SATEC
Powerful Solutions

expertmeter™ **PM180**

PM180 Series
SUBSTATION AUTOMATION UNIT

INSTALLATION MANUAL

LIMITED WARRANTY

The manufacturer offers the customer a 24-month functional warranty on the instrument for faulty workmanship or parts from date of dispatch from the distributor. In all cases, this warranty is valid for 36 months from the date of production. This warranty is on a return to factory basis.

The manufacturer does not accept liability for any damage caused by instrument malfunction. The manufacturer accepts no responsibility for the suitability of the instrument to the application for which it was purchased.

Failure to install, set up or operate the instrument according to the instructions herein will void the warranty.

Your instrument may be opened only by a duly authorized representative of the manufacturer. The unit should only be opened in a fully anti-static environment. Failure to do so may damage the electronic components and will void the warranty.

NOTE

The greatest care has been taken to manufacture and calibrate your instrument. However, these instructions do not cover all possible contingencies that may arise during installation, operation or maintenance, and all details and variations of this equipment are not covered by these instructions.

For additional information regarding installation, operation or maintenance of this instrument, contact the manufacturer or your local representative or distributor.

IMPORTANT

Please read the instructions in this manual before performing installation, and take note of the following precautions:

1. Ensure that all incoming AC power and other power sources are turned OFF before performing any work on the instrument. Failure to do so may result in <u>serious or even fatal injury</u> and/or equipment damage.

2. Before connecting the instrument to the power source, check the labels on the side of the instrument to ensure that your instrument is equipped with the appropriate power supply voltage, input voltages, currents, analog output and communication protocol for your application

3. Do not connect the instrument to a power source if it is damaged.

4. Do not expose the instrument to rain or moisture.

5. The secondary of an external current transformer must never be allowed to be open circuit when the primary is energized. An open circuit can cause high voltages, possibly resulting in equipment damage, fire and even <u>serious or fatal injury</u>. Ensure that the current transformer wiring is made through shorting switches and is secured using an external strain relief to reduce mechanical strain on the screw terminals, if necessary.

6. Setup procedures must be performed only by qualified personnel familiar with the instrument and its associated electrical equipment

7. Do NOT open the instrument under any circumstances.

☞**Read this manual thoroughly before connecting the meter to the current carrying circuits. During operation of the meter, hazardous voltages are present on input terminals. Failure to observe precautions can result in serious or even fatal injury or damage to equipment.**

November 2018

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Chapter 1 Introduction

1. Introduction

1.1 About This Manual

This manual is intended to assist the user in the installation of the *PM180 Series (expertmeter™ PM180) Substation Automation Unit*. The term '*PM180*' is used herein to refer to all models in the series.

This chapter gives an overview of this manual and an introduction to the *PM180.*

Chapter 2, Installation, provides instructions for mechanical and electrical installation.

Chapter 3, Communications, provides drawings for communications connections and instructions.

Chapter 4, installing the Battery, provides the replacement/installation battery procedure and instructions.

Appendix, Technical Specifications for the *PM180*

1.2 About The *PM180*

The *PM180* series is a group of advanced multi-microprocessor-based digital instruments that incorporate the capabilities of a power quality analyzer, energy meter, fault and data recorder and programmable controller, oriented for substation automation. These instruments provide three-phase measurements of electrical quantities in power distribution systems, monitoring external events, operating external equipment via relay contacts, fast and long-term on-board recording of measured quantities, faults with currents up to 100A and events, harmonic network analysis and disturbance recording.

Features

The PM180 combines in a single enclosure:

- Digital Fault Recorder (onboard fault detector - programmable fault thresholds and hysteresis, up to 100 Amps fault currents in standard product (using CS1S model) and up to 200Amps fault current with DFR add-on module, zero-sequence currents and volts, current and volt unbalance; up to 48 external digital triggers from tripping protection relays; ready-for-use fault reports - fault currents magnitude and duration, coincident volts magnitude, fault waveforms and RMS trace)

- Precise Sequence-of-Events Recorder (up to 48 digital inputs at 1-ms resolution, fault events and relay operations)

- Power Quality Recorder (EN50160/IEEE1159/GOST13109/32144-2013, onboard PQ analyzer; programmable thresholds and hysteresis; ready-for-use reports; transients, impulses, sags/swells, interruptions, harmonics, inter-harmonics, frequency variations, volts unbalance)

- Event Recorder for logging internal diagnostics events, control events and I/O operations

- Eight fast Waveform Recorders (simultaneous 8-channel AC, VDC and 16-channel digital inputs recording in a single plot; selectable AC sampling rate of 32, 64, 128 or 256 samples per cycle and 512 or 1024 samples per cycle (TRM); 20 pre-fault cycles, 1-ms resolution for digital inputs; up to 3 hours of continuous recording with a 250-Mbyte onboard memory at a rate of 32 samples per cycle)

- Sixteen fast Data Recorders (from 1/2 cycle RMS to 2-hour RMS envelopes; up to 20 pre-fault cycles; programmable data logs on a periodic basis and on any internal and external trigger)

- Programmable Controller (64 control setpoints, OR/AND logic, extensive triggers, programmable thresholds and delays, relay control, event-driven data recording)

- High-Class 3-phase Power meter (true RMS, volts, amps, powers, power factors, unbalance, neutral current)

- Demand Meter (amps, volts, harmonic demands)

- Precise Energy and Power Demand Meter (TOU, 16 Summary energy and demand registers for substation energy management, accumulation of energy pulses from external watt-meters, block and sliding demands, up to 64 energy sources)

- Harmonic Analyzer (to 63rd harmonic volts and amps, directional power harmonics and power factor, Phasor, symmetrical components)

- 32 digital counters for counting pulses from external sources and numerous internal events

- 16 programmable timers from 1/2 cycle to 24 hours for periodic recording and triggering operations on a time basis

- 1-ms satellite-synchronized clock (IRIG-B time-code input)
- Second backup power supply unit

1.2.1 AC/DC Inputs

The PM180 is provided with a set of fully isolated AC/DC inputs for a connection to the AC feeders and station battery:

Three standard isolated AC voltage inputs (up to 690VAC direct line-to-line input voltage)

AC/DC voltage input (up to 400V AC/DC) for monitoring fourth AC voltage or DC of the station battery

Four optional isolated AC voltage inputs (up to 690VAC direct line-to-line input voltage) for transient up to 2kVp

Four standard isolated AC current inputs:

- using internal CT, with an extended input range up to 1000% overload (up to 50 Amps input currents - fault currents)
- using HACS 100A (PM180-CS1S model), with an extended input range up to 2000% overload (up to 100 Amps input currents - fault currents)

Four optional isolated current inputs up to 200 Amps, external CT, fault currents detector

1.2.2 Digital and Analog I/O Options

The PM180 has three I/O expansion slots for removable "hot-swap" plug-in I/O modules:

DI - Digital inputs (16 optically isolated inputs per module, up to 3 modules per device; options for dry contacts, 24-250VDC wet inputs; programmable de-bounce time from 1 ms to 1 sec; free linkage to Sequence-of-Events Recorder, Fault Recorder, control setpoints, pulse counters and Energy/TOU subsystem)

RO - Relay outputs (8 relays per module, up to 3 modules per device; unlatched, latched and pulse operations, failsafe operation for alarm notifications; programmable pulse width; direct remote relay control through communications)

AI/AO - Mixed analog input/output modules (four optically isolated AI and four AO with internal power supplies per module, up to 3 modules per device; options for 0-1mA, ±1mA, 0-20mA and 4-20mA inputs and outputs; 200% overload current for 0-1mA and ±1mA AI/AO)

TRM – Fast Transient recorder module, with ability to capture transient up to 2kV AC with minimum width of 17μsec, programmable sampling rate 512/1024 samples per cycle (spc)

DFR – Digital Fault Recorder module to enable current fault capture up to 40 x I_n (@ I_n =5A, I_{fault} = 200A max.).

1.2.3 Communications Options

The PM180 has extensive communications capabilities:

Three independent universal serial communications ports (RS-232/RS-485[1], RS-422/RS-485, up to 115,200 bps, Modbus RTU/ASCII and DNP3.0 protocols)

Infrared port (MODBUS RTU/ASCII and DNP3.0 protocols)

Embedded 3.5G wireless modem for communications through public cellular service provider network (MODBUS/TCP or DNP3.0/TCP protocols)

Ethernet 10/100TX- 100FX port (MODBUS/TCP or DNP3.0/TCP protocols, up to five non-intrusive simultaneous connections, Telnet service port)

USB 1.1 port (MODBUS RTU protocol, 12 Mbps) for fast local communications and data retrieving

1.2.4 Remote Displays

The PM180 can be ordered with an optional 3 windows LED Remote Display Module (RDM180) or 12 windows LED Remote Display Module (RDM312) or LCD Remote Graphical Module (RGM180). Both have a fast RS-485 port and communicate with the PM180 through the MODBUS RTU protocol. Remote displays can be located at distances of up to 0.5 km from the device. The RGM180 can also be ordered with an Ethernet 10/100Base-T port and can communicate with the PM180 through a local network.

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[1] RS-485 only on PM180 N3 Version

The RDM180 has 3-row (2x4 characters + 1x6 characters) bright red LEDs well suited for dark areas. It allows the user to view real-time RMS and harmonics measurements, status indication parameters, and perform basic setup operations when installing and servicing the device.

The RDM312 has 3-row x 4-window (9x4 characters + 3x6 characters) bright red LEDs well suited for dark areas. It allows the user to view real-time RMS and harmonics measurements, status indication parameters, and perform basic setup operations when installing and servicing the device.

The RGM180 is equipped with a color graphics LCD display with Touch Panel and has extensive dialog capabilities, allowing the user to view different fault and power quality information in a graphical form, such as waveforms, harmonic spectrum, phasors and data trends, review latest fault and power quality reports for fast fault analysis, and much more.

1.2.5 Upgradeable Firmware

The PM180 uses flash memory for storing device firmware that allows future upgrading of the device without replacing any hardware component. The new features can be easily added to your device by simply replacing the firmware through a local RS-232/485 port, USB port or Ethernet port.

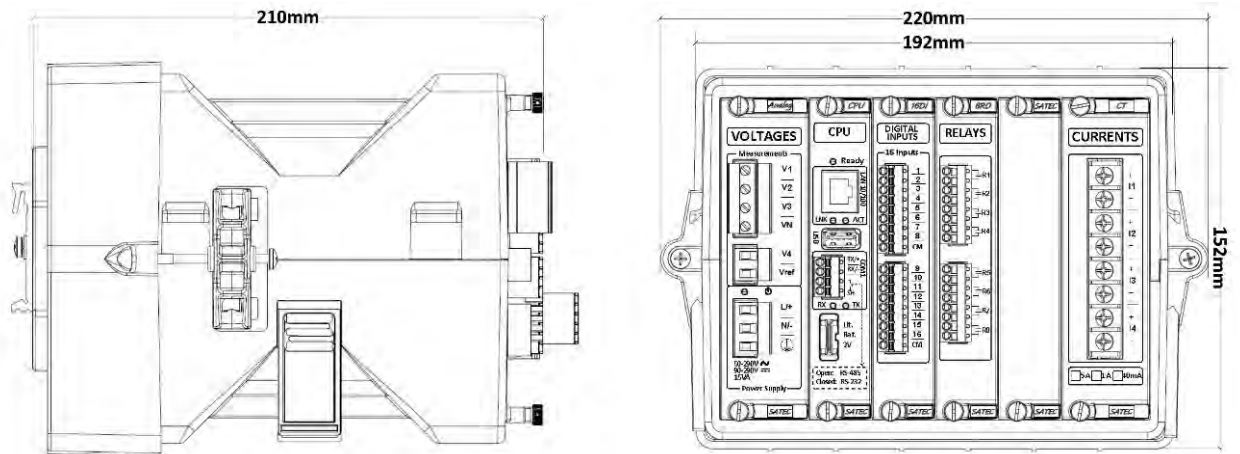# Chapter 2 Installation

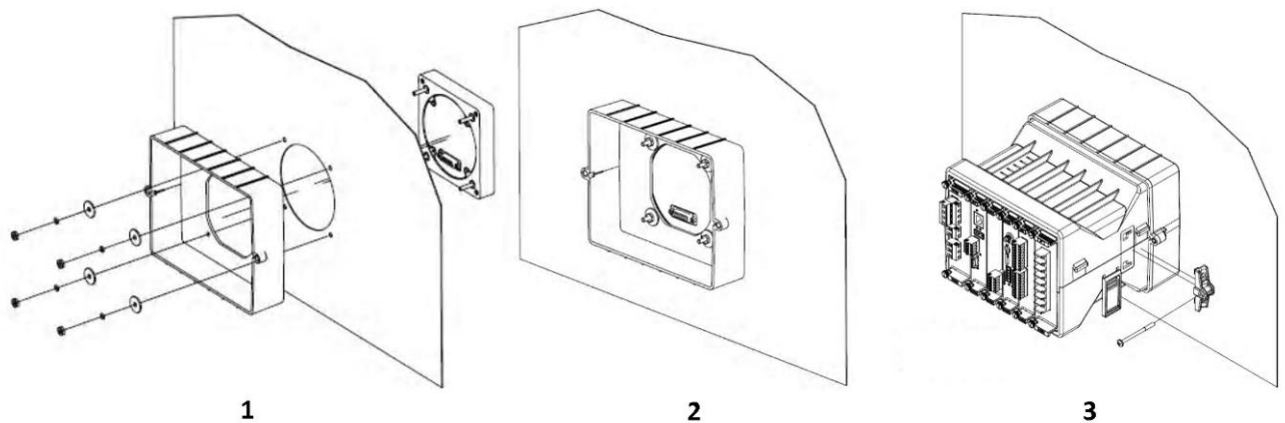## 2.1 Mechanical Installation

Figure 2-1: Dimensions
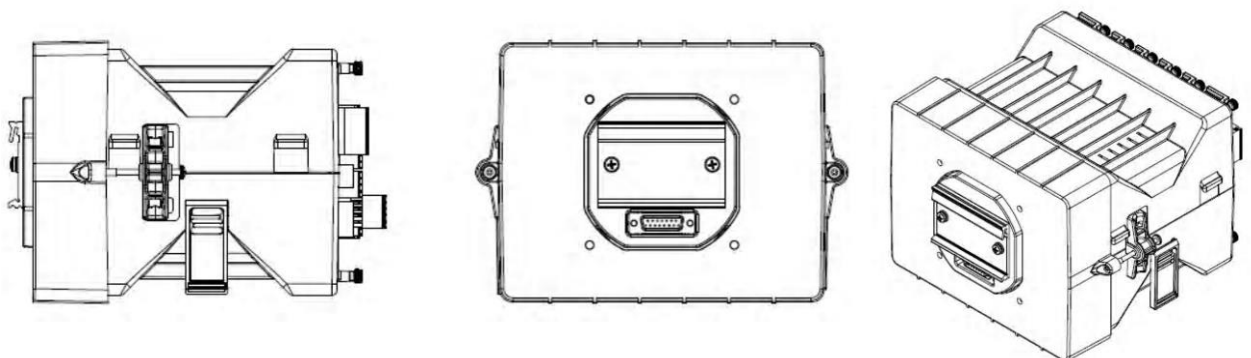

Figure 2-2: Panel Mounting

Figure 2-3: DIN Rail Mounting

2.2 Electrical Installation

☞**The PM180 is packed <u>without</u> battery; therefore it must be installed by the installer during the PM180 installation (see chapter 4. Installing the Battery.).**

After turning "ON" the PM180 power supply for the first time following battery installation, the PM180 initialization process duration may take about <u>7 minutes</u>, while regular PM180 initialization process duration takes 40 seconds

2.2.1 Power Source Connection

The PM180 unit has two independent power supplies: main and auxiliary backup power supply. The standard power supply may be connected to a 50-290V AC or 90-290V DC power source. Lower voltage DC power supply options are also available (see *Appendix: Technical Specifications*).

