We touch your electricity everyday!

mPRO-100-V2
Electronic Motor Protection Relay

C&S electric

PMD Division

CONTENTS

1) Introduction

The mPRO-100 protective relay is an advanced current based numeric relay that provides multi protection and monitoring in compact Din-rail enclosure. The relay offers reliable protection for LV and MV motors which are either operated via power contactors or power circuit breakers.

mPRO-100 offers following features in a compact, modular & smart 35 mm DIN - rail mounting enclosure.

2) Features & Protections

Multi protection functions

Over Load, Short Circuit, Under Current, Unbalance, Phase Loss, Phase Reversal, Stall, Locked Rotor, Earth Fault (Residual/CBCT)

Metering & monitoring information

Three Phase RMS current, Thermal content (%), Unbalance current (%)

Records

One Fault/Failure record to identify the last failure

Date & Time information

In-built Real Time clock available. Fault gets registered with date and time to identify the time/date of failure.

Motor Run Time

Accumulation of motor operating time to analyze motor service factors like bearing check, refueling cycling etc.

High reliability

In-built Fail safe operation feature available for trip contact

Multiple Reset functions

Programmable Automatic/Manual reset functions available for different schemes.

Thermal monitoring

Thermal over-load protection with different trip class

Password setting

All parameter settings protected via password protection to avoid the unauthorized access

3) Application

Every motor failure causes a production stop and costs for service. A cable cut, phase failure, short circuit or overload can destroy the motor or pose danger for the whole production line and for the people who work there.

This is the reason why a reliable motor protection is very important and thus mPRO works as a safe guard. It can be used in following areas :

- Motor Control Center (MCC) application
- Integrated Process & Electrical Control with Protection
- Can be used in inverter control circuit (20-200 Hz)

4) Functional Diagram
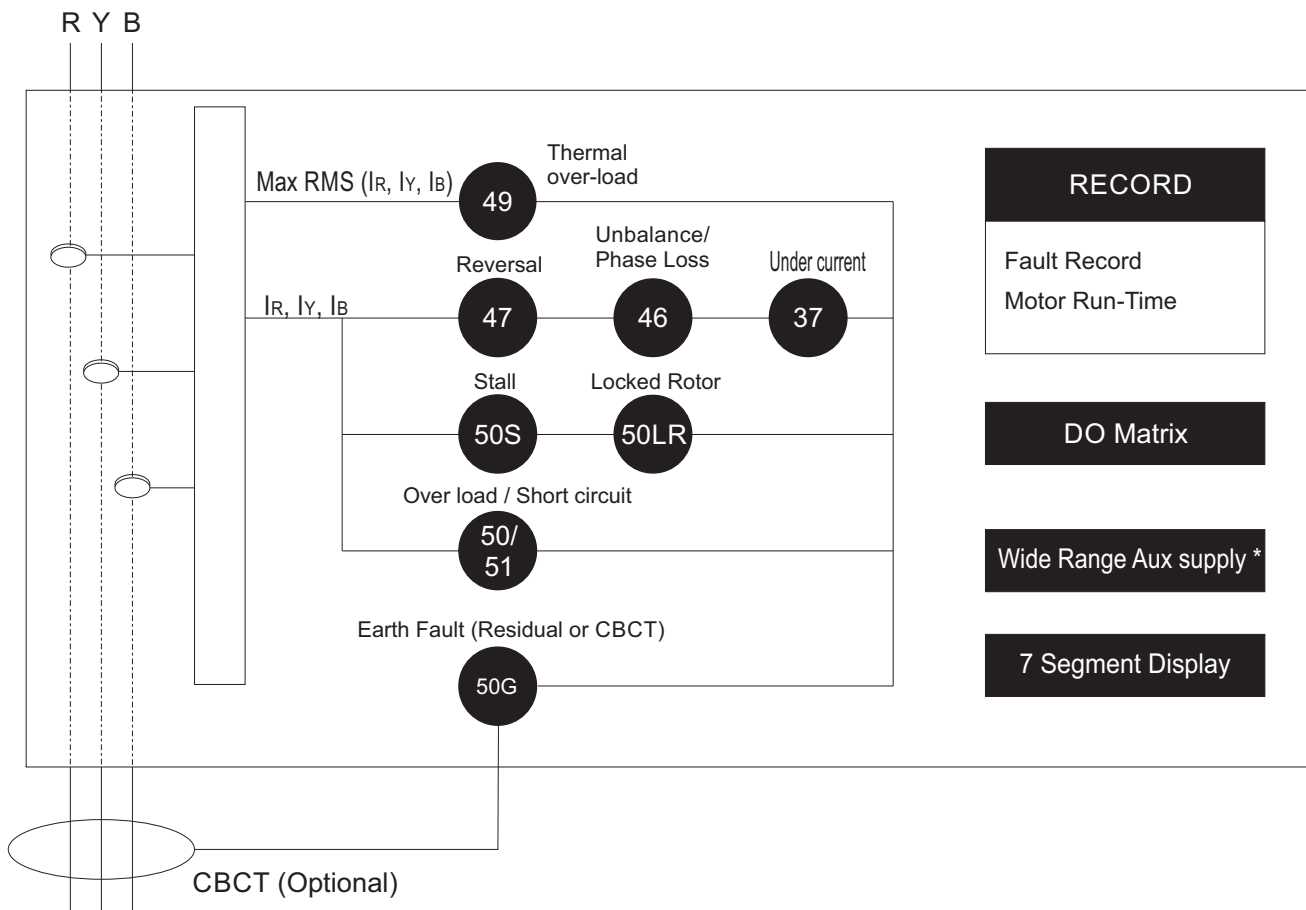
* Model Dependent

5) Functional Description

Motor State Recognition

The mPRO monitors the flow of the current from which the following operational conditions of the motor are gathered.

◆   STOP
◆   START
◆   RUNNING

Fail Safe Operation

mPRO allows user to enable fail safe operation for Trip Relay contacts (DO1). Following occurs when trip relay fail safe mode is enabled.

◆   Trip relay coil is energized.
◆   When mPRO generates a trip signal, the trip relay coil is de- energized.

