SECTION 230923.13 - ENERGY METERS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
	* + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			1. SUMMARY
				1. Section includes thermal and electric power energy meters that connect to DDC systems.
				2. Related Requirements:

Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.13.

* + - 1. DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

* + - * 1. DDC: Direct-digital control.
				2. Ethernet: Local area network based on IEEE 802.3.1 standards.
				3. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
				4. I/O: Input/output.
				5. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
				6. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.
				7. RS-485: A TIA standard for multipoint communications using two twisted pairs.
				8. RTD: Resistance temperature detector.
			1. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Product Data: For each type of product, including the following:

Construction details, material descriptions, dimensions of individual components and profiles, and finishes.

Operating characteristics, electrical characteristics, and furnished accessories indicating electrical power requirements.

Product description with complete technical data, performance curves, and product specification sheets.

* + - * 1. Sustainable Design Submittals:
				2. Shop Drawings:

Include plans, elevations, sections, and[**mounting**] details.

Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

Include diagrams for power, signal, and control wiring.

Retain "Product Certificates" paragraph below to require submittal of product certificates from manufacturers.

* + - * 1. Product Certificates: For each product requiring a certificate.
			1. CLOSEOUT SUBMITTALS
				1. Operation and Maintenance Data: For energy meters to include in operation and maintenance manuals.
1. PRODUCTS

See Editing Instruction No. 1 in the Evaluations for cautions about named manufacturers and products. For an explanation of options and Contractor's product selection procedures, see Section 016000 "Product Requirements."

* + - 1. THERMAL ENERGY METERS
				1. Performance Requirements: Manufacturer shall certify that each energy meter indicated complies with specified performance requirements and characteristics.

Product certificates are required.

* + - * 1. Insertion-Type Thermal Energy Meters:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9841) Subject to compliance with requirements, provide products by one of the following:

[ONICON Incorporated](http://www.specagent.com/Lookup?uid=123457048446).

Siemens Industry, Inc., Building Technologies Division

[Veris Industries](http://www.specagent.com/Lookup?uid=123457048447).

Approved equivalent.

Requirements in remaining subparagraphs are based on Onicon's "System 10 series."

Description:

Factory-packaged meter consisting of supply and return temperature sensors, flow sensor, digital display, keypad user interface, installation hardware, color-coded interconnecting cabling, and installation instructions.

Each thermal energy meter shall be individually calibrated and provided with calibration certification traceable to NIST.

Alphanumeric display of the following on face of enclosure:

Total energy consumption.

Energy rate.

Flow rate.

Supply temperature.

Return temperature.

Visual indication of power status (on/off) on face of enclosure.

Electronics Enclosure:

Remote from temperature and flow sensors.

NEMA 250, Type 12 or Type 13 for indoor applications and NEMA 250, Type 4 or Type 4X for outdoor applications.

Labeled terminal strip for field wiring connections.

Programming:

Factory programmed for specific application and field programmable through keypad on face of enclosure.

Programmed parameters and total energy consumption shall be stored in non-volatile EEPROM memory.

Retain "Output Signals" or "Serial Communication Interface" subparagraph below.

Output Signals:

Total Energy Consumption: Isolated solid-state dry contact with 100 mA, 50-V rating and contact duration of 0.5, 1, 2, or 6 seconds.

Energy Rate, Flow Rate, Supply Temperature, Return Temperature: 4 to 20 mA or zero- to 10-V dc for each.

Retain first subparagraph below to give choice to use serial communication for remote interface in lieu of hardwired signals.

In lieu of hardwired analog signals, a serial communication interface may be used.

Serial Communication Interface: Compatible with host to share total energy consumption, energy rate, flow rate, and supply and return temperature data.

Temperature Sensors:

Temperature range matched to application.

Differential temperature accuracy within 0.15 deg F (0.08 deg C) over the calibrated range.

NEMA 250, Type 4 junction box with thermal isolation.

Stainless-steel thermowell with NPS 1/2 (DN 15) NPT connection for each sensor.

Flow Sensor:

Suitable for an operating pressure of at least 200 psig (1378 kPa).

