We touch your electricity everyday!

mPRO-200

Electronic Motor Protection Relay

Catalogue

C&S electric

PMD Division

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mPRO-200

Introduction

The **mPRO-200** 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-200 comprises of DIN Rail mountable **Base Module** and Panel mountable **Display Module**.

mPRO-200 offers following features in a compact, modular & smart design.

Main Features	Protection	Metering & Monitoring	Communication	Record
Small & compact in size 35mm DIN Rail mounting In-built CT Module User selectable wide range rated current LCD Display 3 Programmable DO (1 DO with Fail Safe) 2 Programmable DI Input 1 No. 4-20mA Output	Over Load Short Circuit Under Current Unbalance Phase Loss Phase Reversal Stall Locked Rotor Earth Fault (Residual/ZCT) Over Temperature* (with PTC Thermistor) External Fault	3 Phase RMS current Thermal Content (%) Unbalance (%)	MODBUS RTU over RS-485 interface*	Fault Records Motor Start-Stop * Records Accumulated Motor Run-Hours Accumulated Trip * Counter Max Starting * Current

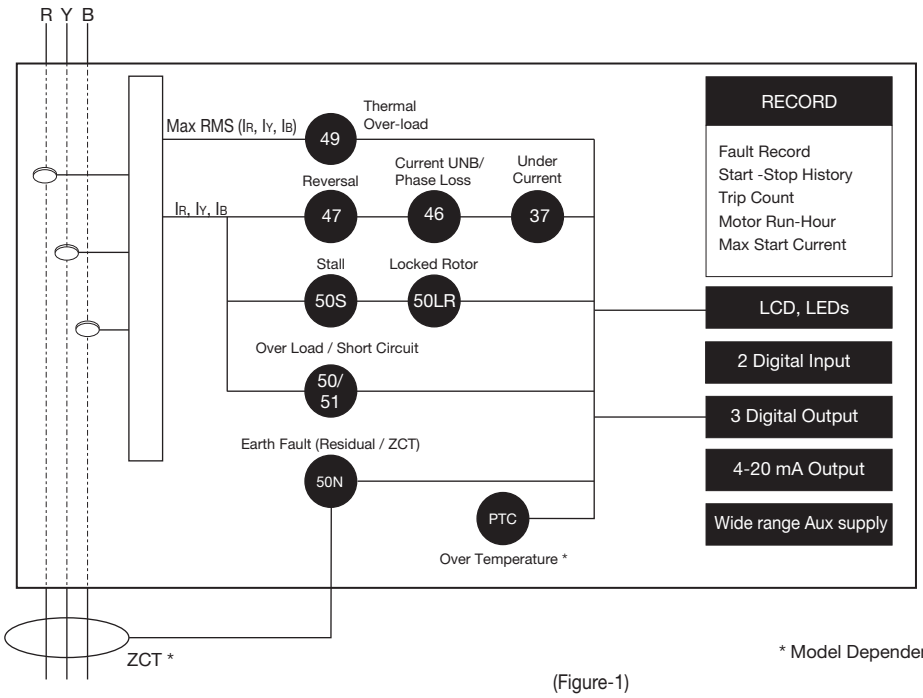
* Model Dependent

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 (20-200Hz)

Functional Diagram



* Model Dependent

(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 DO-1 contacts. Following occurs when fail safe mode is enabled.

- DO-1 relay coil is energized.
- When mPRO generates a trip signal, the DO-1 relay coil is de-energized.
- DO-1 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

PROTECTION FUNCTION DESCRIPTION

Under Current Protection (I<)

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 I< for a t< (Under current trip delay time) selected delay, then mPRO will trip to stop the motor.

Over Current Protection (I>)

Over-current protection is provided by tripping the relay when motor operating current in any of the three phases exceeds over-current setting I> of mPRO for a period greater than the selected operating time t> under DEFT (Definite time over-current protection) .

Short Circuit Protection (I>>)

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 I>> for the set interval (t>>).

Phase Loss or 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 tPhLos. The quick trip time on mPRO helps to prevent over-current damage to the windings.

Phase Unbalance (46)

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] x100[%] .If the calculated value exceeds the set unbalance value Iub for the selected time tIub the relay will trip.

Phase Reversal (47)

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

Locked Rotor (50LR)

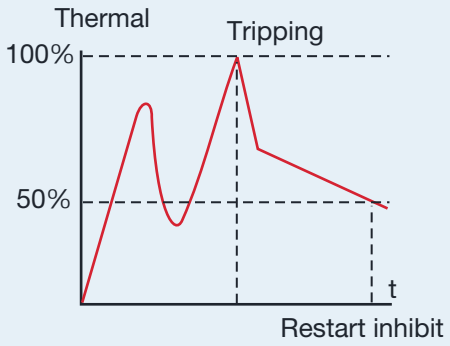
During motor start-up, a locked rotor is detected with the state of increased phase current above the set value (LKR) even after the set start time (tLKR).

Earth / Ground Fault (50N)

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 “ZCT” or internal residual method (model dependent). Once fault is detected (Ie above the set value), the relay will trip after expiry of set time (te).

