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**mPRO-100**

Electronic Motor Protection Relay



Catalogue



PMD Division

## 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.

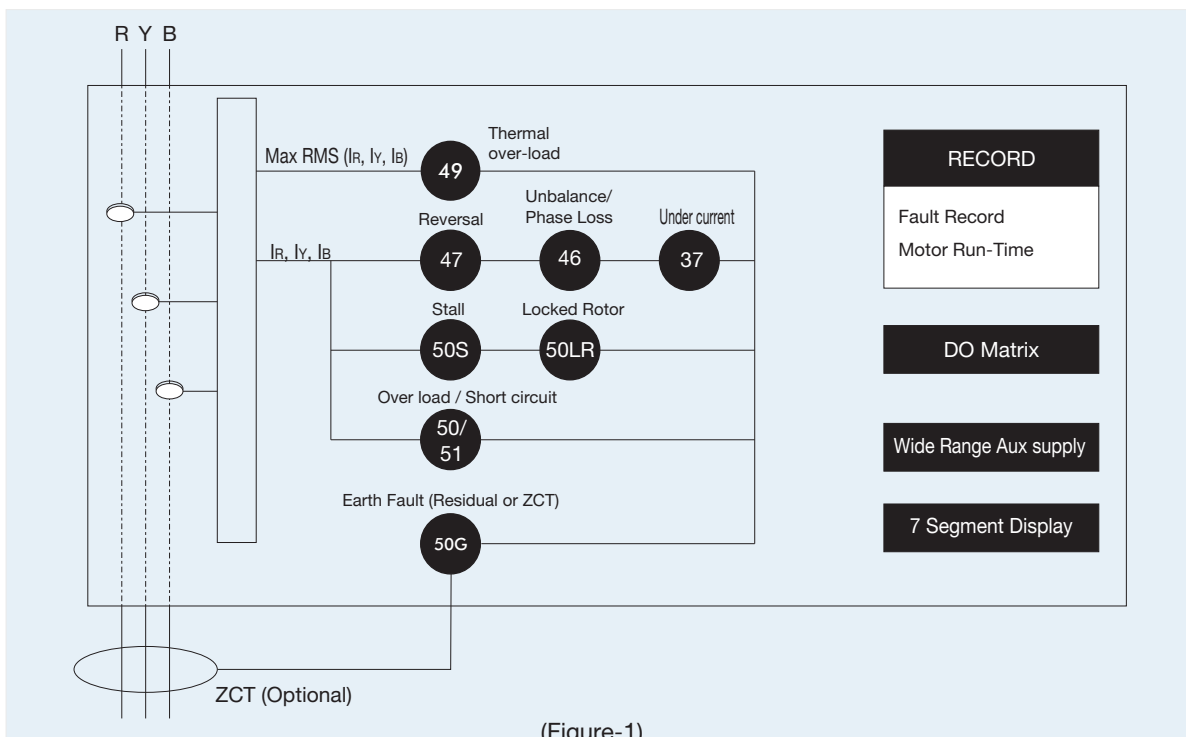
Main Features	Protection	Metering & Monitoring	Record
Small & compact in size	Over-Load	3 Phase RMS current	Fault Record
35mm Din Rail Mounting	Short Circuit	Thermal Content (%)	Accumulated Motor Run Time
In-built CT	Under current	Unbalance (%)	
User selectable wide range current Selection	Unbalance	Load current (%)	
7 Segment Display	Phase Reversal		
2 Programmable Alarm Relay	Locked Rotor		
1 Trip Relay (with Fail Safe)	Earth Fault (Residual / ZCT)		
	Stall		
	Phase Loss		
	CB Fail		

## 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) .

## Functional Diagram



(Figure-1)

## 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. 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	
B1-B3	B4-B3	B1-B3	B4-B3
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  $[(MAX\ Current - MIN\ current) / MAX\ current] \times 100[\%]$ . 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 (100 mSec). It helps to protect a three phase motor while installation.

### Locked Rotor

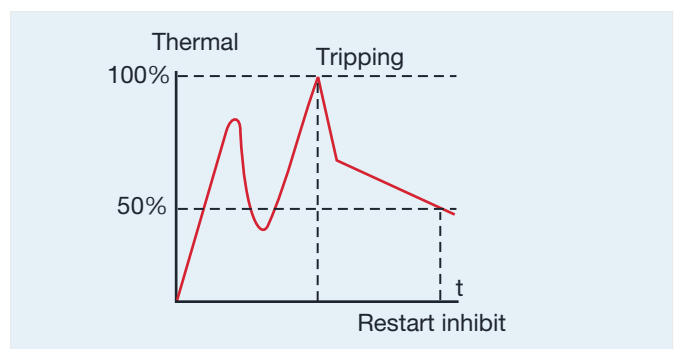
During motor start-up, a locked rotor is detected with the state of increased phase current above the set value (LOC) after the set trip time (500 mSec).