The main power supply connections are:

- AC power: line to VOLTAGES board terminal "L/+"; neutral to VOLTAGES board terminal "N/−".

- DC power: positive to VOLTAGES board terminal "L/+"; negative to VOLTAGES board terminal "N/−".

The auxiliary backup power supply connections:

- AC power: line to AUX. P.S. AC/DC board terminal "L/+"; neutral to AUX. P.S. AC/DC board terminal "N/−"

- DC power: positive to AUX. P.S. AC/DC board terminal "L/+"; negative to AUX. P.S. AC/DC board terminal "N/−".

Copper wiring 1.5-2.5 mm^2 (15 -13 AWG) should be used.

2.2.2 Current Inputs

PM180 has 4 current inputs up to 50A with internal current transformer and up to 100A with external SATEC split core CT – HACS 100A, connected to Relay Protection CT's via CURRENTS board terminal and 4 current inputs for fault up to 40 x In using optional DFR add-on module.

Copper wiring 2.5 – 6 mm^2 (10 AWG) should be used.

2.2.3 Ground

Connect the chassis ground of the *PM180* to the switchgear earth ground using dedicated wire greater than 2 mm^2/14 AWG.

2.2.4 Voltage Inputs

PM180 models have 3 AC Y-connected voltage inputs of 480V[1] (phase-to-phase) and neutral, and one separate isolated AC/DC voltage input of 400V.

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[1] 690 VAC (phase-to-phase) and neutral using PM180-N1 model with 1MOhm voltage input impedance

2.2.5 Wiring Configurations

2.2.5.1 Configurable Wiring mode

Use any of the eight wiring configurations shown in Figures 2-4, 2-4, 2-5a/5b, 2-6, 2-7, 2-8 or 2-9.

| Wiring Configuration		
(See parameter setup instructions in Section 4.1)	Code for Setup	See Figure:
3-wire direct connection using 2 CTs (2-element)	3dir2	2-4
4-wire WYE direct connection using 4 CTs (3-element)	4Ln3 or 4LL3	2-5
4-wire WYE connection using 3 PTs, 3 CTs (3-element)	4Ln3 or 4LL3	2-6
4-wire WYE connection using 3 PTs, 3 CTs (3-element) With External CT – DFR model (CS1S)	4Ln3 or 4LL3	2-7
3-wire open delta connection using 2 PTs, 2 CTs (2-element)	3OP2	2-8
4-wire WYE connection using 2 PTs, 3 CTs (2½-element)	3Ln3 or3LL3	2-9
3-wire open delta connection using 2 PTs, 3 CTs (2½ - element)	3OP3	2-10
4-wire delta direct connection using 3 CTs (3-element)	4Ln3 or 4LL3	2-11
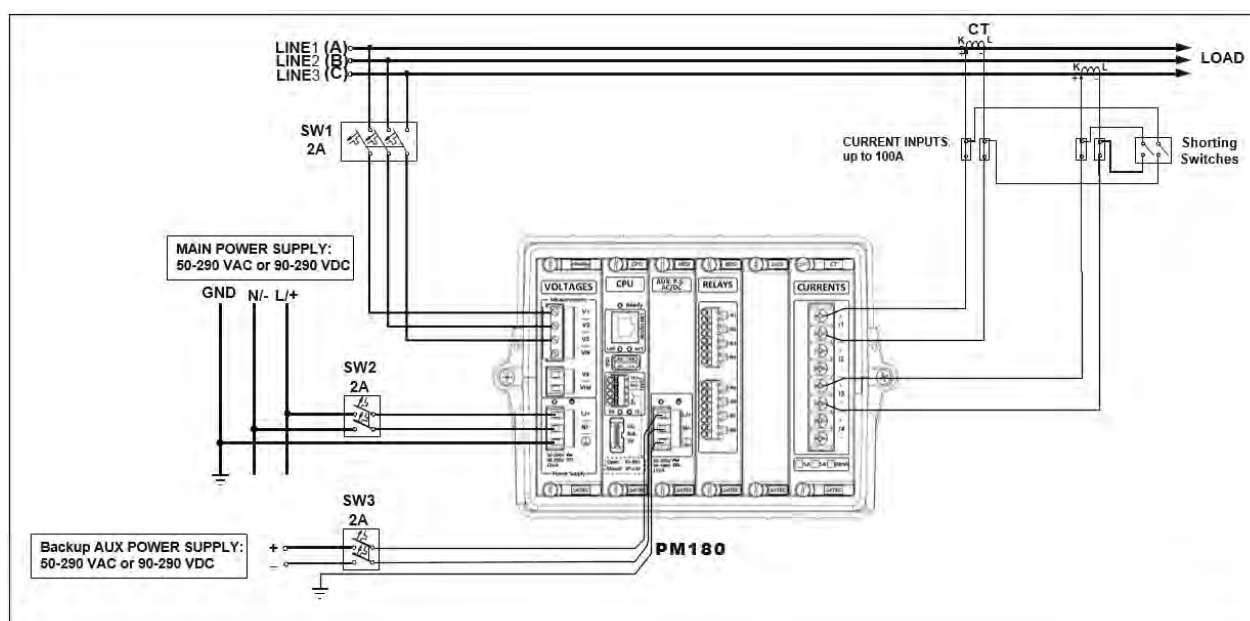
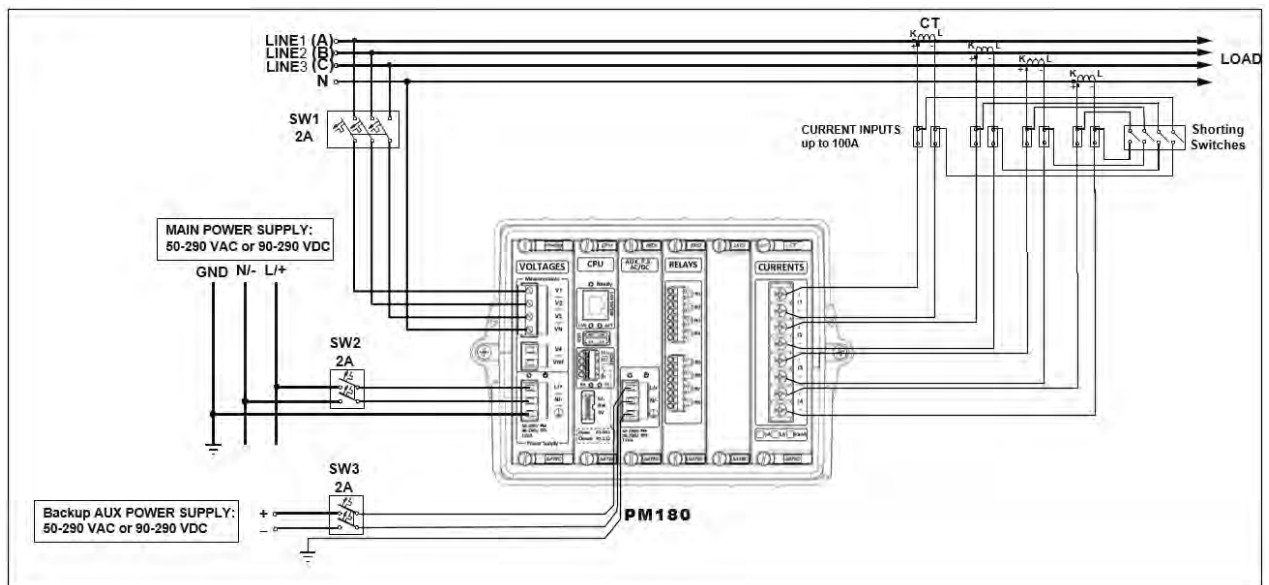*Figure 2-4: Three Wire Direct Connection Using 2 CTs (2-element)*

Wiring Mode = 3dir2

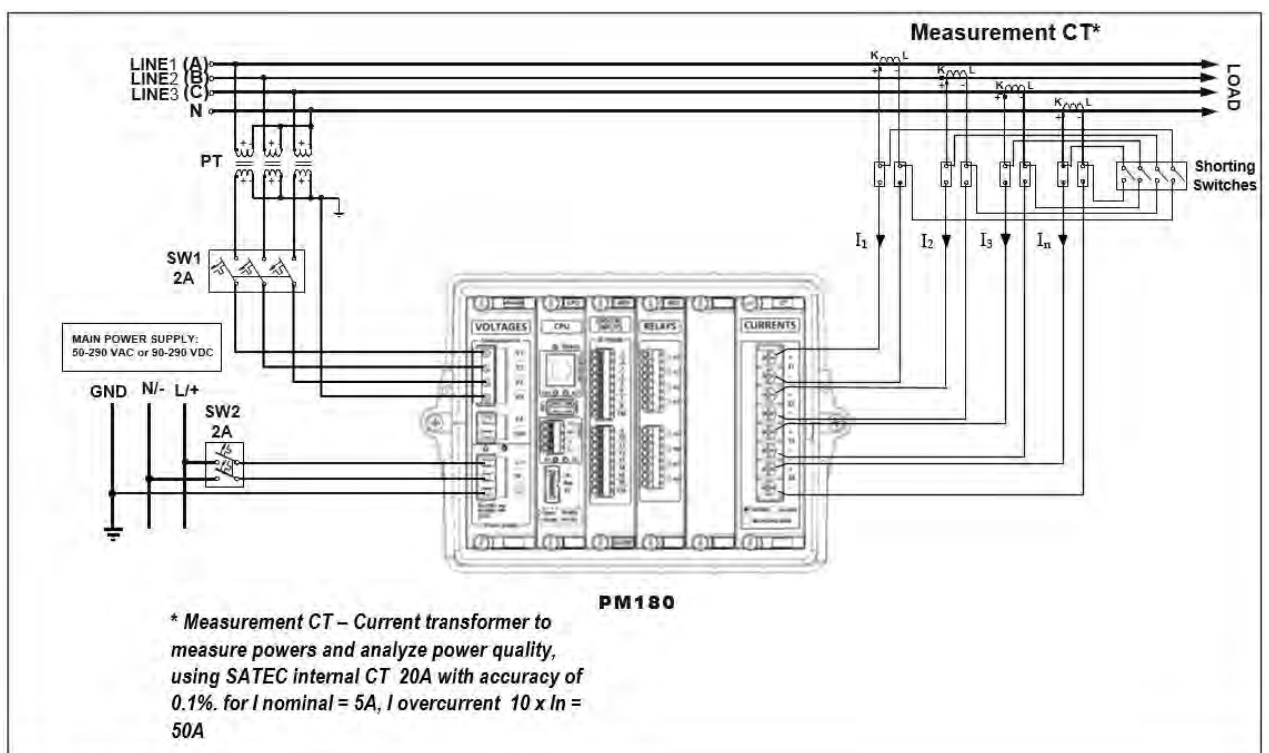*Figure 2-5: Four Wire WYE Direct Connection Using 4 CTs (3-element)*

Wiring Mode = **4LL3** or **4Ln3**

Figure 2-6: Four Wire WYE Connection Using 3 PTs, 4 CTs (3-element) - internal CT
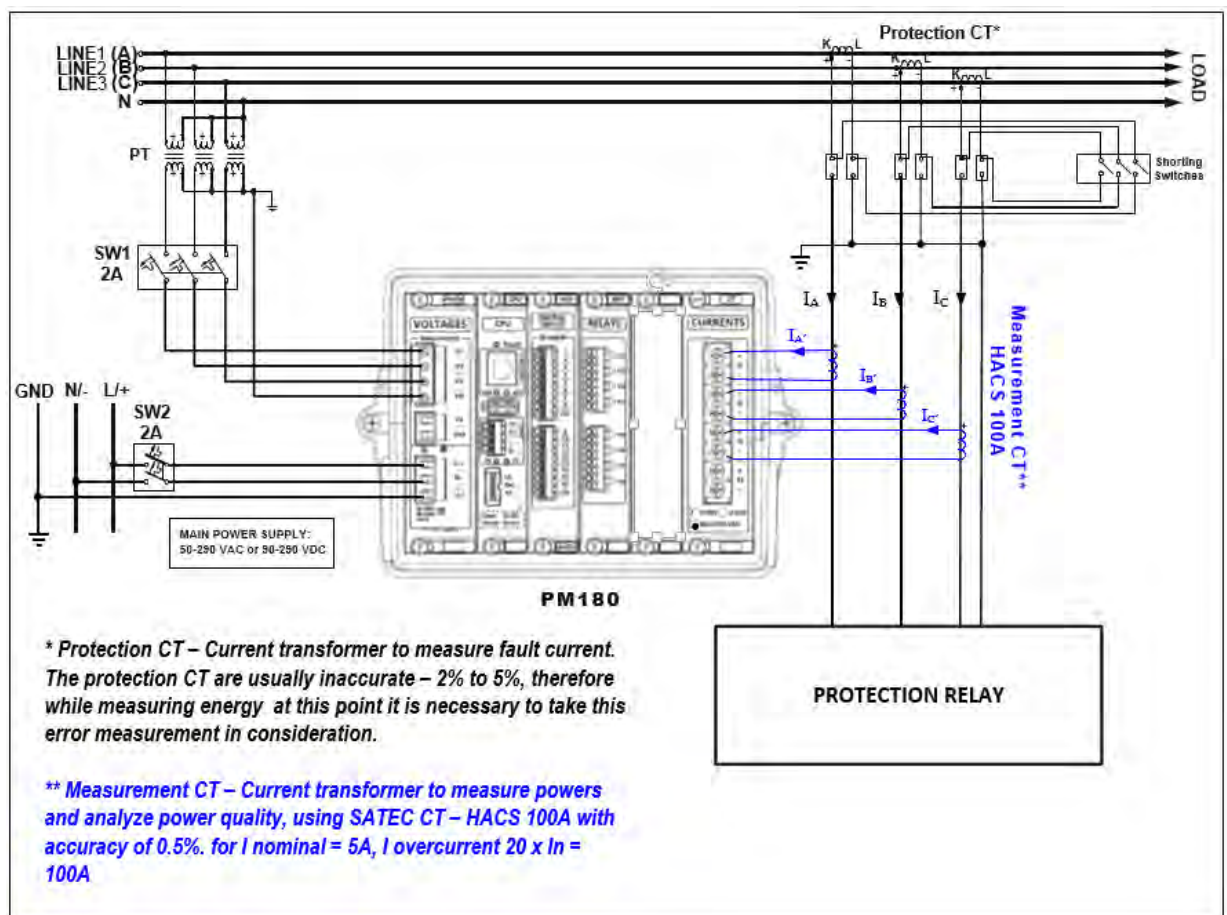
Wiring Mode = **4LL3** or **4Ln3**

