

PM180

DATASHEET



HIGHLIGHTS

- **Accuracy:**
Class 0.2 / 0.2S per ANSI / IEC 62053-22
- **Communication**
 - IEC 61850; IEC 60870-5-101/104;
DNP3; Modbus
 - Interfaces: RS485; ETH
 - Optional ports: IRIG-B; 2nd ETH;
Fiber Optic ETH (TxFX)
- **Fast Transient Sampling**
Transient Recorder: 1024 samples/cycle
- **Control**
I/O: Up to 48 digital and analog I/O

CLASS A MULTI-PURPOSE ANALYZER

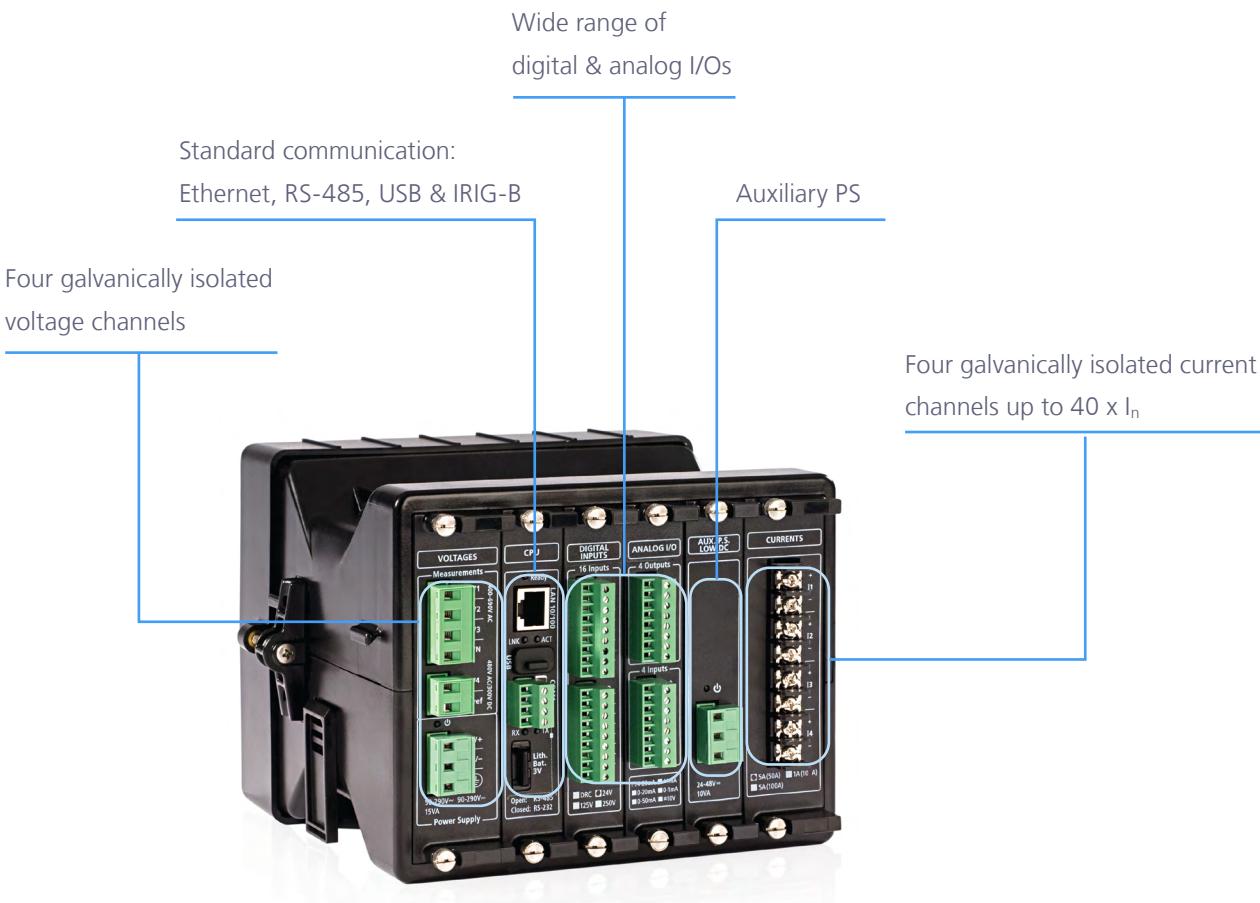
The PM180 is a high performance power quality analyzer which can simultaneously host several applications.