Trip relay is also de-energized, if the auxiliary power is removed or fails.

If trip contact is appropriately connected to the motor breaker or contactor, the motor is automatically tripped, if auxiliary power fails.

Failsafe Mode		Non Failsafe Mode	
A3-A5	A3-A4	A3-A5	A3-A4
NO contact	NC contact	NC contact	NO contact

PROTECTIVE FUNCTION DESCRIPTION

Under Current Protection

This protection covers the Loss of load condition like V-belt split or shaft failure or a pump running un-primed.

If in running condition, the phase currents in all the three phases are below the selected value of undercurrent setting (U-C) for Under current trip time (3 Sec), then mPRO will trip to stop the motor.

Over Current Protection

Over-current protection is provided by tripping the relay when motor operating current in any of the three phases exceeds over-current setting (O-L) of mPRO for a period greater than the selected operating time (td) under DEFT (definite time over-current protection) characteristics.

Short Circuit Protection

Short circuit protection is provided by tripping the relay when the motor operating current in any of the three phases exceeds the value corresponding to Short circuit setting (S-C) for the set interval (50 mSec).

Phase Loss / Single Phase Protection

During a phase loss, the motor winding current will increase by 150% or more. As the motor winding current increases, the winding temperature will increase and possibly damage the winding insulation. When the relay detects loss of phase it will trip after expiry of set time (3 Sec). The quick trip time on mPRO helps to prevent over-current damage to the windings.

Phase Unbalance

The phase unbalance condition is checked only during running condition of the motor. The unbalance % between the three phase currents is calculated by [(MAX Current-MIN current)/MAX current] x 100[%] .If the calculated value exceeds the set unbalance value (UNB) for the set time (3 Sec) the relay will trip.

Phase Reversal

In the event of phase reversal, the relay trips after set time (200 mSec). It helps to protect a three phase motor while installation.

Locked Rotor

During motor start-up, a locked rotor is detected with the state of increased phase current above the set value (LOC) after the set trip time (500 mSec).

Earth / Ground Fault

A large percentage of motor insulation failures result in ground/earth fault currents. Early detection keeps damage to a minimum, thereby shortening repair times and minimizing repair costs. This fault will be detected with the help of external CBCT or internal residual method (model dependent). Once fault is detected (Earth current > E-F setting), the relay will trip after expiry of set time.

Earth fault detection delay (EdLy) to delay the detection of earth fault during motor start-up.

Thermal Over load

Provides reliable protection for motor against over-heating.

The protection feature is based on mathematical model of motor thermal image. The motor thermal overload protection function calculates the heat accumulated in the rotor and stator based on the effective heating current , integrated over a time tInv>. The relay appropriately takes in to account cooling of the winding by gradually emptying the accumulated current bucket. The relay displays the status of thermal condition of motor windings as a % of maximum permissible Thermal capacity.

If inverse overload characteristic (INV) is selected then only the effect of thermal memory phenomenon is enabled. If current in any of the three phases exceeds over-current setting I> as well as accumulated thermal capacity (Thermal MEM) is >=100% then mPRO will trip the motor. f thermal memory is accumulated then Trip Relay Contact Reset depends on Thermal Reset selection (Disable/Enable) as given in following table.

| Thermal Reset	Trip Relay Output Contact Reset
Enable (ON)	When Thermal capacity (Thermal MEM) <90% & Front Reset key is pressed
Disable (OFF)	When Front Reset key is pressed

Stall

Mechanical equipments such as pumps or fans can be quickly damaged if it jams, resulting in a locked rotor stall. The mPRO will trip when the running current exceeds the set value (StL) after the Stalled Rotor Time (3 Sec). Set this value to OFF, if stall protection of driven equipment is not required since the thermal overload protection will protect the motor. This feature is blocked during the inrush of motor starting.

Circuit Breaker Failure (CBFAIL)

After a fault is detected mPRO generates a trip signal via trip relay to stop the motor. If motor current does not get cutoff on expiration of CB Fail set time (tCBF), mPRO will declare it as CBFail.

In this condition trip contact will be released only after manual acknowledgment by RESET push button.
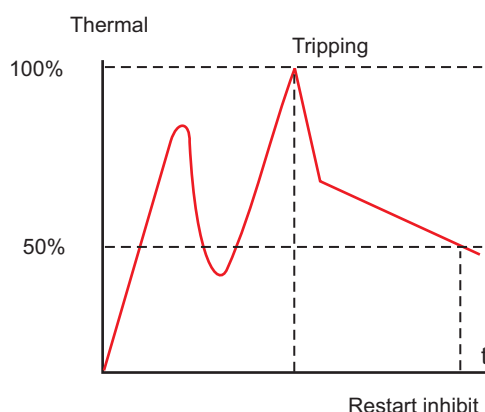
6) Records

mPRO-100 Model stores following records in its non-volatile memory.

(a) Fault Record
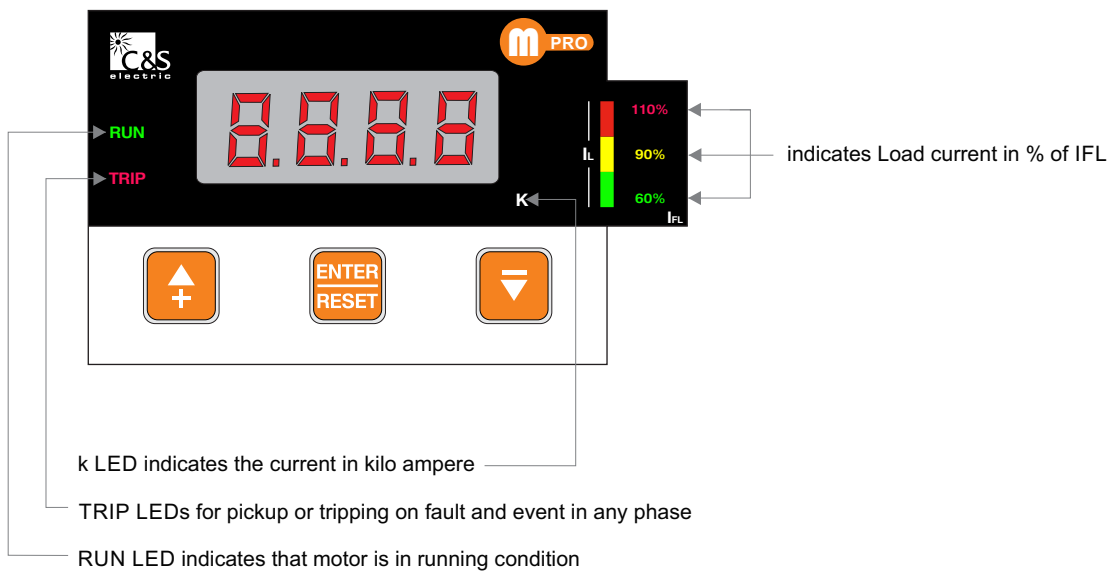mPRO records last fault in its non-volatile memory with time stamp :