Meters in hot-water systems shall be suitable for maximum system temperatures encountered, but not less than 250 deg F (121 deg C).

Pressure drop not to exceed 1 psig (6.89 kPa) at 20-fps (6.1-m/s) flow velocity in NPS 2 (DN 50) pipe and decreasing in large pipe with lower velocity.

Sensor Accuracy:

Within 1 percent of actual flow between the flow velocity range of 3 to 30 fps (0.9 to 9 m/s).

Within 2 percent of actual flow between the flow velocity range of 0.4 to 20 fps (0.1 to 6.1 m/s).

Within 0.5 percent of actual reading at the calibrated velocity.

Wet calibrate and tag each sensor to standards traceable to NIST, and provide each sensor with a certificate of calibration.

Provide single turbine sensors for pipe size NPS 2 (DN 50) and smaller. Provide dual turbine sensors for pipe size NPS 2-1/2 (DN 65) and larger. Provide bidirectional dual turbine sensors where installed in bypass piping.

For sensors with dual contra-rotating turbine elements, provide each turbine element with its own rotational sensing system and an averaging circuit to reduce measurement errors due to a poor flow profile.

Rotational sensing of each turbine shall be accomplished electronically by sensing impedance change. The sensor shall have an integral frequency output linear with flow rate and individual top and bottom turbine outputs for diagnostic purposes.

Provide the flow sensor complete with installation hardware necessary to enable insertion and removal from the pipe without system shutdown.

Construct turbine elements of polypropylene with sapphire jewel bearings and tungsten carbide shafts. Construct wetted metal components of Type 316 stainless steel, including the installation hardware.

House the sensor electronics in a NEMA 250, Type 4 weathertight aluminum enclosure with a gasketed cover. Housing shall include connection for field-installed conduit.

Sensor cable length shall be sufficient to connect to display module.

Sensor housing shall have full-port [**Type 316 stainless-steel**]ball valve for system isolation.

Power Supply:

Field Power: 120-V ac, 60 Hz unless otherwise required by the application.

Internal Power: As required by flow meter.

* + - * 1. In-Line, Compact-Type Thermal Energy Meters:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9842) Subject to compliance with requirements, provide products by the following:

[ONICON Incorporated](http://www.specagent.com/Lookup?uid=123457048449).

Siemens Industry, Inc., Building Technologies Division

Veris Industries

Approved equivalent.

Requirements in remaining subparagraphs are based on Onicon's "System 30 series."

Description:

Factory-packaged meter consisting of supply and return temperature sensors, flow sensor, digital display, operator interface, installation hardware, interconnecting cabling, and installation instructions.

Each thermal energy meter shall be individually calibrated and provided with calibration certifications traceable to NIST.

Meter limited to flow rates between 0.8 and 38 gpm (0.05 to 2.4 L/s).

Meter mode of operation shall be field configurable to accommodate two pipe systems that change from between heating and cooling.

Alphanumeric display of the following on face of enclosure:

Total energy consumption.

Energy rate.

Flow rate.

Supply temperature.

Return temperature.

Diagnostic Lights:

Meter equipped with diagnostic indicator lights that confirm the operation of the microprocessor and its input circuitry.

Red LED labeled "BTU" shall flash as energy is transferred.

Red LED labeled "FLOW" shall flash at a rate that is proportional to the liquid flow rate. An unlit LED indicates no flow signal.

Programming:

Meter shall be factory programmed for specific application.

Programmed parameters and total energy consumption shall be stored in non-volatile memory.

Retain "Output Signals" or "Serial Communication Interface" subparagraph below.

Output Signals:

Mode 1 and Mode 2 Total Energy Consumption: Isolated solid-state dry contact with 100 mA, 50-V rating and contact duration of 0.5, 1, 2, or 6 seconds.

Factory-set isolated analog output for energy rate, flow rate, or temperature difference: 4 to 20 mA, zero to 5 or 10 V.

Retain first subparagraph below to give choice to use serial communication for remote interface in lieu of hardwired signals.

In lieu of hardwired output signals, a serial communication interface may be used.