### 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 "ZCT" or internal residual method (model dependent). Once fault is detected (Earth current > E-F setting), the relay will trip after expiry of set time.

### Thermal Over load

Provides reliable protection for motor against over-heating (See Figure-2).



(Figure-2)

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 (ti). 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<sub>></sub> as well as accumulated thermal capacity (t) is >=100% then mPRO will trip the motor. If 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.

## Records

mPRO-100 Model stores following records in it's 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.

## Setting Parameters (Common)

Parameter	Display	Setting Range		Step Size	Unit	Default Setting
		Min.	Max.			
External CT Selection	CT	nonE	EXCT	---	---	nonE
Full Load Current (IFL) <sup>(3)</sup>	IFL	1.00 <sup>(1)</sup> /0.25 <sup>(2)</sup>	60.00 <sup>(1)</sup> /5.00 <sup>(2)</sup>	0.01	Amp	60 / 5
CT Ratio <sup>(4)</sup>	CTR	1	999	1	---	1
Motor Start Time	StRT	1.0	200.0	1.0	Sec	8
Thermal Memory Reset (Enable : ON/ Disable : OFF)	tMRS	OFF	On	---	---	On
Trip Relay Fail Safe (Enable : ON/ Disable : OFF)	FLSF	OFF	On	---	---	On
Auto Scroll (Enable: ON/Disable: OFF)	SCRL	OFF	On	---	---	On

### Note:

- \* Model Dependent <sup>(1)\*</sup> : - 60A model, <sup>(2)\*</sup> : 5A model.
- <sup>(3)</sup> Full Load Current setting will be model dependent. Refer section “**Current Range Selection**”.
- <sup>(4)</sup> 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 External CT Selection.

## Setting Parameters (Protection)

Parameter	Display	Setting Range		Step Size	Unit	Default Setting
		Min.	Max.			
Overload Pickup	<input type="text" value="o-L"/>	50	150	1	% IFL (Amp)	110
Overload Characteristic	<input type="text" value="CHR"/>	DEFT	1 nU	---	---	DEFT
Overload Definite Time <sup>(5)</sup>	<input type="text" value="td"/>	0.1	60.0	0.1	Sec	10
Overload Operating Time <sup>(6)</sup>	<input type="text" value="ti"/>	5	60	5	Sec	5
Short Circuit Pickup	<input type="text" value="S-C"/>	200	1500 <sup>(9)</sup>	50	% IFL (Amp)	OFF
*Earth Fault Pick up (Residual) <sup>(7)</sup>	<input type="text" value="E-F"/>	10	50	1	% IFL (Amp)	OFF
Earth Fault Trip Time (Residual) <sup>(7)</sup>	<input type="text" value="tE"/>	0.2	10	0.1	Sec	1.0
*Earth Fault Pick up (ZCT) <sup>(8)</sup>	<input type="text" value="E-F"/>	0.10	2.0	0.01	(Amp)	OFF
Earth Fault Trip Time (ZCT) <sup>(8)</sup>	<input type="text" value="tE"/>	0.05	10	0.01	Sec	0.1
Under Current Pick up	<input type="text" value="U-C"/>	20	90	5	% IFL (Amp)	OFF
Unbalance Current Pick up	<input type="text" value="unb"/>	4	50	2.0	%	OFF
Phase Reversal	<input type="text" value="rEU"/>	On	OFF	---	---	OFF
Locked Rotor Pick up	<input type="text" value="LoC"/>	200	1000 <sup>(10)</sup>	50	% IFL (Amp)	OFF
Phase Loss	<input type="text" value="P-F"/>	On	OFF	---	---	OFF
Stall Rotor Pick up	<input type="text" value="StL"/>	150	600	5	x IFL (Amp)	OFF
CB Fail Detection Time	<input type="text" value="tCbF"/>	1	40	1	Sec	5

