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Motor Protection Relay

mPRO-90-SDT

Intelligent Digital Motor Protection Relays

Catalog

C&S electric

CE

PMD Division

content

Description

1) Introduction

The mPRO-90-SDT protective relay is an advanced current based numeric relay that provides multi protection and monitoring. The relay offers reliable protection for LV and MV motors which are either operated via power contactors or power circuit breakers.

Main Features

- Compact in size and easy to install
- User selectable external CTs (05 types)
- Single Row Seven Segment Display for V, I, %unbalance etc.
- Inbuilt Start / Stop, Timer & Protection feature
- kW based STAR-DELTA conversion

Protection

- Over-Load
- Under current
- Short Circuit
- Over / Under Voltage
- Phase Loss
- Phase Unbalance
- Phase Reversal
- Locked Rotor
- Earth / Ground Fault (Residual)
- Thermal overload
- Stall
- Voltage unbalance

Metering & monitoring

- 3 Phase RMS Current
- Phase - Phase Voltage
- Earth Current (Residual)
- Thermal content (%)
- Power in each phase

Pump Control

- By Start / Stop Button in manual mode
- Automatic Start in Auto mode

2) Application

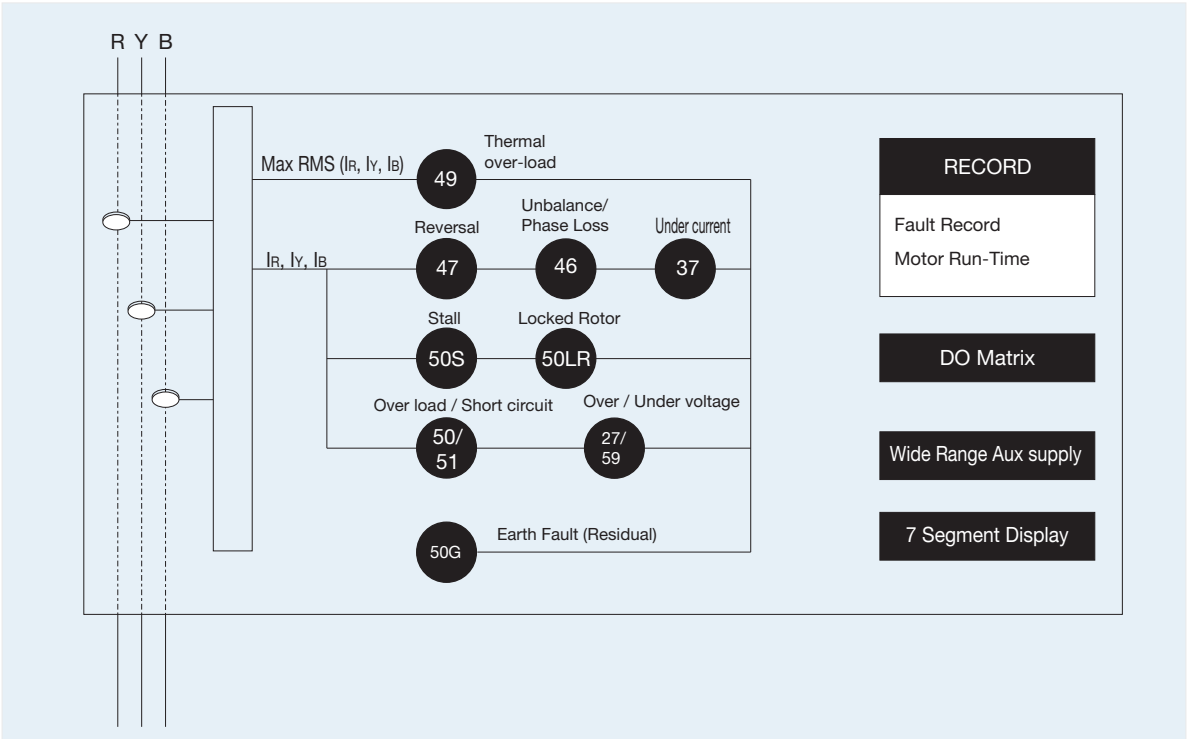
Every motor failure causes a production stop and costs for service. A cable cut, phase failure, short circuit or overload can destroy the motor or pose danger for the whole production line and for the people who work there.
This is the reason why a reliable motor protection is very important and thus mPRO works as a safe guard. It can be used in following areas :

- Motor Control Center (MCC) application.
- Integrated Process & Electrical Control with Protection.
- Agriculture Irrigation
- Factories
- Water Supply Board
- Building & Construction sites
- General Industries
- Domestic Household

3) Customer Benefit

- Eliminates push button / lamp
- Eliminates OLR
- Auto / Manual switch
- Metering (Volt / Amp Meter)
- Protection : Voltage & Current
- STAR - DELTA Timer In-built
- kW based STAR-DELTA conversion

4) Functional Diagram



(Figure-1)

5) Functional Description

Motor State Recognition

The mPRO-90-SDT monitors the flow of the current from which the following operational conditions of the motor are gathered.