Thermal Over load (49)

Provides reliable protection for motor against over-heating.



(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 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. If thermal memory is accumulated then Relay Contact Reset depends on Relay Reset selection (AUTO/MANUAL) and Thermal Reset selection (Disable/Enable) as given in following table.

Relay Reset	Thermal Reset	Relay Trip Output Contact Reset
Auto	Enable	When Thermal capacity (Thermal MEM) <50%
Auto	Disable	When Thermal capacity (Thermal MEM) =0%
Manual	Enable	When Thermal capacity (Thermal MEM) <50% & Front Reset key is pressed
Manual	Disable	When Front Reset key is pressed

The effect of thermal memory can be erased by using the 'Thermal Memory Erase' option from RECORD MENU.

CAUTION: * Make sure that at the time of installation of mPRO relay, motor is in complete cold state having no thermal content otherwise thermal modeling of relay will not be in synchronization with actual thermal state of motor.

Stall (50S)

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 (Stall) value after the Stalled Rotor Time (tStall). 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.

Over Temperature

mPRO provides protection against over temperature by monitoring the temperature in the motor winding. High winding temperature is caused by phase unbalance, phase fail, high torque starting, insufficient cooling etc. mPRO will trip the motor in running condition after PTC trip time (tPtc) expires, once temperature monitored via external PTC thermistor exceeds the PTC Trip value (PtcTrp).

External Fault *

External Fault is sensed through Digital Input (DI). Once this DI is active relay will trip after expiry of set time (tExtFlt).

All the protection functions are effective after the expiry of start time except Phase loss, Phase reversal, Locked rotor & Earth fault which are effective on the motor START condition also.

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 (tCBFL), mPRO will declare it as CBFail.

In this condition trip contact will be released only after manual acknowledgment by RESET push button / External RESET option of DI.

Analog Output (4-20mA)

mPRO converts measured value of MMI selectable parameter (Ir/Iy/Ib/ %Iub) into DC 4mA to 20mA current.

- When there is no current or measured current is upto 10% of IFL (or upto 5% of unbalance), 4mA is sent.
- When current (or % unbalance) goes beyond the predefined value (200% of IFL or 100% of unbalance), 20mA is sent.

Records

mPRO-200 Model stores following records in it's non-volatile memory.

(a) Fault Record (b) Motor Start-Stop Record (c) Motor Run Hour (d) Motor Trip Count (e) Max Starting Current.

(a) Fault Record

mPRO records last 5 faults 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

Fault Records helps the user to identify and analyze the cause of fault. User can view the complete fault information by entering the Fault Record No. 1 to 5. When the available memory space is exhausted, the new fault automatically overwrites the oldest Fault.

When the relay trips, the description of fault in the motor will appear on the LCD screen automatically.

(b) Motor Start-Stop Record *

The mPRO stores the last 3 Start-Stop time events in non volatile memory. When the available memory space is exhausted, the new event automatically overwrites the oldest record.

(c) Motor Run-Hour

mPRO accumulates the total RUN Hour of motor. Update time resolution is 5 min.

(d) Motor Trip Count *

mPRO accumulates the total Trip Count of motor.

(e) Max. Starting Current *

mPRO logs max. current during motor start.

Man-Machine Interfaces

It comprises of bright Alpha-numeric LCD display with 3 Push buttons for setting and other operations for local access and 1 Push button for fault acknowledgment / Reset.

2 LEDs for PICKUP & TRIP on fault, which require Manual reset through 'RESET' key.

1 "ON" LED for device Power On indication.

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.

*** Model Dependent**

(Figure-3)

Setting Parameters (Common)

Parameter	Display	Setting Range Step Size		Unit	Default	Setting
		Min.	Max.			
Max. Rated Current Range Selection	IR	[1]* 5 / 10 / 60 / EXCT [2]* 1.25 / 2.5 / 5.0 / EXCT			Amp	60 5
Full Load Current [3]	IFL	1.00 [1]*/ 0.25[2]*	60.00[1]* / 5.00[2]*	0.01	Amp	60/5
Motor start time	tstart	1.0	200.0	1.0	Sec	8
External CT Ratio [4]	CT_RATIO	1	999	1	-	1
DO Reset (ATO: Auto, MAN: Manual)	DOReset	ATO	MAN	-	-	MAN
Thermal Memory Reset (Enable: ON, Disable: OFF)	ThmRes	OFF	ON	-	-	OFF
DO-1 Fail Safe Mode (Enable: ON, Disable: OFF)	TpRyFlSf	OFF	ON	-	-	ON
Analog Output (4-20mA) selection*	4_20mA	Ir, Iy, Ib, %Iub				Ir

Note:

- *Model Dependent [1]* : - 60A model, [2]* : 5A model.
- [3] Max.Current Selection & Full Load Current setting will be model dependent. Refer section **" 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.

Setting Parameters (RTC)

Date and Time can be set by editing HOUR, MIN, SEC, DATE, MONTH & YEAR parameters.