Versatile functionality is enabled by a unique modular design, allowing the hot-swap of a variety of add-on cards.

Thus, the analyzer combines and substitutes multiple other devices, saving cost and space and mitigating complexity.

APPLICATIONS

- Class A (Ed. 3) power quality analyzer
- IEC 61850 for the digital substation
- Fault Recorder ($I_n \times 40$)
- Phasor Measurement Unit per IEEE C37.118.1, P-Class and M-Class
- Disturbance Direction Detection
- Bay Controller
- Sequence of Events
- Class 0.2S revenue grade check meter



PM180 + RGM180



PM180 + RDM180

APPLICATIONS



CLASS A, ED. 3



SUBSTATION AUTOMATION



FAULT RECORDER



PMU/WAMS



INDUSTRIAL MONITORING



RENEWABLE ENERGY



SCADA READY

FEATURES



Multi-Function Power & Energy Meter

- Real-time cycle-by-cycle measurement of true RMS voltage, current, power, power factor, demand & energy
- Exceeding Class 0.2S/0.2 accuracy for energy metering (kWh, per IEC 62053-22 / ANSI C12.20)
- Advanced Time of Use (TOU) feature: 16 Energy sources, including external digital pulses, up to 4 seasons, 4 daily profiles and 8 Tariffs changes per day; flexible automatic 10-year calendar; suitable for complex billing schemes
- KYZ or KY output
- LED indicator for calibration and testing (via optional display)
- IRIG-B / SNTP / DI time synchronization
- 256 MB memory for data-logging

Power Quality

- Power quality analysis in full compliance with IEC 61000-4-30 Class A, Edition 3 (2015)
- Sags/Swells (dips / overvoltage), interruptions, frequency variations, voltage variations
- Flicker (according to IEC 61000-4-15)
- Voltage unbalance
- Voltage and current individual harmonics (according to IEC 61000-4-7), interharmonics and directional power harmonics (load/source) up to the 63rd harmonic

- Voltage and current THD coefficients
- 3 decimal resolution for frequency readings
- Vector diagram and symmetrical components
- Programmable thresholds and hysteresis
- Built-in statistics and reports per IEEE 1159, EN50160, GOST 13109 or GOST 32144 (market dependent)
- Redundant auxiliary power supply for recording major dips and interruptions
- V-I angle, current TDD coefficients and K-Factors
- Waveform and data recording; phasor display
- Power quality event recorder
- Event recorder for logging internal diagnostic events, control events and I/O operations
- Selectable sampling rate up to 256 / 1024 (fast transients >78/65µs @ 50/60Hz)
- Disturbance Direction Detection: indicating upstream or downstream direction of sags and swells

IEC 61850

- IEC 61850 implemented per Edition 2
- Remote switch control and monitoring via IEC 61850 protocol
- Inter-device GOOSE communications for remote interlocking
- GOOSE Publisher Setup, GOOSE Subscriber Setup and Report Dead-bands
- Configuration of IEC 61850: IED properties, datasets and reports

Bay Controller (BCU)

- 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 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
- Indication of non-controllable breaker trips
- Switch position substitution option
- Counting of breaker and switch operations
- Logging close / open operations and switch position changes
- Local switch control via setpoint control logic
- Configuration tools: PLC configurator based on IEC 61131-3 protocol, using Functional Block Diagram (FBD) or Ladder Diagram (LD)

