

PM180

eXpertMeter™

MULTI-PURPOSE DEVICE FOR MANY APPLICATIONS, INCLUDING:

- ✓ INDUSTRIAL & SUBSTATION AUTOMATION CONTROLLER
- ✓ HIGH PERFORMANCE POWER QUALITY ANALYZER (PQA)
- ✓ REVENUE GRADE CHECK METER
- ✓ DIGITAL FAULT RECORDER (DFR)
- ✓ SEQUENCE OF EVENTS (SOE)
- ✓ POWER METER WITH IEC 61850 PROTOCOL
- ✓ MOTORS AND LARGE LOAD MONITORING



 **SATEC**
Powerful Solutions



PM180

eXpertMeter™

SATEC eXpertMeter™ PM180 is a high performance analyzer that allows versatile uses. The high performance of the PM180, together with the unique flexible design of the expansion cards and the versatile installation on DIN rail, 4" round or 92x92mm cutout, enables its use in a large variety of applications, in which it can substitute several other devices—saving costs, space and complexity.

Wide range of control and alarm options: digital & analog I/O, GPS time sync. and more

Auxiliary PS for redundancy

Standard communication: Ethernet, RS-485 & USB

Four galvanically isolated voltage channels (standard)

50-290V AC, 90-290V DC power supply

Four galvanically isolated current channels up to 20xIn (standard)

Accurate distance to fault calculation

Option for fast transient recording (16µSec)

Add-on communication options: serial, fiber optic & 2G/3G cellular modules

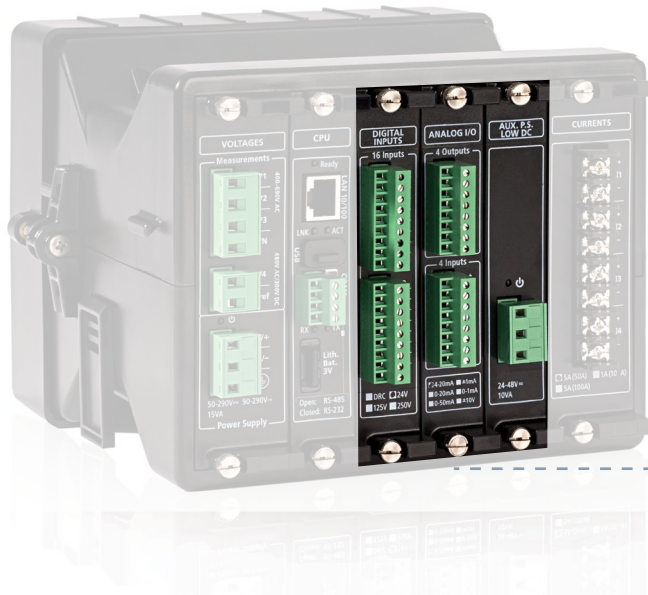
DIN rail, 4" round or 92x92 mm cutout mounting

Local & Remote Displays

The PM180 can be connected to a local display, plus up to two remote displays (via RS-485), at the same time. The selection of displays includes LCD or LED display in various configurations.



Modular Field-Installable Design



The unique modular design of the PM180 ensures its adaptation to changing needs, through a selection of numerous plug-in options for multiple customer applications. The PM180 can have up to 3 expansions modules.

3 slots for add-on modules

Automation & Control

DIGITAL INPUTS

16 inputs (total up to 48 DI)
Optically isolated dry/wet contact
Scan time: 1ms @ 60Hz, 1.25ms @ 50Hz
24/125/250V DC

RELAY OUTPUTS

8 relays (Total up to 24 RO)
8 relays rated at 8A/250V AC,
5A/24V DC, 0.25A/250V DC

ANALOG INPUTS / OUTPUTS

4AI and 4AO (Total up to 12AI / 12AO)
Ranges:

- ±1mA (with 100% overload)
- 0-20mA
- 0-1mA (with 100% overload)
- 4-20mA

Accuracy Class 0.2S FS
Scan/update time: 2 cycles

Communication

COMMUNICATION PORTS

IRIG-B module

- Optically isolated IRIG-B port
- Second RS-422/485 COM port

TXFX module

- Redundant Ethernet port
- 10/100 Mbit with RJ45 connector
- 100Base FX with SC connector

2G/3G cellular modem

- Antenna connection: SMA
- Supports UMTS/HSPA+ bands:
800/850/900/AWS/1900/2100

Transient Recording

TRANSIENT RECORDER MODULE

Records transients at 1024 samples/cycle
Max. 2kV phase to ground
16/19.5 µSec (60/50 Hz) transient
detection

Redundant Power Supply

AUXILIARY POWER SUPPLY

50-290V AC and 40-290V DC, 20W
9.6-35 V DC, 20W
(max. one auxiliary power supply per
PM180)

Industrial & Substation Automation Controller

PM180 as a Bay Controller Unit (BCU)