Setting Parameters (Communication)

Parameter	Display	Setting Range Step Size		Unit	Default	Setting
		Min.	Max.			
Slave Address	SlaveAdd	1	247	1	-	1
Baud Rate	Baudrt	9600	19200	-	bps	19200
Parity	Parity	NONE or ODD or EVEN			-	NONE

Setting Parameters (Protections)

Parameter	Display	Setting Range		Step Size	Unit	Default Setting
		Min.	Max.			
Overload Pickup	I>	50%	150%	1%	x IFL (Amp)	110%
Overload Characteristic	Char	DEFT	INV	-	-	DEFT
Overload Definite Time [5]	t>	0.1	60.0	0.1	Sec	10
Overload Operating Time [6]	tInv>	5	60.0	5	-	5
Short Circuit Pickup	I>>	200%	1500% [9]	50%	x IFL (Amp)	OFF
Short Circuit Trip Time	t>>	0.05	5.0	0.01	Sec	0.08
Earth Fault Pick up (Residual) [7]	Ie>	10%	50%	1%	x IFL (Amp)	OFF
Earth Fault Trip Time (Residual) [7]	te>	0.2	10	0.1	Sec	1
Earth Fault Pick up (ZCT) [8]	Ie>	0.10	2.00	0.01	Amp	OFF
Earth Fault Trip Time (ZCT) [8]	te>	0.05	10	0.01	Sec	1
Under Current Pick up	I<	20%	90%	5%	x IFL (Amp)	OFF
Under Current Trip Time	t<	1.0	300.0	0.1	Sec	3
Unbalance Current Pick up	Iub	5%	50%	2.5%	%	OFF
Unbalance Current Trip Time	tIub	1	30	1	Sec	3
Phase Reversal Trip Time	tPhRev	0.5	10.0	0.1	Sec	OFF
Locked Rotor Pick up	ILR	200%	1000% [10]	50%	x IFL (Amp)	OFF
Locked Rotor Trip Time	tLKR	0.5	5.0	0.1	Sec	0.5
Phase Loss Trip Time	tPhLos	0.5	5.0	0.1	Sec	OFF
Stall Rotor Pick up	IStl	150%	600%	5%	x IFL (Amp)	OFF
Stall Rotor Trip Time	tStall	1	20	1	Sec	3
External Fault Trip Time*	tExFlt	0.5	60	0.1	Sec	1
PTC Trip Value*	PtcTrp	2500	3600	50	Ohm	OFF
PTC Reset Value	Ptc Rst	1000	1650	10	Ohm	1600
PTC Trip Time	tPtc	0.5	10.0	0.1	Sec	1
Trip CB Fail Detection Time	tCBFL	0.5	10	0.1	Sec	0.5

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.
- [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.
- [8] Earth Fault calculation using externally connected ZCT.
- [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%

* Model Dependent

Setting Parameters (DO Matrix)

There are 3 programmable DOs available which can be assigned to different Motor Fault as per the table below:

Fault
Short Circuit
Overload
Earth Fault
Unbalance
Phase Reversal
Lock Rotor
Stall
Under Current
Phase Loss
External Fault *
Over Temperature *
Trip CB Fail

