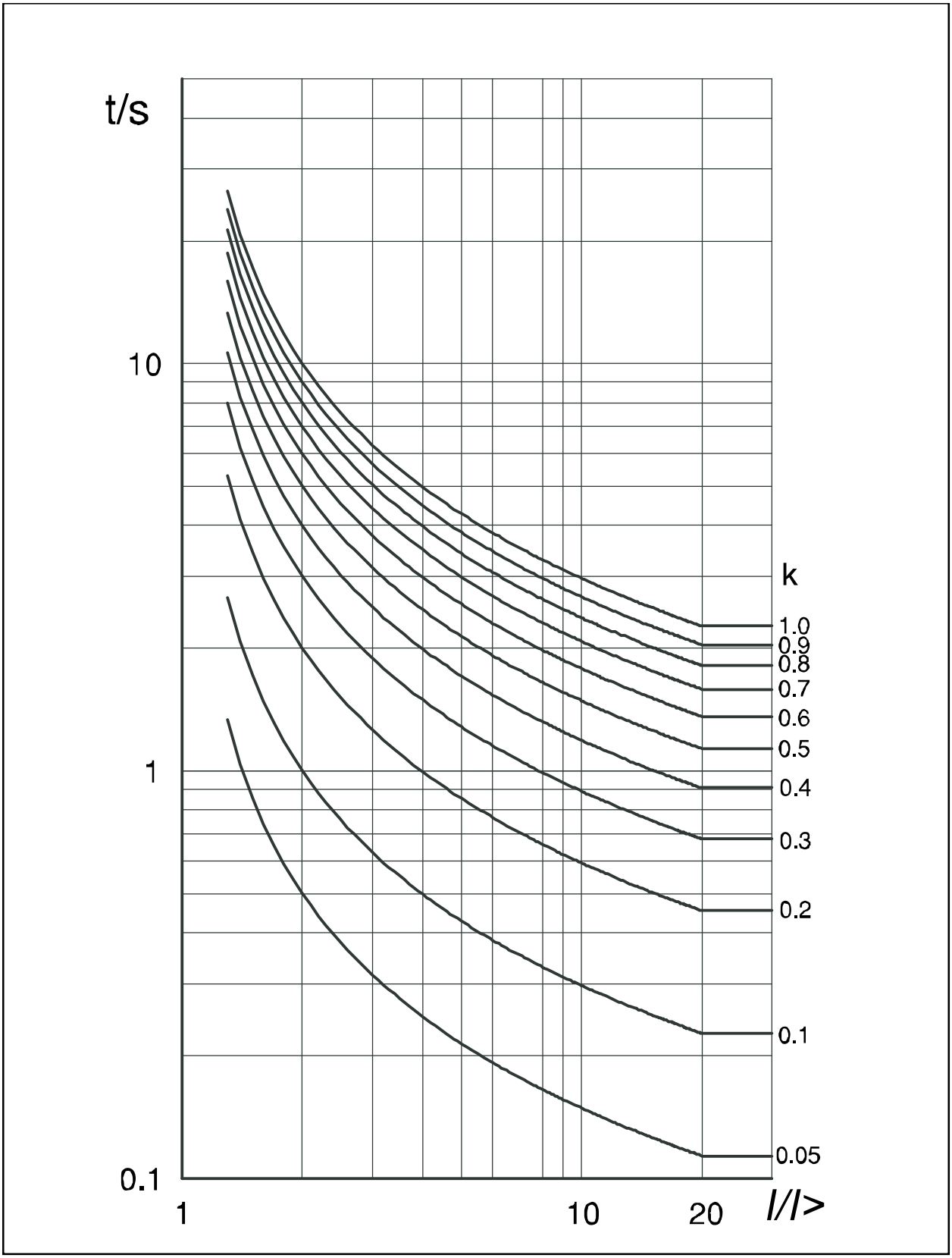
For the case of example 3, the maximum R1 value should be deducted by Trip coil resistance (insignificant in most cases).