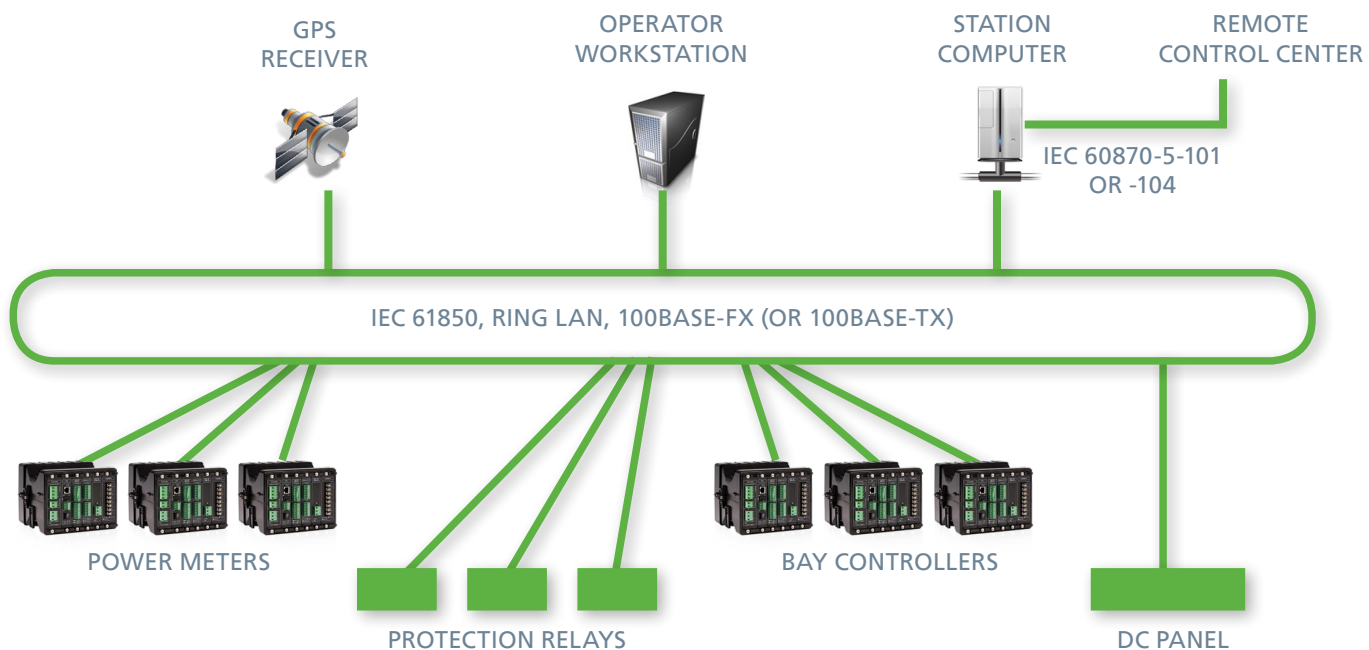
SATEC's PM180 is a cost effective solution for electrical substation automation.

By adding a single PM180 device to each feeder, ALL the information required for substation automation is provided. The PM180 extends the life expectancy of electromechanical relays by providing information lacking in electromechanical devices without interfering in the protection scheme.

PM180 provides fully automated control of substation switching devices. After the switches are configured in the device, typically no additional logic is required for controller operation, except for interlocking logic. Bay control solutions are customized via control logic and a variety of digital I/O and analog measurements.

Features

- Monitoring and control capabilities for 2 circuit breakers and 14 circuit switches
- One-pole and three-pole switch position monitoring using two or six contacts
- One control output for switch closing
- Two synchronous control outputs for switch opening for devices with one and two opening coils
- Select-close control output for secure switch closing operations
- Two select-open control outputs for secure switch opening operations
- Configurable command pulse duration
- Option for adaptive pulses controlled via setpoint control logic
- Supervision of command execution & reporting on operation termination
- Interlocking logic
- Secure timed-out interlocking bypass logic
- Switch position substitution option
- Indication of non-controllable breaker trips
- Counting of breaker and switch operations
- Logging close/open operations and switch position changes
- Local switch control via setpoint control logic
- Remote switch control and monitoring via Modbus and IEC 61850 protocols
- Inter-device IEC 61850 GOOSE communications for remote interlocking



High Performance Power Quality Analyzer (PQA)

Cutting Edge Power Quality Analyzer & Recorder

The PM180 is the most advanced power quality analyzer and recorder on the market. The instrument is a product of SATEC's 25 years of experience in the creation of power quality instruments. The PM180 is designed to fully comply with the most demanding industry standard, IEC 61000-4-30 Class A. It provides power quality reports and statistics according to IEEE 1159, EN50160, GOST 13109 or GOST 54149, complimented

by comprehensive power quality event/data log with waveforms available for detailed Power Quality event analysis. Redundant power supply allows full readiness for any power quality event, including major dips and interruptions. The individual harmonics and inter-harmonics are analyzed according to IEC 61000-4-7. The instrument also supports directional power harmonics analysis. Flicker is measured and analyzed according to IEC 61000-4-15.



- Power quality analysis and reading according to IEC 61000-4-30 Class A
 - Sags/swells (dips/overvoltages), interruptions, frequency variations, voltage variations
 - Flicker, voltage unbalance, harmonic and interharmonic voltages and currents
 - Programmable thresholds and hysteresis
 - Built-in IEEE 1159, EN50160, GOST 13109 or GOST 54149 statistics and reports (market dependant)
 - Redundant auxiliary power supply for recording major dips and interruptions
 - Harmonics and interharmonics according to IEC 61000-4-7
 - Directional power harmonics
 - Voltage and current THD coefficients
 - Currents TDD coefficients and K-Factors
 - Waveform, power factor and phasor data recorder
 - Symmetrical components
 - Flicker measurement according to IEC 61000-4-15
 - Waveform recording
 - Selectable sampling rate up to 256/1024 samples/cycle
 - Power quality event recorder
 - Event recorder for logging internal diagnostic events, control events and I/O operations

Revenue Grade Check Meter

Designed for Revenue Grade metering, the PM180 provides a high accuracy energy measurement that can be used to check the utility meter, as well as adding power quality and control functions.

For high performance revenue metering, the PM180 includes:

- Exceeding Revenue 0.25 Class Accuracy (IEC 62053-22)
- Built-in Time Of Use (TOU) with a 10 year calendar, 16 types of days and up to 8 tariff changes per day for each daily profile

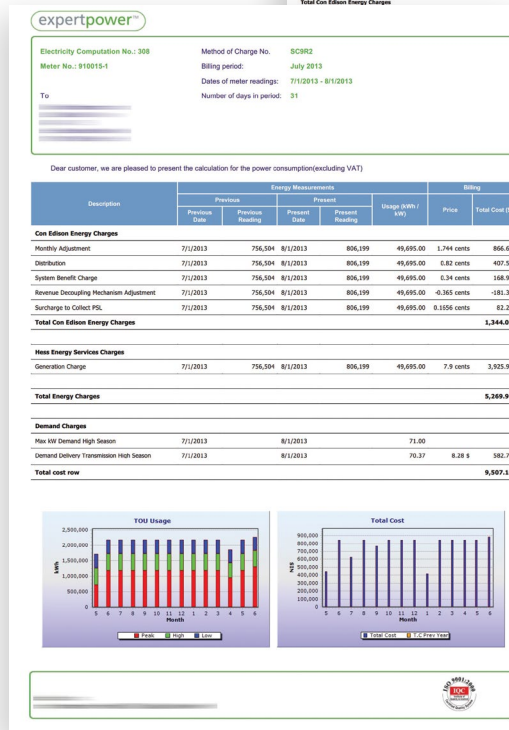
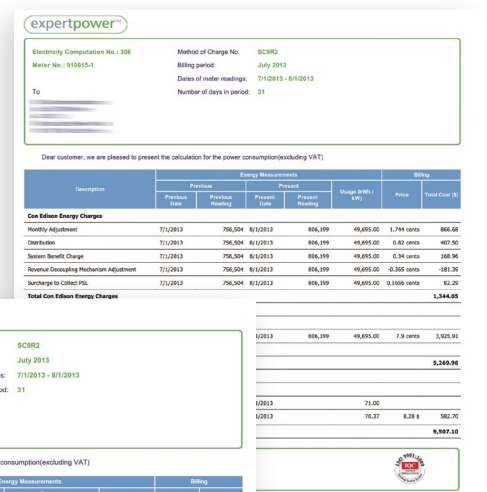
The precise measurement class of accuracy ensures that the energy readings are better than the utility meter's readings, which makes it trustworthy when there is a discrepancy between the utility and the PM180 reading.