■ STOP ■ START ■ RUNNING

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-L) for Under current trip time (tu-L), 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-90-SDT for a period greater than the selected definite operating time (t-dF).

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 (tS-C).

Under Voltage

In the event of Phase-Phase voltage being less than the under voltage setting for the set time, mPRO-90-SDT will detect it as under voltage fault and will trip the pump/motor after under voltage trip time (tu-U), if running or will not allow to run the pump tll the fault persists.

Over Voltage

In the event of Phase-Phase voltage being greater than the over voltage setting (o-U) for the set time, mPRO-90-SDT will detect it as over voltage fault and will trip the pump/motorafter under voltage trip time (to-U), if running or will not allow to run the pump tll the fault persists.

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 (tSPP). The quick trip time on mPRO helps to prevent over-current damage to the windings.

Phase Unbalance (Voltage & Current)

The phase unbalance (current) 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 (I u-b) for the set time (tI ub) the relay will trip.

The Phase unbalance (voltage) condition is checked by monitoring the Ph-Ph Voltage unbalance condition of the supply. The unbalance % between the three phase voltages is calculated by [(max. deviation from AVG. Ph-Ph Voltage)/AVG. Ph-Ph Voltage] x 100[%]. If the calculated value exceeds the set unbalance value (Uu-b) for the selected time (tUub) the relay will trip.

Phase Reversal

In the event of phase reversal, the relay trips after set time (trEU). 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 (tLoC).

Earth / Ground Fault (Residual)

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 internal residual method . Once fault is detected (Earth current >I -E setting), the relay will trip after expiry of set time (tI -E).

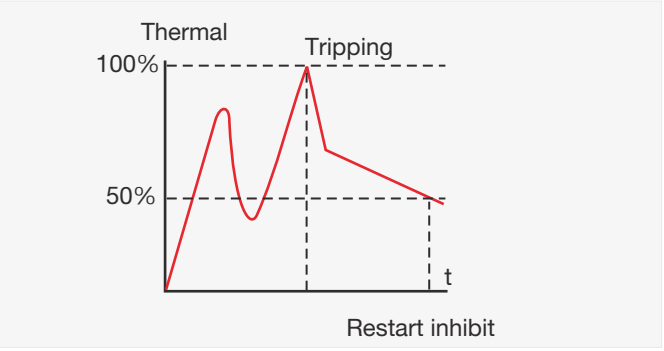
Thermal Over load

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 (t-in). The mPRO-90-SDT appropriately takes in to account cooling of the winding by gradually emptying the accumulated current bucket. The mPRO-90-SDT displays the status of thermal condition of motor windings as a % of maximum permissible **Thermal capacity**.

If current in any of the three phases exceeds over-current setting (o-L) as well as accumulated thermal capacity (**Thermal MEM**) is >=100% then mPRO-90-SDT will trip the motor. If thermal memory is accumulated then Relay Contact (Start/Stop) reset depends on relay operation mode (AUTO/MANUAL) as given in following table.

Thermal Reset	Output Contact Reset
Auto Mode	When Thermal capacity (Thermal MEM) <80%
Manual Mode	When Thermal capacity (Thermal MEM) <80% & Front Reset key is pressed

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 (t- in) .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 (inU) is selected then only the effect of thermal memory phenomenon is enabled. If current in any of the three phases exceeds over-current setting (o-L) as well as accumulated thermal capacity is >=100% then mPRO-90-SDT will trip the motor.

Stall

Mechanical equipments such as pumps or fans can be quickly damaged if it jams, resulting in a locked rotor stall. The mPRO-90-SDT will trip when the running current exceeds the set value (StL) after the Stalled Rotor Time (tStL). 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.

6) Records

mPRO-90-SDT Model stores following records in it's non-volatile memory.

(a) Fault Record

mPRO-90-SDT records last fault in its non-volatile memory :