Figure 2-7: Four Wire WYE Connection Using 3 PTs, 3 CTs (3-element) external CT – HACS 100A (CS1S)
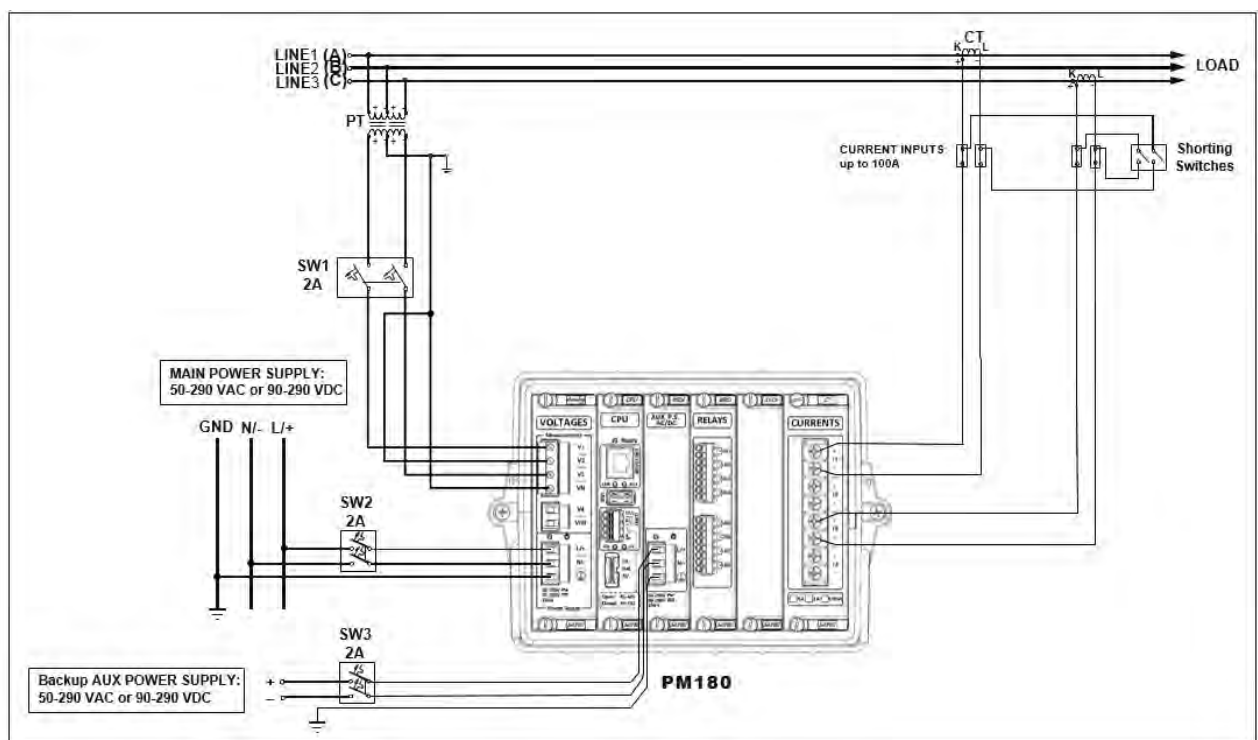
Wiring Mode = **4LL3** or **4Ln3**

Figure 2-8: Three Wire Open Delta Connection Using 2 PTs, 2 CTs (2-element)
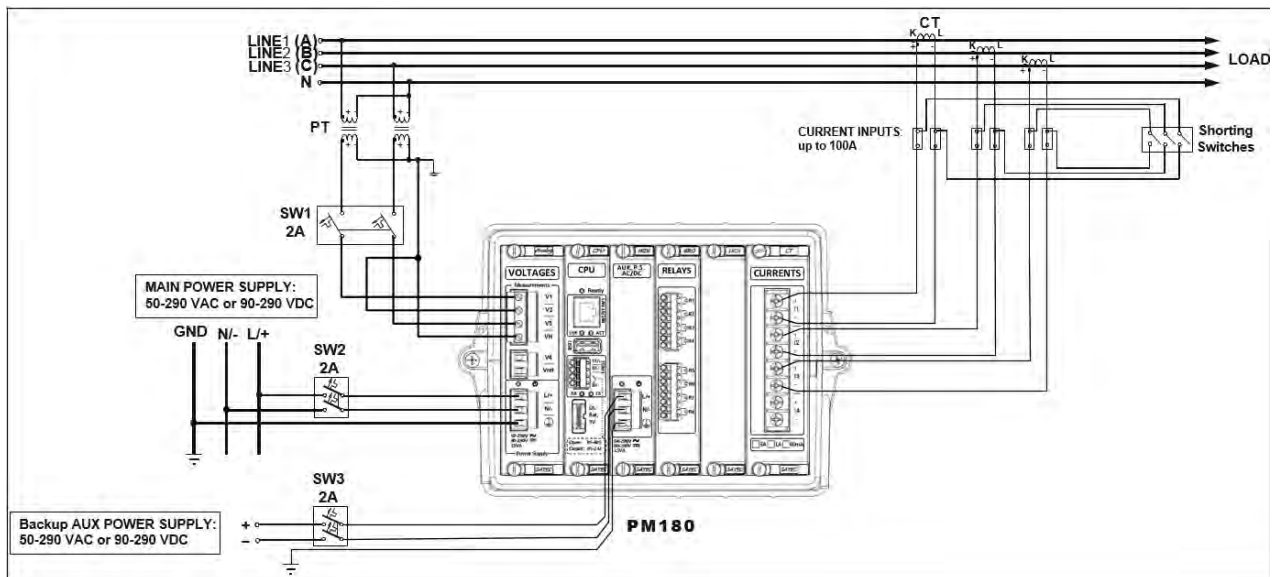
Wiring Mode = **3OP2**

Figure 2-9: Four Wire Wye Connection Using 2 PTs, 3 CTs (2½-element)
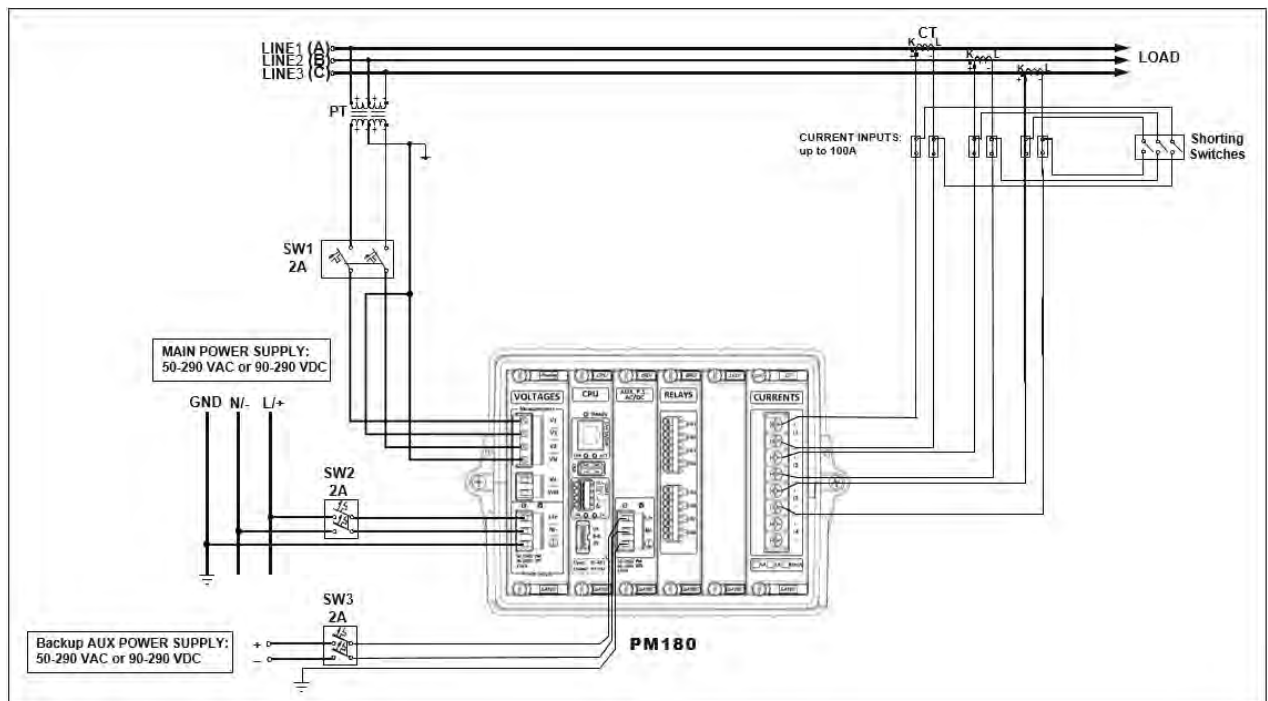
Wiring Mode = **3LL3** or **3Ln3**

Figure 2-10: Three Wire Open Delta Connection Using 2 PTs, 3 CTs (2½-element)

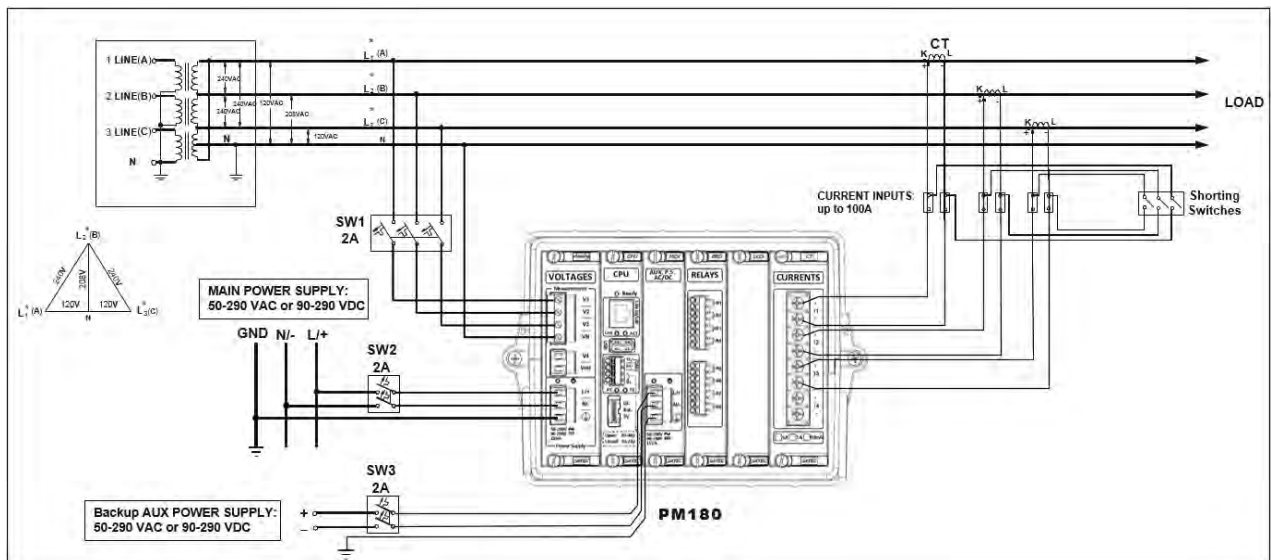Wiring Mode = **3OP3**

Figure 2-11: Four Wire Delta Direct Connection Using 3 CTs (3 element)

Wiring Mode = 4LL3 or 4Ln3

2.2.5.2 Line Monitor wiring

The PM180 can be equipped with a special Current Input board to accommodate direct connection to Medium Voltage lines using MV Pole Top Voltage/Current sensors. The figure below shows typical direct Line Monitor (MV) application using PM180.
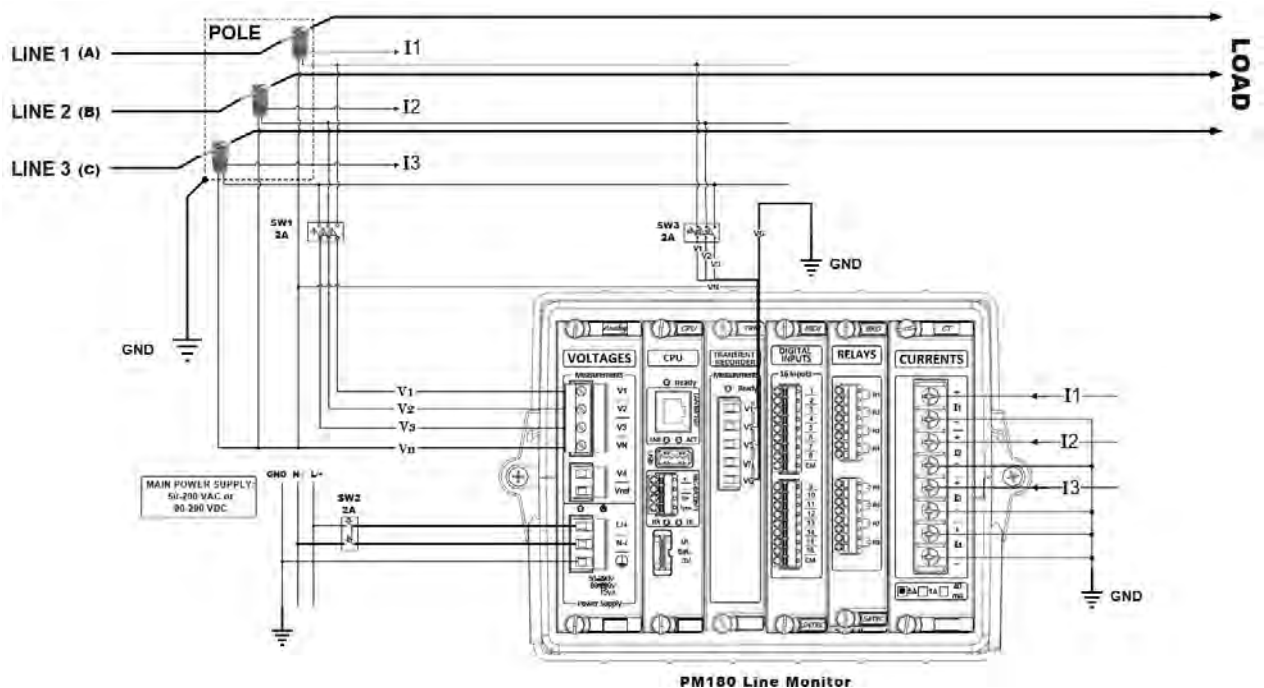
2.2.6 Digital Inputs

16 optically isolated digital inputs in one digital input module (16DI) are provided for status monitoring and external synchronization of power demand period and time. Dry or wet contacts may be connected to these inputs, as shown in *Figures 2-12* and *2-13*. All common terminals are internally connected together.