The Power rating of the resistor R1 is calculated as:

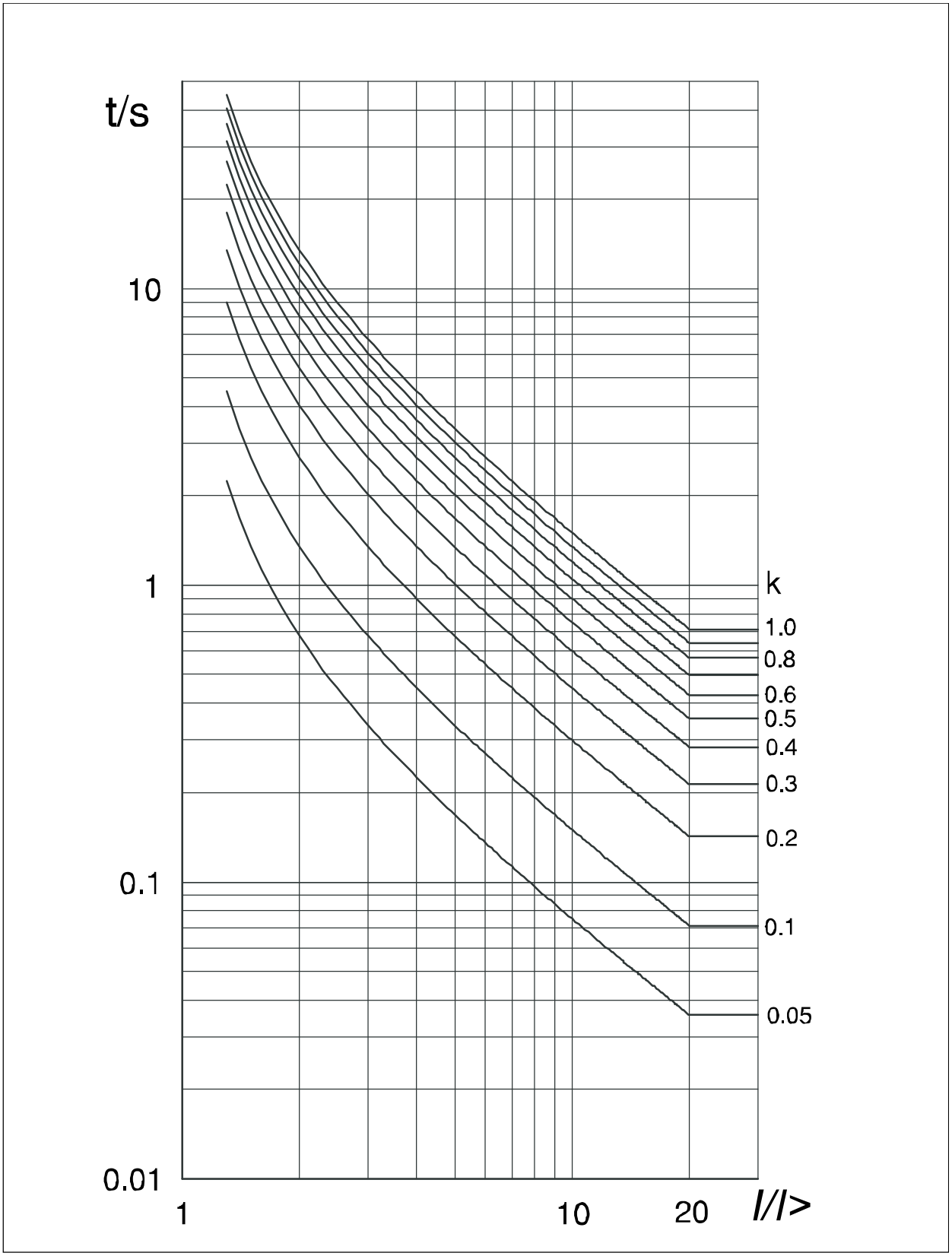
$$P_{R1} > 2 \times \frac{Ua^2}{R1} \text{ Watt}$$