Serial Communication Interface: Compatible with host to share total energy consumption, energy rate, flow rate, and supply and return temperature data.

Temperature Sensors:

Temperature range matched to application.

Differential temperature accuracy within 0.15 deg F (0.08 deg C) over the calibrated range.

One temperature sensor shall be built into the body of the flow sensor.

Second sensor shall be provided with brass thermowell with NPS 1/2 (DN 15) sweat fitting or NPS 1/4 (DN 6) NPT connection.

Flow Sensor:

Ambient Temperature: 40 to 120 deg F (4 to 49 deg C).

Process Temperature: 32 to 200 deg F (0 to 93 deg C).

Maximum Process Pressure: 400 psig (2758 kPa).

Pressure Drop: 3 psig (20 kPa) at 38 gpm (2.4 L/s).

Accuracy:

Within 1 percent of actual flow over flow rate range of 5.7 to 38 gpm (0.4 to 2.4 L/s).

Within 2 percent of actual flow over flow rate range of 0.8 to 38 gpm (0.05 to 2.4 L/s).

Within 0.5 percent of actual reading at the calibrated velocity.

Construct flow sensor body of brass.

Furnish with two tail pieces to facilitate connection to the piping system. One end of each tail piece shall be a compression fitting with retaining nut, and the other end shall either be a sweat fitting for copper or a threaded nipple with NPT threads.

Process Connections: NPS 3/4 or NPS 1 (DN 20 or DN 25).

House electronics in a NEMA 250, Type 4 weathertight aluminum enclosure with a gasketed cover. Housing shall include connection for field-installed conduit.

Sensor cable length shall be sufficient to connect to display module.

Power Supply:

Field Power: 24-V ac, 50 or 60 Hz unless otherwise required by the application.

* + - 1. ELECTRIC POWER METERS
				1. Performance Requirements: Manufacturer shall certify that each energy meter indicated complies with specified performance requirements and characteristics.

Product certificates are required.

* + - * 1. Fully Programmable Multifunction Electric Power Meter:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9843) Subject to compliance with requirements, provide products by one of the following:

ONICON Incorporated

[Siemens Industry, Inc., Building Technologies Division](http://www.specagent.com/Lookup?uid=123457048451).

[Veris Industries](http://www.specagent.com/Lookup?uid=123457048452).

Approved equivalent.

Requirements in remaining subparagraphs are based on Siemens' "9330 series."

Hardware:

Voltage Inputs: Three voltage inputs, capable of measuring from zero- to 347-V rms (line to neutral) or from zero- to 600-V rms (line to line). The device shall have provisions for direct connection for wye (Star) systems up to 347/600-V ac. For higher voltage systems, PTs with 120-, 277-, or 347-V ac secondary shall be supported. Voltage inputs shall provide the following:

1500-V ac continuous surge protection.

25 percent of full-scale voltage over range capability.

Current Inputs: Three 5-A nominal (10-A full-scale) current inputs. Current inputs shall be transformer coupled and accept CTs with 5-A nominal (10-A full-scale) outputs. Current inputs shall provide the following:

300-A surge protection for one second.

25 percent of full-scale current continuous over range capability.

Power Supply: 95- to 240-V ac (within 10 percent) at 47 to 440 Hz, 110- to 300-V dc, or 20- to 60-V dc power source. Load shall not exceed 12 W.

On-board I/O:

Four digital (status) inputs.

Four optically isolated, Darlington transistor digital (status) outputs with the following features:

Outputs shall have the ability to be used to provide pulse outputs according to any energy consumption levels.

Outputs shall be scalable to within 1,000,000,000 units per pulse.

Four analog I/O operator selectable from:

Milliamp inputs.

Zero- to 20-mA inputs.

Four zero- to 1-mA outputs.

Four zero- to 20-mA outputs.

Four zero- to 1-mA inputs and four zero- to 1-mA outputs.

Four zero- to 20-mA inputs and four zero- to 20-mA outputs.

Analog inputs and outputs shall be accurate to within 0.3 percent of full scale.