Up to three 16DI modules can be installed in the PM180.
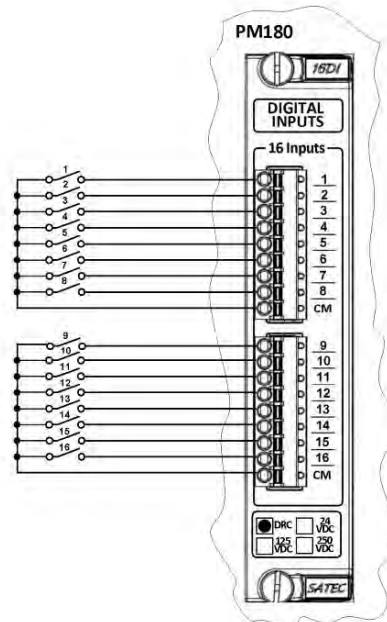
Dry Contacts

Figure 2-12: Digital Input Connection for Dry Contacts

Wet Contacts

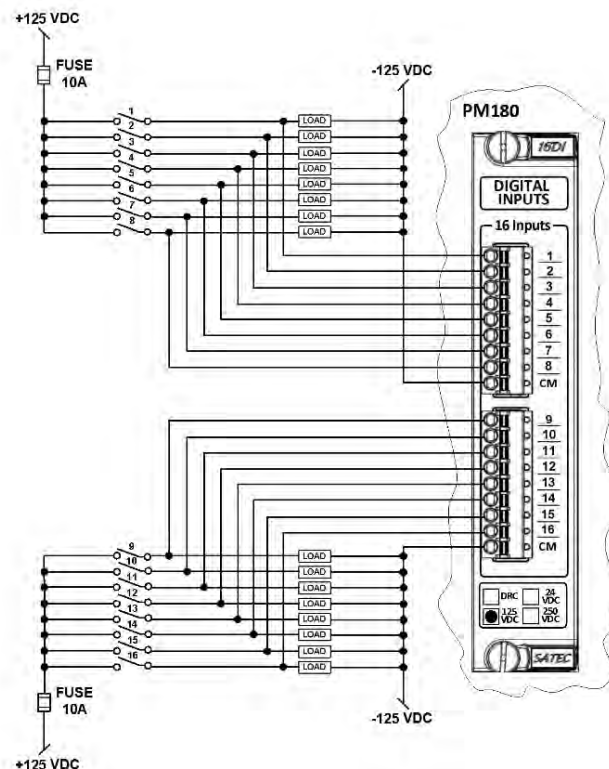Wet contact options are: 24V, 125V or 250V DC (voltage varies according to wet contact option).

Figure 2-13: Digital Input Connection for Wet Contacts

2.2.7 Relays

8 relays in one Relay Output Module (8RO) are provided for alarms, remote control or energy pulsing, as shown in *Figure 2-14*. For ratings, see *Appendix: Technical Specifications*.

Up to three 8RO modules can be installed in the PM180.
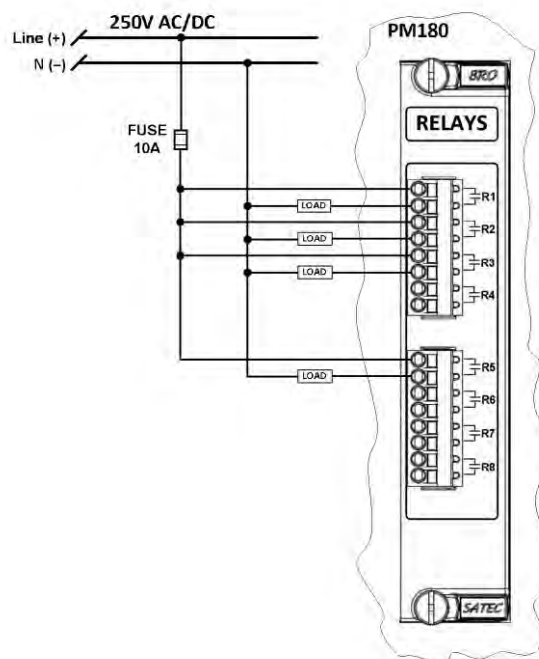
Figure 2-14: Relays Connection

2.2.8 Digital Input/Output

8 optically isolated digital inputs and 4 relay outputs in module (8DI/4RO) are provided for status monitoring and external synchronization of power demand period and time, and for alarms, remote control or energy pulsing, as shown in *Figures 2-15*. All common terminals are internally connected together.

Up to three 8DI/4DO modules can be installed in the PM180 (From Firmware version V31.XX.28).

<u>IMPORTANT</u>: Whenever 16DI and 8DI/4RO modules are used in same installation, the 16DI modules should be placed into lower slots before any 8DI/4RO module
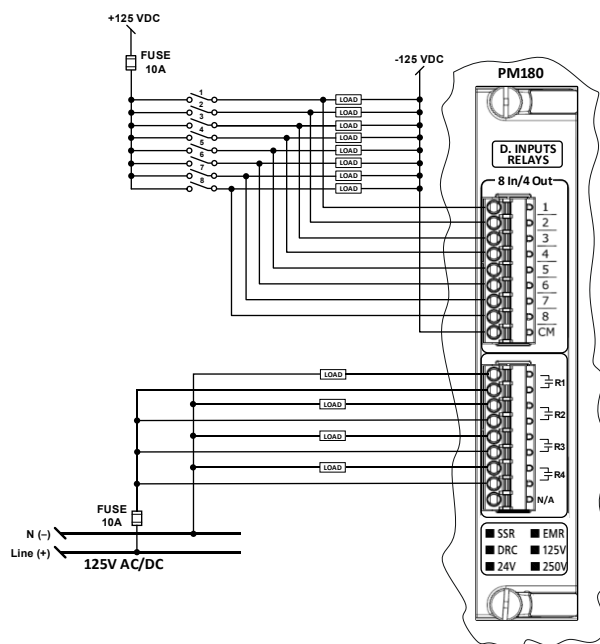
Figure 2-15: Digital Inputs and Relays Connection

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2.2.9   Analog Input/Output

The *PM180* provides 4 optically isolated analog inputs and 4 analog outputs (4AI/AO) with internal isolated power supply. Current input/output options are: 0-20 mA and 4-20 mA (current loop load of up to 500 Ohm), 0-1 mA and ±1 mA (current loop load of up to10 kOhm), for ± 10V option only 4 Analog Inputs module is available as shown in *Figure 2-16*.

Up to three 4AI/AO modules can be installed in the PM180.
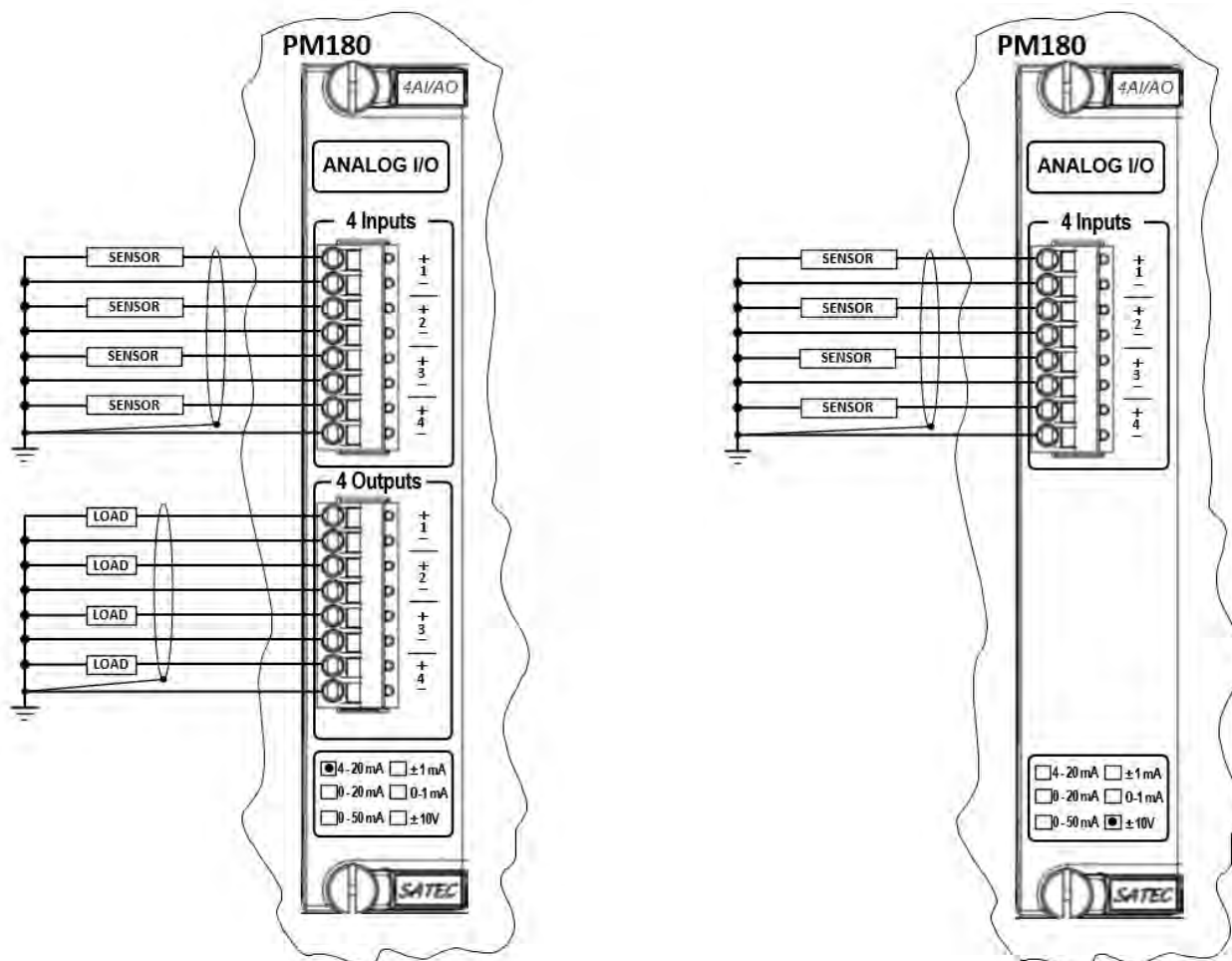
Figure 2-16: Analog Input/Output Connection

2.2.10 Transient Module – TRM

The *PM180* provides a high speed and high voltage transient detection capabilities versus ground, using the transient module TRM, by connecting V1, V2, V3 and Vn, as shown in *Figure 2-17*.

The TRM module is detected automatically by the PM180, no configuration is needed.

TRM Module restrictions:

- The TRM module is supported by the PM180 from firmware version: V31.XX.10

- Only one TRM module can be installed in the PM180. It can be plugged in any optional slot (slot 1, 2 or 3) right after the CPU module
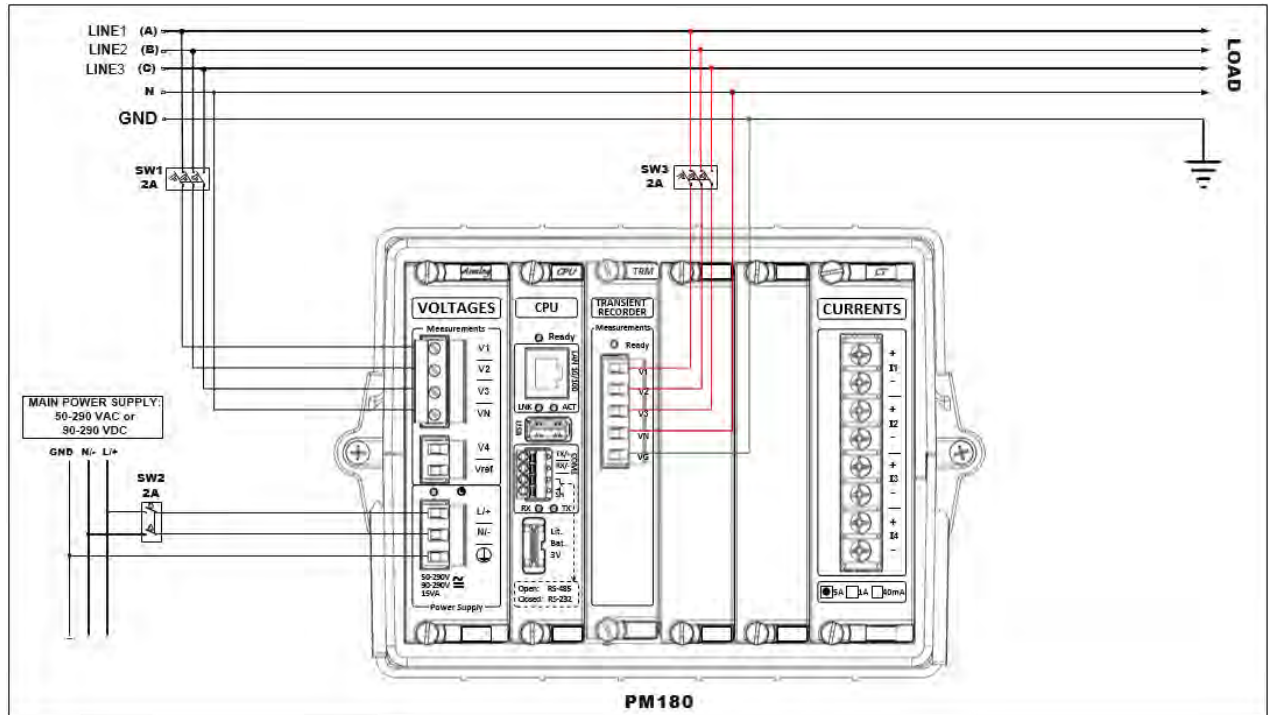
Figure 2-17: Transient Recorder typical installation

2.2.11 Phasor Measurement Unit Module – PMU

The PM180 phasor measurement unit (PMU) provides Synchrophasor and frequency measurements compliant with the IEEE C37.118.1 P performance class, and real-time cyclic exchange of synchronized phasor data with the substation phasor data concentrator (PDC) based on the IEC 61850-9-2 sampled value (SV) service.