The TOU allows for configuring practically any utility tariff scheme, while the on-board storage makes it independent of any communication failures.

The SATEC ExpertPower™ billing module is designed to produce a utility-like bill, based on the PM180 stored information. It has a dynamic tariff definition, including prices, usage, seasons, peak demand and any various charges that a utility bill may contain. This allows for

accurate cost calculation and reliable comparison with the utility bill, which is a key factor in any billing dispute.

These applications encourage efficient energy consumption, by creating energy saving plans, providing indication of excess or unnecessary energy usage and validating the correctness of future electric bills, thus enabling an all around supervision and control of electric expenses and leading to considerable reduction in electric costs.



Digital Fault Recording (DFR)

SATEC PM180 includes true Digital Fault Recording and Disturbance Recording of four current channels for up to 20xIn (100A @ In=5A) of fault currents. Three AC voltage channels and one AC/DC measurement input channels are also included. Multiple PM180 devices can cross trigger for up to 20 cycles of pre-fault information for distributed recording. Fault information can be exported to PQDIF/COMTRADE format via PAS software.

The Fault Recorder can be triggered by the embedded fault detector or externally through any digital input. External triggers are automatically

enabled for the Fault Recorder.

When the Fault Recorder is enabled, it automatically records all internally detected and externally triggered fault events to the Fault Log file and to the Sequence Of Events Log (see pg. 8).

The Fault Recorder setup allows you to adjust thresholds and hysteresis for different fault triggers, and to define the waveform and data log options for recording fault events.

The fault recorder provides 4 measured and recorded currents (including measured neutral current). The event log is complemented by waveform recording.

Features

- IRIG-B/SNTP/DI time synchronization
- 256 MB memory
- Programmable fault thresholds and hysteresis
- Up to 100 Amps fault currents (20xIn)
- Zero-sequence currents and voltages
- Current and voltage unbalance
- Under-voltage, neutral current
- Ready-for-use fault reports—fault currents magnitude and duration, coincident volts magnitude, fault waveforms and RMS trace
- Distance to fault calculation
- Waveforms from multiple separate locations (via PAS)

Distance to Fault

Accurate fault location reduces repair costs by avoiding lengthy and expensive patrol using car or helicopter, and expedites repairs and restoration of the power; thus increasing availability time and customer satisfaction.

The PM180 includes a high accuracy distance to fault calculation algorithm, based on the measuring of 3 or 4 voltages, 3 or 4 currents and the currents of parallel line when present, at the upstream side of the fault. The algorithm includes compensation for CT and PT errors and results with average accuracy of 0.5% (depending on PT, CT and time synchronization accuracy).

Supported line configurations:

- Single line
- Parallel lines
- Partially parallel lines
- A line with a branch

Required parameters:

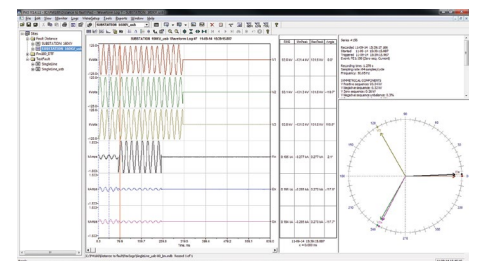
- Configuration of the line/s
- Parameters of the line/s (impedance, length, etc.)
- Compensation parameters for CT & PT

Detected faults:

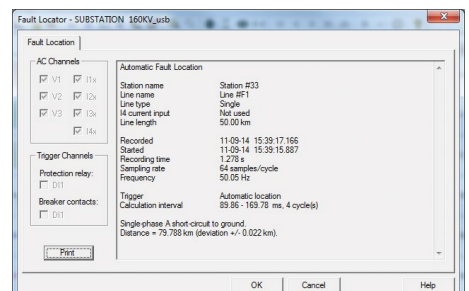
- Three-phase short circuit
- Two-phase short circuit
- Two-phase short circuit to ground
- Single-phase short circuit to ground
- Single-phase open wire

Fault detection information:

- Fault classification (type and phase/s)
- Distance to fault (km or miles)
- Duration of fault



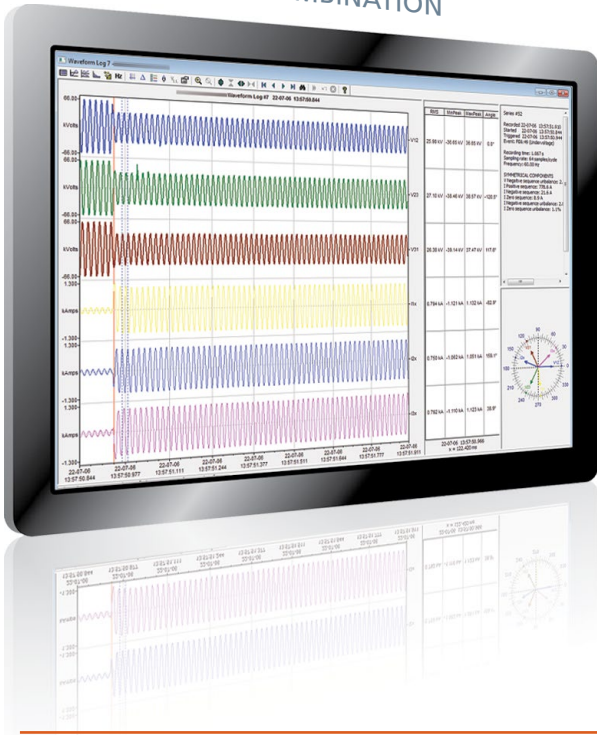
SINGLE PHASE SHORT CIRCUIT FAULT INFORMATION (PAS)