Appendix B

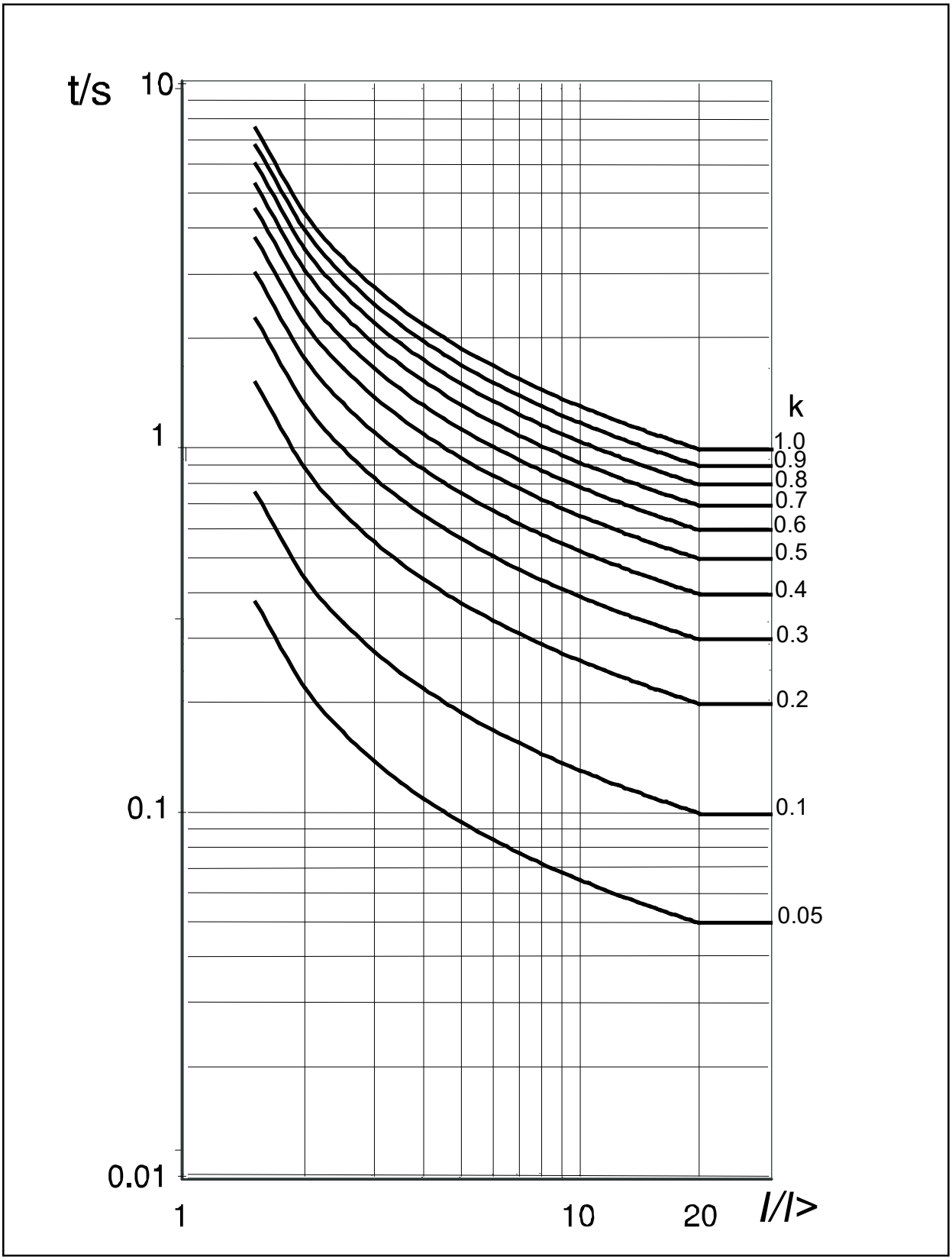
Normal Inverse



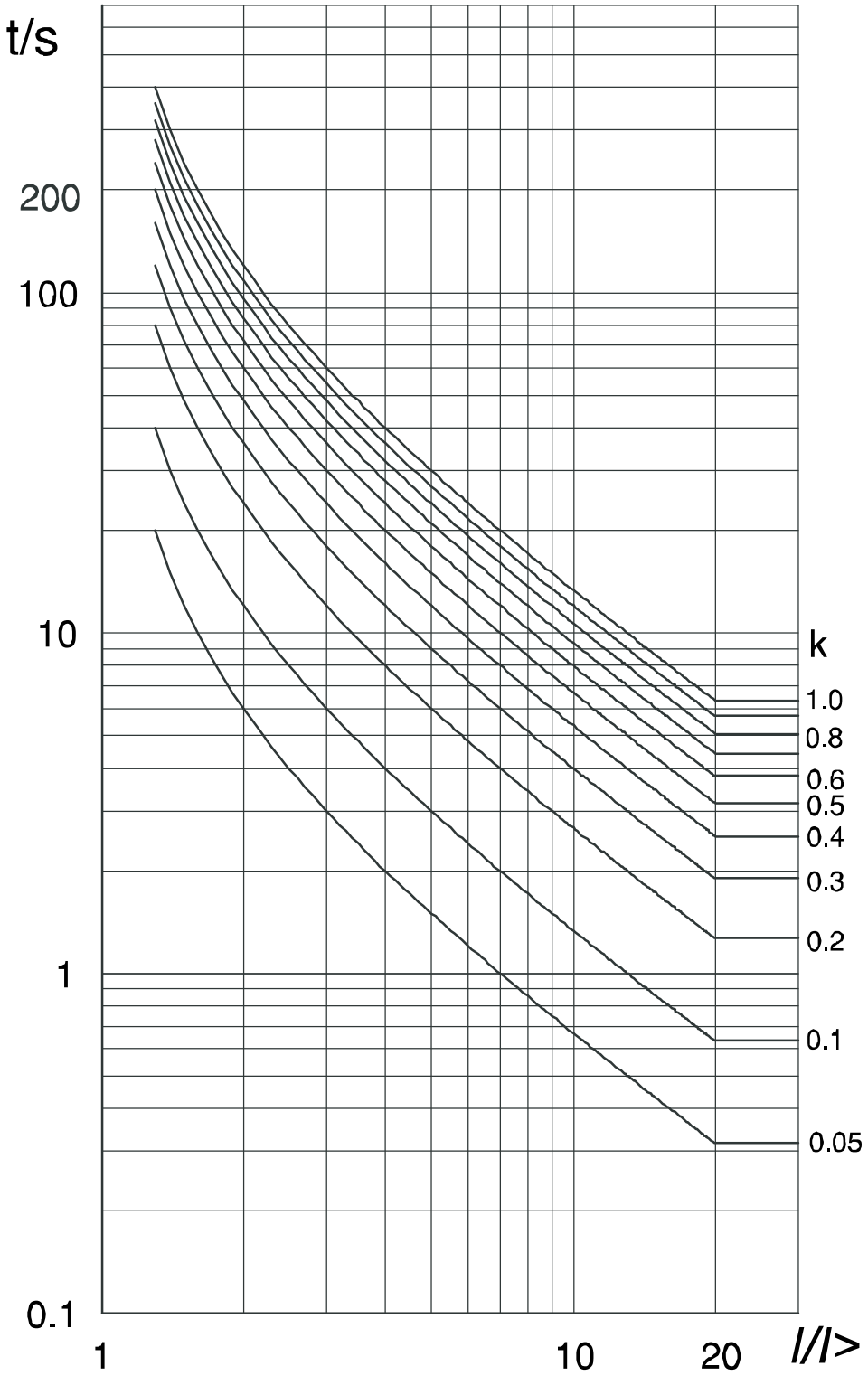
Very Inverse



Normal Inverse 1.3/10



Long-time Inverse



Extremely Inverse