The PMU is implemented as an add-on module integrated in one assembly with the fast transient recorder TRM module.

PMU Module restrictions:

- Only can function with PM180 N3 with new CPU board (AP1451 - with built-in IRIG-B input)

- The PMU module is supported by the PM180 from firmware version: V31.XX.29

- Only one PMU module can be installed in the PM180. It can be plugged in one of the two slots (slot 2 and 3) right before the CURRENTS module
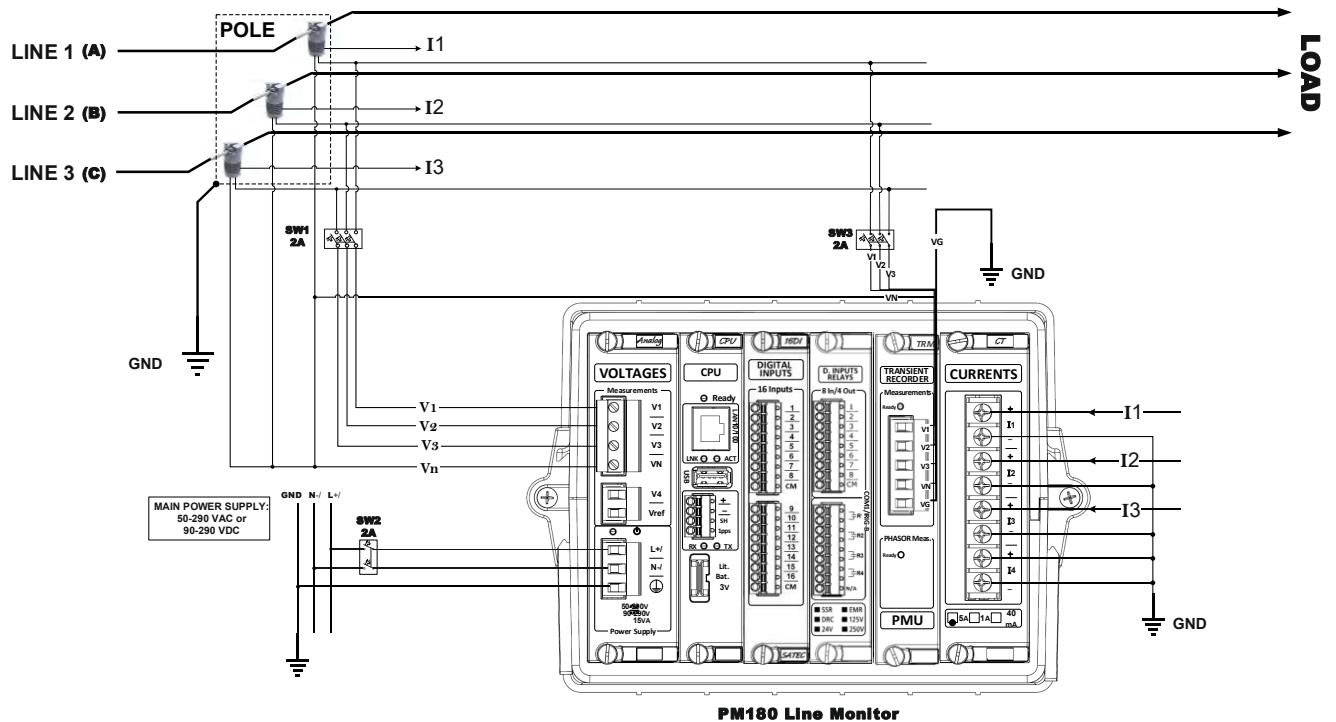
Figure 2-18: Phasor Measurement Unit typical installation – MV line monitoring

2.2.12 Digital Fault Recorder module – DFR

The *PM180* provides a high fault current recorder. The DFR measures and captures up to 40 x I_n (200A @ I_n = 5A) in 4 current channels – I_{1X}, I_{2X}, I_{3X} and I_{4X} from the Current Transformer Protection circuits as shown in *Figure 2-19*.

The DFR module is detected automatically by the PM180, no configuration is needed.

DFR Module restrictions:

- The DFR module is supported by the PM180 from firmware version: V31.XX.11

- Only one DFR module can be installed in the PM180. It can be plugged in at any optional slot (slot 1, 2 or 3) right after the CPU module
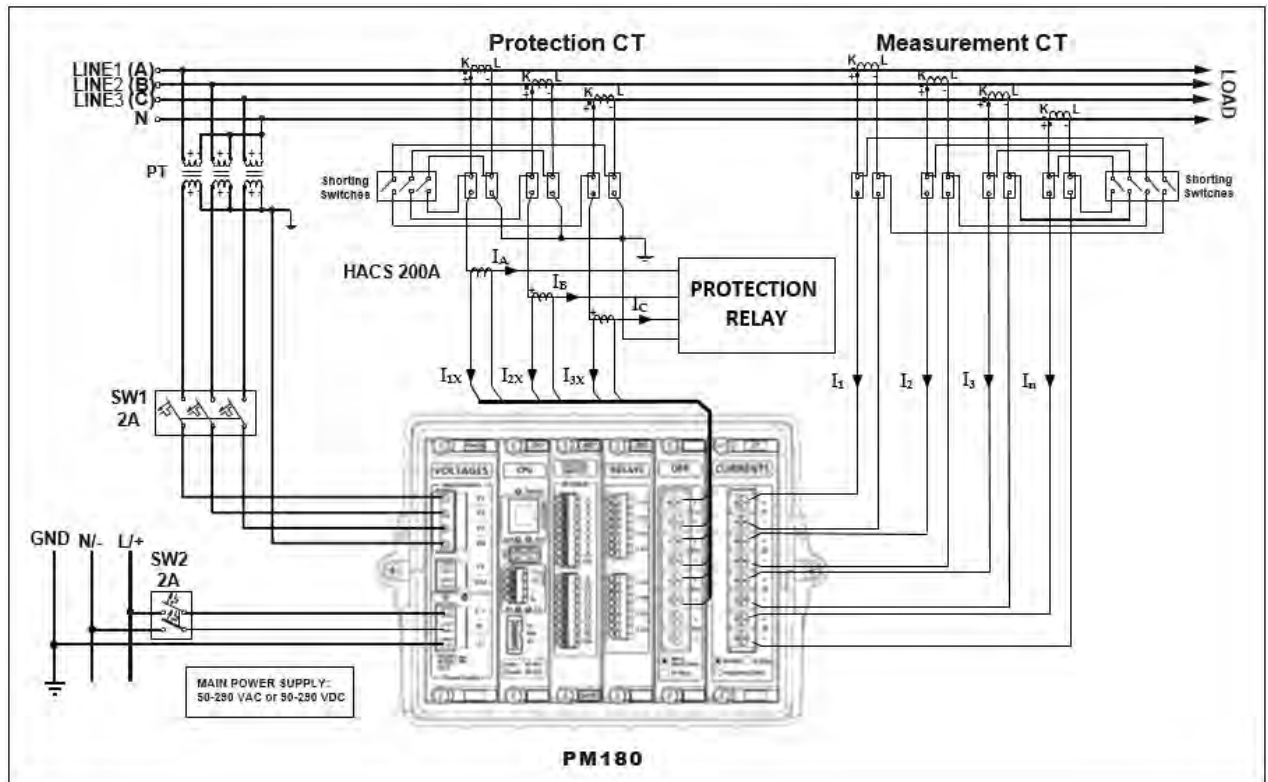

Figure 2-19:Digital Fault Recorder wiring installation

2.2.13 Serial Communication options – COM1, COM2

The *PM180* provides 2 optically isolated serial communication ports, *COM1*[1] in the CPU module and *COM2* (RS422/485) in one of the optional Communication modules (IRIG-B, 2G/3G, TXFX, WiFi[2], DUP), as shown in *Figure 2-20*.

If two or more communication modules are plugged in the PM180, **only one COM2 port will be active**.

The RGM180/RDM180 remote display can be connected to *COM1* or to *COM2* using cable AC0198.
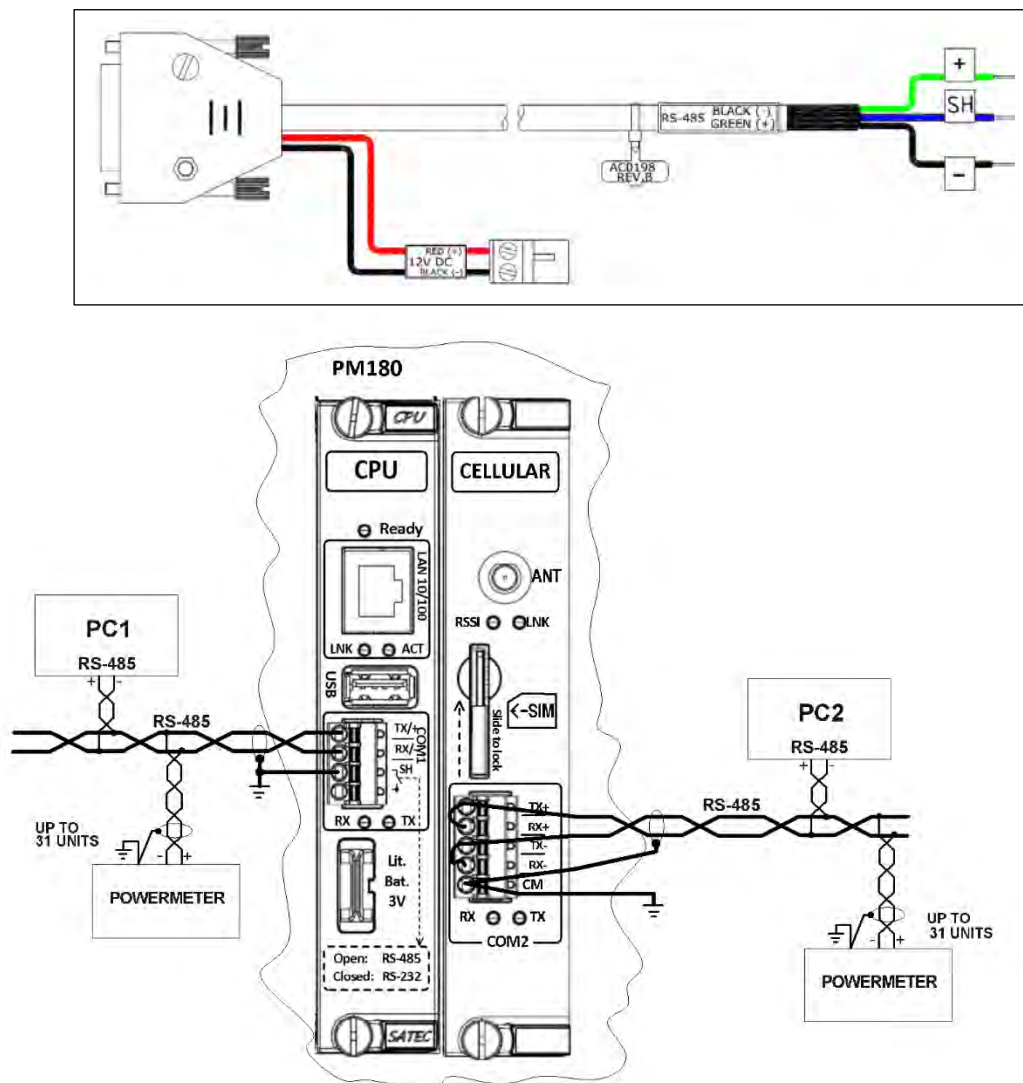
Figure 2-20: Communication Network Connection – RS-485 (Old CPU model)

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[1] COM1: RS-485 only from PM180 N3 version

[2] WiFi, MODEM and PROFIBUS communication modules are not available – future options, contact SATEC for more details.
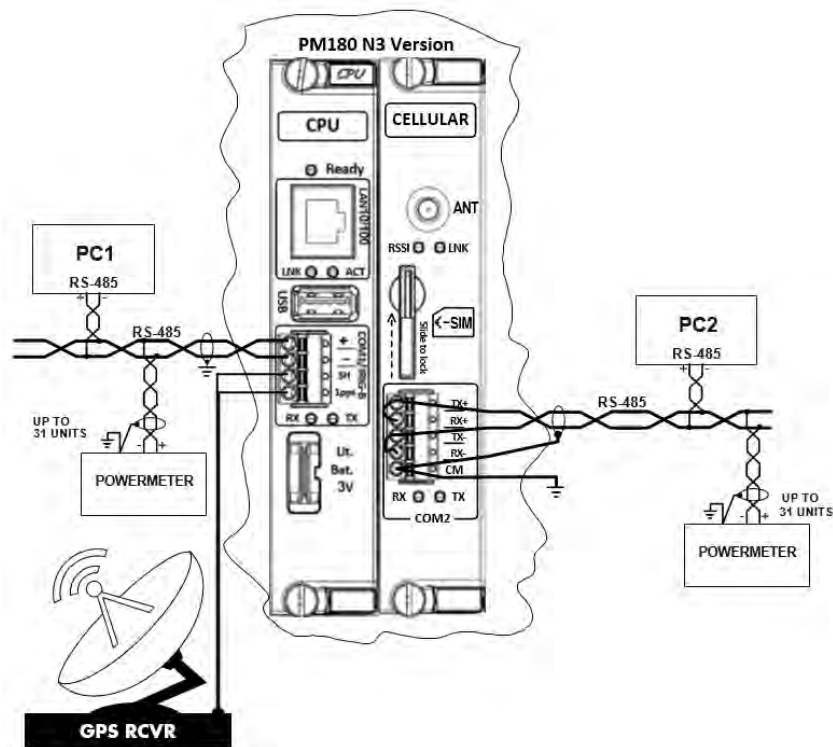
Figure 2-21: Communication Network Connection – RS-485 (PM180 N3 Version) and IRIG-B connection

2.2.14 USB communication port

The *PM180* CPU module provides one galvanic isolated USB Device communication port, to be connected to a personal computer to run PAS™ configuration tool, as shown in *Figure 2-22*.
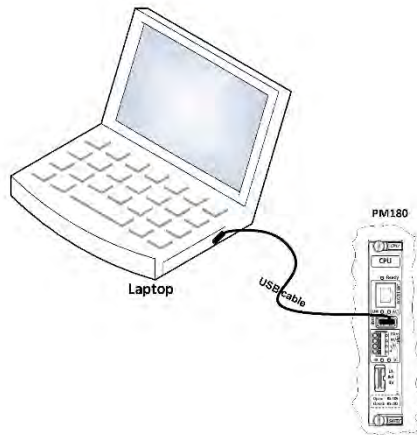
Figure 2-22: USB port Connection – USB device

2.2.15 Network Communication options

ETHERNET module - 10/100Base TX and 100FX

The *PM180* provides one 10/100TX Ethernet communication port in the CPU module and a redundant Ethernet wire line/fiber 10/100TX/100FX Ethernet communication port in the TXFX module, as shown in *Figure 2-23*.