DISTANCE TO FAULT CALCULATION (PAS)

Sequence of Events (SoE)

SOE / WAVEFORM COMBINATION



SEQUENCE OF EVENTS LOG

No	ID	Date/Time	Point	Status	Description
1	Cl Sub	03-25-04 15:40:05.448	DI1-59281	ALARM	TOC LOCKOUT Transformer #1
2	Cl Sub	03-25-04 15:40:05.579	DI1-59281	NORMAL	TOC RESET Transformer #1
3	Cl Sub	03-25-04 15:40:05.947	DI1-59282	OPEN	Feeder # 8 - Breaker TRIP
4	Cl Sub	03-25-04 15:40:07.148	DI1-59282	CLOSE	Feeder # 8 - Breaker RESET
5	CLAY ST	03-25-04 15:40:07.727	DI1-59283	TRIP	Under Frequency TRIP
6	CLAY ST	03-25-04 15:40:07.848	DI1-59283	RESET	Frequency RESET
7	Cl Sub	03-25-04 15:40:08.550	DI1-59284	DI	MANUAL TRIP - T14 BREAKER
8	Cl Sub	03-25-04 15:40:08.614	DI1-59284	OFF	MANUAL RESET - T14 BREAKER
9	Cl Sub	03-25-04 15:40:08.760	DI1-59286	ON	MANUAL TRIP - T14 BREAKER
10	Cl Sub	03-25-04 15:40:08.775	DI1-59285	OFF	MANUAL RESET - T14 BREAKER
11	CLAY ST	03-25-04 15:40:10.540	DI1-59286	TRIP	3M OVER CURRENT DELAY TRIP
12	CLAY ST	03-25-04 15:40:10.592	DI1-59286	RESET	3M OVER CURRENT DELAY RESET
13	CLAY ST	03-25-04 15:40:10.637	DI1-59287	TRIP	3M OVER CURRENT DELAY TRIP
14	CLAY ST	03-25-04 15:40:10.725	DI1-59287	RESET	3M OVER CURRENT DELAY RESET
15	TRANSU	03-25-04 15:40:11.310	DI1-59288	ALARM	TRANSFORMER # 2 OVER TEMP
16	TRANSU	03-25-04 15:40:11.486	DI1-59288	NORMAL	TRANSFORMER #2 NORMAL
17	TRANSU	03-25-04 15:40:11.920	DI1-59289	CLOSED	TOC RESET - FEEDER LLC-1
18	TRANSU	03-25-04 15:40:12.070	DI1-59289	OPEN	TOC LOCKOUT - FEEDER LLC-1
19	LOWELL	03-25-04 15:40:12.525	DI1-59270	ALARM	CONDENSOR PUMP OVERLOAD
20	LOWELL	03-25-04 15:40:12.660	DI1-59270	NORMAL	CONDENSOR PUMP NORMAL
21	LOWELL	03-25-04 15:40:12.704	DI1-59271	ALARM	CONDENSOR PUMP OVERLOAD
22	LOWELL	03-25-04 15:40:12.708	DI1-59271	NORMAL	CONDENSOR PUMP NORMAL
23	LOWELL	03-25-04 15:40:13.604	DI1-59272	ALARM	DI1 TEMP ALARM - XFMR #2
24	LOWELL	03-25-04 15:40:14.633	DI1-59272	NORMAL	DI1 TEMP NORMAL - XFMR #2
25	NEWARK	03-25-04 15:40:14.683	DI1-59273	TRIP	BREAKER 33M - EM INST TRIP
26	NEWARK	03-25-04 15:40:15.240	DI1-59273	RESET	BREAKER 33M - EM INST TRIP
27	NEWARK	03-25-04 15:40:15.062	DI1-59274	ALARM	Under Voltage Alarm >105 VAC
28	NEWARK	03-25-04 15:40:15.240	DI1-59275	OVER	Voltage Return to Normal >120VAC
29	DELMAR	03-25-04 15:40:15.579	DI1-59276	NORMAL	BREAKER 37M TRIP
30	DELMAR	03-25-04 15:40:15.616	DI1-59275	CLOSED	BREAKER 37M TRIP
31	DELMAR	03-25-04 15:40:15.625	DI1-59276	OPEN	BREAKER 37M TRIP
32	DELMAR	03-25-04 15:40:15.700	DI1-59276	CLOSED	BREAKER 37M TRIP

Designed for an electrical utility substation or industrial environment to record contact openings and closings of field devices, such as electromechanical and microprocessor controlled relays. It includes up to three 16 digital input modules, with up to a total of 48 digital

inputs (wet or dry type) with a 1 mSec time resolution between events.

The Sequence of Events (SoE) recorder can log four types of events: digital input events, relay output events, fault events and setpoint events.

When displaying the SoE Log reports, PAS establishes links between the event and other database records where it finds a relationship between the recorded data and the event.

Power Meter with IEC 61850 Protocol

The possibility to build SAS (Substation Automation System) rests on the strong technological development of large-scale integrated circuits, leading to the present availability of advanced, fast, and powerful microprocessors. The result was an evolution of substation secondary equipment, from electro-mechanical devices to digital devices. This in turn provided the possibility of implementing SAS using several intelligent electronic devices (IEDs) to perform the required functions (protection, local and remote monitoring and control, etc.).

As a consequence, the need arose for efficient communication among the RTUs, especially for a standard protocol. Until the introduction of IEC 61850, specific proprietary communication protocols developed by each manufacturer have been employed, requiring complicated and costly protocol converters when using RTUs from different vendors.