Provisions for future external I/O: Instrument shall support the following provisions for I/O for future applications. The external I/O shall support up to four digital output devices and shall support the following devices:

120-V ac, 3.5 A, N.O. solid-state relay.

120-V ac, 3.5 A, zero voltage turn-on, manual override relay.

240-V ac, 3.5 A, N.O. solid-state relay.

240-V ac, 3.5 A, zero voltage turn-on, manual override relay.

60-V dc, 3.5 A, N.O. solid-state relay.

60-V dc, 1.5 mA, zero voltage turn-on, manual override relay.

60-V dc, 1.0 A, low-leakage, N.O. solid-state relay.

200-V dc, 1.0 A, N.O. solid-state relay.

100-V dc, 0.5 A, N.O. mechanical relay.

Communications:

Provide the following built-in communication ports of standard technology, as defined by IEEE:

Two optically isolated RS-485 communication ports, supporting data rates from 1200 to 19200 bits per second.

One front-panel infrared optical port for RS-232 communications, supporting data rates from 1200 to 19200 bits per second. This port shall support an ANSI Type II optocoupler.

Ethernet port that has a gateway that allows the host system to communicate through the Ethernet port to additional metering devices connected to the card's COM2 RS-485 port. The device shall have provisions for an internal Ethernet port compatible with 10Base-T Ethernet. The Ethernet port shall be terminated using an RJ-45 connector.

Internal 33.6-kbps modem that has a gateway that allows the host system to communicate through the modem port to additional metering devices connected to the card's COM1 RS-485 port. The internal modem shall be certified for use on North American telephone systems only. The modem port shall be terminated using either an RJ11 or a captured wire connector.

Communication ports shall support the following communication capabilities, independently configurable:

SEAbus/ION protocol.

Modbus RTU protocol.

DNP 3.0 protocol.

Simultaneous access through all communication ports to any measured or derived parameter.

Protocols shall be field configurable from the front display, or via communication ports, and be capable of being accomplished without resetting the meter or interrupting its operation in any way.

Provisions for flash firmware that can be field upgraded through any communication port, without de-commissioning the instrument or de-energizing the circuit or equipment. The firmware-upgrade procedure shall be robust and able to recover from power failure during an upgrade.

Support time synchronization broadcast messages from a host computer system.

Mounting Options:

3.6-by-3.6-inch (92-by-92-mm) panel cutout, using sliding clamps tightened by thumbscrews.

Transducer-type base unit with a remote backlit digital display, with cable for remote display applications.

Transducer-type base unit with no display, locally mounted.

Allow operator to remove and replace the display panel without removing the instrument from the equipment in which it is mounted.

Front-Panel Display:

Programmable buttons that allow access to eight data display screens.

Display measured parameter with its corresponding label.

Display any four parameters simultaneously using alphanumeric characters.

Display any two parameter simultaneously using large alphanumeric characters.

Display any parameter using very large alphanumeric characters.

Display basic voltage, current, and power readings using extra-large alphanumeric characters.

Allow the operator to change parameter labels.

Feature a programmable time-out interval and adjustable contrast.

Enclosure: If installation requires meter to be installed in a dedicated enclosure, install meter in an NRTL-listed enclosure suitable for operating environment at meter location.

Indoors: NEMA 250, [**Type 1**] [**or**] [**Type 12**].

Outdoors: NEMA 250, [**Type 4**] [**or**] [**Type 4X**].

Memory: 512 kBs of non-volatile RAM to store the following:

Setup data.

A time-stamped event log with the following features:

Support at least 500 events.

Number of records in the log shall be programmable.

Each event record shall record the date and time of the event, the cause and effect of the event, and the priority of the event.

Events relating to set-point activity, relay operation, and self-diagnostics shall be recorded in the event log.

Time stamps shall have a resolution of one millisecond.

Time stamps shall be able to be synchronized to within 100 ms between devices on the same serial communication medium.

Minimum event recording response time shall be one second.

The priority of set-point events shall be programmable.

Two programmable data recorders that can each store up to 16 channels of historical trend data with the following features:

Each data recorder shall be able to record any parameter, either measured or derived.

