SECTION 26 09 13 94 10
ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This section defines low voltage Power Metering for use in AC systems, rated 600 V or less.

B. Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for electrical power monitoring and control equipment as required for the complete performance of the work, and as shown on the Drawings and as herein specified.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. ***[Related Sections (where applicable) include the following:***
   1. ***Section 16430 – Low Voltage Switchgear***
   2. ***Section 16441 – Switchboard***
   3. ***Section 16442 – Panelboards***
   4. ***Section 16443 – Motor Control Centers***

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of the Contract and Division 01 - General Requirements.

B. Product Data: Submit shop drawings and product data showing material proposed for approval and final documentation in the quantities listed according to the Conditions of the Contract. Customer name, customer location and customer order number shall identify all transmittals.

C. ***[Final Documents: Record documentation to include wiring diagrams, instruction and installation manuals [and certified test reports].]***

1.4 RELATED STANDARDS

A. Meet the following recognized standards for application in hardened environments
   1. Power Meter must meet all ANSI (American National Standards Institute) and CSA (Canadian Standards Association) Standards applicable to this type of device:
      a. ANSI C12.20, "Electricity Meters – 0.1, 0.2, and 0.5 Accuracy Classes – Part 5.5.4 Accuracy tests."
      b. ANSI / ISA – 61010-1, "Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements."
      c. ANSI / ISA – 61010-2-030, "Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 2-030: Particular requirements for testing and measuring circuits."
      d. CAN/CSA C22.2 No. 61010-1, "Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements."
      e. CAN/CSA C22.2 No. 61010-2-030, "Safety Requirements for Electrical Equipment for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 2-030: Particular requirements for testing and measuring circuits."
   2. Power Meter must meet the following CENELEC (European) Standards (EN) applicable to this type of device:
      a. EN 55022/CISPR22, "Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement."
      b. CLC/TR 50579, "Electricity metering equipment (a.c.) - Severity levels, immunity requirements and test methods for conducted disturbances in the frequency range 2 kHz-150 kHz."

c. EN 61557-12, “Electrical safety in low voltage distributions systems up to 1,000 V a.c. and 1,500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 12: Power metering and monitoring devices (PMD).”
d. EN 61326-1, “Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements.”

3. Federal Communications Commission (FCC):
   a. Title 47 CFR Part 15, Subpart B, "Radio Frequency Devices."
4. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. ANSI/IEEE C37.90.1, "Surge Withstanding Capability (SWC) Tests for Relays and Relay Systems Associated with Electrical Power Apparatus."
   b. IEEE 802.3, “Standard for Ethernet.”
   c. IEEE 1588, “Precision Clock Synchronization Protocol for Networked Measurement and Control Systems.”
   d. IEEE 1815, “Electrical Power Systems Communications – Distributed Network Protocol (DNP3).”
5. Industry Canada (IC) Standards, Interference Causing Equipment Standard (ICES):
   a. ICES 003, “Information Technology Equipment (ITE) (including digital apparatus) - Limits and Methods of Measurement.”
6. International Electrotechnical Commission (IEC):
   a. IEC 61000-3-2, “Electromagnetic compatibility (EMC) -Part 3-2: Limits - Section 2: Limits for Harmonic Current Emissions (Equipment Input Current ≤16 Amperes per Phase).”
   b. IEC 61000-3-3, “Electromagnetic compatibility (EMC) -Part 3-3: Limits - Section 3: Limitation of Voltage Fluctuations and flicker in Low-Voltage Supply Systems for Equipment with Rated Current ≤16 Amperes Per Phase and Not Subject to Conditional Connection.”
   c. IEC 61000-4-2, “Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test.”
   d. IEC 61000-4-3, “Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test.”
   e. IEC 61000-4-4, “Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test.”
   f. IEC 61000-4-5, “Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test.”
   g. IEC 61000-4-6, “Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields.”
   h. IEC 61000-4-7, “Electromagnetic Compatibility (EMC) - Part 4-7: Testing and Measurement Techniques; General Guide on Harmonics and Interharmonics Measurements and Instrumentation, for Power Supply Systems and Equipment Connected Thereto.”
   i. IEC 61000-4-8, “Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test.”
   j. IEC 61000-4-11 “Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests."
   k. IEC 61000-4-12, “Electromagnetic compatibility (EMC) - Part 4-12: Testing and measurement techniques - Ring wave immunity test.”
   l. IEC 61000-4-18 “Electromagnetic Compatibility (EMC) – Part 4-18: Testing and Measurement Techniques – Damped Oscillatory Wave Immunity Test.”
   m. IEC 61010-1, “Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements.”
   n. IEC 61010-2-030, “Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 2-030: Particular requirements for equipment having testing or measuring circuits”