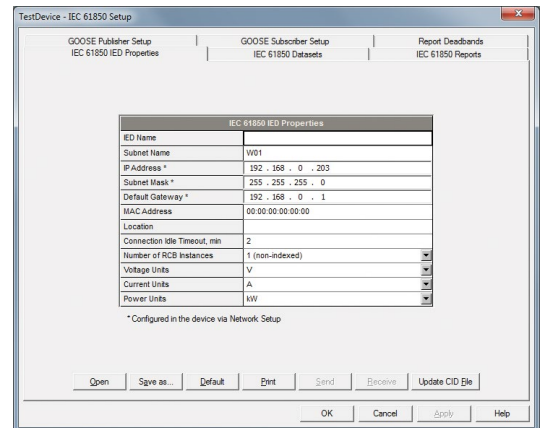
IEC 61850 is an international standard of communications for substations, which enables integration of all protection, control, measurement and monitoring functions within a substation and provides the means for high-speed substation protection applications, interlocking and intertripping. It combines the convenience of Ethernet with the performance and security which is essential in substations today.

The use of IEC 61850 in digital substations provides various benefits:

1. A single protocol for complete substation considering modelling of different data required for the substation
2. Definition of basic services required to transfer data so that the entire mapping to communication protocol can be made future proof
3. Promotion of high interoperability between devices from different vendors
4. A common method and format for storing complete data
5. Define complete testing required for the equipment, conforming to the standard

The PM180 can be used either as a bay controller (see. pg. 5) or as a Power Meter. The PM180 supports the following sections of IEC 61850 (completely or partially):

- IEC 61850-1: Introduction and overview
- IEC 61850-2: Glossary
- IEC 61850-3: General requirements
- IEC 61850-4: System and project management



PAS IEC 61850 Setup

- IEC 61850-5: Communication requirements for functions and device models
- IEC 61850-6: Configuration language for communication in electrical substations related to RTUs
- IEC 61850-7: Basic communication structure for substation and feeder equipment
 - IEC 61850-7-2: Abstract comm. service interface (ACSI)
 - IEC 61850-7-3: Common Data Classes
 - IEC 61850-7-4: Compatible logical node classes and data classes
- IEC 61850-8: Specific communication service mapping (SCSM)
 - IEC 61850-8-1: Mappings to MMS (ISO/IEC 9506-1 and ISO/IEC 9506-2) - Ed.2
- IEC 61850-10: Conformance testing

Configuration of IEC 61850 includes IEC 61850 IED Properties, IEC 61850 Datasets, IEC 61850 Reports, GOOSE Publisher Setup, GOOSE Subscriber Setup and Report Deadbands.

Motors & Large Load Monitoring

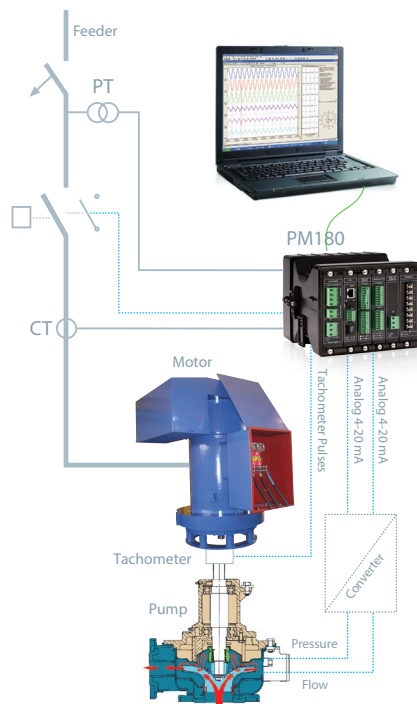
Monitoring Large motors

Electrical motors and other large loads are an important part of the electrical equipment and are dominant in the overall consumption. As a result, they significantly affect the energy efficiency and site reliability. Monitoring main motors includes observing their energy consumption, tracking their health and examining their efficiency.

Energy Consumption

Electric motors consume about 50% of the world's energy. It is therefore very important to track their energy consumption. While a basic power meter can do this job, for large motors it is recommended to use a higher accuracy device, with power quality and control functions.

Real-Time Pumps Efficiency Monitoring Application



Using the PM180 to measure the electricity consumption, the digital pulse input to read the speed of the motor and the analog inputs to read the flow and pressure allows creating an advanced real-time pump efficiency monitoring.

The pump's efficiency can be calculated ($\text{Efficiency}\% = P_{\text{pump}} / P_{\text{E}} * 100\%$) and the system notifies when the efficiency is too low, which helps in increasing energy efficiency, as well as alerting on potential failures.

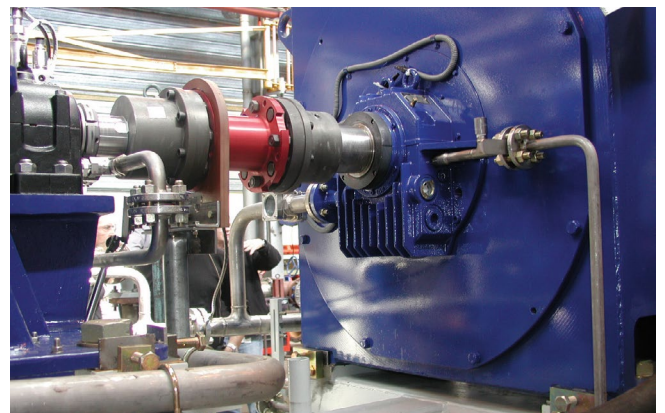
Features

- Accurate efficiency monitoring
- A single PM180 device performs all data logging, time synchronized
- Improved reliability
- Allows additional control functions using relay outputs, digital inputs and analog I/O

Motor Reliability & Troubleshooting

Monitoring the power quality of the motor, particularly the harmonics, inter- and sub-harmonics, is a good practice for proactive maintenance. Typically, internal motor damages cause a high level of harmonics, inter- and/or sub-harmonics. Monitoring power quality allows for maintaining motors during a planned shutdown, rather than very expensive unscheduled shutdowns.

Large motor startup may take minutes, while most digital motor protection devices can record for a few seconds only. SATEC PM180 provides continuous logging of up to 3.5 minute waveforms (including up to 20xIn high current), which allows for analyzing failures and for monitoring the motor health, thus improving the facility's reliability.