Each data recorder shall be enabled and triggered manually or through internal operating conditions, including periodic timer or set-point activity.

The number of records (depth) of each data recorder and the overflow conditions (stop-when-full or circular) shall be programmable.

Memory shall be dynamically allocated between data recorders and event log to allow storage of any 16 parameters at 15-minute intervals for not less than 30 days.

Min/Max data for any monitored parameter.

Instrument:

Display Web pages over a standard Internet browser. Web pages shall include real-time instantaneous values, accumulated energy values, and total harmonic distortion.

Automatically e-mail alarm notifications or scheduled system status updates. E-mail messages sent shall be received as ordinary e-mail message.

Data logs shall be sent on an event-driven or scheduled basis.

Accommodate high-speed Modbus TCP communications when connected to Ethernet port.

Instrument shall measure and calculate the following information at one-second intervals:

Voltage line-to-neutral and line-to-line for each phase and average of all three phases.

Percent voltage unbalance.

Current for each phase and average of three phases.

Percent current unbalance.

kW for each phase and total of three phases.

kVAR for each phase and total of three phases.

kVA for each phase and total of three phases.

kWh for total of three phases, provided as accumulating import, export, net, and total readings.

kVARh for total of three phases, provided as accumulating import, export, net, and total readings.

kVAh for total of three phases, provided as an accumulating net reading.

Power factor for each phase and total of three phases.

Frequency.

Harmonic distortion for each voltage and current input, provided as individual harmonic magnitudes up to the 15th harmonic and as total odd, total even, and total overall harmonic distortion; readings given as a percentage of fundamental.

K-Factor calculations of the first 15 harmonics for all current inputs.

Operator interface features are as follows:

Capable of calculating the following information for any reading at one-second intervals:

Thermal demand calculations for any parameter, with operator-programmable length of demand period to match local utility billing method.

Sliding window demands for any parameter with operator-programmable length of demand period and number of subperiods to match local utility billing method.

Predicted Demand calculations of sliding window demand parameters, with operator-programmable predictive response characteristics.

Minimum value for any measured parameter.

Maximum value for any measured parameter.

Derived values for any combination of measured or calculated parameter, using the following arithmetic, trigonometric, and logic functions (equivalent PLC capabilities):

Arithmetic functions: division, multiplication, addition, subtraction, power, absolute value, square root, average, max, min, rms, sum, sum-of-squares, unary minus, integer ceiling, integer floor, modulus, exponent, PI.

Trigonometric Functions: COS, SIN, TAN, ARCCOS, ARCSIN, ARCTAN, LN, and LOG10.

Logic Functions: Equal to, equal to or more than, equal to or less than, more than or less than, less than, more than, and, "OR," "NOT," and "IF."

Thermocouple Linearization Functions: Type J, Type K, Type R, Type RTD, or Type T.

Temperature Conversion Functions: C to F, F to C.

Support direct display of all parameters on the front panel or remote display in user-programmable groups, using plain language labels. Simultaneous access to all parameters shall be available through any communication port.

Field programmable as follows:

Basic Parameters: Voltage input scale, voltage mode (wye, delta, single phase), current input scale, auxiliary input and output scales, and communication setup parameters are programmable from the front panel.

Parameters described above, plus additional set-point/relay and data log setup parameters, shall be programmed via the communication port using a portable or remotely located computer terminal.

Using ION modules, support customized configurations of all operating parameters.

Provisions to ensure that programming through a computer can be secured by user ID and password.

Provisions to ensure that programming through the front panel is secured by password.

Provisions for creating periodic or non-periodic schedules for up to two years. Schedules may be used to perform the following functions:

Demand control.

Load scheduling.

Logging.

Periodic resetting.

Alarming and set-point control shall include following minimum requirements:

Set-point control of internal recording mechanisms and all digital output relays as follows:

12 programmable set points, each of which shall respond to out-of-range and alarm conditions for any measured parameter.

Each set point shall have one-second minimum response time.

Each set point shall have programmable pick-up and drop-out levels (high and low limits) and time delays on operate and release.