o. IEC 61850, “Communication networks and systems for power utility automation.”
p. IEC 62052-11, “Electricity Metering Equipment (AC) - General Requirements, Tests and Test Conditions - Part 11: Metering Equipment.” (Edition 1)
q. IEC 62053-22, “Electricity Metering Equipment (AC) - Particular Requirements - Part 22: Static Meters for Active Energy (Classes 0,1 S, 0,2 S, and 0,5 S).” (Edition 2)
r. IEC 62053-23, “Electricity Metering Equipment (AC) - Particular Requirements - Part 23: Static Meters for Reactive Energy (Classes 2 and 3).”
s. IEC 62053-24, “Electrical Metering Equipment (AC) – Particular Requirements – Part 24: Static Meters for Reactive Energy at Fundamental Frequency (Classes 0,5 S, 1 S, and 1).”
t. IEC 61588, “Precision Clock Synchronization Protocol for Networked Measurement and Control Systems.”

7. Underwriters Laboratories, Inc. (UL):
a. UL. 61010-1, “Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements.”
b. UL 61010-2-030, “Safety Requirements for Electrical Equipment for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 2-030: Particular requirements for equipment having testing or measuring circuits.”
c. UL 508A, “Industrial Control Panels.” (Product Supports Installation in UL 508A Rated Industrial Panels)

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of this equipment shall have a minimum of 5 years experience producing similar electrical equipment.

1. Comply with requirements of latest revisions of applicable industry standards.

2. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing electrical power monitoring and control equipment similar in type and scope to that required for this Project and shall be approved by the manufacturer.

1.6 DELIVERY, STORAGE AND HANDLING

A. Store and handle in strict compliance with manufacturer’s instructions and recommendations. Protect from potential damage from weather and construction operations. If the meters are installed in equipment, store the equipment so condensation will not form on or in it. If necessary, apply temporary heat where required to obtain suitable service conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The Power Meter shall be type 9410 by Siemens Industry Inc., or pre-approved equal. Approved manufacturers are as follows:
1. SIEMENS
2. ***[ ]***

2.2 GENERAL PROVISIONS

A. All setup parameters required by the Power Meter shall be stored in nonvolatile memory and retained in the event of a control power interruption.

B. The Power Meter may be applied in ***[4-wire wye] [3-wire wye] [3-wire delta] [direct delta] [single phase]*** systems.

C. A one-piece and remote display (Tran) design shall be available for the meter.

D. The Power Meter shall be fully supported by Power Meter Software.

2.3 Markings:

A. The Power Meter shall be CE marked and comply with the applicable EU directives.

B. The Power Meter shall be marked as UL compliant with the applicable UL standards.

2.4 Standards Compliance:

A. The Power Meter shall comply to the following safety/construction standards:

1. CAN/CSA C22.2 No. 61010-1.
2. CAN/CSA C22.2 No. 61010-2-030.
3. IEC 61010-1.
4. IEC 61010-2-030.
5. IEC 62052-11.
6. UL 61010-1.
7. UL 61010-2-030.

B. The Power Meter shall comply to the following electromagnetic immunity standards at levels consistent with those outlined in the construction standards:

1. ANSI/IEEE C37.90.1 (all inputs tested).
2. IEC 61000-4-2 (Electrostatic discharge immunity).
3. IEC 61000-4-3 (Radiated, radio-frequency, electromagnetic field immunity).
4. IEC 61000-4-4 (Electrical fast transient/burst immunity).
5. IEC 61000-4-5 (Surge immunity).
6. IEC 61000-4-6 (Immunity to conducted disturbances, induced by RF fields).
7. IEC 61000-4-11 (Voltage dips, short interruptions and voltage variations immunity).
8. IEC 61000-4-12 (Ring wave immunity).
9. IEC 61000-4-18 (Damped oscillatory wave immunity)
10. CLC/TR 50579 (Conducted disturbances immunity 2 kHz-150 kHz)

C. The Power Meter shall comply to the following electromagnetic emission standards:

1. FCC Title 47 CFR Part 15 (Subpart B, Class B: Class B digital device, radiated emissions).
2. EN 55011/CISPR11 (radiated/conducted emissions, Group 1, Class B).
3. EN 55032/CISPR32 (radiated/conducted emissions, Class B).
4. ICES 003 (industry Canada, ICES Class B digital device, radiated/conducted emissions).
5. IEC 61000-3-2 (limits for harmonic currents emissions; equipment input current less than 16 amperes per phase).
6. IEC 61000-3-3 (limitation of voltage fluctuations and flicker in low voltage supply systems for equipment with rated current less than 16 amperes).

D. The Power Meter shall comply to the following measurement standards with third party compliance certification as noted:

1. ANSI C12.20, Class 0.2 (Accuracy tests 1-9, 11, 13, 14 & Harmonic influence Tests 39-44). Third party certified.
2. IEC 62053-22, Class 0.2S. Third party certified.
3. IEC 62053-23, Class 2. Third party certified.
4. IEC 62053-24, Class 0.5S.