*** Model Dependent**

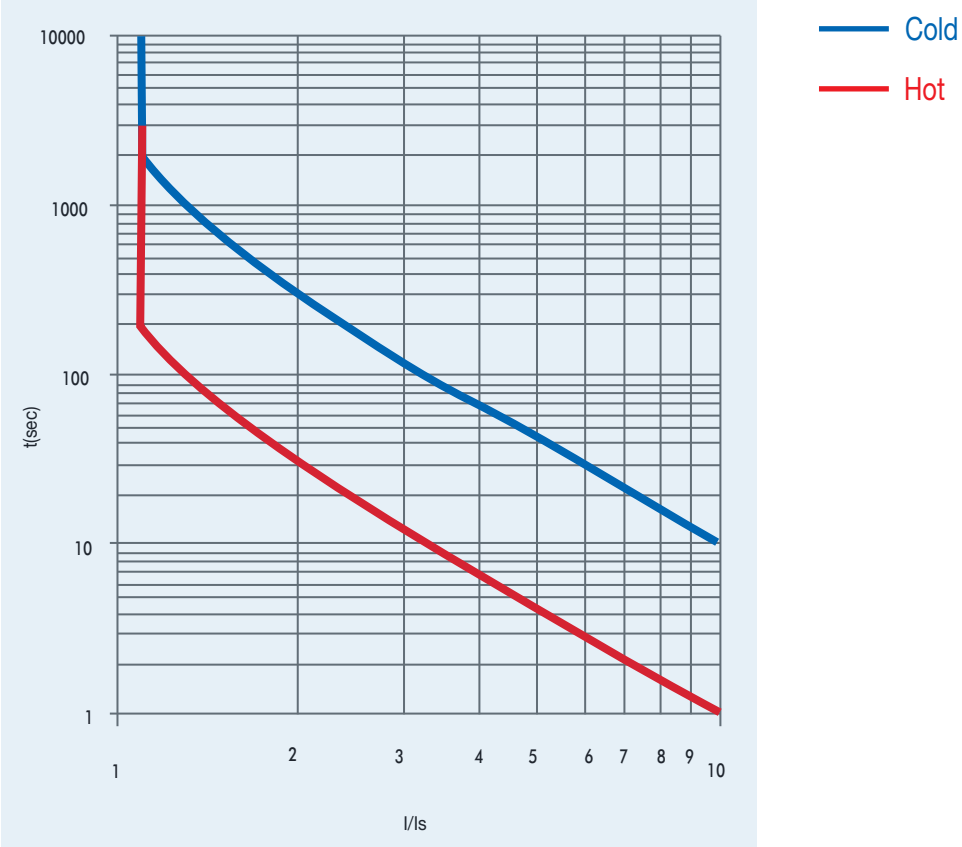
Setting Parameters (DI Matrix) *

There are 2 programmable Digital Input (DI) available which can be used as External Fault, External Reset & Protection Blocking purpose as per table below:

Function
External Fault
External Reset
Over load Block
Short circuit Block
Earth Fault Block
Locked Rotor Block
Stall Block
Under current Block
Phase Loss Block
Phase Reversal Block
Unbalance Block
Thermal Block
External Fault Block *
Over Temperature Block *

*** Model Dependent**

Thermal Inverse Characteristics



(Figure-4)

Technical Data

Parameter		Description
Operational Current		0.2 - 8.0 x IFL
Frequency Range		50 / 60 Hz
Protection		Over-Load, Under-Current, Short Circuit, Lock Rotor, Stall, Unbalance,
		Phase Loss, Phase Reversal, Earth Fault, Over Temperature, 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) (which ever is higher)
	Current	± 3% (or ± 0.01 Amp) (which ever is higher)
Display		
	LCD Display	Metering and Fault information
	LED	Base Module : 'ON'
		Display Module : 'RUN' , 'PICKUP' & 'TRIP' .
Auxiliary Supply (Refer Ordering Information)		L: 110V AC (100-130V) / H: 220V AC (200-240V) / D: 90-300V DC
Power Consumption		Approx. 6W
Contact Rating		
	DO Contact	1 C/O Contact, 6A / 250V AC or 24V DC
		2 N/O Contact with 1 common, 6A / 250V AC or 24V DC
ZCT Input		100mA / 50 mV (available when ZCT is used)
DO Reset		Automatic / Manual
DI Input *		Active : 80 - 260V AC / 40 - 300V DC
Analog Output (4-20mA) *		Max Load Resistance 300 Ohm
Temperature Sensor (PTC) *		Total Resistance in cold State : 1500 Ohm
		Return Value:1.5 kOhm to 1.65 kOhm, Response Value:2.7kOhm to 3.6 kOhm
Mounting		35 mm Din-rail / Panel mount
Temperature	Operation	0^{0}C to 70^{0}C
Temperature	Storage	-10^{0}C to 85^{0}C
Wiring Connection		
	For current	Penetration / Tunnel Type
	For Others (Aux supply, Relay contact etc.)	Screwed Terminal

Rated Current Range Selection

mPRO-200 supports 0.25 to 60 Amp rated current (built-in-CT) and supports CT ratio upto 999 external CT as per following configuration: -

Model 1(1.0 to 60 Amp) through Built-in CT		Model 2(0.25 to 5 Amp)		No of times wire passes
Max Rated Current	Rated Current Range	Max Rated Current	Rated Current Range	
5	1 - 5 Amp	0.25	0.25 - 1.25 Amp	4 times
10	2.5 - 10 Amp	0.5	0.5 - 2.5 Amp	2 times
60	5 - 60 Amp	5	1 to 5 Amp	Once
Ext CT	5 Amp	Ext CT	5 Amp	Once