◆   Phase and earth fault current level
◆   Date and time of fault
◆   Origin of fault (over current, short circuit, stall etc.)
◆   Faulty phase

(b) Motor Run Time Record
mPRO accumulates the total RUN Time of motor. Update time resolution is 1 min.

7) Human Machine Interface

indicates Load current in % of IFL

k LED indicates the current in kilo ampere

TRIP LEDs for pickup or tripping on fault and event in any phase

RUN LED indicates that motor is in running condition

It comprises of 7 Segment display :-

◆ Three Push buttons for setting and other operations for local access. one push button for fault acknowledgment/Reset.
◆ 1 LED for PICKUP/TRIP on fault, which require Manual reset through RESET key.
◆ 1 RUN LED for motor Start/Run indication.
◆ Motor State Indicator: Flashing of START LED for Motor Start & glowing steady of RUN LED for run condition.

Keys	Description
ENTER RESET	used as ENTER key in Edit / Setting / View menu
	Long press to enter in Edit menu
	used as Fault RESET/ acknowledgment key with single press
▲	used as scroll key / increment key
▼	used as scroll key / decrement key

8) Setting Parameters

Common Setting Parameters

| Parameter | Display | Setting Range | | Step Size | Unit | Default |
		Min.	Max.			Setting
External CT Selection	Ct	nonE	EHCt	- - -	- - -	nonE
Full Load Current (IFL) [3]	IFL	1.00[1]/0.25[2]	60.00[1]/5.00[2]	0.01	Amp	60 / 5
CT Ratio [4]	Ctr	1	999	1	- - -	1
Motor Start Time	Strt	1.0	200.0	1.0	SEc	8
Thermal Memory Reset (Enable : ON/ Disable : OFF)	thrS	OFF	On	- - -	- - -	On
Trip Relay Fail Safe (Enable : ON/ Disable : OFF)	FLSF	OFF	On	- - -	- - -	On
Alarm Relay (DO2 & DO3) Reset option (Ato: Auto / Man: Manual)	ALrS	Ato	MAn	- - -	- - -	MAn

Note:
- Model Dependent [1]* : - 60A model, [2]* : 5A model. In case of EXCT selection, IFL value will be multiplied by CT_RATIO
- [3] Full Load Current setting will be model dependent. Refer section Rated Current Range Selection.
- [4] CT ratio parameter will come into picture only when external primary CT is required to be used. This settings will only be displayed, when EXCT is selected in Max. Current Selection.
- [5] When External CT (EXCT) is selected, Step size will be as per CT ratio value. Step size=CT_Ratio/100

Protection Setting Parameters

| Parameter | Display | Setting Range | | Step Size | Unit | Default |
		Min.	Max.			Setting
Overload Pickup	o-L	50	150	1	% IFL (Amp)	110
Overload Characteristic	CHA	dEFt	InU	- - -	- - -	dEFt
Overload Definite Time [5]	td	0.1	60.0	0.1	Sec	10
Overload Operating Time [6]	t1	5	60	5	Sec	5
Short Circuit Pickup	S-C	200	1500 [9]	50	IFL (Amp)	OFF
*Earth Fault Pick up (Residual) [7]	E-F	10	50	1	IFL (Amp)	OFF
Earth Fault Trip Time (Residual) [7]	tE	0.2	10	0.1	Sec	1.0
*Earth Fault Pick up (CBCT) [8]	EFCt	0.03	3.0	0.01	(Amp)	OFF
Earth Fault Trip Time (CBCT) [8]	tECt	0.05	10	0.01	Sec	0.1
Under Current Pick up	U-C	20	90	5	IFL (Amp)	OFF
Unbalance Current Pick up	unb	5	50	2.5		OFF
Phase Reversal	rEU	On	OFF	- - -	- - -	OFF
Locked Rotor Pick up	LoC	200	1000 [10]	50	IFL (Amp)	OFF
Phase Loss	P-F	On	OFF	- - -	- - -	OFF
Stall Rotor Pick up	StL	150	600	5	IFL (Amp)	OFF
CB Fail Detection Time	tCbF	1	40	1	Sec	5

Note:
- All above protection are available with disable option (OFF) & in % of IFL (except Earth Fault with CBCT).
- All protection settings which are in % of IFL will be displayed on HMI (Display module) in Amp.
- mPRO will allow change in IFL setting only if motor is in stop condition and there is no fault pickup.
- [5] Definite time is applicable when DEFT characteristic is selected.
- [6] Operating time is applicable when INV characteristic is selected. This is the tripping time at I = 6 x I>.
- [7] Earth Fault Residual Internal Calculation (Model dependent).
- [8] Earth Fault calculation using externally connected CBCT (Model dependent).
- [9] Max. protection setting :
     - 60A Model   1500% for external primary CT selection (EXCT)
                    800% for built in CT selection.
     - 5A Model   800%
- [10] Max. protection setting :
     - 60A Model   1000% for external primary CT selection (EXCT)
                    800% for built in CT selection.
     - 5A Model   800%

Advanced Setting Parameter

Parameter	Display	Setting Range		Step Size	Unit	Default Setting
		Min.	Max.			
Short Circuit detection state	SCdt	on / run		—	—	run
Phase Reverse detection state	rPdt	on / Strt / run		—	—	on
Earth Fault detection delay time	EdLY	0.0	200.0	0.1	Sec	E model: 8.0
						Z model: 0.0
Motor type (1Ph or 3Ph)	-mtYP	3PH	1PH	—	—	3PH
Auto Scroll (Enable: ON/Disable: OFF)	SCrL	OFF	On	---	---	On
Protection Setting Display	PSEt	AbS	PEr	-	-	PEr

Note:
- on - Protection active during both motor start and run state.
- Strt - Protection active during motor start state only.
- run - Protection active during motor run state only.
- Selecting motor type to 1 Ph then Phase loss, Unbalance, Earth fault & Reversal function will not work.
- In Protection Setting display (PSEt) : AbS indicates protection setting in Amperes and PEr indicates protection setting in Percentage.