5. IEC / EN 61557-12, PMD-S.

E. The Power Meter shall comply to the following communications standards with third party compliance certification as noted:

1. EIA/TIA-485.
2. IEC 61850 – Parts 6, 7-1, 7-2, 7-3, 7-4 and 8-1. Third party certified.
3. IEEE 802.3
4. IEEE 1815 (DNP3 - Distributed Network Protocol).
5. Modbus Interoperability.
6. IEEE 1588 / IEC 61588 (Precision Time Protocol).

2.5 COMPONENTS

A. Current/Voltage Inputs
1. The Power Meter shall have no less than 4 voltage measurement terminals (including 3 phase and 1 neutral inputs).
2. The Power Meter shall have no less than 4 current inputs.
3. The Power Meter in its standard configuration shall be able to accept direct low voltage connections up to 600VLL/347VLN (UL) and 400 VLN/690 VLL (IEC) without using potential transformers.
4. The Power Meter shall be able to withstand 3300 volts AC RMS for 2 seconds without damaging the device.
5. The Power Meter in its standard configuration shall accept currents with nominal values of 1A, 2A, 5A, and 10A.
6. The Power Meter shall withstand an over current of 500 amperes for 1 second.

B. Control Power
1. The Power Meter shall be able to accept a wide range of control power inputs including 90 V AC to 415 V AC +/- 10% (45 to 65 Hz), 90 V AC to 120 V AC +/- 10% (400 Hz) or 110 V DC to 415 V DC +/- 10%, without need for a control power transformer.
2. The Power Meter shall be available with a low voltage DC control power option supporting 24 V DC to 60 V DC +/-10%.
3. The Power Meter shall have the ability to sustain operation through a control power outage of 200ms (12 cycles), typical, and ensure any events resulting in a control power outage will be captured.

C. Mechanical
1. The Power Meter shall be available in multiple form factors for panel mounting with an integrated display, and for DIN rail mounting without a display or with a remotely mounted display.
2. The panel mount meter with integrated display shall mount in a ¼ DIN, 92 x 92 mm (3.622” x 3.622”), cut-out without the need for tools.
3. The DIN rail mount meter, without a display, shall mount on a TS35 (35mm x 7.5mm) “top hat” (IEC/EN 60715) DIN rail without the need for tools.
4. The remotely mounted display shall support mounting in a ¼ DIN, 92 x 92 mm (3.622” x 3.622”), cutout, and support mounting in a 30.5 mm round hole (M30 punch).
5. The panel mount meter and the remotely mounted display shall meet UL/NEMA Type 12 and IP54 installation criteria when properly installed.
6. The Power Meter unit shall have removable connectors for voltage inputs, control power, communications, inputs, and outputs.
7. The Power Meter shall provide screw terminals for the current measurement inputs that accommodate ring terminals, spade terminals, and stripped wire.
8. The Power Meter shall have terminal covers for voltage inputs and current inputs.
9. The Power Meter shall allow the installation of a wire seal to provide tamper detection for voltage inputs, current inputs, the meter’s case, and the installation of the meter.

D. Environmental
   1. The Power Meter shall have an operating temperature rating of -25 to 70 ºC (-13 to 158 ºF).
   2. The Power Meter display shall have an operating temperature rating of -25 to 60 ºC (-13 to 140 ºF).
   3. The Power Meter and display shall be installable in environments up to 3000 meters (9843 feet), relative humidity of 5% to 95% non-condensing (to a maximum dewpoint of 37 ºC), pollution degree 2.
   4. The Power Meter shall be fully compliant with RoHS European directive ensuring the product does not include any of the 6 substances stated in the directive.
   5. The Power Meter shall be fully compliant with the REACH European regulation ensuring the product does not include any of the identified Substances of Very High Concern (SVHC).
   6. The Power Meter manufacturer shall provide, on request, a Product Environmental Profile (PEP) that provides a list of material, a recycling rate and a calculation of eleven environmental impacts such as raw material, energy consumption, carbon footprint and damage to the ozone layer that spans the entire product life cycle, from manufacture to end of working life.
   7. The Power Meter manufacturer shall provide, on request, an End of Life Instruction guide (EoLI) providing clear instructions for recycling and disposal of the Power Meter at the end of its working life.
   8. The Power Meter shall have select conformal coating of its internal circuitry for increased robustness of installations exposed to high degrees of humidity.