### Note:

- All above protection are available with disable option (OFF) & in % of IFL (except Earth Fault with ZCT).
- mPRO will allow change in IFL setting only if motor is in stop condition and there is no fault pickup.
- <sup>(5)</sup> Definite time is applicable when DEFT characteristic is selected.
- <sup>(6)</sup> Operating time is applicable when INV characteristic is selected.  
This is the tripping time at  $I = 6 \times I >$ .
- <sup>(7)</sup> Earth Fault Residual Internal Calculation.
- <sup>(8)</sup> Earth Fault calculation using externally connected ZCT.
- <sup>(9)</sup> Max. protection setting :
 

60A Model	1500% for external primary CT selection (EXCT)
	800% for built in CT selection.
5A Model	800%
- <sup>(10)</sup> Max. protection setting :
 

60A Model	1000% for external primary CT selection (EXCT)
	800% for built in CT selection.
5A Model	800%

## 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

## Technical Data

Parameter	Description
Operational Current	0.2 - 8.0 x IFL
Nominal Frequency	50 / 60 Hz
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 Electrostatic Discharge Immunity (Class A)
IEC 60947-4-1	Radiated RF E-Field (80 to 1000 MHz) (Class A) Electrical Fast Transient / Burst Immunity (Class A) Surge Immunity (Class A)
Accuracy	
Trip Time	± 5% (or ± 100 mSec)
Current	± 3% (or ± 0.01 Amp)
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 <small>(Refer Ordering Information)</small>	L: 110V AC (100-130V) / H: 220V AC (200-240V) / D: 90-300V DC
Power Consumption	Approx. 6W
Contact Rating	
Trip Relay Contact	1 C/O Contact, 6A / 250V AC or 24V DC
Alarm Relay Contact	2 N/O Contact with 1 common, 3A / 250V AC or 24V DC
ZCT Input	100mA / 40~55 mV (available, when ZCT is used)
Relay Reset	Trip Relay Reset : Manual Alarm Relay Reset : 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

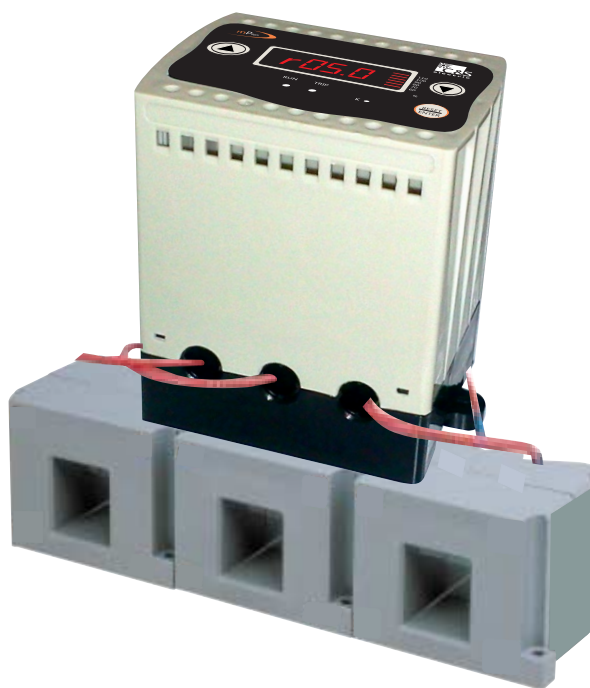
### Current Range Selection

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

Model 1 (1 to 60 Amp) (Full Load Current Range)		Model 2 (0.25 to 5 Amp) (Full Load Current Range)		No. of times wire passes through Built-in CT tunnel
Min	Max	Min	Max	
1	4.99	0.25	0.99	4 times
5	60	1	5	Once
Ext CT (5A)		Ext CT (1 to 5A)		Once

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.**



(mPRO with external three phase CT )