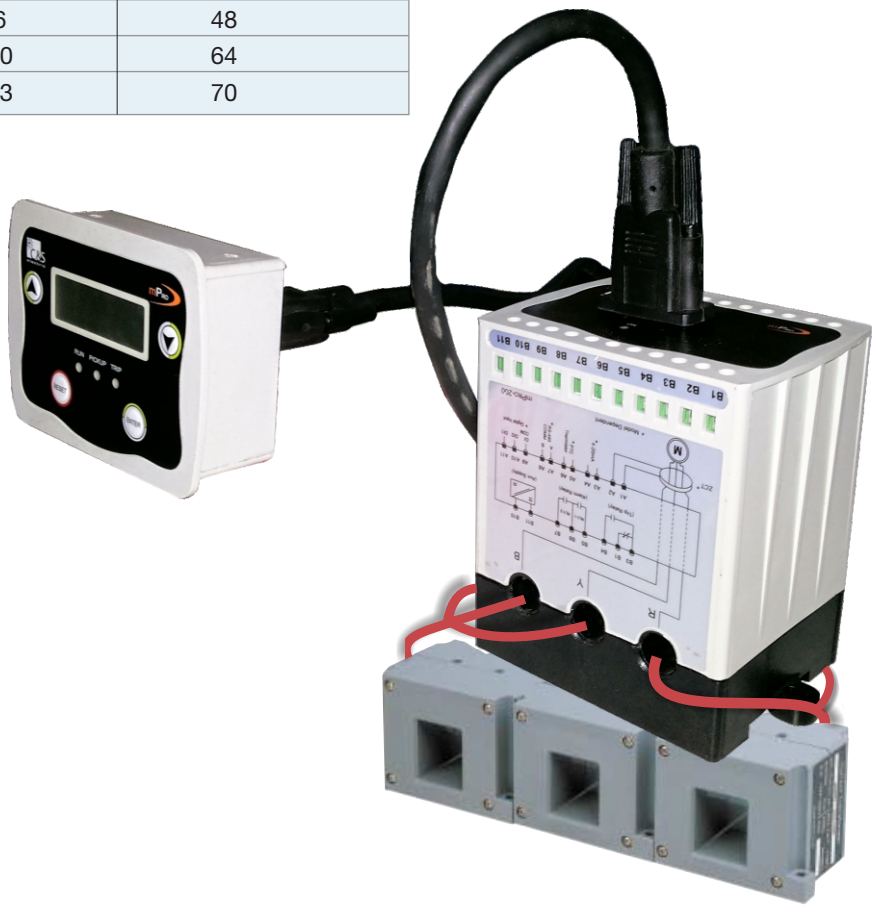
mPRO-200 supports motor current above 60 Amp with external CT with rated secondary current of 5 Amp. e.g : 100 : 5, 200:5, 800 : 5 etc.

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

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



mPRO with external Three Phase CT (Figure-5)

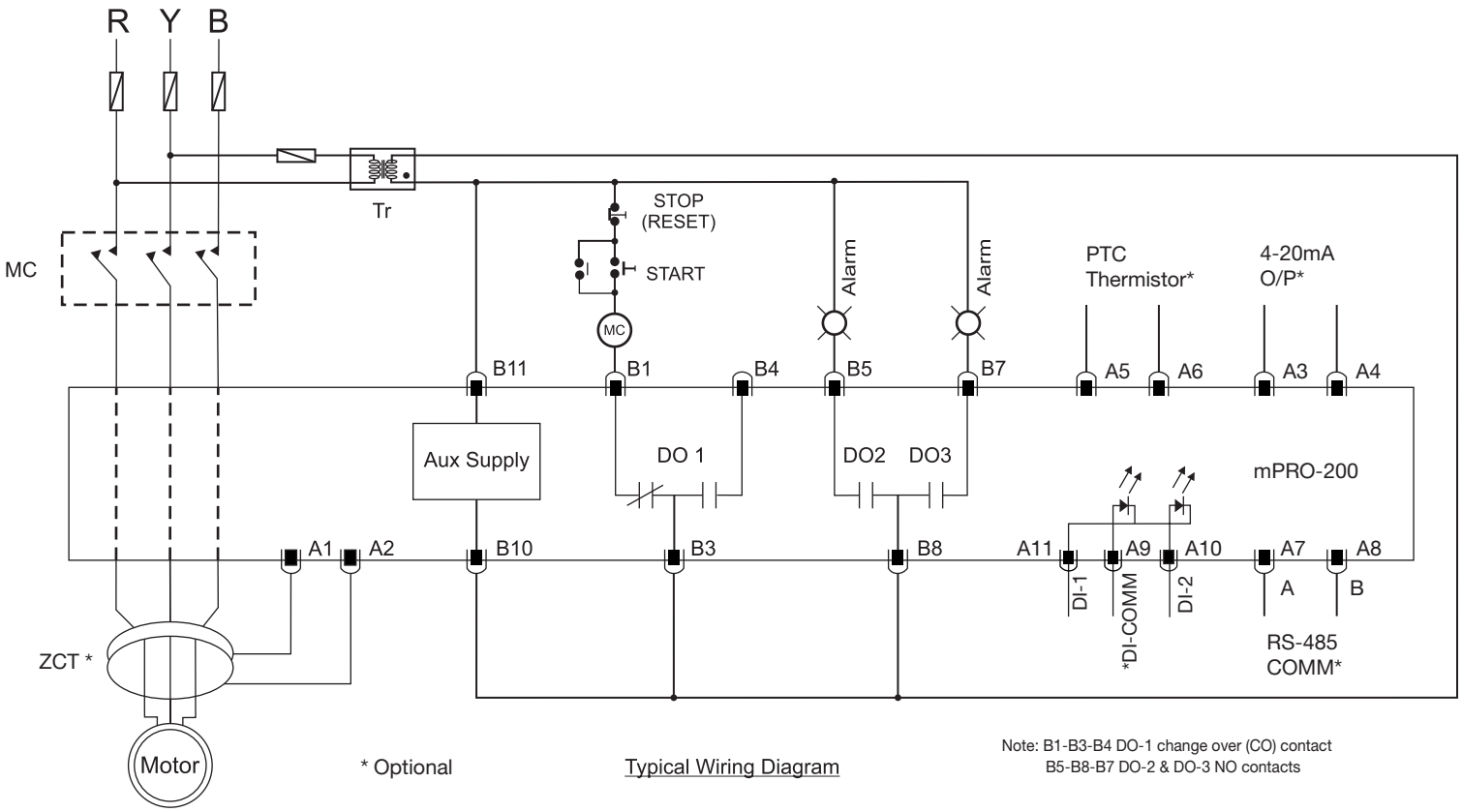
mPRO-200 will continue to work as per last saved settings even if Display Module fails.