E. Measured Values
   1. The Power Meter shall provide the following, true RMS metered quantities for voltage:
      a. Voltage L–L Per-Phase
      b. Voltage L-L 3-Phase Avg
      c. Voltage L–N Per-Phase
      d. Voltage 3-Phase Avg
      e. Voltage % unbalanced
   2. The Power Meter shall provide the following true RMS metered quantities for current:
      a. Current Per-Phase
      b. Current, Neutral (measured)
      c. Current 3-Phase Avg
      d. Current % Unbalanced
   3. The Power Meter shall provide the following true RMS metered quantities for power:
      a. Real Power (Per-Phase, 3-Phase Total)
      b. Reactive Power (Per-Phase, 3-Phase Total)
      c. Apparent Power (Per-Phase, 3-Phase Total)
      d. Power Factor – True (Per-Phase, 3-Phase Total)
      e. Power Factor – Displacement (Per-Phase, 3-Phase Total)
   4. The Power Meter shall provide the following true RMS metered quantities for energy:
      a. Accumulated Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
      b. Incremental Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
      c. Conditional Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
      d. Energy by Quadrant (Real kWh, Reactive kVARh, Apparent kVAh)
   5. The Power Meter shall be able to provide a minimum/maximum value for any measured parameter.
   6. The Power Meter shall be capable of deriving values for any combination of measured or calculated parameter, using the following arithmetic, trigonometric, and logic functions:
      a. Arithmetic functions; division, multiplication, addition, subtraction, power, absolute value, square root, average, maximum, minimum, RMS, sum, sum-of-squares, unary minus, integer ceiling, integer floor, modulus, exponent, PI.

b. Trigonometric functions; COS, SIN, TAN, ARCCOS, ARCSIN, ARCTAN, LN, LOG10.
c. Logic functions; =, =>, <=, <>, <, >, AND, OR, NOT, IF.
d. Thermocouple linearization functions; Type J, Type K, Type R, Type RTD, Type T.
e. Temperature conversion functions; C to F, F to C.

F. Demand
1. The Power Meter shall be able to provide last completed interval demand, predicted demand, peak demand with date and time, and coincident demand values on multiple demand channels.
2. The Power Meter shall be able to perform multiple accepted demand calculation methods, including, but not limited to, block, rolling block, and thermal demand with user-programmable demand period lengths.
3. The Power Meter shall support the synchronization of the demand interval using a digital input, a command via communications, or internal clock.

G. Accuracy
1. The Power Meter shall meet ANSI C12.20 accuracy Class 0.2, current class 10.
2. The Power Meter shall meet IEC 62053-22 accuracy Class 0.2S with nominal current of 1A and 5A and maximum current of 10A.
3. The Power Meter shall meet IEC 62053-24 accuracy Class 0.5S with nominal current of 1A and 5A and maximum current of 10A.
4. The Power Meter shall meet IEC 62053-23 accuracy Class 2.0S with nominal current of 1A and 5A and maximum current of 10A.
5. The Power Meter shall provide four-quadrant metering fully compliant with IEC 61557-12 PMD.

H. Sampling
1. The Power Meter shall sample continuously at 256 samples per cycle for nominal frequencies of 50Hz and 60Hz.
2. The Power Meter shall be able to perform sag/swell detection of voltage disturbances on a half-cycle basis, providing the duration of the disturbance, the minimum, maximum, and average value of the voltage for each phase during the disturbance. Disturbances less than one cycle in duration can be detected.

I. Memory
1. The Power Meter shall have a maximum of 64 MB of non-volatile memory for configuration settings, log data, alarms, events, waveform captures, web pages, and documents. This will be virtually limited. Device should still contain minimum 512 MB of physical memory.
2. The Power Meter shall store critical internal and revenue data upon sudden power loss.
3. The Power Meter shall retain all data and configuration in non-volatile memory for 15 years without control power.
4. The Power Meter shall provide a real time clock (RTC) with battery backup that will provide ride-through of at least 7 years without control power.
5. The Power Meter shall have a field installable battery for real time clock ride-through that can be installed without need to remove the instrument from the installation.
6. Onboard meter clock shall be able to be paced by a choice of sources, including, but not limited to: GPS (RS485), IRIG-B, Precision Time Protocol (PTP), Network Time Protocol (NTP/SNTP), power line, or internal clock.
7. The Power Meter shall have a time-stamped event log with the following features:
   a. The number of records shall be user programmable up to 20000 events.
   b. Each event shall be recorded with the date and time of the event, the cause and effect of the event, and the priority of the event.
   c. Events relating to setpoint activity, relay operation, and self-diagnostics shall be recorded in the event log.
   d. Events relating to security activity such as successful or unsuccessful user log-in attempts, configuration changes, and resets shall be recorded in the event log.
   e. Time stamps shall have a resolution of 1 millisecond.

f. Time stamps can be synchronized to within +/- 1 millisecond between devices through the use of PTP (Precision Time Protocol), GPS (Global Positioning Satellites) serial input, or IRIG-B digital input.
g. Minimum event recording response time shall be 1/2 cycle (8.3 ms 60 hertz, 10 ms 50 hertz) for high speed events and 1 second for other events.
h. The priority of set point events shall be programmable.

8. The Power Meter shall be able to log any parameter in the meter, including, but not limited to, minimum/maximum and waveforms.
9. The Power Meter shall be capable of supporting a minimum of 50 independent data logs that support the following configuration options:
   a. Recording method of Fill and Hold or First In First Out (FIFO).
   b. Selection of up to 16 parameters per log.
   c. Log data on an event or based on internal clock.
   d. Ability to automatically fill gaps in data logs with a value of zero (0) or leave blank.