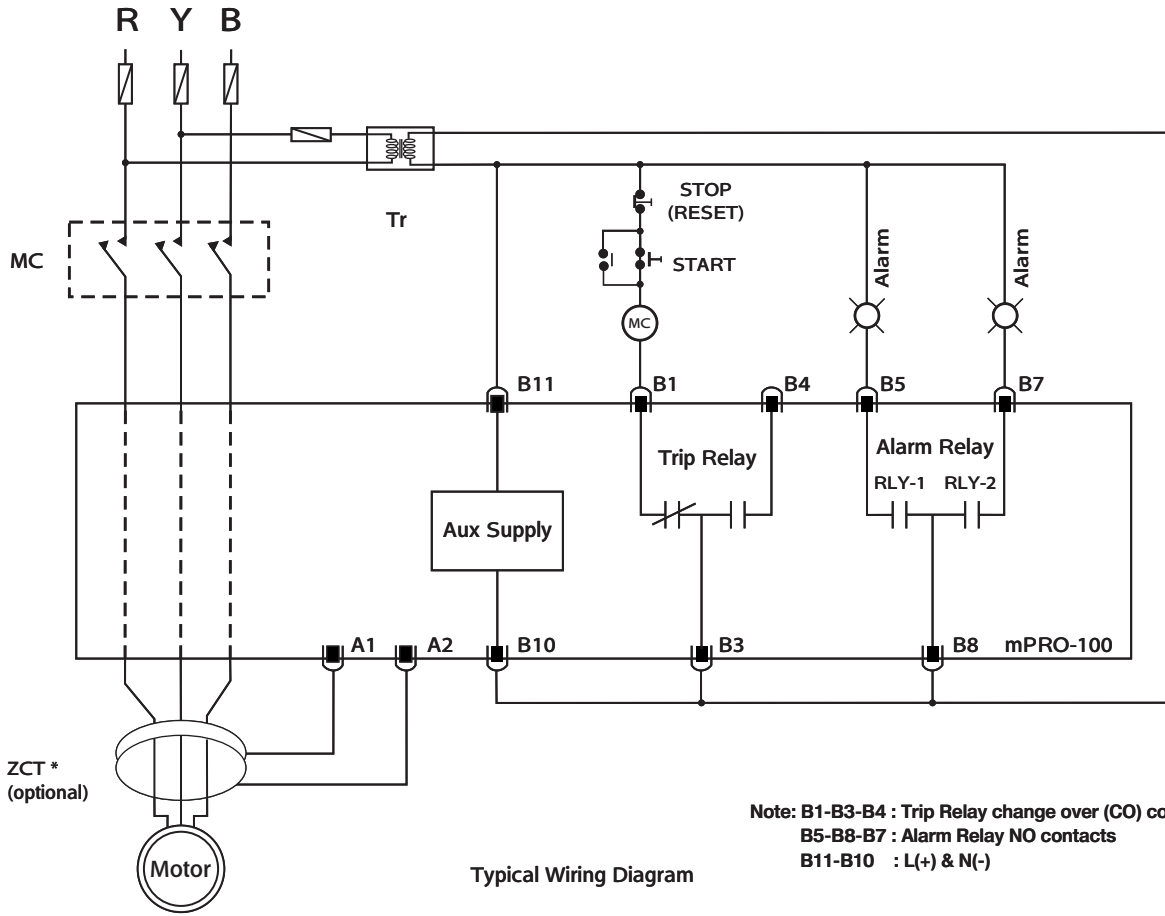
(Figure-3)

### Cable Selection

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

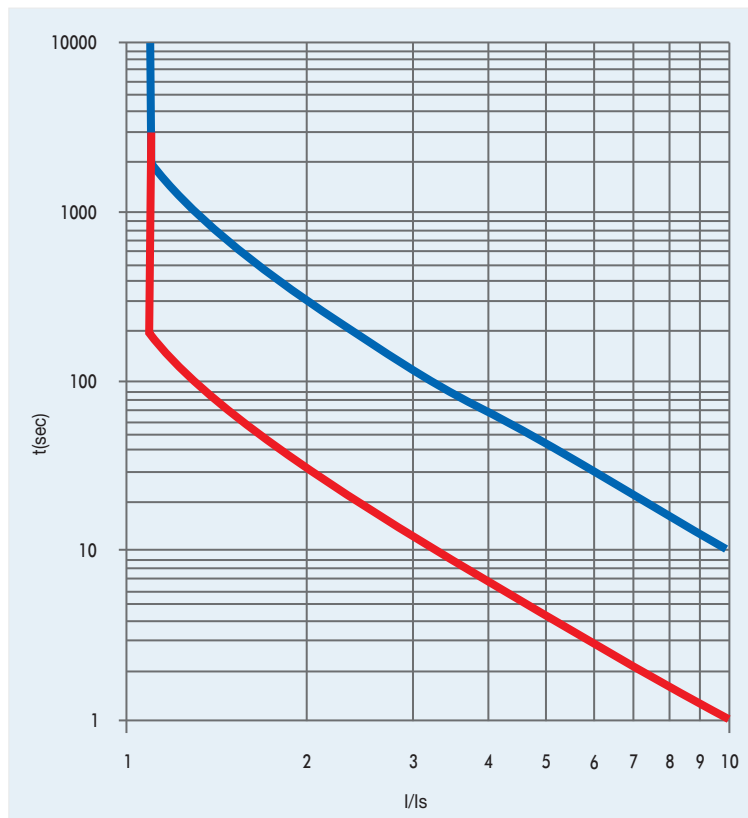
Material	Size (mm <sup>2</sup> )	Current (A)
Copper PVC	1.5	23
	2.5	30
	4	38
	6	48
	10	64
	13	70