Commercial Installation of mPRO-200

Display Module fixed on the Panel

Base Module fixed on the Panel

Connection Diagram



(Figure-6)

Terminal Description

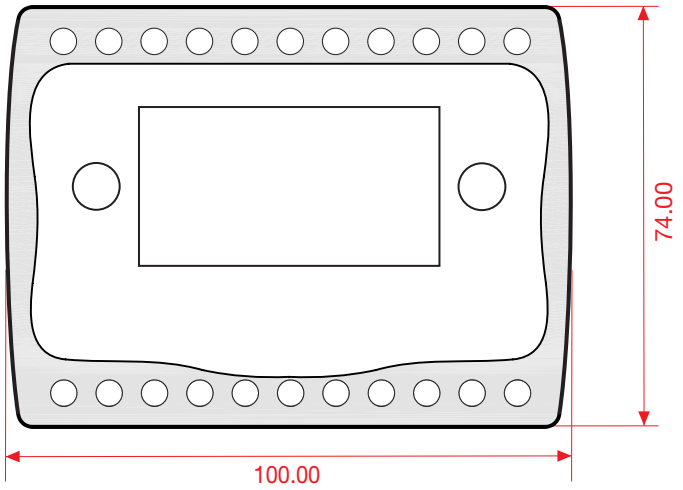
Terminal	Terminal Description	Terminal	Terminal Description
A1	ZCT -1	B1	DO-1 (NC contact)
A2	ZCT -2	B2	x
A3	4-20 mA output (+)	B3	DO-1 Common
A4	4-20 mA output (-)	B4	DO-1 (NO contact)
A5	PTC Thermistor	B5	DO-2 (NO contact)
A6	PTC Thermistor	B6	x
A7	RS-485 (A)	B7	DO-3 (NO contact)
A8	RS-485 (B)	B8	DO-2 & DO-3 Common
A9	Digital Input-1 & 2 Common	B9	x
A10	Digital Input-2	B10	Aux Supply (+)
A11	Digital Input-1	B11	Aux Supply (-)

Dimensional Details

Base Module

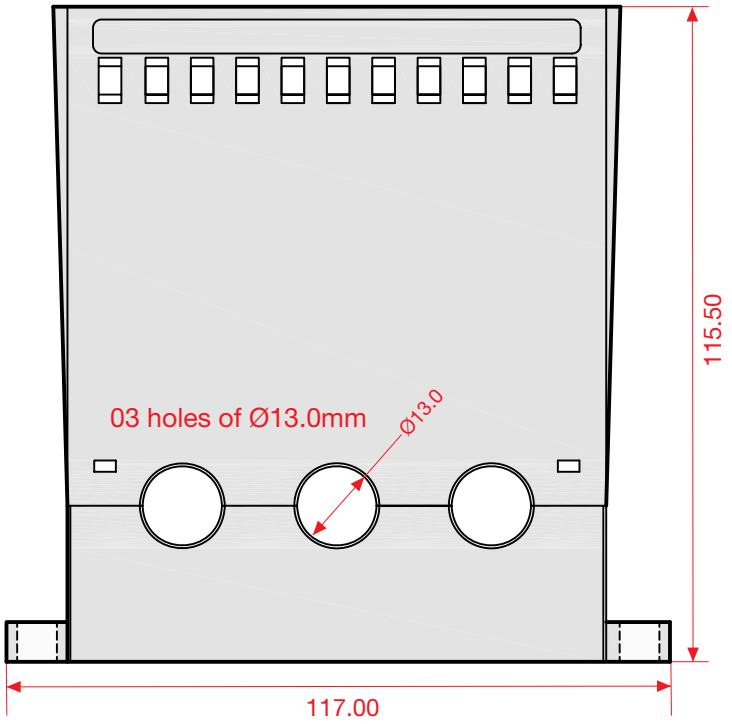
(WxHxD : 100x74x115.5) / Weight: 700 gm (Approx)
All the Dimensions are in mm.