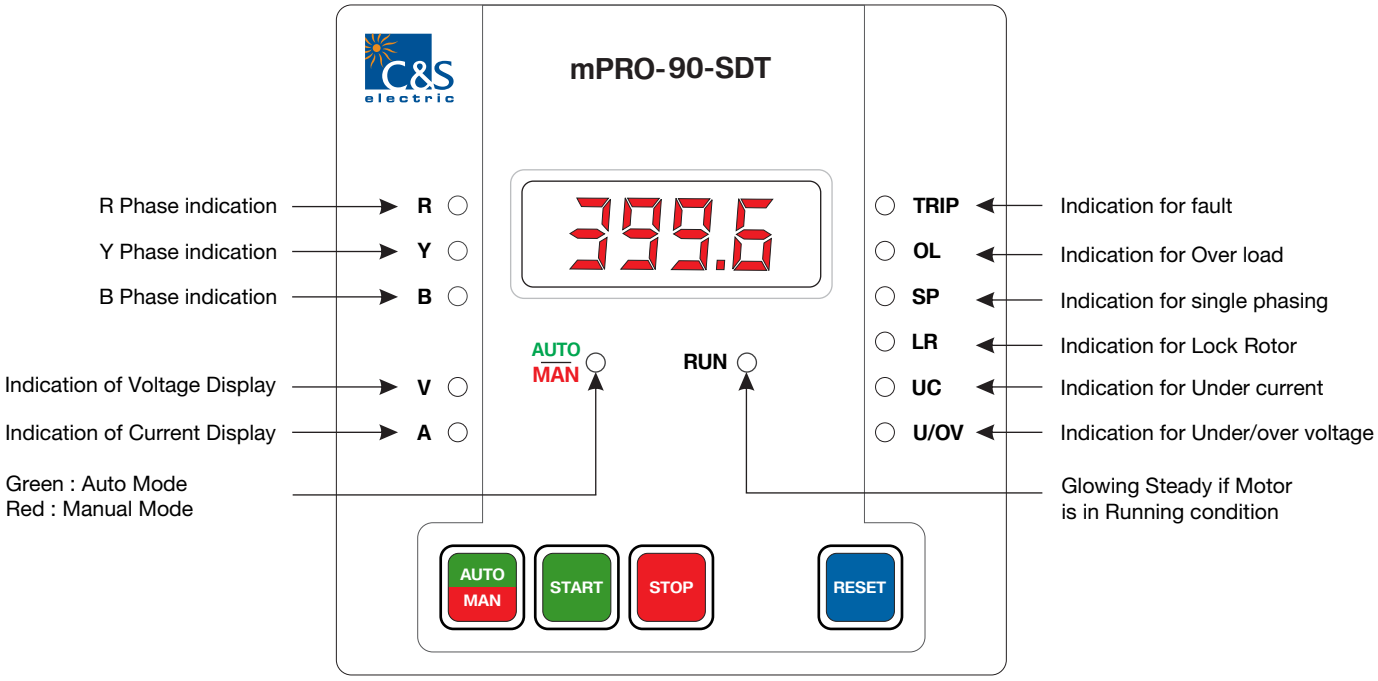
- Phase and Earth fault current level, Phase to Phase voltages
- Origin of fault (over current, short circuit, stall etc.)

(b) Motor Run Time Record

mPRO-90-SDT accumulates the total RUN Time of motor. Update time resolution is 5 min.

7) Human Machine Interface (HMI)

- ❖ Single Row 7 Segment display. Parameters will be displayed in Auto scroll fashion.
- ❖ Keys for START STOP control and parameter editing/saving in password protected **edit** mode.
- ❖ One 'RESET' key for Fault Reset locally.
- ❖ LEDs for indication of measuring parameters, pump running, operation mode and trip status.



(Figure-3)

Key Description

Keys	Function
START	Press this key in manual mode to **START** the pump/motor. Press this key to scroll/edit a parameter in EDIT mode.
STOP	Press this key in manual mode to **STOP** the pump/motor. Long Press this key to enter into EDIT mode when parameter is stopped.
RESET	Press this key to **RESET** the fault.
AUTO MAN	This is operating mode selection key Long Press : To switch between **AUTO** & **MANUAL** mode AUTO/MAN Green : Auto mode Red : Manual mode In EDIT mode this key will function as a ENTER/SAVE key

8) Setting Parameters (Common)

Parameter	Display	Setting Range		Step Size	Unit	Default Setting
		Min.	Max.			
External CT Selection #	CT	C 10.0	C250	---	---	C 10.0
Full Load Current (IFL-CT1)	I FL	0.2	10.0	0.01	Amp	2.0
Full Load Current (IFL-CT2)	I FL	0.8	25.0	0.01	Amp	2.0
Full Load Current (IFL-CT3)	I FL	2.0	62.5	0.01	Amp	2.0
Full Load Current (IFL-CT4)	I FL	4.0	125.0	0.01	Amp	8.0
Full Load Current (IFL-CT5)	I FL	8.0	250.0	0.01	Amp	8.0
Rated Voltage (Vnom)	Vnom	220	425	1	V	415
Power on Delay Time	tPUr	30	300	1	Sec	45
Under Voltage Setting	U-U	20	90	5	%Vnom	45
Over Voltage Setting	O-U	80	125	5	%Vnom	110
Under load setting	U-L	20	90	5	% IFL	20
Overload Pickup	O-L	50	150	1	% IFL	110
Current Unbalance	I U-b	5	50	1.0	%	OFF
Voltage Unbalance	VU-b	5	50	1.0	%	10
Locked Rotor Pick up	LoC	200	800[5]	50	% IFL	OFF
Stall Rotor Pick up	StL	150	600	5	x IFL	OFF
Short Circuit Pickup	S-C	200	800 [4]	50	% IFL	OFF
Power - Low set	PUL	1	70	0.1	kW	1.0
Power - High set	PUH	1	70	0.1	kW	3.0
Earth Fault Pick up (Residual) [3]	I-E	10	50	1	% IFL	20

Note : Password : P100

CT selection is applicable only for CT1, CT-2 & CT-3 model.