Connection Diagram



Typical Wiring Diagram

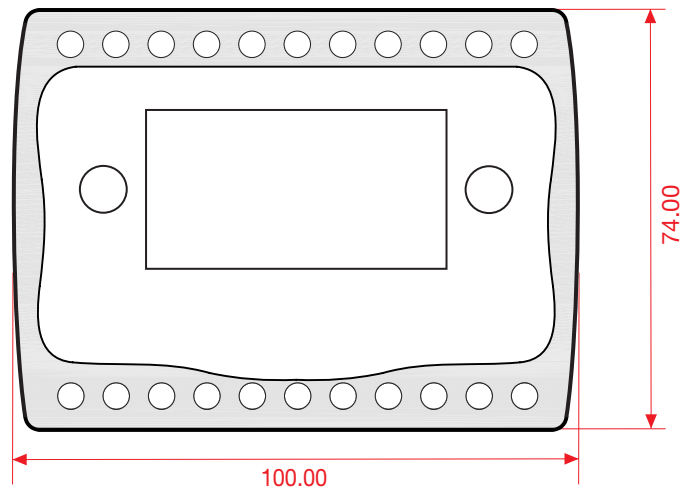
Thermal (inverse) Characteristic



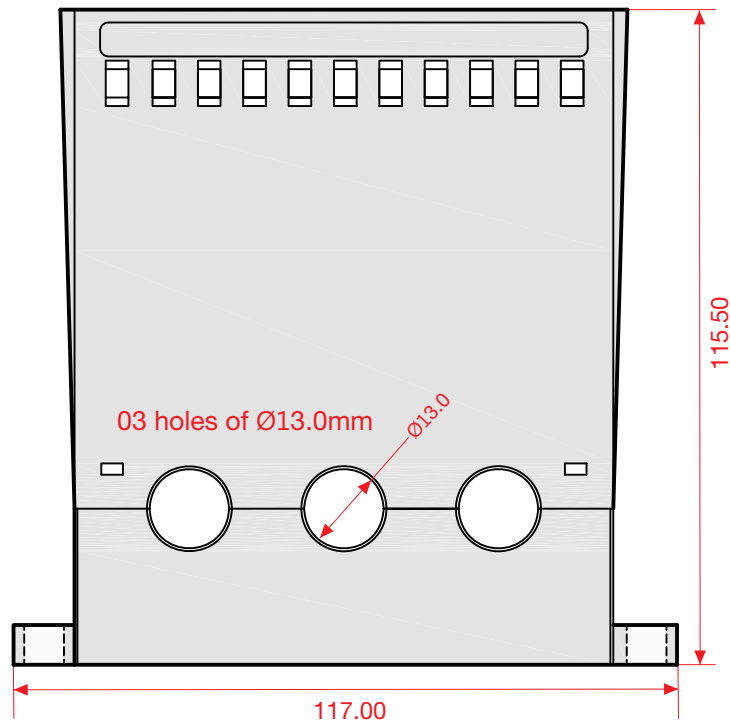
(Figure-5)



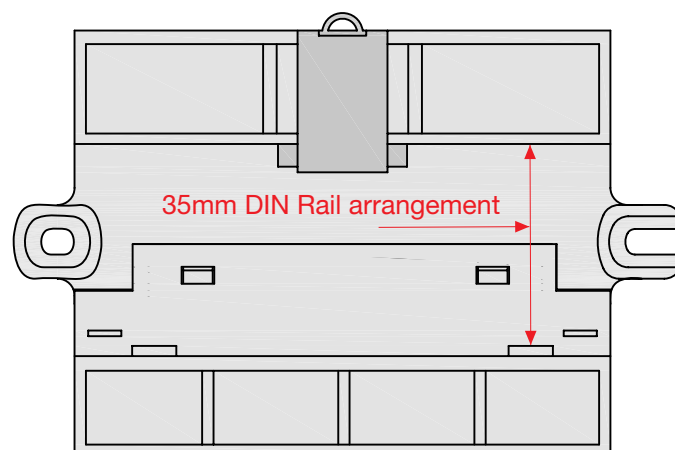
**Dimensional Details** (WxHxD : 100x74x115.5) / Weight ~ 700 gm  
All the Dimensions are in mm.