Digital Fault Recorder

- Programmable fault threshold and hysteresis
- Direct reading of fault currents of up to 200 Amps (40 X In, from CT secondary)
- Dual current inputs: from measurement CT and protection CT connection (optional)
- 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

- Selectable pre-fault / post-fault recording length
- Programmable post fault on any internal and/or external trigger condition
- Disturbance capture recording
- Distance to fault calculation
- Waveforms from multiple locations
- View faults and receive alerts via the Expertpower software platform:
<https://www.satec-global.com/ExpertPower>

Distance to Fault Calculation

Compensation for CT / PT errors, resulting in 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
 - Line/s configuration
 - Line/s parameters (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

Phasor Measurement Unit (PMU)

- IEEE C37.118.1 M-Class and P-Class
- IEEE C37.118.1 three-phase voltage and current phasor measurements synchronized to a common UTC time reference (e.g. GPS), using an IRIG-B timecode source or an IEEE 1588 PTPv2 master clock source
- IEEE C37.118.1 synchronous frequency and Rate of Change of Frequency (ROCOF) measurements
- Expected steady-state total vector error (TVE): less than 0.5%
- Streaming rate: from 1 to 50 or 60 frames/sec @ 50 or 60Hz, respectively
- IEEE C37.118.2 commanded client-server UDP and TCP data transmission and spontaneous UDP data transmission over IP protocol
- Optional IEEE C37.118.2 frame extensions with analog data (total active, reactive and apparent power and power factor) and digital status data (up to 32 inputs)
- Streaming of phasor data over Ethernet using the IEC 61850-9-2 multicast sampled value (SV) service with IEEE C37.118.2 compliant mapping of synchrophasor data upon IEC 61850-9-2 and IEC 61850-90-5 guidelines

Data Logging, Waveform Recording & PLC Programming

- 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 (2 cycles of 1024 samples per cycle or 4 cycles

- with 512 samples per cycle with Transient Module)
- 3.5 min. of continuous waveform recording
- 1ms resolution for digital inputs
- 16 fast Data Recorders (16 parameters on each data log): From $\frac{1}{2}$ 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 programmable timers ($\frac{1}{2}$ cycle to 24 hours)

Wide Range Voltage Inputs

- Three galvanically isolated AC voltage inputs. Impulse dielectric withstand: 6kV
- Nominal voltage: 100-828V AC (L-L)

Wide Range Current Inputs

- 4 dual purpose current inputs (3 phase + Neutral current), calibrated to 1A or 5A nominal:
 - Class 0.25 revenue grade accuracy: up to $4 \times$ nominal current (4A and 20A, respectively; designed for measurement CTs' secondary current)
 - Basic Fault current reading: up to $10 \times$ nominal current (10A and 50A, respectively, designed for protection CTs' secondary current)
- Fault Recorder Modules:
 - Extended Fault Current reading: up to $40 \times$ nominal current (200A, designed for protection CTs' secondary current)

Communication Interfaces

- Built-in: RS-485 and Ethernet
- Optional:
 - TFX (fiber optic)
 - 2nd Ethernet port

Communication Protocols

- Modbus RTU, DNP3
- IEC 60870-5-101/104
- Optional: IEC 61850

Real-Time Clock & Synchronization

- Real-Time Clock with maximum 5 second drift per month @ 25°C
- 1ms time resolution per IRIG-B time code input or satellite clock for common time base
- Periodic clock synchronization from an SNTP server, as SNTP client
- Time sync from digital input with 1ms accuracy

Digital & Analog I/O Modules

3 expansion slots for a wide range of plug-in modules, up to 48 DI / 24 DO / 12 AI / 12 AO or various combinations

- **DI16:** 16 high-speed digital inputs (dry contact or 24/125/250V DC)
- **RLY8:** 8
- **8DIO:** 8 digital inputs (24/125/250V DC) and 4 digital outputs (Electro Mechanical Relay or Solid State Relay)
- **4AIO:** four analog inputs and four analog outputs (internal power supply); selection of 0-20mA, 4-20mA, 0-1mA or ±1mA output for inputs/outputs; ½ cycle update time