Note : Value of power Power-Low set should always be less than Power-High set value, if user increase the value of Power-Low set and make this value equal to or greater than the Power-High set, in that case value of Power-Low set & Power-High set will set to the default value.
Similarly if user decrease the value of Power-High set and makes it equal to or less than the Power-Low set, in that case value of Power-Low set and Power-High set will set to the default value.

9) Setting Parameters (Advance)

Parameter	Display	Setting Range		Step Size	Unit	Default Setting
		Min.	Max.			
Under Voltage Trip Time	tu-U	1	600	1	Sec	4
Over Voltage Trip Time	to-U	1	600	1	Sec	4
Under Load Trip time	tu-L	1	600	1	Sec	4
Overload Characteristic	CHr	dEFt	InU	---	---	InU
Overload Definite Time [1]	t-dF	0.1	60.0	0.1	Sec	10.0
Overload Operating Time [2]	t- In	5	60	5	Sec	10
Single Phasing (SPP) Trip Time	tSPP	0.5	10.0	0.1	Sec	4
Current unbalance Trip Time	tIub	1	600	1.0	Sec	4
Voltage Unbalance Trip time	tUub	1	600	1.0	Sec	4
Phase Reversal Trip Time	trEU	1	100	1	Sec	4
Lock Rotor Trip Time	tLoC	0.5	10.0	0.1	Sec	4
Stall Rotor Trip Time	tStL	1	20	1	Sec	4
Short circuit Trip Time	tS-C	0.05	5.00	0.05	Sec	0.5
Earth Fault Trip Time (Residual) [3]	tI-E	0.2	10.0	0.1	Sec	10.0
Run Time	trun	5	3000	1	Min	480
Star Time	tStr	1.0	100.0	0.1	Sec	10
Change over (STAR-DELTA) delay time	tSdC	0.01	99.99	0.01	Sec	1.00
Delta Time	tdEL	1.0	100.0	0.1	Sec	10
Change over (DELTA-STAR) delay time	tdSC	0.01	99.99	0.01	Sec	1.00
Scroll	SCrL	OFF	On	--	--	OFF

Note: Run time setting is available with exit (OFF) option, when it is selected "oFF", mPRO-90-SDT will not switch off pump/motor after run time is expired in Auto mode. Run time calculation is for continuous motor operation, If in between power fails, Run time timer will get reset and on restoration of power mPRO-90-SDT will calculate fresh run time from zero. However this will not affect the Pump Run Hour (rHrS) information.

Password : P200

FUNCTIONAL LOGIC OF Control O/P, Star-Delta timer & Delta Star timer:

1) After switching on the power of relay, DO-4 will turn ON and after the lapse of Power ON delay time DO-2 (main contactor output) & DO-1 (STAR output) gets ON immediately. After settable STAR-DELTA timer delay DO-1 (STAR output) will turn OFF and DO-3 (DELTA output) will Turn ON after lapsing of Change over (STAR-DELTA) delay time.

2) If measured kW Power is < Low set kW, than after lapsing off settable DELTA-STAR timer delay DO-3 (Delta Output) will Turn OFF and DO-1 (STAR output) will turn ON after lapsing of change over (DELTA-STAR) delay time.

3) If measured kW Power is > High set kW than after lapsing off settable STAR-DELTA timer delay DO-1 (Star Output) will Turn OFF and DO-3 (Delta output) will turn ON after lapsing of change over (STAR-DELTA) delay time.

4) After every time when device trip, the DO-2 (main contactor output), DO-3 Delta (Output), DO-4 & DO-1 (STAR output) will turn OFF.

10) Technical Data

Parameter		Description	
Operational Current		0.2 - 8.0 x IFL	IFL : Full Load Current
Measuring voltage		80 - 550 V AC	(Ph-Ph), 50 Hz
Nominal Frequency		50 Hz	
Protection		Over-load, Under-current, Short circuit, Under voltage, Over voltage, Lock rotor,	
		Stall, Unbalance, Phase loss, Phase reversal, Earth/Ground fault	
		Voltage unbalance, Thermal overload	
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	$\pm$ 5% (or $\pm$ 100 mSec)	
	Current	$\pm$ 3% (or $\pm$ 0.01 Amp) is for CT-1, CT-2, CT-3, CT-4	
		$\pm$ 8% (or $\pm$ 0.01 Amp) is for CT-5	
Display			
	7 Segment	Metering and Fault information	
	LED	R : Current in R Phase, Y : current in Y Phase, B : current in B Phase	
		V: Flash for Voltage indication, A : Flash for Current indication	
		TRIP: Flash when Relay Trips, OL : Flash when overload condition occurs	
		SP: Flash when single phase condition occurs	
		LR: Flash when lock rotor exist, UC : Flash when under current condition occurs	
		U/OV : Flash when Under or over voltage condition occurs	
		RUN : Flashing for ‘Motor Start’ / Steady for ‘Motor Run’	
		AUTO/MAN : Flashing GREEN when in Auto mode & RED when Manual mode	
Auxiliary Supply		190 - 450V AC	
Type of Starter		STAR-DELTA	
Contact Rating			
	Alarm Relay Contact	3 N/O Contact, 10A / 250V AC or 5A, 30V DC	
		1 C/O Contact, 10A / 250V AC or 5A, 30V DC	
Temperature			
	Operation	0^{0}C to 70^{0}C	
	Storage	-10^{0}C to 85^{0}C	
Wiring Connection		Screwed Terminal	