9) Trip Time for Protection

Parameter	Description
Trip Time	
Over-Load	According to setting time
Short Circuit	50 mSec
Earth Fault	According to setting time
Under current	3 Sec
Phase Unbalance	3 Sec
Phase Reversal	200 mSec
Lock Rotor	500 mSec
Phase Loss	3 Sec
Stall	3 Sec
CB Fail	According to setting time

10) Technical Data

Parameter	Description
Operational Current	0.2 - 8.0 x IFL
Nominal Frequency	50 / 60 Hz
Phase Current Measurement	Accuracy : $\pm$ 5% [0.5 - 6.0 x IFL (5Amp model) / 0.25 - 6.0 x IFL (60 Amp model)]
Protection	Over-Load, Under-Current, Short Circuit, Lock Rotor, Stall, Unbalance, Phase Loss, Phase Reversal, Earth Fault, CB Failure
Design Standards (As per IEC 60947)	
IEC 60947-4-1	Radiated Electromagnetic Field (Class A)
	Mains Terminal Disturbance Voltage (Class A)
IEC 61000-3-2	Harmonic Current Emissions
IEC 61000-3-3	Voltage changes, Voltage fluctuations & Flicker
IEC 60947-4-1	Electrostatic Discharge Immunity (Class A)
	Radiated RF E-Field (80 to 1000 MHZ) (Class A)
	Electrical Fast Transient / Burst Immunity (Class A)
	Surge Immunity (Class A)
Accuracy	
Trip Time	$\pm$ 5% (or $\pm$ 100 mSec) (which ever is higher)
Pickup Current (Phase)	$\pm$ 5% (or $\pm$ 0.020 Amp) (which ever is higher)
Pickup Current (Earth)	$\pm$ 5% (or $\pm$ 0.020 Amp) (which ever is higher) - (Z model i.e CBCT model)
	$\pm$ 10% (or $\pm$ 0.040 Amp) (which ever is higher) - (E model)
Display	
7 Segment	Metering and Fault information
Bar Graph	60 - 110 % of IFL setting
LED	RUN : Flashing for Motor Start/ Steady for Motor Run
	TRIP : Flashing for Fault Pick up/ Steady for Trip
	K : kiloAmp, LED glows for Current > 999 Amp
Auxiliary Supply (Refer Ordering Information)	L: 110V AC (100-160V) / H: 220V AC (190-260V)
Power Consumption	Approx. 6W
Contact Rating	
DO Contact	1 C/O Contact - N/O contact, 5A / 250V AC or 24V DC ; N/C contact, 2A / 250V AC or 24V DC
	2 N/O Contact with 1 common, 5A / 250V AC or 24V DC
CBCT Input	30 mA to 3 Amp : CT Ratio 1:1500 (available when CBCT is used)
Relay Reset	Trip Relay (DO1) Reset : Manual
	Alarm Relay (DO2 & DO3) Reset : Manual / Automatic
Mounting	35 mm Din-rail
Temperature	
Operation	0°C to 70°C
Storage	-10°C to 85°C
Wiring Connection	
For current	Penetration / Tunnel Type
For Others (Aux supply, Relay contact etc.)	Screwed Terminal

11) Current Range Selection

mPRO-100 supports 0.25 to 60 Amp Full Load current (built-in-CT) and supports CT ratio up-to 999 with external CT as per following configuration: -

Model 1 (60 Amp)		Model 2 (5 Amp)		No.of times wire passes through Built-in CT
Phase CT selection	Rated Current Range	Phase CT selection	Rated Current Range	
nonE	5 - 60 Amp	nonE	1 to 5 Amp	Once
Ext CT	5 Amp	Ext CT	1Amp / 5 Amp	Once
Above are the recommended range of Current range. However optionally mPRO-100 can be used for extended current range with following option.				
nonE	1 - 4.99 Amp	nonE	0.25 - 0.99 Amp	4 times

mPRO-100 supports motor current above 60 Amp with external CT with rated secondary current of 5 Amp. e.g : 100 : 5, 200 : 5, 800 : 5 etc.

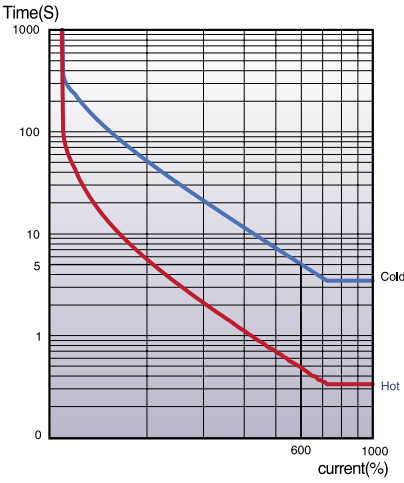> Note : C&S recommend to use Model-2, when using External CT.