Features

Fast Data Logging Recorder

- From ½ cycle RMS to 2-hour envelopes
- Programmable post fault on any internal and/or external trigger condition

Waveform Capture

- Provides simultaneous capture for all voltage and current channels with choice of sample rate, up to 256. Selectable pre-fault / post-fault recording length. Disturbance capture recording up to several minutes
- Transient capture (>78/65µs—50/60Hz)

Harmonic Analyzer

- Total Harmonic Distortion for Voltage and Current and up to the 63rd individual harmonic for V, I, P, Q
- Including directional power harmonics (Load or Source)
- V-I angle, TDD and K factors

Multi-Function Power & Energy Meter

- Real time cycle-by-cycle measurement of high accuracy, true RMS voltage, current, power, demand and energy
- Revenue accurate meter
- Exceeding Class 0.2S (IEC 62053-22 / ANSI C12.20)
- Advanced Time Of Use (TOU) feature (16 Energy sources include external digital pulses, up to 4 seasons, 4 daily profiles, 8 Tariffs, flexible automatic calendar) for any complex billing scheme
- KYZ or KY output and LED indication for calibration and test (via optional display)
- Vector diagram and symmetrical components

Real-Time Clock & Synchronization

- Real-Time Clock with maximum 5 seconds drift per month @ 25°C
- Provides 1 msec time resolution via IRIG-B time code input or satellite clock for common time base (requires IRIG-B module)
- As an SNTP client, it can accept periodic synchronization of the meter clock from an SNTP server
- Time sync from digital input with 1ms accuracy

Wide Range Voltage Inputs

- Three impulse galvanic isolated AC voltage inputs
- Impulse dielectric withstand 6kV
- Wide range application up to 828V
- AC/DC voltage input: station battery monitoring (up to 300V DC)

Wide Range Current Inputs

- 4 dual purpose current inputs (3-phase + Neutral)—1A/5A for measurement CTs with Class 0.2S revenue grade accuracy to 10A/20A and 50A/100A (5A/HACS) for protection CTs (10/20x)

Communication Platforms

- 3 independent built-in Ports plus 3 optional:
 - IRIG-B and RS-422/485 port
 - TFX (fiber optic)
 - 2G/3G cellular modem
- Communication Protocols: Modbus RTU, ASCII, DNP 3.0, Modbus/TCP, DNP3/TCP, IEC 61850 (option), IEC 60870-5-101/104 (option)

Digital & Analog I/O Options

3 expansion slots for a wide range of plug-in modules:

- 16 high speed digital inputs, total up to 48 DIs
- 8 dry contact relay outputs, total up to 24 ROs
- Mixed 4 analog inputs and 4 outputs, total up to 12 AI/12AO

Logging, Recording & Programming

- Standard onboard memory: 256 MB
- Programmable controller: up to 64 control setpoints, up to 8 conditions OR, AND, arithmetical functions logic, extensive triggers, programmable thresholds and delays, relay control, event-driven data recording
- 8 fast waveform recorders: simultaneous 8-channel AC, one DC: up to 48 digital inputs in a single plot
- Waveform sampling rate 32, 64, 128 or 256 samples per cycle; up to 20 pre-fault cycles
- Up to 3.5 min. of continuous waveform recording
- 1-ms resolution for digital inputs
- 16 fast Data Recorders (16 parameters on each data log): From ½ cycle RMS to 2 hour RMS envelopes; up to 20 pre/post-fault cycles; programmable data logs on a periodic basis and on internal or external trigger
- 32 digital internal counters
- 16 internal programmable timers (½ cycle to 24 hours)

Technical Specifications

INPUT RATINGS

3 Voltage Inputs: V1, V2, V3

- Direct input and input via PT up to 828V AC line-to-line, up to 480V AC line-to-neutral
- Burden for 480V: <0.35 VA
- Burden for 120V: <0.03 VA
- Overvoltage withstand: 1000V AC continuous, 2500V AC for 1 sec.
- Galvanic isolation: 4kV AC / 1 min.
- Impulse dielectric withstand 6kV

Current Inputs: I1, I2, I3, I4

- Selectable 5A or 1A (upon order)
- Operating range: continuous 4xIn ANSI (20A/4A) or 2xIn IEC (10A/2A)
- Fault currents: up to 20xIn (100A @ HACS, 50A @ 5A, 10A @ 1A), max 1 sec.
- Burden for 5A: <0.15 VA;
Burden for 1A: <0.02 VA
- Overload withstand: 4xIn RMS continuous (20A/4A)
- Max. wire size: 10 AWG/6mm²
- Terminals pitch: 13mm
- Galvanic isolation: 4kV AC / 1 min.
- Impulse dielectric withstand 6kV

AC/DC Voltage Input: V4, Vref

- Operating Range: 400V AC
- Direct input and input via PT (up to 480V AC) or Battery input
- Input Impedance: > 10MΩ
- Burden for 400V: << 0.01 VA
- Burden for 120V: << 0.01 VA
- Overvoltage Withstand: 1000V AC continuous, 2500V AC for 1 second
- Resistive Isolation, Insulation withstand: 4kV AC @ 1mn
- Wire Size: 10 AWG (up to 6 mm²)
- Terminals Pitch: 7.5 mm

Power Supplies

- Two redundant galvanically isolated power supplies
- Selection of power supplies:
 - 50-290V AC and 40-290V DC
 - 9.6-35V DC

COMMUNICATION

COM1

- Optically isolated RS-232/485
- Insulation withstand: 4kV AC @ 1 min.
- Connector: removable, captured-wire, 4 terminals
- Max. wire size: 12 AWG / 2.5 mm²
- Max. baud rate: 115,200 bps
- Protocols: MODBUS RTU, MODBUS ASCII, DNP 3.0, IEC 61850 (option), IEC 60870-5-101/104 (option)

COM2

- Optically isolated RS-422/485
- Insulation withstand: 4kV AC @ 1 min.
- Connector: removable, captured-wire, 5 terminals
- Max. wire size: 12 AWG / 2.5 mm²
- Max. baud rate: 115,200 bps
- Protocols: MODBUS RTU, MODBUS ASCII, DNP 3.0

COM3 (Display)

- Optically isolated RS-485 port for the remote display
- Insulation withstand: 2.5kV AC @ 1 min
- Connector: DB15
- Max. baud rate: 115,200 bps.
- Protocols: MODBUS RTU, MODBUS ASCII, DNP 3.0

USB Port

- Isolated USB port
- Insulation withstand: 4kV AC @ 1 min.
- Connector: Type A male
- Supported protocols: MODBUS RTU