TXFX Module restrictions:

- The TXFX module is supported by the PM180 from firmware version: V31.XX.8

- Only one TXFX module can be installed in the PM180. It must be plugged in at the first optional slot right after the CPU module.
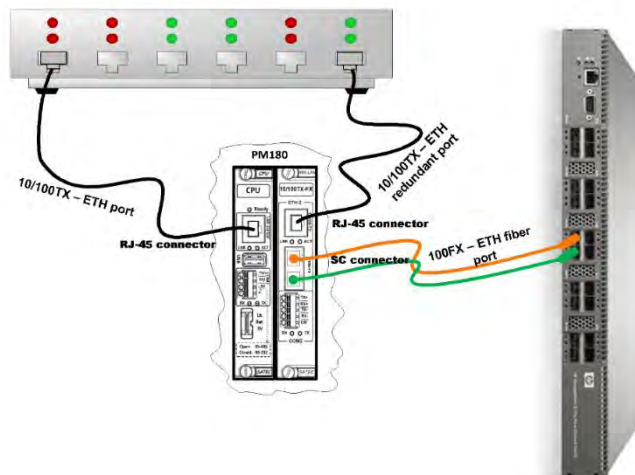
Figure 2-23: ETHERNET port Connection – RJ45 and SC

CELLULAR module - 2G/3G

The *PM180* provides one 2G/3G Cellular communication using the CELLULAR module, as shown in *Figure 2-24*.

Insert SIM card at the SIM card compartment, connect Antenna cable using SMA connector.

CELLULAR Module restrictions:

- The CELLULAR module is supported by the PM180 from firmware version: V31.XX.15
- Only one CELLULAR module can be installed in the PM180. It must be plugged in at the first optional slot right after the CPU module.

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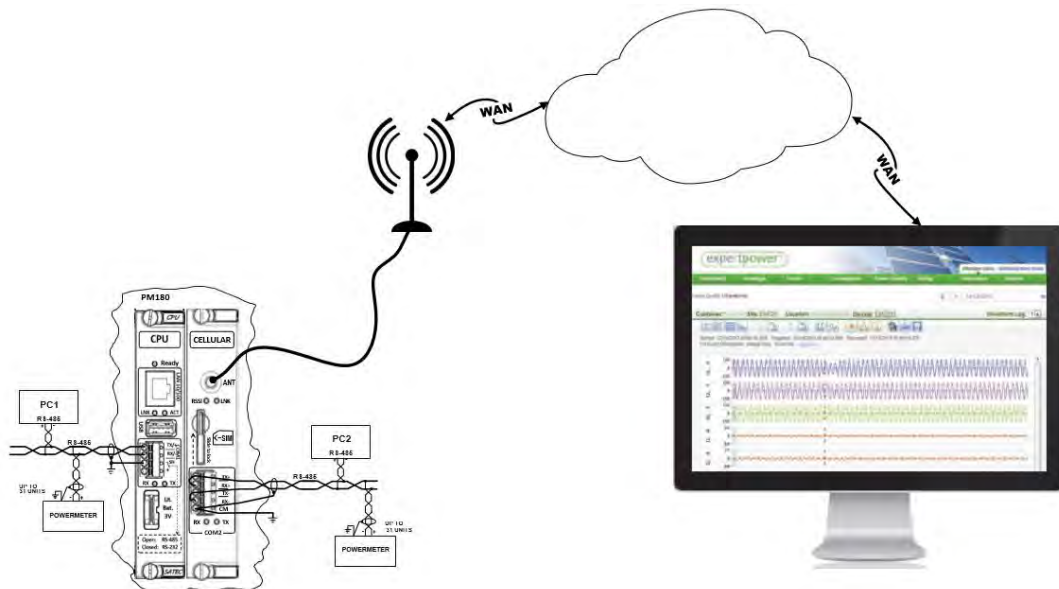
Figure 2-24: CELLULAR port Connection – SMA connector

2.3 Location of Modules

The PM180 provides a total of 6 modules slots: 3 fixed slots for COLTAGES, CPU and CURRENTS factory installed modules and 3 general purpose field installable "hot swap" modules slots (slot #1, #2 and #3) for input/output, measurement and communication optional modules. Any type of optional module can be installed in any slot
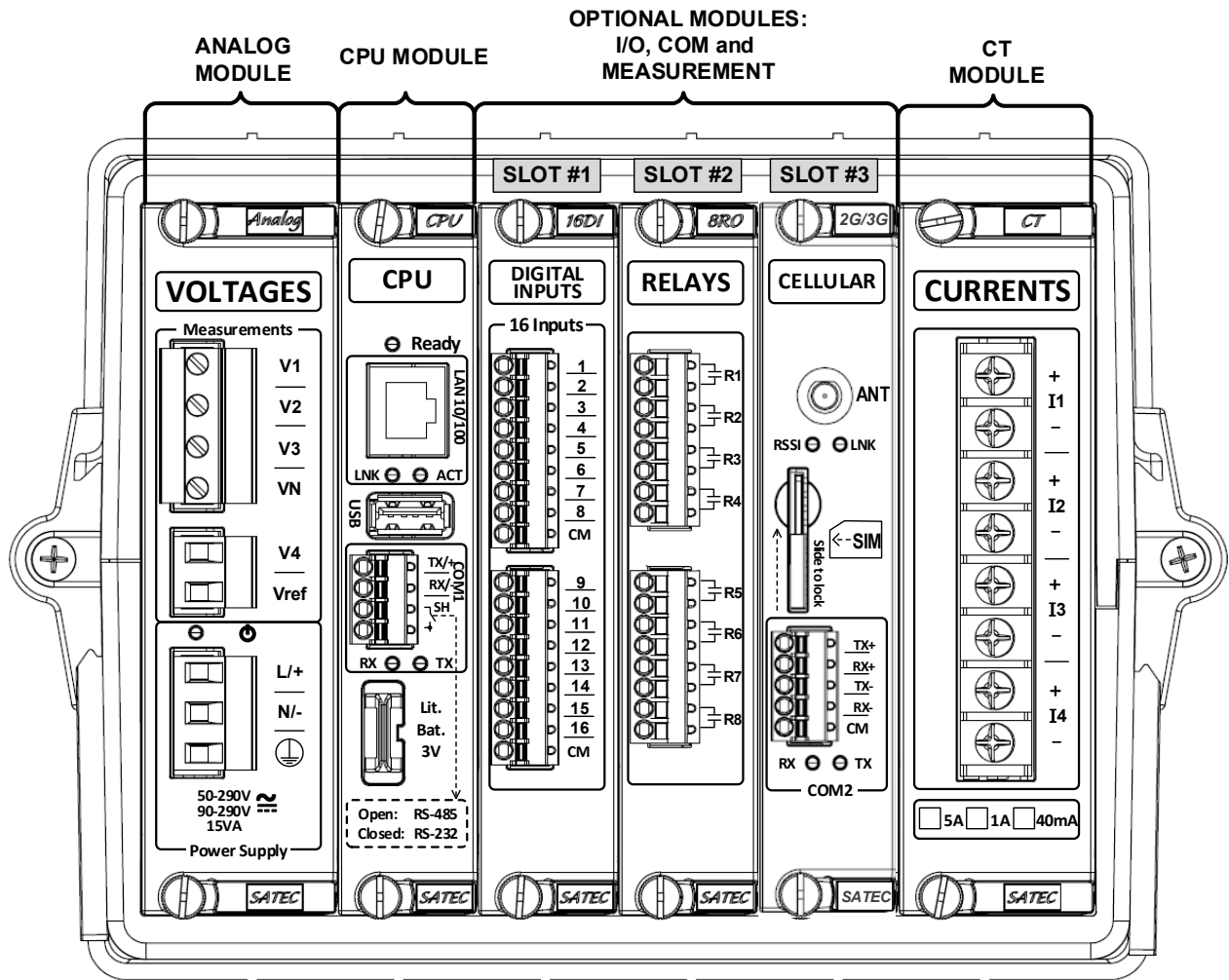
Figure 2-25: Location of Modules

Chapter 3 Serial Communications
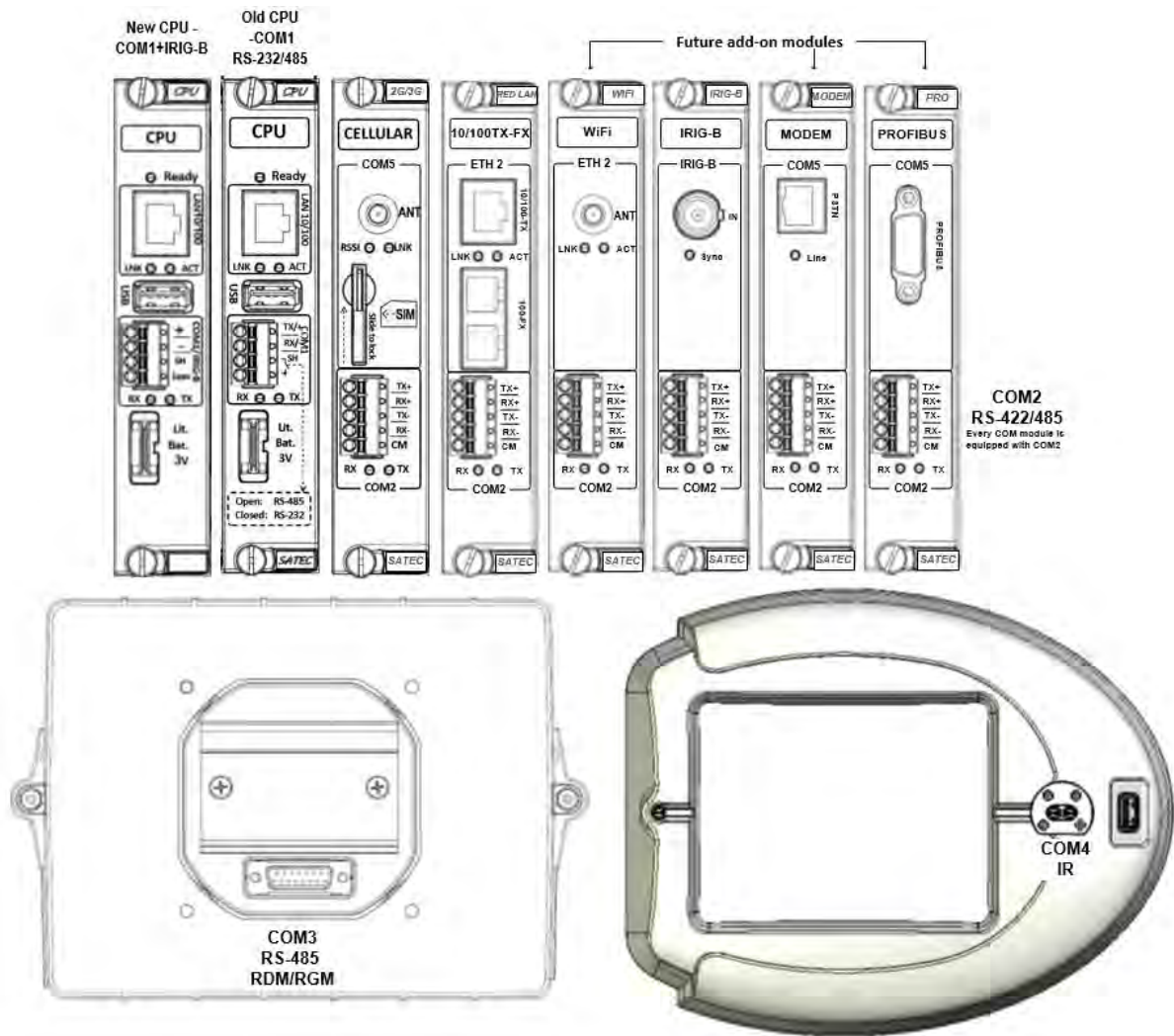
Figure 3-1

Figure 3-1: RS-232/RS-422/RS-485 ports location

COM1[1], RS-232/485 versatile port is provided CPU module.

COM2[2], RS-422/485 port is provided by a number of Communication modules: CELLULAR, TXFX, WiFi, PROFIBUS and IRIG-B.

COM3, RS-485 port communicates with any SATEC remote display: RGM180 or RDM.

COM4, IR port is provided in the RGM180 display when directly attached to the PM180.

COM5[1], RS-232 to communicate with modules to activate following modules communication ports: MODEM port, PROFIBUS port and CELLULAR port.

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[1] COM1: RS-485 only from PM180 N3 version

[2] WiFi, MODEM and PROFIBUS communication modules are not available – future options, contact SATEC for more details.