TECHNICAL SPECIFICATIONS

Input Ratings

VOLTAGE INPUTS

MODEL WITH AUX. POWER SUPPLY

Installation	Category III
Nominal voltage (L-N/L-L)	57/100V AC 277/480V AC 400/690V AC
Operating range	Direct input / input via PT up to 828V AC
Burden	480V L-N: 0.3VA 277V L-N: 0.1VA 120V L-N: 0.02VA
Over-voltage withstand	1,000V AC continuous, 2,500V AC @ 1 second
Galvanic isolation	4kV AC @ 1 min. Impulse dielectric withstand 6kV
Input impedance	1 MΩ
Wire size	up to 10 AWG (up to 6mm ²)
Terminal Pitch	7.5 mm

CURRENT INPUTS

STANDARD INPUTS FROM CT SECONDARY

Current ratings	» 1A input » 5A input
Guaranteed accuracy: » per IEC 62053-22	up to 2 X I _n @ Class 0.25
» per ANSI	up to 4 X I _n @ Class 0.2
Continuous overload	up to 10 X I _n
CONNECTION VIA SPLIT CORE SENSORS TO CT SECONDARY (HACS CS1S)	
Current ratings	» 1A input » 5A input
Continuous overload	up to 20 X I _n
Burden	< 0.15 VA @ 5A < 0.02 VA @ 1A

ATTENTION

The device may house up to 3 additional modules of choice from those mentioned below.

HACS SENSORS

40mA inputs, designated for SATEC's HACS (100-3,000A, see [HACS product page](#))

FLEX CLAMPS

3V AC inputs for 3rd party flex clamps

Power Supply

MAIN POWER SUPPLY

Withstanding insulation	4kV AC @ 1mn
AD/DC POWER SUPPLY (STANDARD)	L+, N- AND GND
Rated input	50-290V AC (50/60 Hz) 90-290V DC Max. power 10W (Burden: <20VA)
Wire size	up to 12 AWG (2.5mm ²)
Terminal pitch	7.5 mm, three pins

AUXILIARY POWER SUPPLY (MODULE)

Withstanding insulation	4kV AC @ 1mn
AC/DC option	L+, N- and GND
Rated input	50-290V AC (50/60 Hz) 40-290V DC
Low DC/DC option (12/24)	(+), (-) and GND
Rated input	9.6-35V DC, Maximum Power 20W (Burden: <40VA)
Wire size	Up to 12 AWG (2.5 mm ²)
Terminal pitch	7.5 mm, three pins

IrIG-B Time Sync

PORT ON CPU MODULE

Optically isolated IRIG-B port for GPS time synchronization

Recommended cable	51Ω low loss - RG58A/U (Belden 8219 or equivalent)
Recommended GPS time code generator	Masterclock GPS-200A

Built In Communication

SERIAL COMMUNICATION (RS-485)

Max. baud rate	115.2 kb/s
Optical isolation	4000V AC (L-G) @ 1 min.
Max. cable length	1000 m

Protocols	» MODBUS RTU/ASCII » DNP3 » IEC 60870 -5-101
2 nd com (RS485)	available with GSM / fiber optic
Connector Type	removable, captured-wire, 4 terminals
Wire size	up to 12 AWG (up to 2.5 mm ²)

ETHERNET PORT

Transformer-isolated 10/100BaseT Ethernet port	
Withstanding insulation	4kV AC @ 1 mn
Supported protocols	Modbus/TCP (Port 502), IEC 60870-5-104 (port 2404), IEC 61850, DNP3/TCP (Port 20000)
Num. of simultaneous connections	5 (2 Modbus/TCP + 2 DNP3/TCP + IEC 61850)
Connector type	RJ45 modular

USB PORT

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

FIBER OPTIC ETH PORT (MODULE)