Ethernet Port

- Transformer-isolated 10/100 Base-T port
- Insulation withstand: 4kV AC @ 1 min
- Connector: Modular RJ45
- Protocols: MODBUS TCP (Port 502), DNP 3.0/TCP (Port 20000), IEC 61850 (option)
- Number of simultaneous connections (sockets): 5

IRIG-B Port (Option)

- Optically isolated IRIG-B Port
- Time code signal: unmodulated (pulse-width coded)
- Level: unbalanced 5V
- Connector type: BNC
- Recommended cable: 51Ω low loss: RG58A/U (Belden 8219 or equivalent), TNC connector

TX/FX Port (Option)

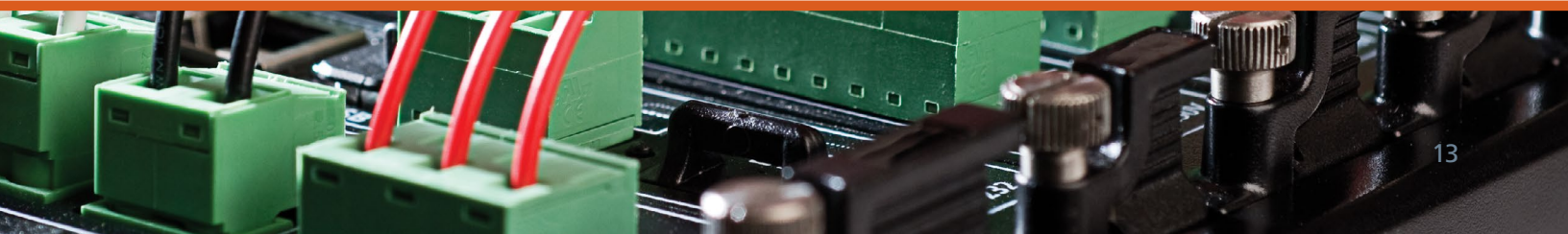
- Transformer-isolated 10/100Base-T port
- TX Connector: Modular RJ45
- Optical-isolated 100Base FX
- FX Connector: SC
- Supported protocols: MODBUS TCP (Port 502), DNP 3.0/TCP (Port 20000), IEC 61850 (option)
- Number of simultaneous connections (sockets): 5

ENVIRONMENTAL CONDITIONS

- Operating temperature: -22°F to 158°F / -30°C to 70°C
- Storage temperature: -40°F to 185°F / -40°C to 85°C
- Relative humidity: 0-95% non-condensing

DIMENSIONS

- **HxWxD**
 - **PM180** 6x8.6x8.3" / 152x220x210 mm
 - **RGM180** 7.1x8.7x1.9" / 181x221x48 mm
 - **RDM180** 4.5x4.5x0.8" / 114x114x20 mm
 - **RDM312** 6.1x12.3x1" / 155x313x26 mm
- **Weight**
 - **PM180** 2.5 kg / 5.5 lb
 - **RGM180** 0.7 kg / 1.54 lbs



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
- IEC 61000-6-2
- IEC 61000-6-4
- IEC 60255-5
- IEC 60255-22

Accuracy

- Active Energy, IEC/AS 62053-22, class 0.2S¹
- Reactive Energy, class 0.5S (under conditions as per IEC 62053-22:2003 @ $0 \leq |PF| \leq 0.9$)

Power Quality

- EN50160: Power Quality in European Electricity Supply Networks
- IEEE 1159: Power Quality Recorder in US
- GOST 13109: 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

- IEC 61000-4-7, Harmonics and inter-harmonics measurement
- IEC 61000-4-15, Flicker measurement
- IEC 61000-4-30 class A, Power quality measurement methods
- IEC 62054-21: Real time clock backup, RTC accuracy $\pm 2\text{ppm}$ @ 23°C

EMC Immunity

- IEC 61000-4-2, IEC 60255-22-2: Electrostatic discharge, 15kV/8kV – air/contact
- IEC 61000-4-3, IEC 60255-22-3: Radiated Immunity, 10V/m and 30V/m @ 80 MHz – 1000 MHz
- IEC 61000-4-4, IEC 60255-22-4: Fast Transients burst, 4KV on current and voltage circuits and 2 KV for auxiliary circuits
- IEC 61000-4-5, IEC 60255-22-5: Surge 6KV on current, voltage circuits and power supply
- 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
- IEC 61000-4-6, IEC 62052-11: Conducted Radio-frequency, 10V @ 0.15 MHz – 80MHz
- IEC 61000-4-8: Magnetic Field
- IEC 61000-4-12, IEC 62052-11, IEEE C37.90.1: 2002: Oscillatory waves, CMM 2.5KV & DFM 1KV @ 100KHz and 1MHz

Emission (radiated/conducted)

EN55022, IEC 60255-22: Class A

Construction

Safety

IEC/UL 61010-1

Insulation

- IEC 62052-11: Insulation impulse 6KV/500Ω @ 1.2/50 μs
- IEC 62052-11, IEC 61010-1: 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)