(Figure-6)

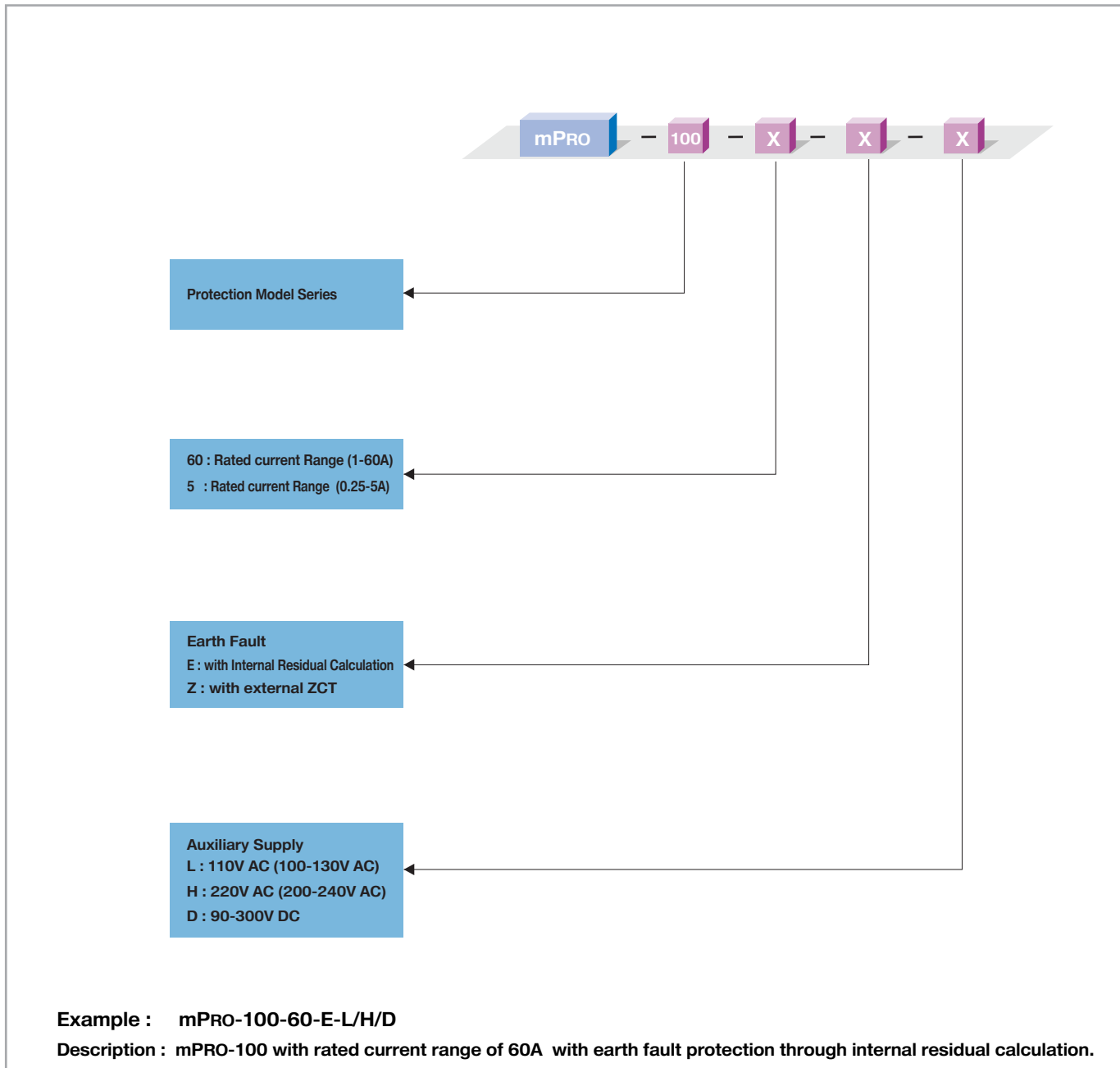


(Figure-7)



(Figure-8)

## Ordering Information





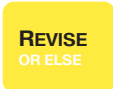
**Revision History**

S.No.	Rev.No.	Details	Date
01	02	Change in Setting parameters (common), Current selection range	09.08.14
02	03	Change in Aux supply range in Tech data and addition of Aux supply range field in ordering information	26.02.16
03	04	Removed Earth current from metering & monitoring on Page-2	29.02.16

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Rev. Date: 29.02.16

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