Activity of each set point shall generate an event of a programmable priority. Priority levels shall support up to 256 levels of alarm severity.

Any set point shall be programmable to any operating condition, and any number of available set points shall be concurrently programmable to operate on a particular condition to support multiple threshold conditions.

Set points shall be programmable to operate on any over or under condition for the following:

Any voltage or current input or average.

Voltage or current imbalance.

kW or kVAR forward or reverse.

kVA.

Power factor lag or lead.

Frequency.

kW or current demand on any phase or total or average.

Individual harmonic distortion on any phase input.

Total harmonic distortion on any phase input.

Total even or odd harmonic distortion on any phase input.

Any maximum or minimum value.

Multiple energy accumulation conditions.

Phase reversal.

Pulse count levels.

Any internally derived value.

Any set-point condition shall be able to control any number of digital output relays in an AND or an OR configuration, using pulse mode or latch mode operation, for control and alarm purposes. Digital outputs shall also be operable remotely via any communication port.

Any set-point condition shall be able to provide breaker trip relay operation.

Consecutive alarm conditions and triggers shall be supported with no "dead" time between events. There shall be no need for a rearming delay time between events.

It shall be possible to use any logical combination of any number of available set-point conditions to control any internal or external function or event.

Digital outputs shall support pulse output relay operation for kWh total, kWh imported, kWh exported, kVARh total, kVARh imported, kVARh exported, and kVAh values.

* + - * 1. Multifunction Electric Power Meter:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=9844) Subject to compliance with requirements, provide products by one of the following:

ONICON Incorporated

[Siemens Industry, Inc., Building Technologies Division](http://www.specagent.com/Lookup?uid=123457048454).

[Veris Industries](http://www.specagent.com/Lookup?uid=123457048455).

Approved equivalent.

Requirements in remaining subparagraphs are based on Siemens' "9200 series."

Hardware:

Voltage Inputs: Three voltage inputs capable of measuring from zero- to 400-V rms (line to neutral) or from zero- to 690-V rms (line to line). The instrument shall have provisions for direct connection for wye (Star) systems up to 347/600-V ac. For higher-voltage systems, PTs with 120-, 277-, or 347-V ac secondaries shall be supported. Voltage inputs shall provide the following:

1500-V ac continuous surge protection.

25 percent of full-scale voltage over range capability.

Current Inputs: Three 5-A nominal (6-A full-scale) current inputs. Current inputs shall be transformer coupled and accept CTs with 5-A nominal (6-A full-scale) outputs. Current inputs shall provide the following:

120-A surge protection for one second.

20 percent of nominal current continuous over range capability.

Power Supply: 100- to 240-V ac (within 10 percent) at 50 to 60 Hz, 110- to 300-V dc, or 20- to 60-V dc power source. Load shall not exceed 15 W.

Onboard I/O:

Two Form A solid-state digital (status) outputs with the following features:

The ability to be used to provide pulse outputs according to any energy consumption levels.

Rated 200-V ac/dc with a maximum current of 100 mA.

Communications:

Provide the following built-in communication ports of standard technology, as defined by the IEEE:

One optically isolated RS-485 communication port, supporting data rates from 1200 to 19200 bits per second.

Communication ports shall support the following communication capabilities, independently configurable:

PML protocol.

Modbus RTU protocol.

Shall provide simultaneous access through all communication ports to any measured or derived parameter.

Protocols shall be field configurable from the front display, or via communication ports, and be capable of being accomplished without resetting the meter or interrupting its operation in any way.

Support time synchronization broadcast messages from a host computer system.

Mounting and Display:

The instrument shall support the following mounting options:

3.6-by-3.6-inch (92-by-92-mm) panel cutout, using sliding clamps tightened by thumbscrews.

ANSI 4-inch (100-mm) round cut-out.

Transducer-type base unit with a remote LED display with cable for remote display applications.

Transducer-type base unit only with no display locally mounted.

Allow the operator to remove and replace the display panel without removing the instrument from the equipment in which it is mounted.