11) Current Range Selection

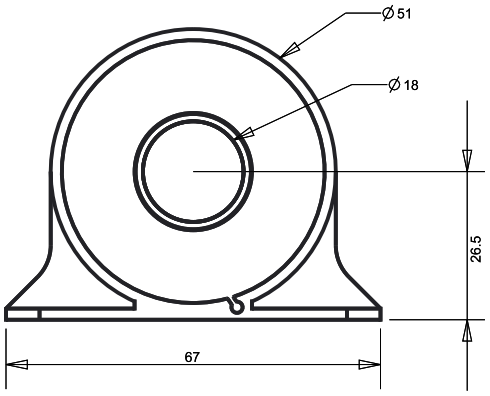
mPRO-90-SDT supports 0.2 to 250 Amp Full Load current as per following CTs configuration: -

Description (External CTs)	Min. Value	Max. Value
CT1 IFL (Current in Amp)	0.2	10.0
CT2 IFL (Current in Amp)	0.8	25.0
CT3 IFL (Current in Amp)	2.0	62.5
CT4 IFL (Current in Amp)	4.0	125.0
CT5 IFL (Current in Amp)	8.0	250.0

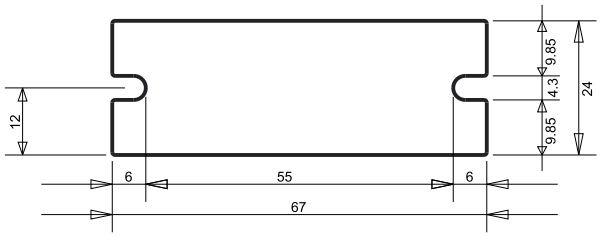
Note (for CT-1, CT-2, CT-3) : Before doing any IFL / Protection Settings, first select the CT type in the relay menu As soon as user change the CT type value, IFL sets to default value.

12a) Dimensional Drawing of CT1, CT2 & CT3 (common size)

All the dim. are in mm (Gen. Tol ± 1.0 mm)

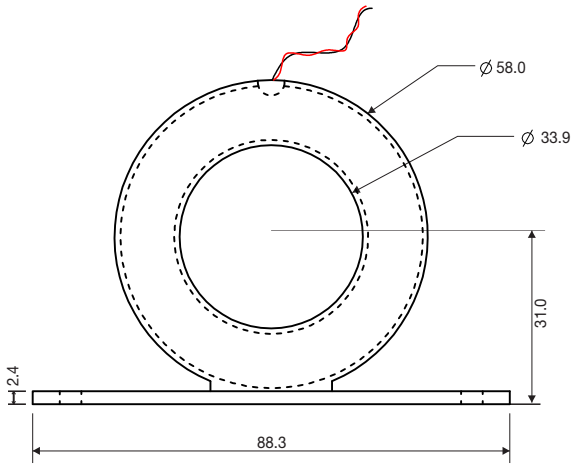


(Figure-4)

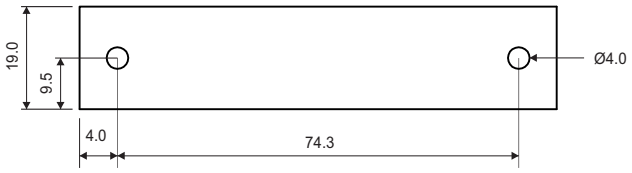


(Figure-5)

12b) Dimensional Drawing of CT4

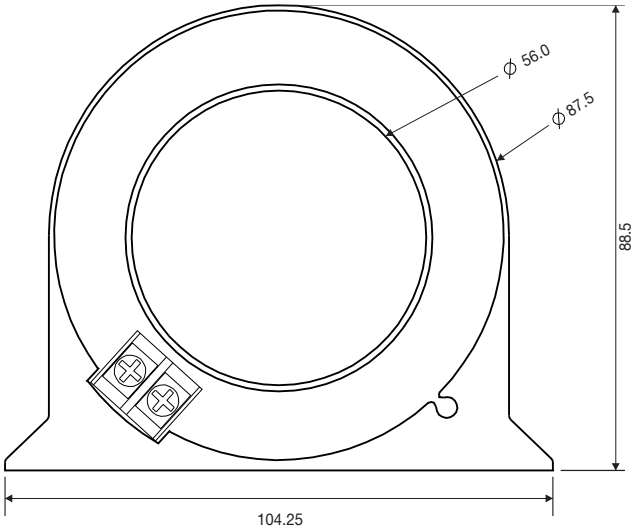


(Figure-6)