J. Alarming
1. The Power Meter shall have the ability to support a minimum of 65 setpoint driven alarms evaluated once per second or once every ½ cycle, user configurable
2. The Power Meter shall have the ability to support disturbance alarms for detecting voltage and current dips and swells on all monitored phases
3. The Power Meter shall be able to generate an E-mail on an alarm condition.
4. The Power Meter shall have millisecond time stamp resolution on alarm entries.
5. The Power Meter shall be able to adjust alarm setpoints based on the alarm quantity (alarm setpoint learning).
   a. The user shall be able to enable the Power Meter to learn the characteristics of normal operation of metered values and selected alarm setpoints based on this data
   b. The quantities to be learned shall be user selectable, including, but not limited to, standard speed alarms, high speed alarms, and disturbance alarms.
   c. The user shall be able to configure this feature using one of two modes:
      1.) Manual: Once the learning is completed, the recommended values shall be stored for review and manual installation.
      2.) Automatic: Once the learning is completed, the recommended values shall be automatically installed and operational.
   d. The learning period shall be user configurable from 1 to 365 days to ensure system stability prior to determining the recommended setpoints.
6. The Power Meter shall support consecutive high speed alarm conditions which shall trigger on a cycle-by-cycle basis with no delay time between events (i.e., no need for a rearming delay time between events).
7. The Power Meter shall be able to operate relays on alarm conditions.
8. The Power Meter shall be able to initiate data log captures on alarm conditions.
9. The Power Meter shall be able to control digital output relays using pulse mode or latch mode operation, for control and alarm purposes.
10. The Power Meter shall be able to combine any logical combination of any number of available setpoint conditions to control any internal or external function or event.

K. Communications
1. The Power Meter shall be capable of the following communications methods:
   a. Ethernet (Dual-port, single network) 10/100 Base –TX on both ports
   b. Ethernet Switch 10/100 Base –TX on both ports
   c. Ethernet Switch with RSTP (Rapid Spanning Tree Protocol) 10/100 Base –TX on both ports
   d. Serial - RS-485 (port 1).
2. The Power Meter shall support multiple concurrent Ethernet communication protocols over an Ethernet network at any one time:
   a. IEC61850
   b. DNP3.0 TCP/IP
   c. DLMS

d. Modbus TCP/IP
e. Modbus TCP/IP Mastering of Ethernet devices
f. ION TCP/IP
g. Ethernet to serial line gateway
h. FTP (file transfer)
i. HTTP/HTTPS (web interface)
j. PTP (precision time protocol)
k. NTP/SNTP (time synchronization)
l. SMTP (Email)
m. SNMP (network management with traps)
n. DHCP (automatic IP address assignment)
o. Syslog (to push security events to a remote server)
p. MV-90 compatibility

3. The Power Meter shall support any one of the following serial communications protocols on any one serial port at any one time:
   a. Modbus
      1.) Modbus RTU
      2.) Modbus mastering of serial RS-485 slaves.
   b. DNP 3.0
   c. DLMS
   d. ION
   e. MV-90 compatibility
   f. IEC 61850 compatibility
4. The Power Meter shall be able to support at least 32 concurrent Modbus TCP/IP connections.
5. The Power Meter shall have a Modbus TCP/IP gateway to provide a network connection to Modbus serial devices connected to a serial port on the instrument.
6. The Power Meter shall have the ability to read from and write to Modbus devices connected to a serial port on the instrument and on a common local area Ethernet network.
7. The Power Meter shall serve web pages with the following capabilities to:
   a. Provide real-time and historical data views in both tabular and graphical formats.
   b. Provide a histogram of harmonic data through the 31st harmonic.
   c. Provide a NEMA motor derating curve.
   d. Provide a phasor diagram representation of the electrical connections to the meter.
   e. Provide a graphical trend for voltage, average current, frequency, and power demand along with a forecast of the next 4 points.
   f. Provide the ability to visualize all voltage and current phases of captured waveforms concurrently using a standard web browser. Waveform viewer allows waveform selection, voltage, and current phase selection in any combination, zoom in, zoom out, panning with selected zoom, saving, and printing.
   g. Support the ability to provide technical documents, images, and drawings.
   h. Support user defined web pages containing data from the host meter as well as data from Modbus devices connected to a serial port on the instrument and on a common local area Ethernet network.
8. The Power meters shall have two (2) Ethernet ports that support both IPv4 and IPv6, as well as the following functions:
   a. The Power Meter shall automatically provide E-mail notifications for alarms and system status updates based on user configuration. E-mail messages sent by the Power meters shall be able to be received like any ordinary E-mail message.
   b. Ability to push historical logs through the Ethernet communication port to a remote server based on a user defined schedule or an event.
   c. The Power Meter shall have the ability to support SNMP with a standard MIB2 and custom MIB, and be capable of sending traps to an SNMP server when alarm conditions are detected.
   d. The Power Meter shall be able to automatically acquire an IPv4 and IPv6 address assignment from a DHCP server.

e. The Power Meter shall support Syslog protocol to allow it to send detected security events to a remote server.