Computer Connections – RS-232 (COM1)
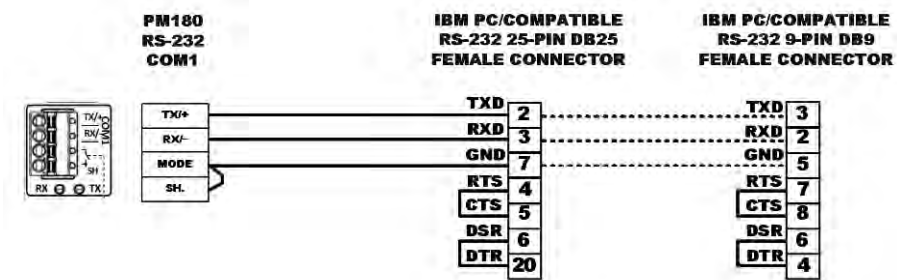
Figure 3-2: RS-232 Simple 3-wire Connection, 9-pin and 25-pin female

External Modem Connections
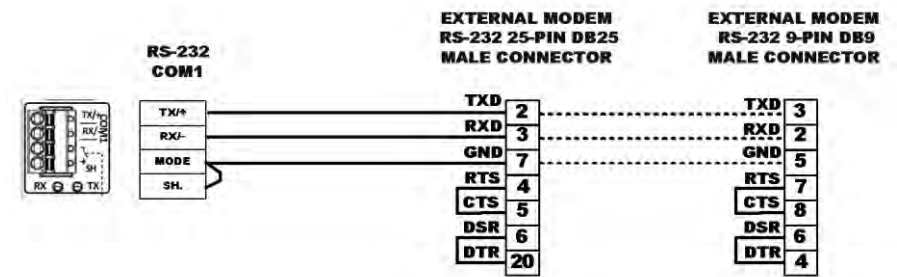
Figure 3-3: RS-232 Simple 3-wire Connection, 9-pin and 25-pin female

Initialization String: ATS0=1&D0&K0&W0

Computer Connections – RS-485 (COM1), RS-422/485 (COM2)
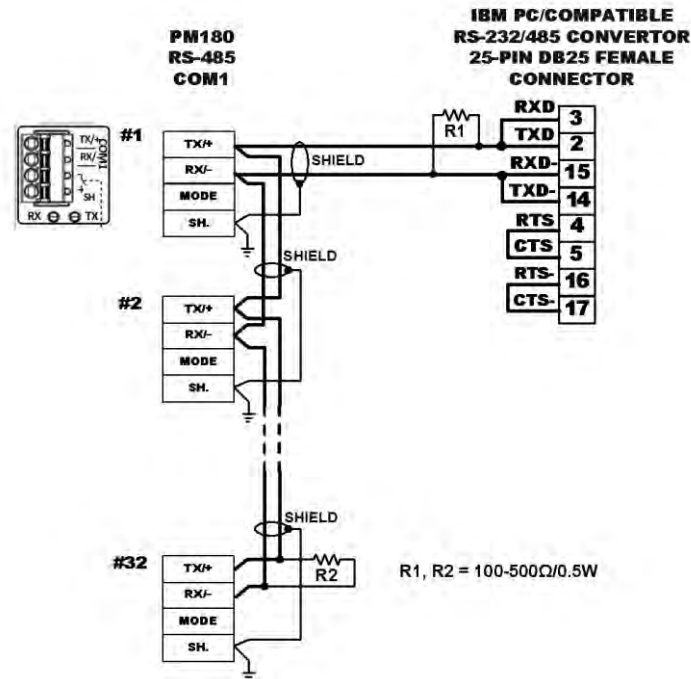
Figure 3-4: RS-485 Multidrop COM1 Connection, 25-pin PC Port
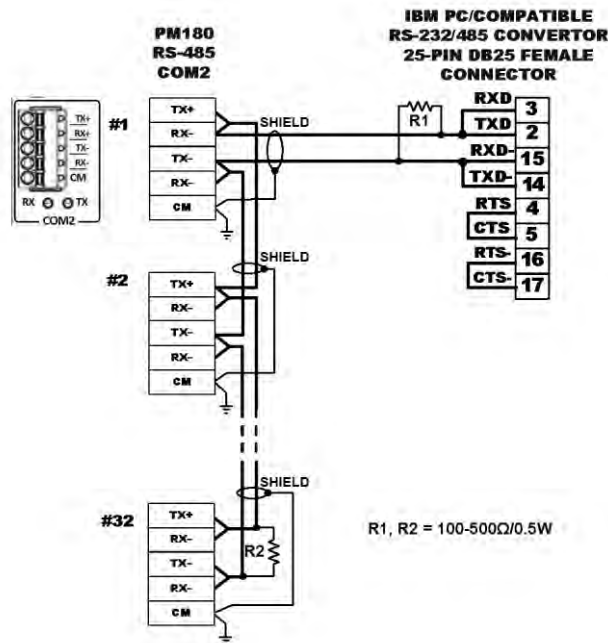
Figure 3-5: RS-485 Multidrop COM2 Connection, 25-pin PC Port
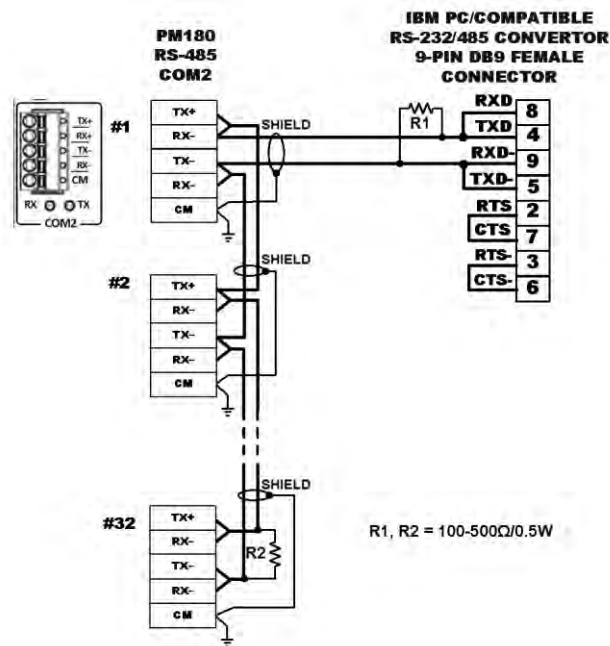
Figure 3-6: RS-485 Multidrop COM2 Connection, 9-pin PC Port
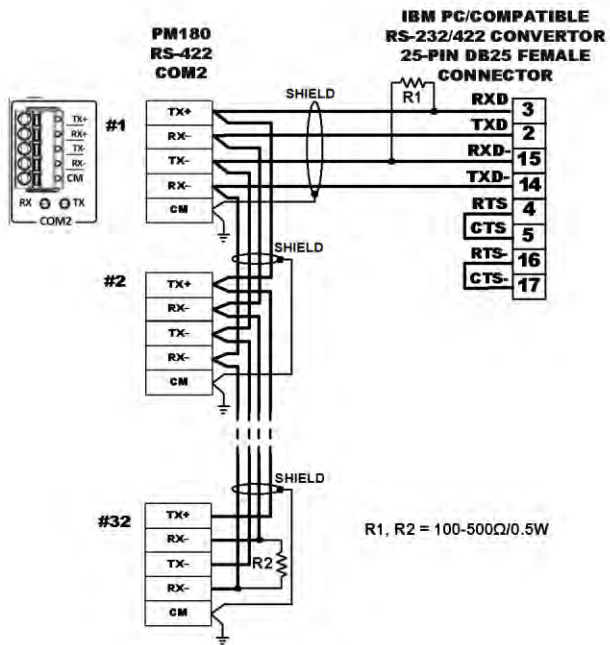
Figure 3-7: RS-422 Multidrop COM2 Connection, 25-pin PC Port
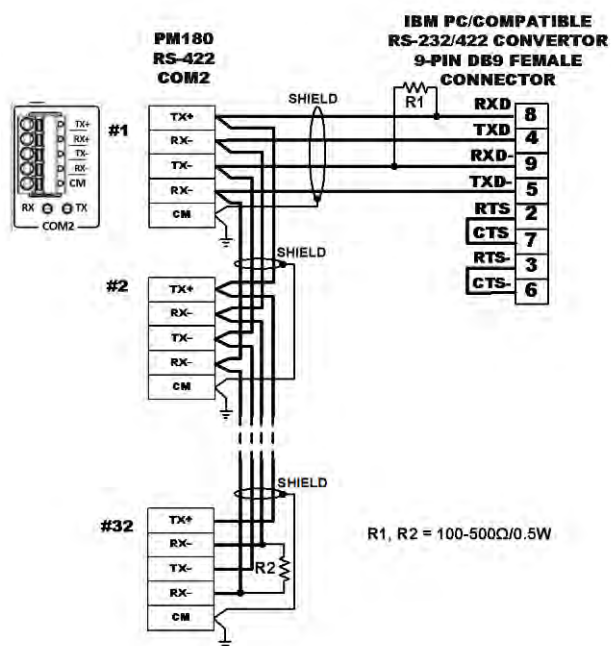
Figure 3-8: RS-422 Multidrop COM2 Connection, 9-pin PC Port

Chapter 4 Installing the Battery

☞ **The PM180 is packed <u>without</u> battery; therefore it must be installed by the installer during the PM180 installation.**

After turning "ON" the PM180 power supply for the first time following battery installation, the PM180 initialization process duration may take about <u>7 minutes</u>, while regular PM180 initialization process duration takes 40 seconds

IMPORTANT

Use CR1225 lithium 3.0 volt battery.

The battery can be replaced or installed in any powered PM180 condition while operating or not; if PM180 Power Supply is turned "OFF" the battery can be replaced/installed in the coming 30 minutes without loosing any data. The data may be uploaded and restored in a PC using PAS (see PM180 Operation Manual, Chapter 12) to avoid loosing data.

When the battery level drops below the minimum allowed threshold, the "BATTERY LOW" flag is set and an event is generated in the "Event Log" memory, indicating that the battery should be replaced. Use the following procedure:

1. Use a flat screwdriver to pull the battery holder out from the CPU Panel.

2. Pull the battery from the battery holder

3. Insert the new battery with the correct polarity

4. Insert the battery holder with the new battery in the CPU panel battery compartment

5. Push the battery holder until a click is heard

Appendix: Technical Specifications

5.1 Environmental Conditions

Operating Temperature: -30°C to 70°C (-22°F to 158°F)

Storage Temperature: -40°C to 85°C (-40°F to 185°F)

Humidity: 0 to 95% non-condensing

Altitude $\leq$ 2000m

5.2 Construction

Overall Dimensions

Width: 220.00 mm (8.66 Inches)

Height: 152 mm (5.98 Inches)

Depth: 210.00 mm (8.26 Inches)

Weight: 2.5kg (5.51 Lb)

Materials

Enclosure: Polycarbonate

Panels: Polycarbonate

PCB. : FR4 (UL94-V0)

Terminals: PBT (UL94-V0)

Connectors-Plug-in type: Polyamide PA6.6 (UL94-V0)

Packaging Case: Carton and Stratocell (Polyethylene Foam) Brackets

Labels: Polyester film (UL94-V0)

5.3 Power Supply

Main Power Supply

Withstanding Insulation: 4kV AC @ 1mn

AD/DC Power Supply (standard): L/+, N/- and GND

Rated input: 50-290VAC 50/60 Hz, 90-290VDC, Maximum Power 10W

Wire Size: up to 10 AWG (up to 6 mm^2)

Terminals Pitch 7.5 mm, three pins

Auxiliary Power Supply (module)

Withstanding Insulation: 4kV AC @ 1mn

AC/DC Power Supply: L/+, N/- and GND

Rated input: 50-290VAC 50/60 Hz, 40-290VDC, Maximum Power 20W

Low DC/DC Power Supply (module option): (+), (-) and GND

12/24 VDC Option: Rated input 9.6-35 VDC, Maximum Power 20W

Wire Size: up to 10 AWG (up to 6 mm^2)

Terminals Pitch 7.5 mm, three pins

5.4 Input Ratings

AC Voltage Inputs: V1, V2, V3, VN

PM180-N1 model

Measuring range: 57/100 – 400/690 VAC PM180-N1 to N3 model only

Direct input and input via PT (up to 576VAC line-to-line, up to 335VAC line-to-neutral)

Input Impedance: > 1 MΩ

Burden for 400V: < 0.2 VA

Burden for 277V: < 0.1 VA

Burden for 120V: < 0.02 VA

PM180 model

Measuring range: 57/100 – 277/480 VAC

Direct input and input via PT (up to 576VAC line-to-line, up to 335VAC line-to-neutral)

Burden for 277V: < 0.76 VA

Burden for 120V: < 0.144 VA

Overvoltage Withstand: 1000VAC continuous, 2500VAC for 1 second

Galvanic Isolation, withstanding insulation: 4kV AC @ 1mn

Wire Size: up to 10 AWG (up to 6 mm^2)

Terminals Pitch 7.5 mm

AC/DC Voltage Input: V4, Vref

Operating Range: 400VAC

Direct input and input via PT (up to 480VAC) or Battery input

Input Impedance: > 10 MΩ

Burden for 400V: << 0.01 VA

Burden for 120V: << 0.01 VA

Overvoltage Withstand: 1000VAC continuous, 2500VAC for 1 second

Resistive Isolation, withstanding Insulation: 4kV AC @ 1mn

Wire Size: 10 AWG (up to 6 mm^2)

Terminals Pitch: 7.5 mm

AC Transient Voltage Inputs: V1, V2, V3, VN, VG (TRANSIENT RECORDER module)

Measuring range: up to 2kV AC

High impedance input: 10 MΩ, withstanding insulation: 4kV AC @ 1mn

Wire Size: up to 10 AWG (up to 6 mm^2)

Terminals Pitch 7.5 mm

AC Current Inputs:

Standard: I1, I2, I3, I4

Input via Internal CT with 5A secondary

Operating range: maximum continuous 10A/20A RMS (ANSI C12.20 and IEC 62053-22)

Nominal measured Current: I_n = 5A RMS

Fault measured Currents: up to 50A RMS (10 x I_n) – without DFR module

Burden: < 0.15 VA

Overload Withstand: 50A RMS continuous, 250A for 1 second

Wire Size: 10 AWG (2.5 to 6 mm^2)

Terminals Pitch: 9.5 mm

Input via Internal CT with 1A secondary

Operating Range: continuous 4A RMS (ANSI C12.20) or 2A RMS (IEC 62053-22)

Nominal measured Current: I_n = 1A RMS

Fault measured Currents: up to 10A RMS

Burden: < 0.02 VA

Overload Withstand: 10A RMS continuous, 50A for 1 second

Wire Size: 10 AWG (2.5 to 6 mm^2)

Terminals Pitch: 9.5 mm

Input via SATEC HACS 100A with 40mA secondary

Operating range: maximum continuous 10A/20A RMS (ANSI C12.20 and IEC 62053-22)

Nominal measured Current: 5A RMS

Fault measured Currents: up to 100A RMS (20 x I_n)

Burden: < 0.15 VA

Overload Withstand: 100A RMS continuous, 250A for 1 second

Wire Size: 10 AWG (2.5 to 6 mm^2)

Terminals Pitch: 9.5 mm

Fault Current Inputs:

Optional DFR Module: I1x, I2x, I3x, I4x – 40 x I_n maximum measured fault current

Input via SATEC HACS 200A with 40mA secondary

Fault measured Currents: up to 200A RMS @ I_n = 5A (40 x I_n)

Burden: < 0.15 VA

Overload Withstand: 200A RMS continuous, 1000A for 1 second

Wire Size: 10 AWG (2.5 to 6 mm^2)

Terminals Pitch: 9.5 mm

5.5 Plug-In I/O Ratings

Digital Inputs – 16 Inputs (up to 3 Modules)

Scan time: 1 ms @ 60Hz, 1.25 ms @ 50Hz.