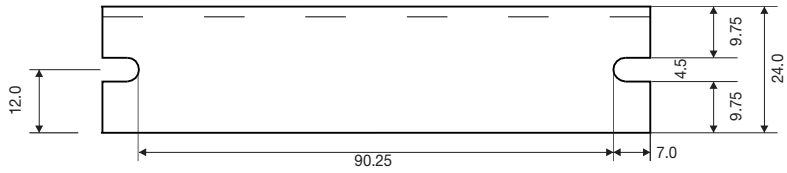


(Figure-7)

12c) Dimensional Drawing of CT5

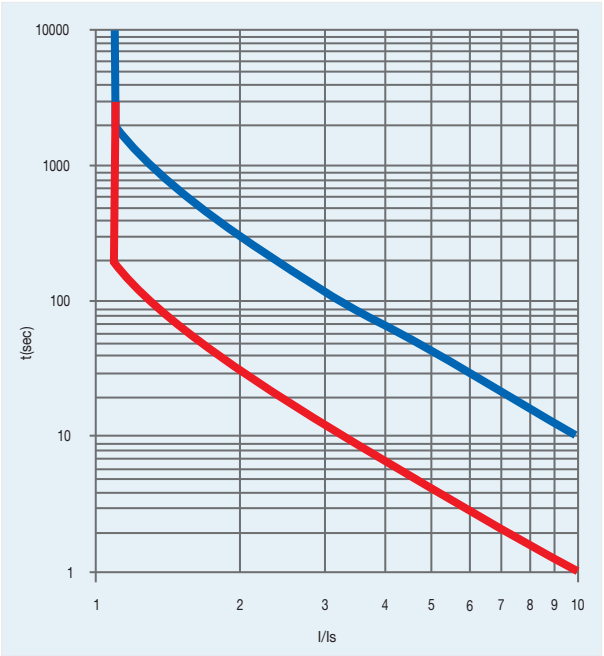


(Figure-8)



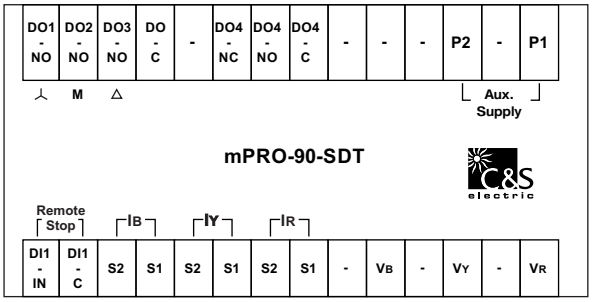
(Figure-9)