12) Cable Selection

The mPRO relay is provided with built-in CT operated for current up to 60 Amp.
Following are the recommended cable size :-

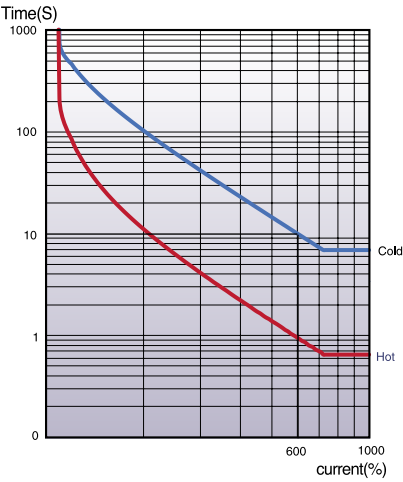| Material	Size (mm^2)	Current (A)
Copper PVC	1.5	23
	2.5	30
	4	38
	6	48
	10	64
	13	70
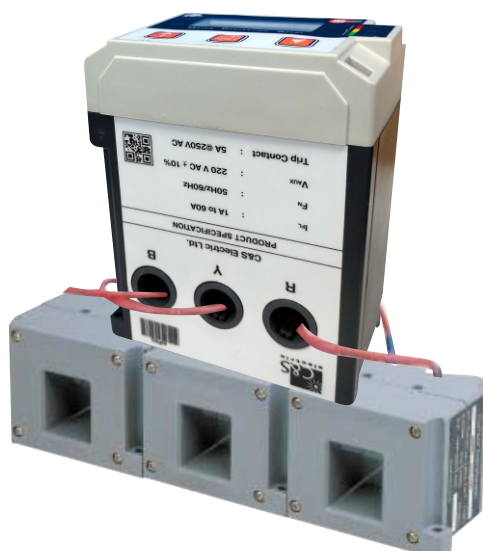
13) Thermal (Inverse) Curve

Class5	Class10

Time(S) — current(%)

Class20	Class30

Time(S) — current(%)
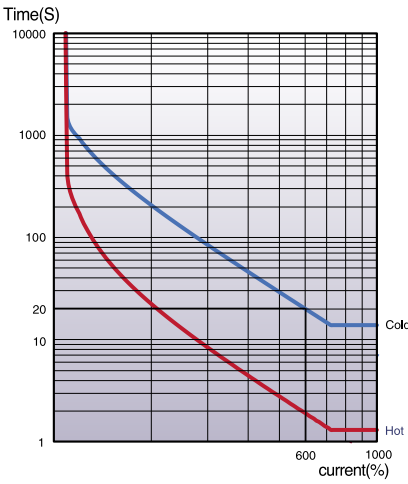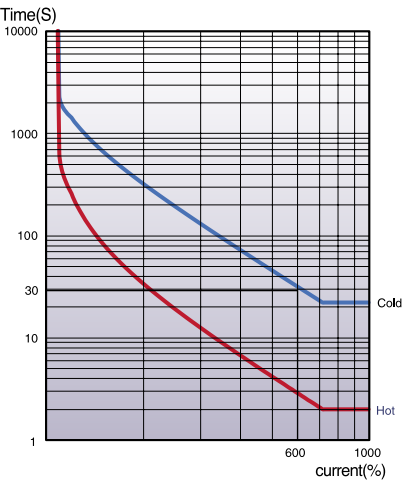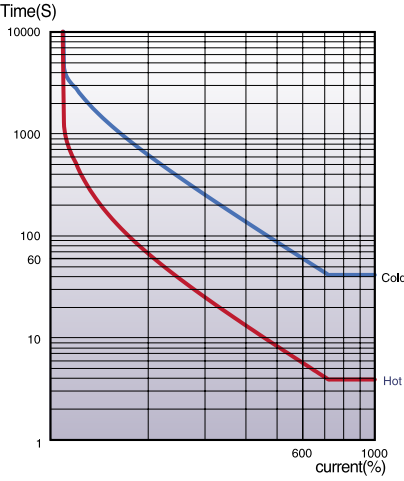
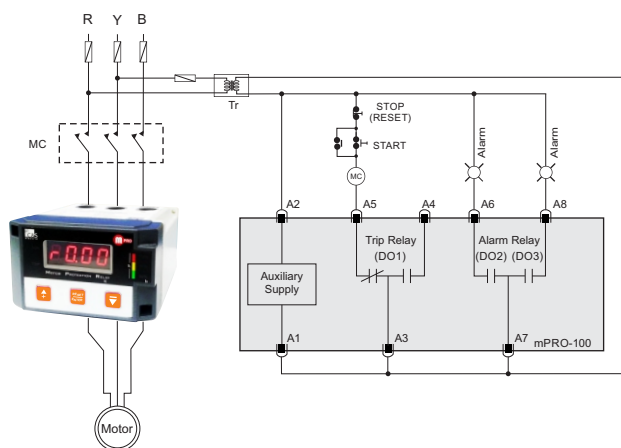| Class60	Definite time characteristic

Time(S) — current(%)
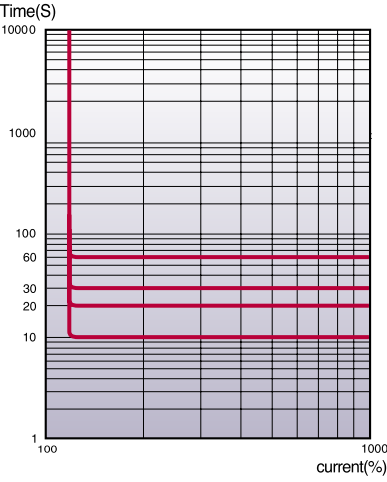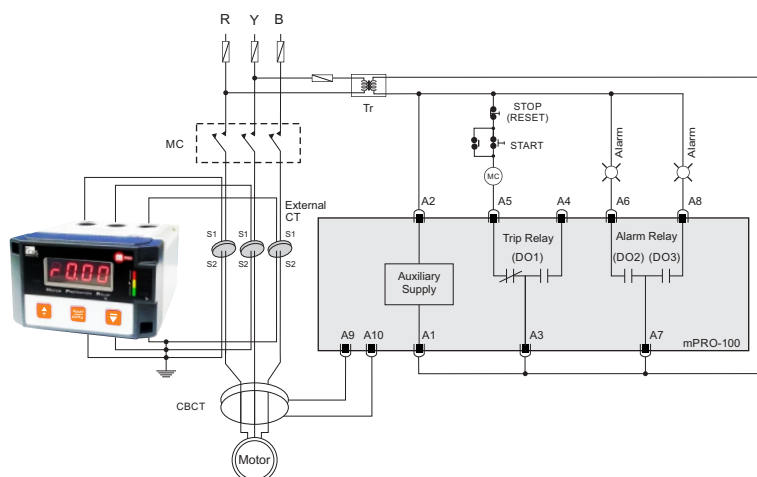
14) Connection Diagram