Enclosure: If installation requires meter to be installed in a dedicated enclosure, install meter in an NRTL-listed enclosure suitable for operating environment at meter location.

Indoors: NEMA 250, [**Type 1**] [**or**] [**Type 12**].

Outdoors: NEMA 250, [**Type 4**] [**or**] [**Type 4X**].

Memory: Sufficient non-volatile (RAM) to store setup data and accumulated energy values.

The instrument shall measure and calculate the following information:

Voltage line-to-neutral and line-to-line for each phase and average of three phases.

Current for each phase and average of three phases.

Peak current demand.

Neutral current.

Power (kW).

Peak power demand (kW).

Energy (kWh) import/export.

Power factor total.

Frequency.

Operator interface features are as follows:

Capable of calculating the following information for any reading at one-second intervals:

Sliding window demands for any parameter with operator-programmable length of demand period and number of subperiods to match local utility billing method.

Support direct display of all parameters on the front panel or remote display in user-programmable groups, using plain language labels. Simultaneous access to all parameters shall be available through any communication port.

Field programmable as follows:

Basic Parameters: Voltage input scale, voltage mode (wye, delta, single phase), current input scale, auxiliary input and output scales, and communication setup parameters are programmable from the front panel.

Using ION modules, support customized configurations of all operating parameters.

Provisions to ensure that programming through a computer can be secured by user ID and password.

Provisions to ensure that programming through the front panel is secured by password.

Digital outputs shall support pulse output relay operation for kWh total, kWh imported, kWh exported, kVARh total, kVARh imported, kVARh exported, and kVAh values.

1. EXECUTION
	* + 1. EXAMINATION
				1. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
				2. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
				3. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
				4. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
				5. Proceed with installation only after unsatisfactory conditions have been corrected.
			2. THERMAL ENERGY METER APPLICATIONS

Retain this article unless requirements for thermal energy meters are indicated on Drawings.

Copy and revise paragraph below to suit each unique application requiring a thermal energy meter. Where "(Insert equipment type)" is indicated, insert equipment to be metered, such as terminal unit, air-handling unit, chiller, or boiler. Where "(Insert service)" is indicated, insert service to be metered, such as chilled water, condenser water, or heating hot water.

* + - * 1. <**Insert equipment type**>, <**Insert service**>.
			1. ELECTRIC POWER METER APPLICATIONS

Retain this article unless requirements for electric power meters are indicated on Drawings.

Copy and revise paragraph below to suit each unique application requiring a different electric power meter type. Where "(Insert equipment type)" is indicated, insert equipment to be metered, such as switchboard, distribution panelboards, or branch-circuit panelboards.

* + - * 1. <**Insert equipment type**>: [**Fully programmable, multifunction, electric power meter**] [**Multifunction, electric power meter**].
			1. INSTALLATION, GENERAL
				1. Install products level, plumb, parallel, and perpendicular with building construction.
				2. Support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a <**Insert value**> force.
				3. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for OwnerDirector’s Representative's access, confirm unrestricted ladder placement is possible under occupied condition.
			2. ELECTRIC POWER
				1. Provide electrical power to products requiring electrical connections.
				2. Provide circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
				3. Provide power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
				4. Provide raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."
			3. MAINTENANCE SERVICE

Verify with Owner that maintenance service is required for Project.

* + - * 1. Maintenance Service: In addition to the contractors 1-year project warranty requirements, beginning at Substantial Completion, maintenance service shall include [**three**] [**six**] [**nine**] [**12**] months' full maintenance by [**skilled employees of systems and equipment Installer**] [**manufacturer's authorized service representative**]. Include [**monthly**] [**quarterly**] [**semiannual**] [**annual**] preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper <**Insert equipment**> operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
			1. DEMONSTRATION
				1. [**Engage a factory-authorized service field advisor to train**] [**Train**] Director’s Representative's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
				2. Coordinate video with operation and maintenance manuals and classroom instruction for use by Director’s Representative in operating, maintaining, and troubleshooting.
				3. Record videos on DVD disks.
				4. Director’s Representative shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION 230923.13