Transformer-isolated 10/100BaseT Ethernet port	
Withstanding insulation	4kV AC @ 1 mn
Supported protocols	Modbus/TCP (Port 502), IEC 60870-5-104 (port 2404), DNP3/TCP (Port 20000), IEC 61850
Num. of simultaneous connections	5 (2 Modbus/TCP + 2 DNP3/TCP + IEC 61850)
Connector type	RJ45 modular

INFRA RED COMMUNICATION

Optional optical IEC/ANSI head, available on-board RGM remote display	
Baud rate	Up to 15.200 kb/s
Protocols	MODBUS RTU/ASCII, DNP3.0

SECOND SERIAL COMMUNICATION (RS-485)

Available on IRIG-B module. specs: identical to built-in serial port (above).	
--	--

Optional I/O Modules

8 RELAYS

Electromechanical; SPST Form A

Contact ratings	8A @ 250V AC 5A @ 30V DC 0.25A @ 250V DC 5A @ 24V DC
Galvanic isolation	4kV AC @ 1 min
Operate time	10ms max
release time	5ms max
Update time	1/2 cycle
Wire size	12 AWG (up to 2.5 mm ²)
Terminal pitch	3.81mm

16 DIGITAL INPUTS

Optically isolated

Sensitivity	open @ input resistance >16kΩ, closed @ input resistance <10kΩ
Galvanic isolation	4kV rms @1 min
Scan time	1 ms @ 60Hz, 1.25 ms @ 50Hz
Connector type	Removable, 5 pins
Wire size	12AWG (up to 2.5 mm ²)
Terminal pitch	3.81 mm

WET CONTACT SENSING OPTIONS

External power supply	24/48/125/250V DC
-----------------------	-------------------

DRY CONTACT SENSING OPTION

Internal power supply	24V DC
-----------------------	--------

COMBO: 8 DIGITAL INPUTS + 4 RELAY OUTPUTS

Galvanic isolation	4kV rms @1 min
Wire size	12AWG (up to 2.5 mm ²)
Terminal pitch	3.81 mm

DIGITAL INPUTS

Sensitivity	open @ input resistance >16kΩ, closed @ input resistance <10kΩ
Scan time	1 ms @ 60Hz 1.25 ms @ 50Hz

WET CONTACT SENSING OPTIONS

External power supply	24/48/125/250V DC
-----------------------	-------------------

DRY CONTACT SENSING OPTION

Internal power supply	24V DC
-----------------------	--------

RELAY OPTIONS

EMR (Electro Mechanic Relay) @ 250V/5A	
SSR (Solid State Relay) @ 1500V/20mA	
operate time	10ms max
release time	5ms max

4 ANALOG INPUTS + 4 ANALOG OUTPUTS

Optically isolated

Module rating (upon order)	» ± 1 mA, max. load 10 k Ω (100% overload)
Identical for inputs/ outputs	» 0-20 mA, max. load 510 Ω
	» 4-20 mA, max. load 510 Ω
	» 0-1 mA, max. load 10 k Ω (100% overload)

Power supply	Internal
Accuracy	0.5% FS
Update time	2 cycles
Connector type	Removable, 5 pins
Wire size	12 AWG (up to 2.5 mm ²)
Terminal pitch	3.81mm

Additional Modules

FAST TRANSIENT RECORDER

Measuring range	Up to 2kV AC
High impedance input	10 M Ω , withstanding insulation: 4kV AC @ 1mn
Wire size	Up to 10 AWG (up to 6 mm ²)
Terminal pitch	7.5 mm

DIGITAL FAULT RECORDER

VIA SPLIT CORE SENSORS (HACS CS2S) CLAMPED ON TO PROTECTION CT SECONDARY

Fault currents measured	Up to 200A RMS @ In = 5A (40 x In)
Accuracy	Class 1
Burden	< 0.15 VA
Wire size	10 AWG (2.5 to 6 mm ²)
Terminal pitch	9.5mm
Overload	Continuous: 200A RMS 1 second: 1000A

IRIG B

Optically isolated IRIG-B port for GPS time synchronization

Recommended cable	51 Ω low loss - RG58A/U (Belden 8219 or equivalent), BNC connector
Recommended GPS time code generator	Masterclock GPS-200A
Second RS-422/485 COM port included	

PHASOR MEASUREMENT UNIT

Per IEEE C37.118.1-4

IMPORTANT NOTE: Should be assembled on unit with min. Version No. N3 and min. firmware version No. v31.x.38.