**m P R O - 1 0 0 w i t h
external CBCT for**
earth fault detection
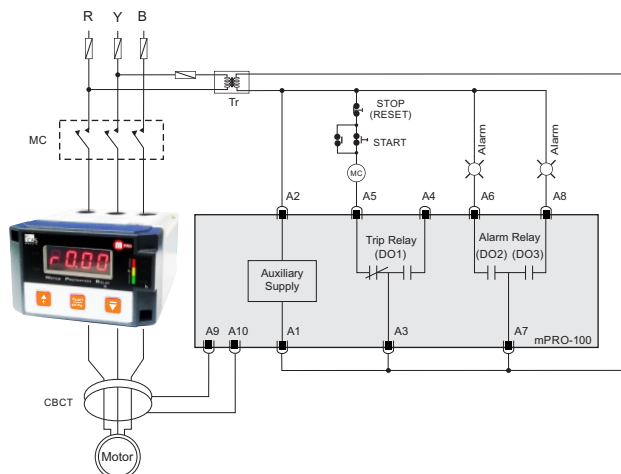
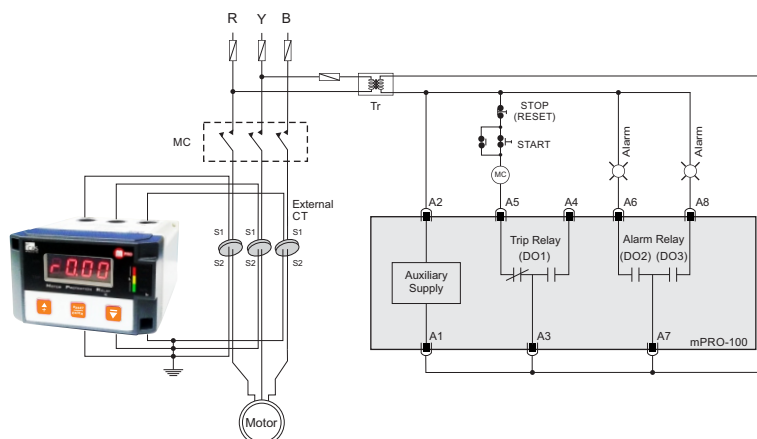mPRO-100 with **'Built in
Earth fault'** detection

mPRO-100 with
**External Phase CT
& external CBCT** for
Earth fault detection

mPRO-100 with
**External Phase CT &
Built in Earth fault**
detection

15) Dimensional Details

All the Dimensions are in mm.

(W x H x D : 95 x 59 x 116) / Weight ~ 700 gm

Front view

57.0

59.0

95.0

116.0

Side view

95.0

116.0

Bottom view

93.0
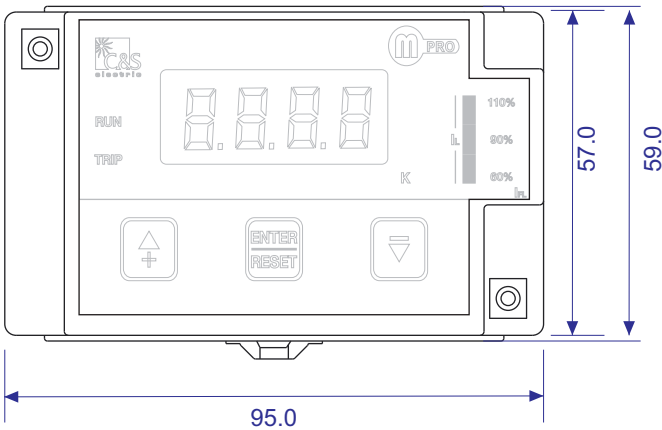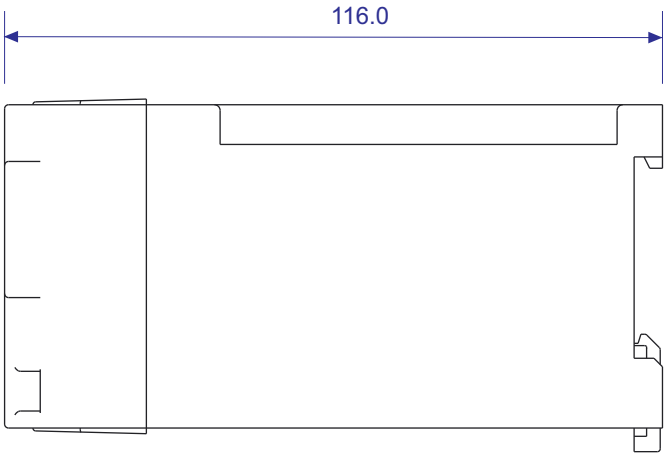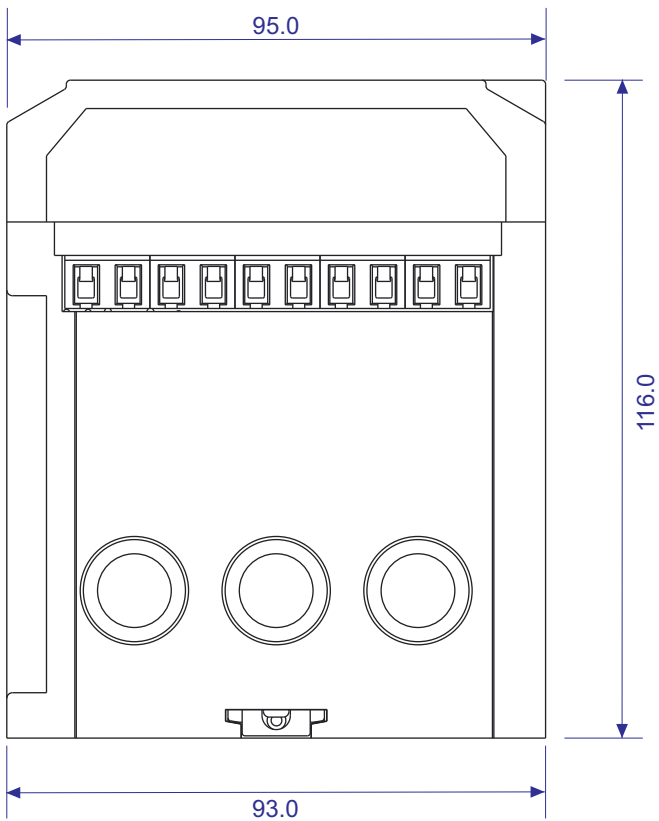
16) CBCT Details