Top View



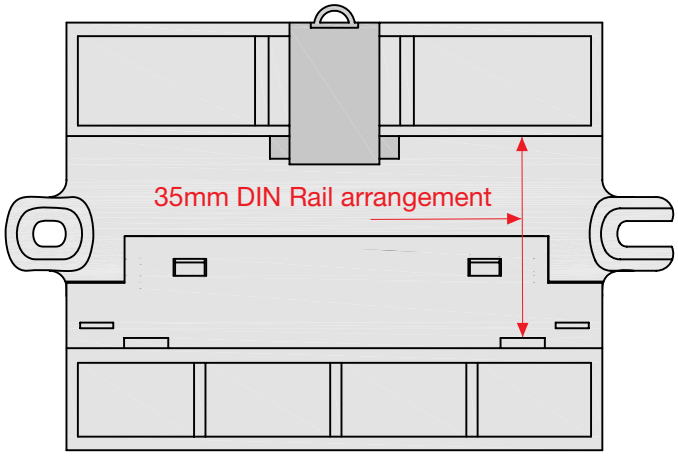
(Figure-7)

Side View



(Figure-8)

Bottom View

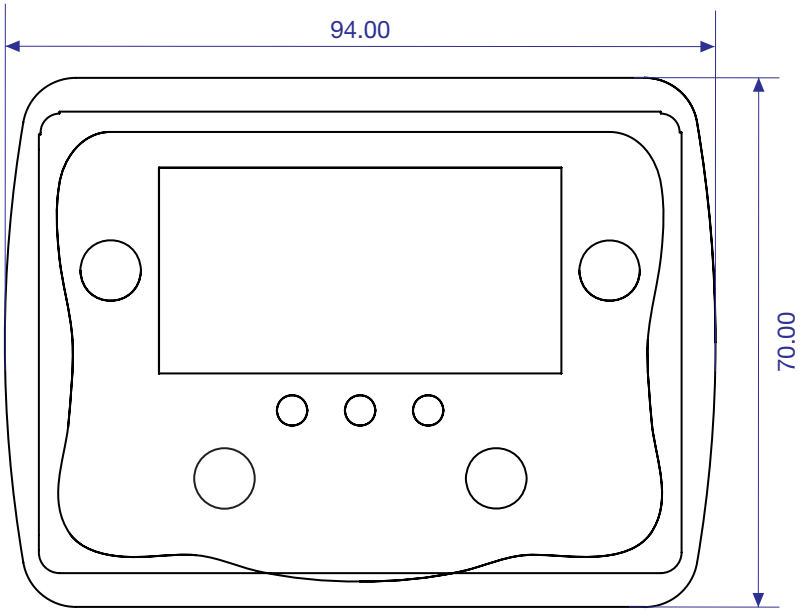


(Figure-9)

Display Module

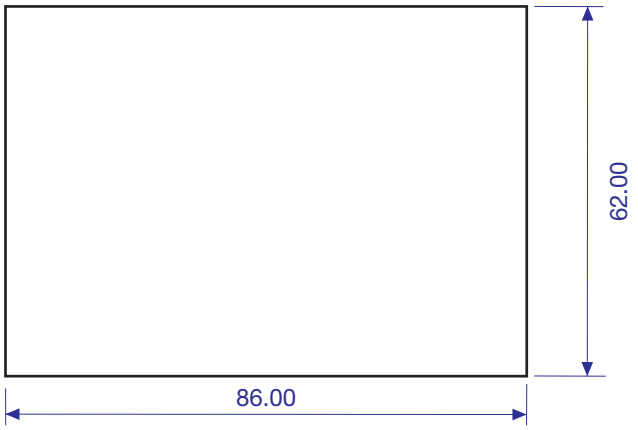
(WxHxD : 70x94x44.5) / Weight : 100 gm (Approx)
All the Dimensions are in mm.

Top View



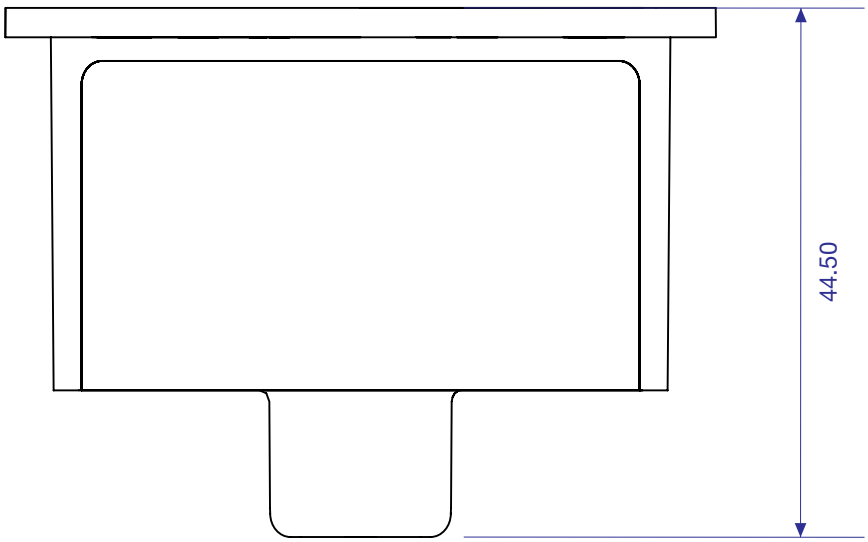
(Figure-10)