9. The Power Meter shall provide an IEC 61850 compliant communications interface with the following features:
   a. Four (4) concurrent client connections
   b. File based setup via FTP.
   c. Network time sync via NTP.
   d. Configurable reports, including, but not limited to, selectable dataset member and configurable dead band values.
   e. Support four (4) buffered reports and twenty (20) unbuffered reports (one (1) buffered and five (5) unbuffered per client).
   f. Map up to 16 analog and/or 16 digital calculated values for reporting in IEC 61850.
   g. Fault capture data for three-phase voltage and current in COMTRADE format, including, but not limited to, the following:
      1.) Up to 225 COMTRADE fault capture files.
      2.) The files shall be downloadable via standard FTP client.
      3.) The device shall support client notification through IEC 61850 to signal when new fault captures have been created and are available (RDRE logical node).
   h. The following logical nodes shall be supported in addition to LLNO and LPHD (mandatory):
      1.) MHAI; harmonics.
      2.) MMTR; metering.
      3.) MMXU; measurement.
      4.) MSQI; sequence and imbalance.
      5.) MSTA; metering statistics.
      6.) GGIO; the ability to view data from and control all I/O points in the meter.
      7.) RDRE; disturbance recorder function.
10. The Power Meter shall have the ability to announce its presence on a local network segment using Device Profile Web Services (DPWS) over IPv6 local addressing without user interaction. The instrument shall be viewable in a Microsoft™ Windows™ Windows Explorer window view of network devices as a link that will provide access to the instrument's web interface.
11. The Power Meter shall have the ability to request and receive a precision time synchronization message through the Ethernet network using PTP (precision time protocol) in compliance with IEEE 1588 / IEC 61588 standards supporting the PTP default profile.

L. Security
1. The Power Meter shall have the ability to independently enable or disable communication ports, enable or disable communication protocols per communications port, and assign TCP/IP port numbers per communications protocol.
2. The Power Meter shall support secure protocols that include HTTPS in accordance with TLS 1.2.
3. The Power Meter shall provide a Security log to capture security related events such as log-in / log-out (whether successful or failed), configuration changes, resets, and other events identifying the date and time of the event and the user name of the requestor.
4. The Power Meter shall support Syslog protocol to deliver security events to a network management server.
5. The Power Meter shall have multi-level security which shall support customized access for up to 50 users.
6. The Power Meter shall have revenue security capabilities, including, but not limited to, the following:
   a. Password protected, no hardware lock, or
   b. Password protected, and hardware locked, or
   c. The following data shall be protected from alteration when locked:

1.) kWh and kVARh (import, export, net and total).
2.) kVAh (import, export, net and total).
3.) kW, kVAR, kVA demand (block and sliding window).
4.) kWh, kVARh, kVAh pulse outputs.

7. The Power Meter shall be field upgradeable with a digitally signed update file.
8. The Power Meter shall provide a physical lock switch that will preserve all meteorological configuration values to ensure accurate and consistent energy metering.
9. The Power Meter shall provide the ability to secure its meteorological lock switch as well as all voltage, current and control power inputs with tamper detectable wire seals.

M. I/O Options
1. The Power Meter shall be capable of having up to 27 digital inputs capable of one (1) millisecond timing resolution.
2. The Power Meter shall be capable of receiving unmodulated IRIG-B time synchronization protocol through integrated digital inputs to ensure system wide time accuracy.
3. The Power Meter shall have one (1) Form A digital output that supports pulse output operation for kWh total, kWh imported, kWh exported, kVARh total, kVARh imported, kVARh exported, and kVAh values.
4. The Power Meter shall have an optical test output that is compliant with IEC 62052-11.
5. The Power Meter shall be capable of having up to eight (8) Form C relays which shall be isolated for up to 3200 volts AC (2 seconds), with reinforced isolation rated for 300 V. Overvoltage Category II. The relays shall support maximum current of eight (8) amperes continuous for 250VAC or five (5) amperes continuous for 24 volts DC for 20,000 cycles (resistive load).
6. The Power Meter shall be capable of having up to sixteen (16) Analog inputs which shall be isolated and support inputs of four (4) to twenty (20) milliamps, zero (0) to twenty (20) milliamps, or zero (0) to thirty (30) volts DC.
7. The Power Meter shall be capable of having up to eight (8) Analog outputs of four (4) to twenty (20) milliamps, zero (0) to twenty (20) milliamps, or zero (0) to ten (10) volts DC range.