All the Dimensions are in mm. (Tolerance : ± 2.0 mm)

CBCT output wire connection

Screwed terminal
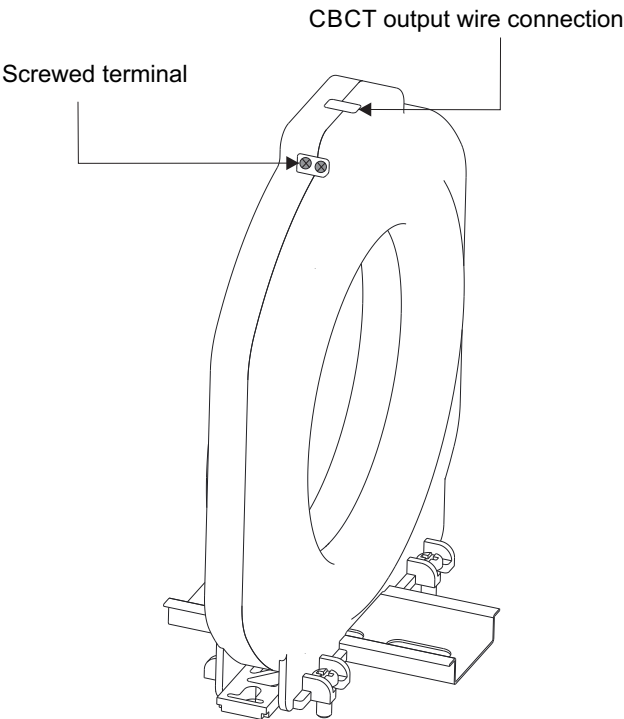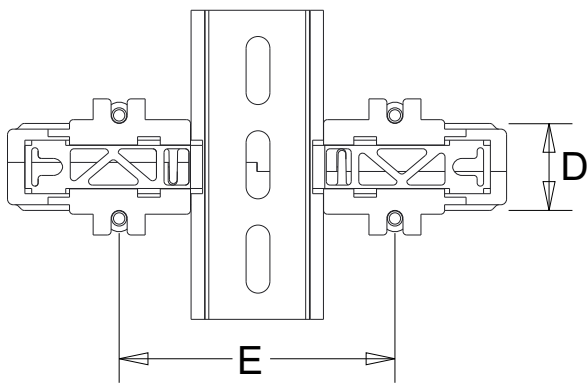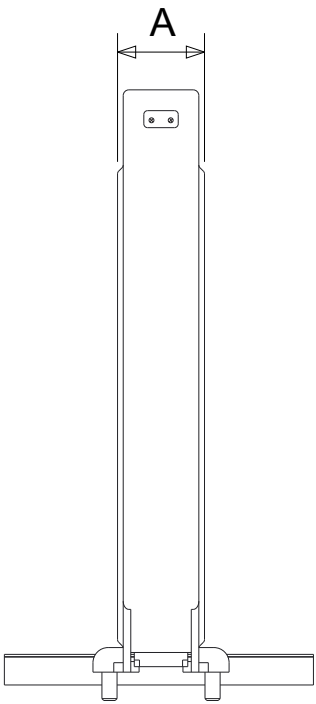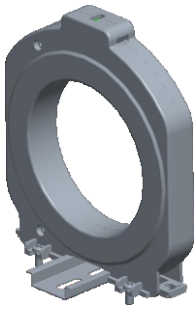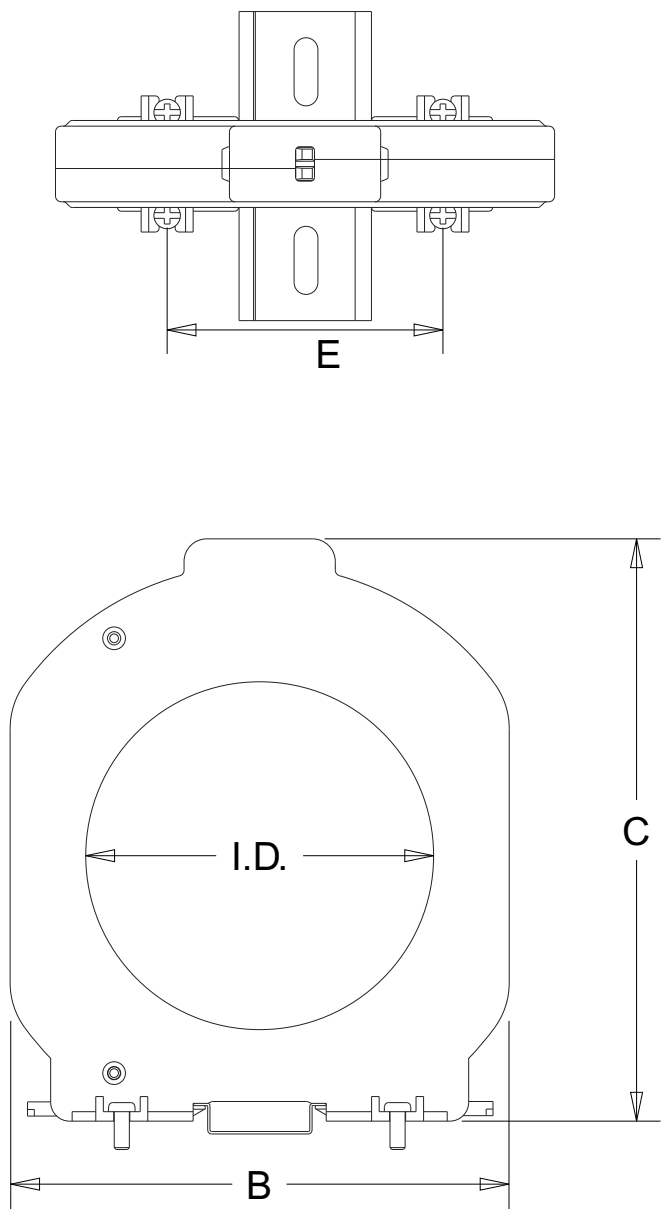
Ordering code	I.D. (mm.)	A	B	C	D	E
CBCT55	57	20	97	117	22	55
CBCT70	70	20	109	133	22	59
CBCT90	92	20	132	155	22	73
CBCT120	120	20	153	176	22	73