1. Only for PM180-5A and PM180-1A models (internal CT), PM180-DFR model accuracy meets class 1

Measurement Specifications

PARAMETER	FULL SCALE@ INPUT RANGE	ACCURACY			RANGE
		% READING	% FS	CONDITIONS	
Voltage V1-V3	120V x PT ratio @ 120V 400V x PT ratio @ 690V	0.05	0.01	10% to 120% FS	0 to 999,000 V
Line current I1-I4	CT	0.05	0.01	ANSI C12.20: 1%-120% FS	0 to 120,000 A
		0.05		120%-400% FS	
		0.05	0.01	IEC 62053-22: 1%-200% FS	
Fault current I1- I4	CT	2.0		400%-2000% FS	0 to 120,000 A
AC/DC Voltage	125V / 220V		0.3	10%-120% FS	0 to 290V DC
Active power	0.36 x PT x CT @ 120V 1.2 x PT x CT @ 690V	0.2	0.002	PF ≥ 0.5 and ⊕	-10,000 to +10,000 MW
		0.2	0.002		
Reactive power	0.36 x PT x CT @ 120V 1.2 x PT x CT @ 690V	0.3	0.002	PF ≤ 0.9 and ⊕	-10,000 to +10,000 Mvar
		0.3	0.002		
Apparent power	0.36 x PT x CT @ 120V 1.2 x PT x CT @ 690V	0.2	0.002	PF ≥ 0.5 and ⊕	0 to 10,000 MVA
		0.2	0.002		
Power factor	1.000		0.35	PF ≥ 0.5, I ≥ 2% FSI	-0.999 to +1.000
Frequency	50 Hz	0.002			40.000 Hz to 64.999 Hz
	60 Hz	0.002			45.100 Hz to 70.000 Hz
Total Harmonic Distortion, THD V(I), %V _f (%I _f)	100	1.5	0.2	THD ≥ 1% FS, V (I) ≥ 10% FSV (FSI)	0 to 999.99
Total Demand Distortion, TDD, %	100		1.5	TDD ≥ 1% FS, I ≥ 10% FSI	0 to 100
Active Energy Import & Export		Class 0.2 ANSI C12.20, Current class 20 Class 0.2S (IEC 62053-22)			0 to 999,999.999 MWh
Reactive Energy Import & Export		Class 0.2 under conditions as per ANSI C12.20 Class 0.2 under conditions as per IEC 62053-22			0 to 999,999.999 Mvarh
Apparent Energy		Class 0.2 under conditions as per ANSI C12.20 Class 0.2 under conditions as per IEC 62053-22			0 to 999,999.999 MVAh
Volt-Hours		Class 0.2		20%-120% FS	0 to 999,999.999 kWh
Ampere-Hours		Class 0.2		10%-200% FS	0 to 999,999.999 kWh
Symmetrical Components	Voltage FS	1		10%-120% FS	
	Current FS	1		10%-200% FS	
	Current FS	3		200%-300% FS	
Phasor angles		1 degree			

Key:

PT	External potential transformer ratio
CT	Primary current rating of external current transformer
FSV	Voltage full scale
FSI	Current full scale
V _f	Fundamental voltage
I _f	Fundamental current
⊕	@ 80% to 120% of voltage FS and 1% to 200% of current FS

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.

PM180 ORDER STRING

OPTIONS

DISPLAY

Transducer version—no display	X
Graphic color display—5.7" touchscreen	G
3 line ultra bright LED display	D
Multi window ultra bright LED display with 12 values + 1 text window	M

VOLTAGE INPUTS

690V AC Nominal Voltage Input	-
120V AC Nominal Voltage Input	U

CURRENT INPUTS

5 Ampere	5
1 Ampere	1
100A Split Core HACS (Calibrated to 5A)	CS1S

FREQUENCY

50 HZ	50Hz
60 HZ	60Hz

ACCURACY AND POWER QUALITY STANDARD

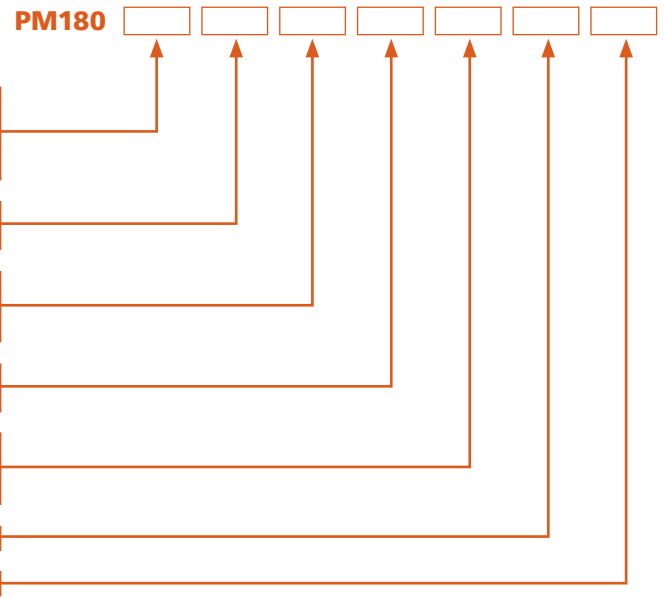
ANSI C12.20—USA Standard IEEE1159 Full Power Quality	A
IEC 62053-22—European Standard EN50160 Full Power Quality	E
GOST 13109 / GOST 54149—Russian Standard	G

POWER SUPPLY—MAIN

85-265V AC and 88-290V DC (Default)	ACDC
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COMMUNICATION STANDARD

IEC 61850	850
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OPTIONAL PLUG-IN MODULES

Maximum 3 modules per instrument

OPTIONS

TRANSIENT CAPTURE

Standard (256 samples per cycle)	-
Transient module (1024 samples per cycle, max. 2kV)	TRM

DIGITAL INPUTS (MAX. 48 DIGITAL INPUTS)

DI 16 Dry Contacts	DI16-DRC-180
DI 16 24V DC	DI16-24V-180
DI 16 125V DC	DI16-125V-180
DI 16 250V DC	DI16-250V-180

RELAY OUTPUTS (MAX. 24 RELAY OUTPUTS)

8 Relays	RLY8-180
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COMMUNICATION

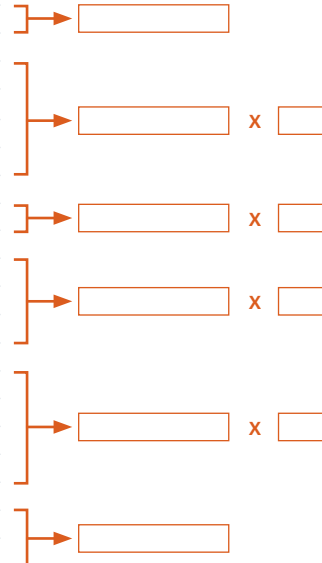
IRIG-B and RS-422/485 port	IRIG-180
TXXF	TXXF-180
2G/3G Cellular modem	T3G-180

4 ANALOG INPUT / 4 ANALOG OUTPUT MODULE (MAX. 12AI/12AO)

± 1mA (0±1)	4AI01-180
0-20 mA (0-10-20)	4AI02-180
0-1 mA (0-0.5-1)	4AI03-180
4-20 mA (4-12-20)	4AI04-180

AUXILIARY POWER SUPPLY (MAX. 1 MODULES PER INSTRUMENT)

AUX. P.S. 50-290V AC and 40-300V DC	BACDC-180
AUX. P.S. 9.6-35V DC	B21DC-180



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