N. Advanced Metering Option Modules:
1. The Power Meter shall be capable of supporting option modules to expand digital and analog I/O and physical communication capabilities without need for additional control power sources.
2. I/O Expansion Modules
   a. Digital Module
      1.) 6 Digital status input
      2.) 2 Form C relay output, 250 V AC, 8 A
   b. Analog Module
      1.) 4 analog inputs (0-20 mA, 4-20 mA; 0-30 V).
      2.) 2 analog outputs (0-20 mA, 4-20 mA; 0-10 V)
3. Communication Option Modules
   a. Fiber-Ethernet option Module
      1.) Multimode 10/100 Base-FX
   b. 4-Wire RS-485 option module
      1.) 4 Wire RS-485 serial port
4. The Power Meter shall be capable of supporting up to four (4) optional modules (Fiber-Ethernet, 4-Wire RS-485, I/O modules) that can be connected to the meter.
5. The Power Meter shall be capable of supporting only one (1) Fiber-Ethernet and one (1) 4-Wire RS-485 option module per meter.
6. The Power Meter onboard 2-Wire RS-485 port shall be disabled after connecting with 4-Wire RS-485 option module.

O. Display

1. The Power Meter shall have two (2) 96x96 mm (3.5”) pushbutton controlled graphical color display options: an integral display for panel mounting and a remote mounted display for a DIN rail mounted meter.
    a. The Power Meter shall have an integral 320 x 240-pixel backlit color graphical LCD display, TFT, 2.8 inches (71 mm) by 2.1 inches (53 mm), with a UL type 12 / IP54 rating.
    b. The Power Meter displays shall have a -25 to 60° C operating temperature at < 3000 meters (9843 ft) above sea level.
    c. The remotely mounted display shall be able to be located up to 100 meters (330 feet) from the Power Meter and be powered through a single standard Cat5/5e unshielded twisted pair cable.
2. The Power Meter shall be capable of presenting all real-time parameters on the instrument’s display.
3. The Power Meter shall have a user-programmable custom display that shall be capable of displaying up to six (6) quantities on a single screen.
4. The Power Meter shall be capable of displaying advanced graphical representations of metering information, including, but not limited to, harmonic histograms, phasor diagrams, and bar graphs.
5. The Power Meter shall be able to display measurements in either IEC or IEEE formats.
6. The Power Meter display shall support multiple languages, including, but not limited to, English, French, Spanish, German, Italian, Portuguese, Russian, and Chinese.
7. The Power Meter shall be able to present the following display screens:
    a. Numeric: Display one (1) parameter, one (1) parameter with timestamp, two (2) parameters, three (3) parameters, three (3) parameters with timestamp, or four (4) parameters at a time.
    b. Event Log: Display recent events written to the Power Meter’s event log, including, but not limited to, diagnostic events.
    c. Nameplate: Display information in a tabular format (default nameplates shall show Owner and meter details).
    d. Bar: Display up to three (3) real time numeric parameters along with their upper and lower extremes.
    e. Histogram: Display harmonics content in histogram format, including, but not limited to, 2nd to 31st harmonic, THD (total, even, odd).
8. Phasor: Display color coded current and voltage phase information in a phasor diagram format, including tabular display of magnitudes and angles.
9. Inputs and Outputs: Display digital input and output status, and analog input and output values.
10. Alarm: Display a listing of active and historical alarms and events.
11. Waveform: Display voltage and current waveforms captured by the meter based on measured disturbances, events, or manual trigger.

P. Field Configuration: The Power Meter shall be configurable as follows:
1. Provide voltage input scale, voltage mode (wye, delta, single-phase), current input scale, auxiliary input and output scales, and communications setup parameters that shall be configurable from the instrument’s display, or via web pages.
2. Basic parameters described above, plus additional setpoint and data log setup parameters may be programmed via the communications port using a PC.
3. Custom configuration of operating parameters shall be possible through a graphical, flexible programming language.
4. The configuration of the device shall be done using programmable modules. The modules shall be linked together in an arbitrary manner to create arbitrary functionality. Some example module types include, but shall not be limited to, minimum, maximum, setpoint, digital input, and digital output.
5. Programming through a computer shall be secured by user ID and password.
6. Programming through the instrument’s display shall be secured by password.

7. Programmability shall be sectioned such that when the meter is sealed it shall still be configurable to an extent that does not affect the accumulation of revenue metering related data.

Q. Power Quality
1. The Power Meter will provide basic power quality information including, and limited to, harmonics to the 31st harmonic and sag/swell measurement. The data provided is meant to be informational and not compliant to any standard.
2. The Power Meter will not be third party compliant for any Power Quality features.
3. The Power Meter shall be capable of monitoring and comparing the value of any statistical indicator of basic power quality (present, predicted, average, or otherwise manipulated value) with an absolute or relative setpoint. When such setpoint is exceeded, an alert shall be issued via E-mail or pager, or control shall be enabled via a local interface to mitigation equipment or control systems through relays and analog or digital outputs.