17) Instruction for wiring of Display Module with Base part

Front View

Open the Front screw to access the terminal from the wiring

R   Y   B

A
1 2 3 4 5 6 7 8 9 10
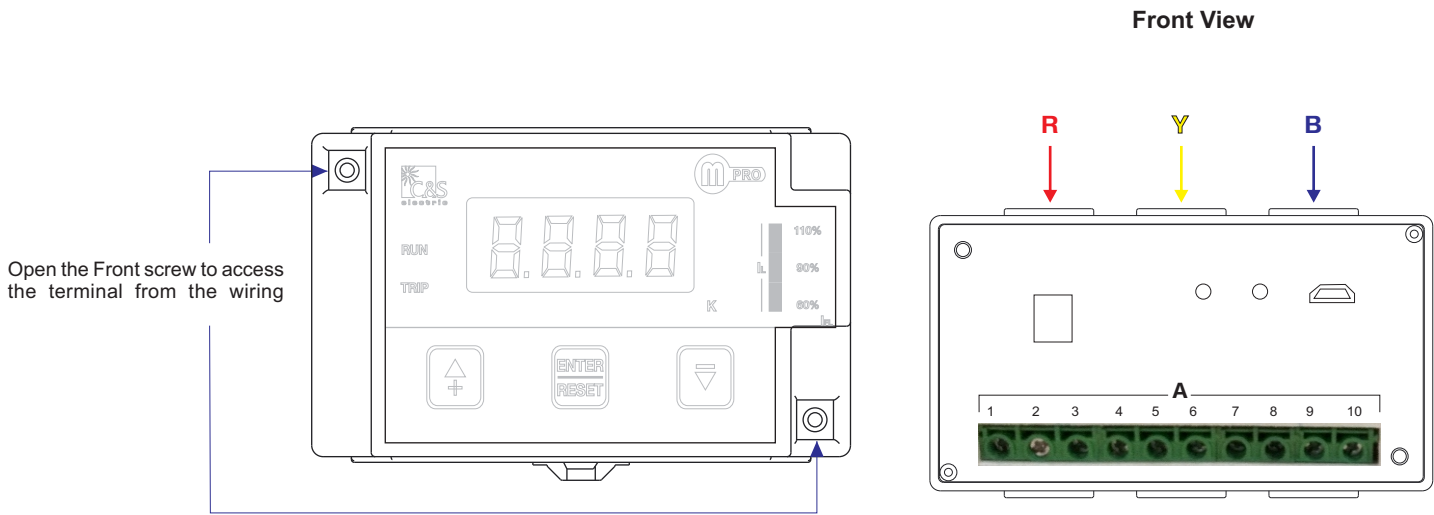
DISPLAY MODULE

Users are advice to remove the Front display from base part gently as RJ cable is adjoining these to parts.
Extra pressure may cause the damage of the product.

1 2 3 4 5 6 7 8 9 10

R   Y   B

BASE MODULE

Term No.	Terminal Description	
1	Aux Supply (N)	
2	Aux Supply (L)	
3	DO-1 (Common)	Trip
4	DO-1 (NO)	Relay
5	DO-1 (NC)	
6	DO-2 (NO)	
7	DO-2 & DO-3 (Common)	Alarm
8	DO-3 (NO)	Relay
9	CBCT-1 Input	
10	CBCT-1 Input	

A

18) Ordering Information

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mPRO — 100 — X — X — X   V2
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Protection Model Series

Rated Current

60 : Rated current Range (5-60A)
5 : Rated current Range (1-5A)

Earth Fault

E : with Internal Residual Calculation
Z55 : with external CBCT - Circular, ID 57 mm (CBCT 55), Plastic casing
Z70 : with external CBCT - Circular, ID 70 mm (CBCT 70), Plastic casing
Z90 : with external CBCT - Circular, ID 92 mm (CBCT 90), Plastic casing
Z120 : with external CBCT - Circular, ID 120 mm (CBCT120), Plastic casing

Auxiliary Supply

L : 110V AC (100-160V AC)
H : 220V AC (190-260V AC)

* CBCT Ordering Information (To be selected for mPRO-100-x-Z-x-x model)

CBCT SIZE
Z55   : Circular, ID 57 mm (CBCT 55), Plastic casing
Z70   : Circular, ID 70 mm (CBCT 70), Plastic casing
Z90   : Circular, ID 92 mm (CBCT 90), Plastic casing
Z120 : Circular, ID 120 mm (CBCT 120), Plastic casing

Example : mPRO-100-60-E-L

Description : mPRO-100 with rated current range of 60A with earth fault protection through internal residual calculation.

Revision History

S.No.	Rev.No.	Details	Date
01	01	Change in Ordering information for CBCT details	24.11.20
02	02	Change in Advance setting parameters details	30.11.20
03	03	Change in Thermal Inverse curve on page 12	12.06.21
04	04	Change in Thermal Inverse curve on page 12	04.12.24

NOTE

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Hyderabad:	+91-40-485340 80/82	----	hyderabad@cselectric.co.in
Kolkata:	+91-33-392121 19-21	----	----
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