Must be housed next to current module only.

Other Characteristics

REAL-TIME CLOCK & SYNCHRONIZATION

Real-Time Clock with maximum 5 seconds drift per month @ 25°C

1ms time resolution per IRIG-B time code

CONSTRUCTION

Mounting	DIN Rail mount / panel mount / 19" rack installation. Complies with EN50022
Dimensions [WxHxD]	220 x 152 x 210mm
Weight	2.5kg (5.51 Lb)

ENVIRONMENTAL CONDITIONS

Operational	-25°C to 60°C / -13°F to 140°F
Storage	-30°C to 85°C / -22°F to 185°F

STANDARDS COMPLIANCE

- Directive complied with EMC: 89/336/EEC as amended by 92/31/EEC and 93/68/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: Class 0.2S per IEC/AS 62053-22
- Reactive Energy: Class 0.5S (under conditions as per IEC 62053-24:2014 @ $0 \leq |PF| \leq 0.9$)

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

- Meets IEC/UL 61010-1 and UL94 V-0

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

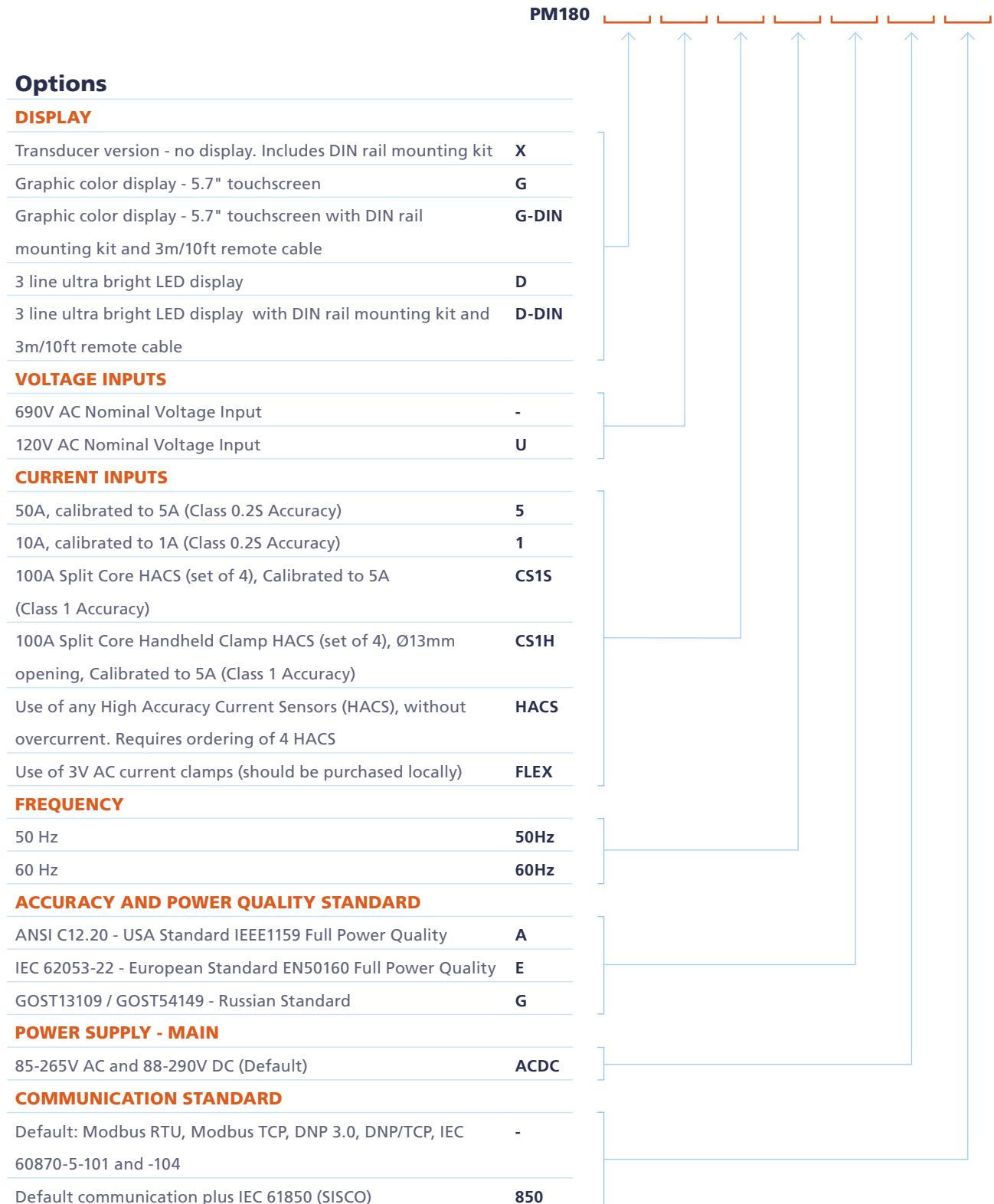
Panel Display protection

- IEC 60529: IP54 (NEMA type 13)

Instrument protection

- IEC 60529: IP30 (NEMA type 13)

ORDER STRING



Optional Plug-In Modules

Maximum 3 additional modules per device

PHASOR MEASUREMENT UNIT (max. 1 module per unit)

PMU with Transient Recorder including PTP (IEEE 1588)	PMU