R. Waveform Capture
1. The Power Meter shall simultaneously capture voltage and current channels for sub-cycle disturbance, transients, as well as multi-cycle sags, swells, and outages in quick succession, without dead time between recordings.
2. The Power Meter shall be able to perform 128 samples per cycle waveform recording (60/50 Hz).
3. The Power Meter shall have eight (8) programmable oscillographic waveform recorders. Each waveform recorder shall have the following features:
   a. Able to record a digitized representation of any phase voltage or current signal with no dead time between such recordings, and the ability to trigger multiple such recordings in continuous succession, and at different resolutions simultaneously.
   b. Enabled and triggered manually or through internal operating conditions, including, but not limited to, periodic timer or setpoint activity.
   c. Half-cycle triggering shall be supported for waveform recorders.
   d. The number of records (depth) of each data recorder, and the overflow conditions (stop-when-full or circular) shall be programmable.
   e. Ability to record 720 cycles with 120 cycles prior to the fault at 128 samples per cycle minimum.
4. The Power Meter shall be able to record continuously to capture long duration waveforms. The duration of the waveform capture shall be limited by memory alone.
5. The Power Meter shall be configurable to provide up to 225 COMTRADE disturbance capture files for waveforms that are available via FTP and provide client notification of new captures through IEC 61850 (RDRE logical node).
6. The Power Meter shall provide a web interface for viewing captured waveforms with the ability to display any combination of or all recorded voltage and currents channels concurrently, display the value and time stamp of any point along the waveform, provide zooming, panning and allow panning with a user selected zoom.

S. High-Speed Data Logging:
1. The Power Meter shall be capable of recording high-speed data captures containing one (1) cycle of RMS data updated every half (1/2) cycle.
2. The Power Meter shall be able to record over 1 minute of 1-cycle RMS values every ½ cycle for voltage, current, frequency, power, power factor and unbalance, based on a power system event and record up to 30 seconds of 1-cycle RMS values prior to the event.
3. The Power Meter shall be able to initiate a high-speed data capture based on a setpoint condition, user programmed logical condition, or command received via communication.
4. The Power Meter shall be capable of capturing high-speed logs concurrently with a waveform capture.

T. Disturbance Direction Detection
1. The Power Meter will not support Disturbance Direction Detection feature at launch for the Essential variant.

U. Programmability
   1. Provide a graphical flexible programming capability with programmable modules that access metered and input data.
   2. Capable of deriving values and combinations of measured or calculated parameters, using arithmetic, trigonometric, logic, thermocouple linearization and temperature conversion functions.
   3. Programming modules can be arbitrarily linked together to create application functionality such as totalizations, efficiency measurements, load aggregation, control functions, load shedding, demand response, power factor correction, and compliance monitoring.
   4. Ability to read data from networked Modbus devices for the purposes of logging, exporting, aggregation, totalization, display visualization, web visualization or other user defined functions.

V. Advanced Features
   1. The Power Meter shall have provisions for creating periodic or non-periodic schedules for up to two (2) years. These schedules shall be used to perform the following functions:
      a. Time of use (TOU).
      b. Demand control.
      c. Load scheduling.
      d. Logging.
      e. Periodic resetting.
   2. The Power Meter shall have multiple tariffs and time-of-use (TOU) functionality to store and monitor up to twenty (20) years of seasonal rate schedules. The TOU feature shall allow four (4) seasons, four (4) day types (each one capable of at least eight (8) switch times, with a resolution of one (1) minute). The TOU feature shall support four (4) rate tariffs, and at least twelve (12) holidays per year, and shall allow periodic self-read capability.
   3. The Power Meter shall be capable of providing consumption and rate of usage information with user defined units of measure from pulse inputs and analog inputs to support metering of utilities such as water, air, gas, electricity, and steam (WAGES).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

   1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION

A. The meter shall be installed at the factory by a manufacturer's trained employee.

B. Additional connections to metering systems, where applicable, shall be done in the field by ***[the manufacturer's start-up service group] [the installing contractor]***.

3.3 ADJUSTING AND CLEANING

A. The meters shall be adjusted so that accurate readings appear on the front of the meter and that the readings are within the meters accuracy range.

B. Clean exposed surfaces using manufacturer recommended materials and methods.

3.4 TESTING

A. Perform factory and installation tests in accordance with applicable NEC, NEMA and UL requirements.

3.5 WARRANTY

A. Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, but not more than eighteen months from date of shipment.

3.6 ***[STARTUP SERVICES]***

A. ***[Engage a factory-authorized service representative to perform startup service.]***

B. ***[Train Owner's maintenance personnel on procedures and schedules for energizing and de-energizing, troubleshooting, servicing and maintaining equipment and schedules.]***

C. ***[Verify that the [meter is] [meters are] installed and cone***

D. ***cted according to the Contract Documents.]***

E. ***[Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 16 Sections.]***

F. ***[Complete installation and startup checks according to manufacturer's written instructions.]***

END OF SECTION