Cut Out Dimensions



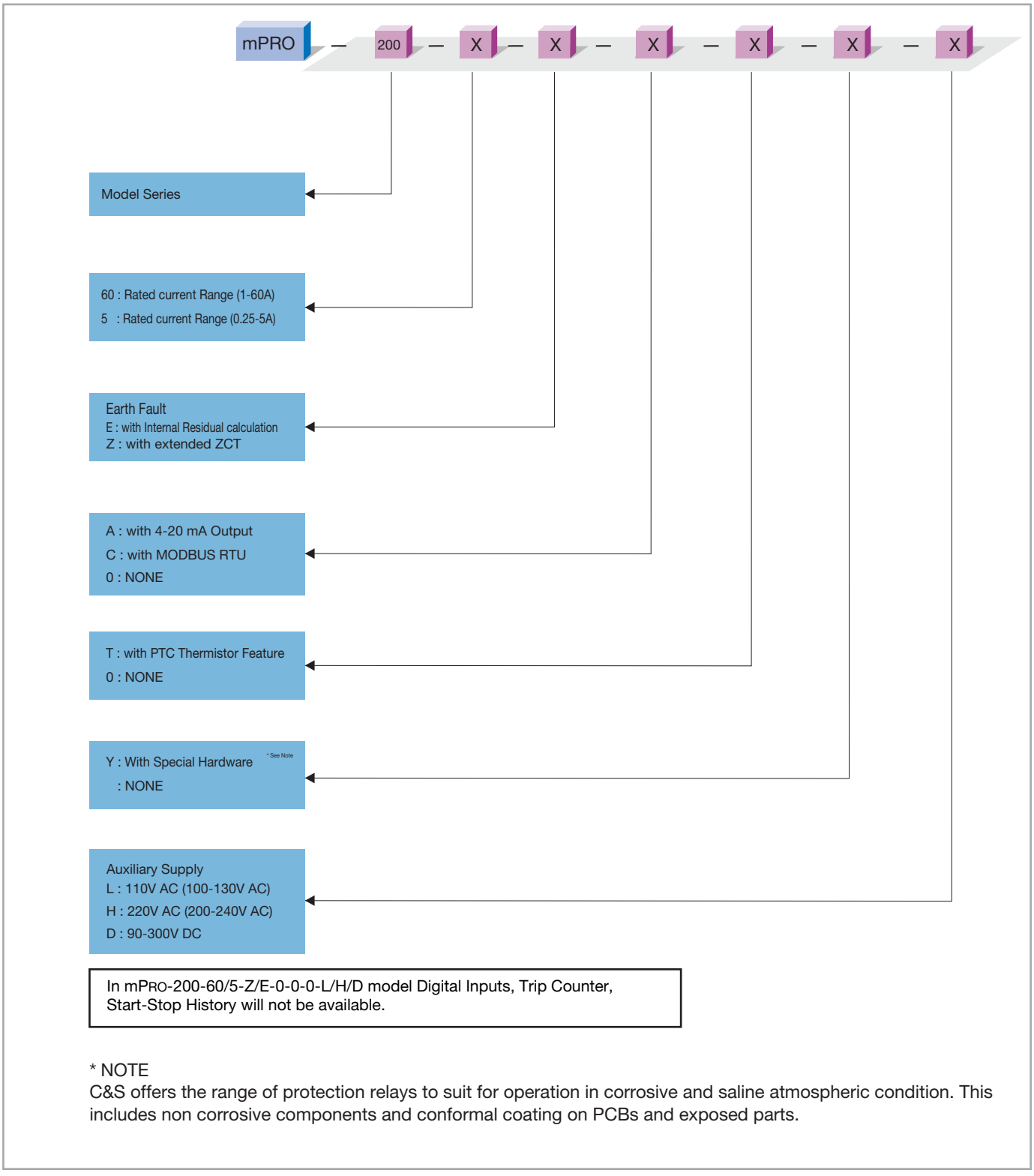
(Figure-11)

Side View



(Figure-12)

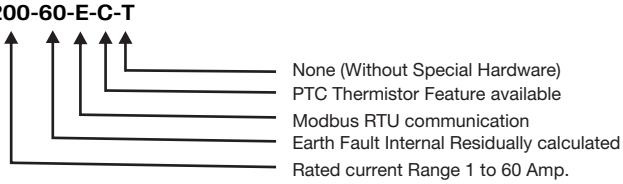
Ordering Information



In mPRO-200-60/5-Z/E-0-0-0-L/H/D model Digital Inputs, Trip Counter, Start-Stop History will not be available.

* NOTE
C&S offers the range of protection relays to suit for operation in corrosive and saline atmospheric condition. This includes non corrosive components and conformal coating on PCBs and exposed parts.

Example: mPRO-200-60-E-C-T



S.No.	Rev.No.	Details	Date
01	04	Inclusion of “Commercial Installation of mPRO-200” on Page 12	21.03.14
02	05	Change in Aux supply range in Tech data and addition of Aux supply range field in ordering information	26.02.16
03	06	Removed Earth current from metering & monitoring on Page-2	29.02.16

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Rev. No: 06
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