---	-----

TRANSIENT RECORDER MODULE (max. 1 module per unit)

4 voltage channels, up to 2kV and 1024 samples/cycle	TRM-180
--	---------

FAULT RECORDER MODULE (max. 1 module per unit)

4 current channels, up to 200A, via 4 HACS CTs (included) as follows:

4 × solid core CTs (Ø 23 aperture)	DFR-CS2-180
4 × split core CTs (Ø 23 aperture)	DFR-CS2S-180
4 × split core CTs (Ø 33 aperture)	DFR-CS2SL-180

DIGITAL INPUTS (max. 48 Digital Inputs per unit)

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 per unit)

8 Relays	RLY8-180
8DI/4RO EMR DRC	8DIOR-DRC
8DI/4RO SSR DRC	8DIOS-DRC
8DI/4RO EMR 24V	8DIOR-24
8DI/4RO SSR 24V	8DIOS-24
8DI/4RO EMR 125V	8DIOR-125
8DI/4RO SSR 125V	8DIOS-125
8DI/4RO EMR 250V	8DIOR-250
8DI/4RO SSR 250V	8DIOS-250

COMMUNICATION

BNC IRIG-B and 2nd RS-422/485 port	IRIG-180
Fiber Optic Ethernet (TXXF), redundant Ethernet and 2nd RS-422/485 port	TXXF-180

4 ANALOG INPUT / 4 ANALOG OUTPUT MODULE (max. 12AI/12AO per unit)

+/- 1mA (0+/-1)	4AIO1-180
0-20 mA (0-10-20)	4AIO2-180
0-1 mA (0-0.5-1)	4AIO3-180
4-20 mA (4-12-20)	4AIO4-180

4 ANALOG INPUT (max. 12AI per unit)

+/- 10V	4AIV-180
---------	----------

AUXILIARY POWER SUPPLY (max. 1 modules per unit)

AUX. P.S. 85-265V AC and 40-300V DC	BACDC-180
AUX. P.S. 9.5-36 V DC	B21DC-180