13) Thermal (inverse) Characteristic



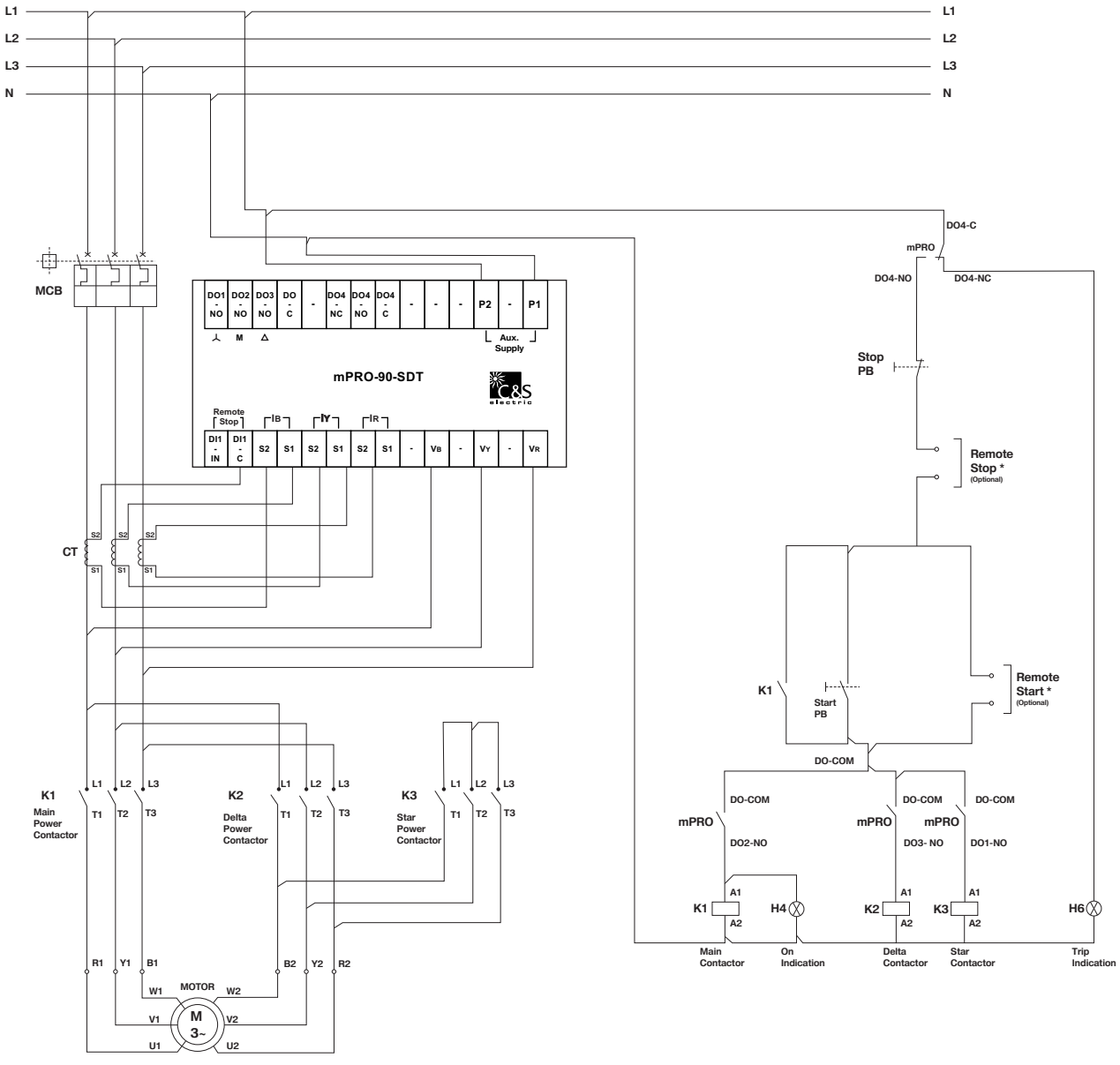
(Figure-10)

14) Terminal Diagram for STAR DELTA



(Figure-11)

15) Typical Wiring Diagram of mPRO-90-SDT

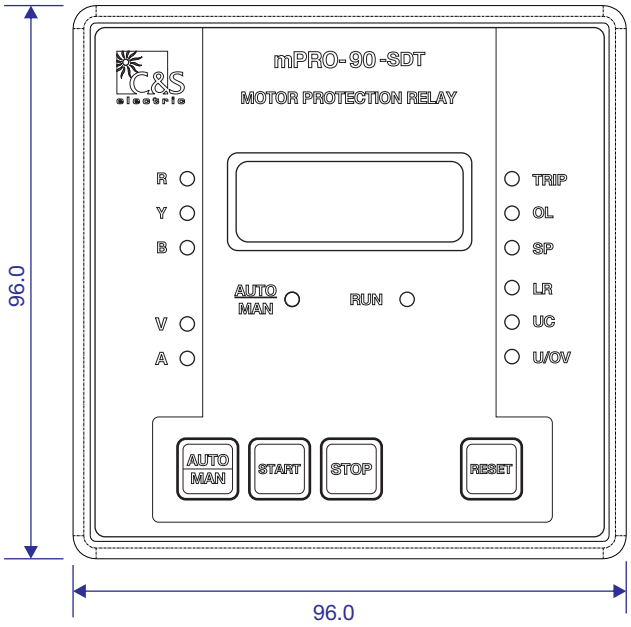


(Figure-12)

16) Dimension Details

(All the dimensions are in mm, Gen Tol ± 1.0mm)

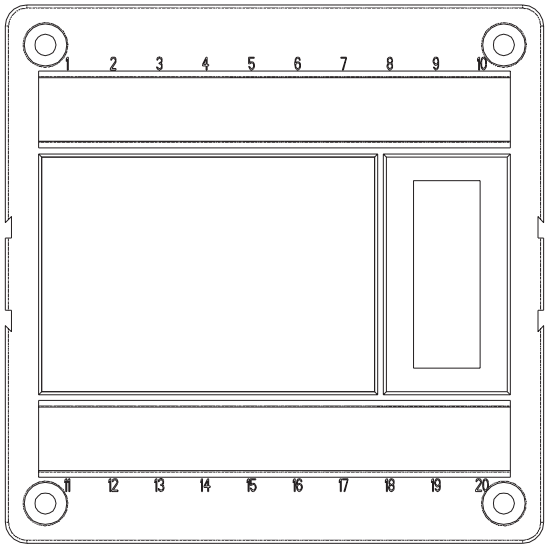
Front View



(Figure-13)