16 optically isolated, dry contact sensing (voltage-free):

Internal power supply 24 VDC

Sensitivity: open @ input resistance >16kOhm, closed @ input resistance <10kOhm

Wire Size: 12 AWG (up to 2.5 mm^2)

Terminals Pitch: 3.81 mm

16 optically isolated, wet contact sensing:

External Power Supply: 24 VDC

Sensitivity: open @ input resistance >16kOhm, closed @ input resistance <10kOhm

Wire Size: 12 AWG (up to 2.5 mm^2)

Terminals Pitch: 3.81 mm

16 optically isolated, wet contact sensing:

External Power Supply: 48 VDC

Wire Size: 12 AWG (up to 2.5 mm^2)

Terminals Pitch: 3.81 mm

16 optically isolated, wet contact sensing:

External Power Supply: 125 VDC

Wire Size: 12 AWG (up to 2.5 mm^2)

Terminals Pitch: 3.81 mm

16 optically isolated, wet contact sensing:

External Power Supply: 250 VDC

Wire Size: 12 AWG (up to 2.5 mm^2)

Terminals Pitch: 3.81 mm

Relays - 8 Outputs (up to 3 Modules)

8 relays - SPST Form A

Contact rating:

      8A @ 250V AC, 5A @ 30V DC

      0.25A @ 250V DC (sw. Volt.)

      5A 24V DC (sw. Cur.)

Wire Size: 12 AWG (up to 2.5 mm^2)

Terminals Pitch: 3.81 mm

Update time: 1/2 cycle

Analog I/O – 4 Inputs, 4 Outputs (up to 3 Modules)

4 Analog Inputs:

Ranges (upon order):

      $\pm$1 mA (100% overload)

      0-20 mA

      4-20 mA

      0-1 mA (100% overload)

Accuracy: 0.5% FS

Scan time: 2 cycles

Wire Size: 12 AWG (up to 2.5 mm^2)

Terminals Pitch: 5 mm

4 Analog Outputs:

Ranges (upon order):

      $\pm$1 mA, maximum load 10 kΩ (100% overload)

      0-20 mA, maximum load 510 Ω

      4-20 mA, maximum load 510 Ω

      0-1 mA, maximum load 10 k Ω (100% overload)

Accuracy: 0.5% FS

Update time: 2 cycles

Wire Size: 12 AWG (up to 2.5 mm^2)

Terminals Pitch: 5 mm

5.6 Communication Ports

COM1 (CPU)

Serial EIA RS-232/485 optically isolated port

Withstanding Insulation: 4kV AC @ 1 mn

Connector Type: removable, captured-wire, 4 terminals.

Wire Size: up to 12 AWG (up to 2.5 mm^2).

Baud Rate: up to 115,200 bps.

Supported Protocols: MODBUS RTU/ASCII, DNP 3.0

COM2 (Communication Module)

Serial EIA RS-422/RS-485 optically isolated port

Withstanding Insulation: 4kV AC @ 1 mn

Connector type: removable, captured-wire, 5 terminals.

Wire Size: up to 12 AWG (up to 2.5 mm^2).

Baud Rate: up to 115,200 bps.

Supported Protocols: MODBUS RTU/ASCII, DNP 3.0

COM3 (Display Communication port)

Serial EIA RS-485 optically isolated port for the RDM.

Withstanding Insulation: 2.5kV AC @ 1 mn

Connector Type: DB15.

Baud Rate: up to 115,200 bps.

Supported Protocols: MODBUS RTU/ASCII, DNP 3.0

USB Port (CPU)

Isolated USB 1.1 port.

Withstanding Insulation: 4kV AC @ 1 mn

Connector Type A male, standard USB cable, max. Length 2 meters

Supported protocols: MODBUS RTU

Ethernet Port (CPU)

Transformer-isolated 10/100Base-T port

Withstanding Insulation: 4kV AC @ 1 mn

Connector Type: RJ45 modular.

Supported Protocols: MODBUS TCP (Port 502), DNP 3.0/TCP (Port 20000), IEC 61850

Number of simultaneous connections (sockets): 5.

ETH2 - 10/100 TX- 100 FX (Communication Module)

Transformer-isolated 10/100Base-T port

Connector Type TX port: RJ45 modular

Optical-isolated 100Base FX

Connector Type FX port: SC

Supported Protocols: MODBUS TCP (Port 502), DNP 3.0/TCP (Port 20000), IEC 61850

Number of simultaneous connections (sockets): 5.

COM5 - CELLULAR (Communication Module)

2G/3G CELLULAR MODEM

Withstanding Insulation: 2.5kV AC @ 1 mn

Connector type: SMA

Supported Protocols: MODBUS TCP (Port 502), DNP 3.0/TCP (Port 20000)

Infrared (RGM180)

Optional optical IEC/ANSI head

Baud Rate: up to 115,200 bps.

Supported Protocols: MODBUS RTU/ASCII, DNP 3.0

Real-time Clock

Accuracy: maximum error 5 seconds per month @ 25°C

5.7 IRIG-B

Recommended cable: 51Ohm low loss - RG58A/U (Belden 8219 or equivalent), TNC connector

Recommended GPS time code generator: Masterclock GPS-200A

CPU Board (PM180 – N3 version)

Optically isolated IRIG-B port

Withstanding Insulation: 4kV AC @ 1 mn

Time code signal: non-modulated (pulse-width coded).

Level: unbalanced 5V.

Connector type: removable, captured-wire, 4 terminals

Communication Module

Optically isolated IRIG-B port

Withstanding Insulation: 4kV AC @ 1 mn

Time code signal: non-modulated (pulse-width coded).

Level: unbalanced 5V.

Connector Type: BNC.

5.8 Log Memory

Standard onboard memory: 250 Mbytes.

5.9 Remote Display Module

RDM180 (PM180-D model)

Display: high-brightness seven-segment digital LEDs, two 4-digit windows and one 6-digit windows

Keypad: 6 push buttons

Communication: EIA RS-485 port with 12V supply voltage

Connector Type: DB15

Wires Size: up to 12 AWG (up to 2.5 mm^2)

Distance:

      3m cable (10 feet)

      up to 500m (2000 feet) with external 12VDC power supply

RDM312 (PM180-M model)

Display: high-brightness seven-segment digital LEDs, nine 4-digit windows and three 6-digit windows

Keypad: 7 push buttons

Communication: EIA RS-485 port with 12V supply voltage

Connector Type: DB15

Wires Size: up to 12 AWG (up to 2.5 mm^2)

Distance: up to 500m (2000 feet) with external 12VDC power supply

RGM180 (PM180-G)

5.7 Inch Touch-Panel LCD graphic TFT display

Resolution: 320 x 240

Operating temperature: -20°C - +70 °C

Communication:

EIA RS-485 port with 12V supply voltage

Connector Type: DB15

Wires Size: up to 12 AWG (up to 2.5 mm^2)

Distance: up to 500m (2000 feet)

10/100Base T ETHERNET port with 12 V supply voltage and PoE (Power over ETHERNET)

Connector Type: RJ-45 and DB15 (for 12VDC external Power Supply connection)

5.10 Standards Compliance

Directive complied with: EMC: 89/336/EEC as amended by 92/31/EEC and 93/68/EEC

LVD: 72/23/EEC as amended by 93/68/EEC and 93/465/EEC

Harmonized standards to which conformity is declared: EN55011:1991; EN50082-1:1992; EN61010-1:1993; A2/1995

ANSI C37.90.1 Surge Withstand Capability (SWC)

EN50081-2 Generic Emission Standard - Industrial Environment

EN50082-2 Generic Immunity Standard - Industrial Environment

EN55022: Class A

IEC61000-6-2

IEC61000-6-4

IEC60255-5

IEC60255-22

Accuracy

Active Energy, IEC/AS 62053-22, class 0.2S[1]

Reactive Energy, class 0.5S (under conditions as per IEC 62053-22:2003 @ $0 \leq |PF| \leq 0.9$)

Power Quality

EN50160: 2007 & 2010 Power Quality in European Electricity Supply Networks

IEEE 1159: Power Quality Recorder in US

GOST 32144/145-2013: Electric energy, Electromagnetic compatibility of technical equipment, Power quality limits in public electrical systems

GOST 54149: 2010: Electric energy, Electromagnetic compatibility of technical equipment, Power quality limits in public electrical systems

IEC61000-4-7, Harmonics and inter-harmonics measurement

IEC61000-4-15, Flicker measurement

IEC61000-4-30:2015 3rd ed. class A, Power quality measurement methods

IEC62586-1/2:2017 2nd ed. Power quality measurement for power supply systems

IEC 62054-21: Real time clock backup, RTC accuracy $\pm$ 2ppm @ 23°C

EMC Immunity:

IEC61000-4-2, IEC60255-22-2: Electrostatic discharge, 15kV/8kV – air/contact

IEC61000-4-3, IEC60255-22-3: Radiated Immunity, 10V/m and 30V/m @ 80 MHz – 1000 MHz

IEC61000-4-4, IEC60255-22-4: Fast Transients burst, 4KV on current and voltage circuits and 2 KV for auxiliary circuits

IEC61000-4-5, IEC60255-22-5: Surge 6KV on current, voltage circuits and power supply

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[1] Only for PM180-5A and PM180-1A models (internal CT), PM180-CS1S model accuracy meets class 1

IEEE C62.41.2-2002: high voltage line surges,

- 100 kHz ring wave – 6kV @ 0.5kA
- 1.2/50 microsecond – 8/20 microsecond Combination Wave – 6kV @ 3kA

IEC61000-4-6, IEC62052-11: Conducted Radio-frequency, 10V @ 0.15 MHz – 80MHz

IEC61000-4-8: Magnetic Field

IEC61000-4-12, IEC62052-11, IEEE C37.90.1: 2002: Oscillatory waves, CMM 2.5KV and DFM 1KV @ 100KHz and 1MHz

Emission (radiated/conducted)

EN55022, IEC60255-22: Class A

Construction

Safety

Meets IEC/UL 61010-1

Insulation

Meets IEC62052-11: Insulation impulse 6KV/500Ω @ 1.2/50 µs

Meets IEC62052-11, IEC61010-1: AC voltage tests related to ground, 4 KV AC @ 1mn

Atmospheric Environment

Operational ambient temperature range: –30°C to +70 °C

Long-term damp heat withstand according to IEC 68-2-3 <95%, +40 °C

Transport and storage temperature range: –40°C to +85 °C

Vibration

IEC 60255-21-1: Vibration Response, Table I, Class-2

IEC 60255-21-1: Vibration Endurance, Table II, Class-1

Mechanical Shock

IEC 60255-21-2: Shock, Table II, Class-1

IEC 60255-21-2: Bump, Table III, Class-1

Seismic Vibration

IEC 60255-21-3: Bump, Table III, Class-1

Panel Display protection

IEC 60529: IP54 (NEMA type 13)

Instrument protection

IEC 60529: IP30 (NEMA type 13)

5.11 Measurement Specifications

Parameter	Full Scale @ Input Range	Accuracy			Range
		% Reading	% FS	Conditions	
Voltage V1-V3,Vn	120VxPT @ 120V 277VxPT @ 480V	0.05	0.01	10% to 120% FS	0 to 99,999,999 V
Line current I1- I4	CT	0.05 0.05 0.2	0.01 0.01	For ANSI C12.20: 1% - 120% FS 120% - 400% FS For IEC 62053-22: 1% - 200% FS	0 to 29,999 A
Fault current I1- I4 (standard without DFR module)	CT	2.0		400% - 1000% FS	0 to 29,999 A
Fault current I1- I4 (PM180-CS1S)	HACS 100	2.0		400% - 2000% FS	0 to 29,999 A
Fault current I1x - I4x (with DFR module)	HACS 200	2.0		400% - 4000% FS	0 to 29,999 A
DC Voltage	125V/220V		0.3	10% - 120% FS	0 to 290VDC
Active power	0.36×PT×CT @ 120V 1.2×PT×CT @ 480V	0.2	0.002 0.002	$\vert PF\vert \geq 0.5$ and ①	-2,000,000 to +2,000,000 kW
Reactive power	0.36×PT×CT @ 120V 1.2×PT×CT @ 480V	0.3	0.002 0.002	$\vert PF\vert \leq 0.9$ and ①	-2,000,000 to +2,000,000 kvar
Apparent power	0.36×PT×CT @ 120V 1.2×PT×CT @ 480V	0.2	0.002 0.002	$\vert PF\vert \geq 0.5$ and ①	0 to 2,000,000 kVA
Power factor	1.000		0.35	$\vert PF\vert \geq 0.5$, $I \geq 2\%$ FSI	-0.999 to +1.000
Frequency		0.002 [3]			40.00 Hz to 70.00 Hz
Total Harmonic Distortion, THD V (I), %Vf (%If)	999.9	1.5	0.2	THD $\geq 1\%$ FS, V (I) $\geq 10\%$ FSV (FSI)	0 to 999.9
Total Demand Distortion, TDD, %	100		1.5	TDD $\geq 1\%$ FS, I $\geq 10\%$ FSI	0 to 100
Active energy[1] Import & Export		Accuracy Class 0.2 ANSI C12.20-2002 Current class 20 Class 0.2S IEC 62053-22			0 to 999,999.999 MWh
Reactive energy[1] Import & Export		Accuracy Class 0.2%			0 to 999,999.999 Mvarh
Apparent energy[2]		Accuracy Class 0.2%			0 to 999,999.999 MVAh
Volt-hours		Class 0.2		20% - 120% FS	0 to 999,999.999 kVh
Ampere-hours		Class 0.2		10% - 200% FS	0 to 999,999.999 kAh
Symmetrical components	Voltage FS Current FS Current FS	1 1 3		10% - 120% FS 10% - 200% FS 200% - 2000%FS	
Phasor angles		1 degree			

Key: PT - external potential transformer ratio   ① @ 80% to 120% of voltage FS and 1% to 200% of current FS

CT - primary current rating of external current transformer

FSV - voltage full scale;   FSI - current full scale

Vf - fundamental voltage;   If - fundamental current

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[1] Specified Accuracy Class Only for PM180-5A and PM180-1A models (internal CT), for PM180-CS1S model (HACS 100) accuracy meets class 1

[2] Specified Accuracy Class Only for PM180-5A and PM180-1A models (internal CT), for PM180-CS1S model accuracy meets class 1

[3] This accuracy specification is available from PM180 firmware version V31.XX.8 and can be displayed from RGM180 software version V22.1.5

Notes

1.   Accuracy is expressed as ± (percentage of reading + percentage of full scale) ± 1 digit. This does not include inaccuracies introduced by the user's potential and current transformers. Accuracy calculated at 1 second average.

2.   Specifications assume: voltage and current waveforms with THD ≤ 5% for kvar, kVA and PF; reference operating temperature: 20°C - 26°C.

3.   Measurement error is typically less than the maximum error indicated here.