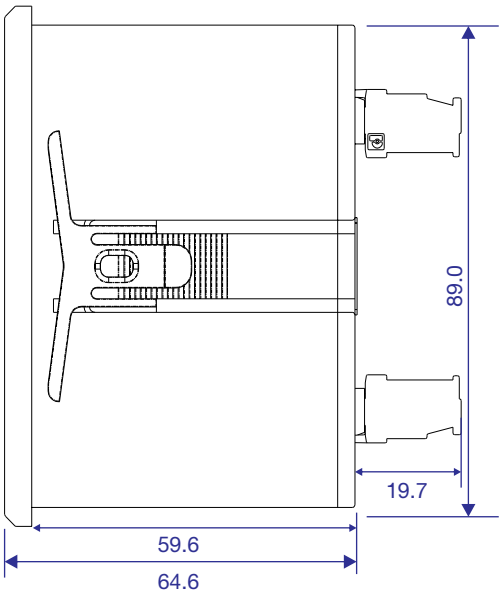
Dimension Details	
Mounting	Flush on Panel
Dimensions	96 x 96 mm
	Panel cut out : 91 x 91 mm
	Depth : 79.5 mm behind bezel
Terminal connector	Pluggable Type
Weight	0.3 Kg (Approx)

Back View



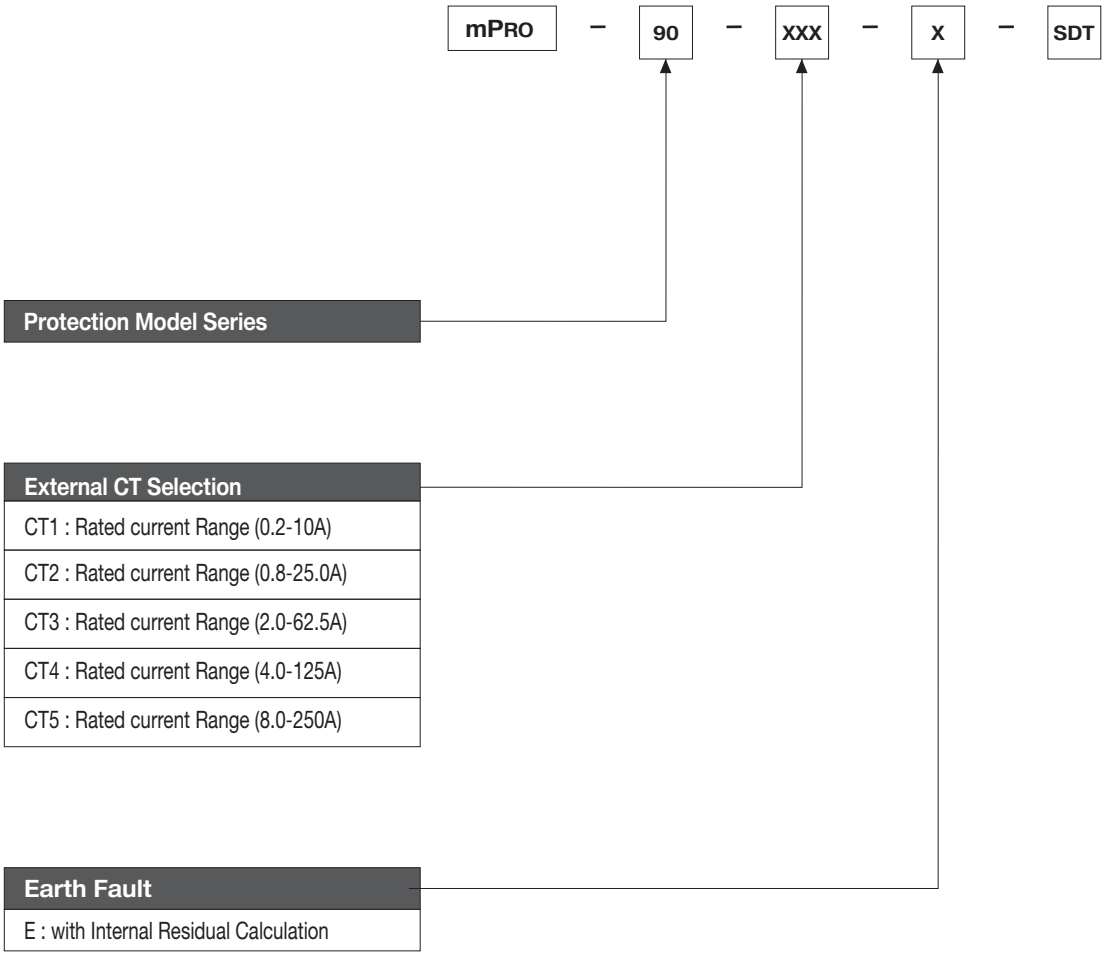
(Figure-14)

Side View



(Figure-15)

17) Ordering Information



Revision History

S.No.	Rev.No.	Details	Date
01	01	Terminal diagram & wiring diagram of the relay on page 13 changed	04.10.19
02	02	Functional logic of control O/P changed on page 9	16.10.19
03	03	Setting change in common & advance parameters	24.10.19

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