SECTION 26 27 13

**ELECTRICITY METERING**

**BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/23**

This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.

***The consultant shall show all metering related devices (meter, test switch, CTs, PTs) on the one-line diagram.***

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes electronic meters including test switch and instrument transformers as specified herein and shown on the Drawings. Included are the following topics:

PART 1 - GENERAL

 Scope

 Related Work

 References

 Submittals

 Operation and Maintenance Data

PART 2 - PRODUCTS

 Utility Metering

 Electronic Meter at Main Electric Service (Non-Utility Metering)

 Meter Test Switch

 Sub-Meter(s)

 Meter Interface Gateway

 Provisions for Sub-Meters

 Accessories

 Current Transformers

 Potential Transformers

PART 3 - EXECUTION

 Installation

 Construction Verification Items

 Agency Training

**RELATED WORK**

Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02 – Commissioning Process

Section 26 08 00 – Commissioning of Electrical

Section 26 24 13 – Switchboards

Section 26 24 16 – Panelboards

**REFERENCES**

ANSI C57.13 – Instrument Transformers

**SUBMITTALS**

Provide product data showing model numbers, dimensions, mounting requirements, and parameters measured and displayed.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

**PART 2 - PRODUCTS**

 ***Coordinate the location of the CT’s and meter with the local utility. Some utilities will not allow the CT’s to be located in the switchboard. Delete the Utility Metering section if the electric service is provided from a customer-owned distribution system.***

**UTILITY METERING**

Provide a stand-alone CT cabinet, or a separate utility metering section in the switchboard. Provide a meter socket with a 1-inch conduit to the CT cabinet. Coordinate approved manufacturer(s), style, and location of metering equipment with local utility requirements.

**ELECTRONIC METER at MAIN ELECTRIC SERVICE (Non-Utility Metering)**

Electronic meter with digital display (LED or LCD), shall accept input from standard current transformers rated 5 amperes. Meters for systems operating at 480V and below shall measure circuit potential without the use of external potential transformers. Meter shall be suitable for connection to a three-phase, four-wire wye system or a three-phase, three-wire delta system.

Meter shall display actual numeric values without requiring the use of a multiplier. Meter shall measure and display the following:

* Current:
	+ Phase A Current
	+ Phase B Current
	+ Phase C Current
	+ Average Phase Current
* Voltage:
	+ Phase-to-Phase (A-B, B-C, C-A)
	+ Phase-to-Neutral (A-N, B-N, C-N)
* Real Power (kW):
	+ Phase A Real Power
	+ Phase B Real Power
	+ Phase C Real Power
	+ 3-Phase Real Power
	+ 3-Phase Real Power Demand\*
	+ 3-Phase Real Power Demand Maximum\*\*
* Reactive Power (kVAR):
	+ 3-Phase Reactive Power
	+ 3-Phase Reactive Power Demand\*
* Apparent Power (kVA):
	+ 3-Phase Apparent Power
	+ 3-Phase Apparent Power Demand\*
	+ 3-Phase Apparent Power Demand Maximum\*\*
* \* The “Demand” value is the maximum demand taken in 15-minute windows. These values are not necessarily displayed values, but must be available as an output to a BAS or other data collection system.
* \*\* The “Maximum Demand” is the all-time maximum demand.
* Frequency (Hz)
* Power Factor
* Real Energy Usage (kWh): Three-Phase Total

All meter potential leads and control power leads shall be fuse protected. Provide a fused disconnecting device or circuit breaker with downstream fuses in the main switchboard or panelboard for protection of the meter potential leads and control power leads. Fuses shall be sized per manufacturer’s recommendations.

***Include the following paragraphs for projects on the UW Madison campus. Delete these paragraphs (up to line 29 on page 3) for projects at other locations. This meter should only be provided for main building metering on UW Madison projects. For the SEL-735 p/n provided, fill in “#” appropriately for project specific installation conditions. Do not use this for sub-metering within the building unless specifically requested by UW Madison Physical Plant.***

**[Electricity Meters for Services on UW-Madison Campus**

Meter shall be Schweitzer Engineering Laboratories SEL-735 p/n: 0735##00###EXXXXXX16101XX with Modbus RTU communication output to match existing metering system at UW - Madison campus. No substitute manufacturers will be accepted.

Provide a Meter Interface Gateway device to convert the meter’s Modbus RTU output (measured values listed above) to BACnet/IP for interface to the campus Building Automation System (BAS). Meter gateway device shall include a prebuilt template for the meter information specifically designed for UW Madison. Gateway to be provided is: Real Time Automation – model RTA 460-MMBS-S051. Consult with UW Madison DoIT and Physical Plant Digital Control Group personnel for proper wiring and termination procedures and gateway software configuration.

The electrical contractor shall be responsible for providing all communication wiring between the meter and the interface gateway and shall provide Ethernet communication wiring from the interface gateway to the IT closet. The gateway shall be installed in the IT closet where the Ethernet connection is provided for gateway communications to the BAS.

For UW Madison projects, this contractor shall be responsible for data wiring and jack termination as specified under division 27 and the paragraph below unless specified to be provided by the division 27 contractor. Reference the division 27 Technical Guidelines on the UW-Madison Facilities Planning & Management (FP&M) website:

First, go to the FP&M **Project Delivery** webpage at <https://facilities.fpm.wisc.edu/>. Scroll down to the **Technical Guidelines** to find the Division **27 – Communications** guidelines.

Building Automation System (BAS) data jacks shall be installed according to the campus standard except that a data jack is not needed, and a patch cord can be used between the utilizing equipment and the network switch port under the following exceptions:

A. If the utilizing equipment is mounted on or within the vertical sides of the floor or wall rack.

B. If the utilizing equipment is mounted within the same telecommunications room and can be reached with a 40 foot or shorter patch cord that is routed with existing cabling in the racks, trays, J-hooks, etc., and is not stretched tight.

NOTE: If a patch cord is used in exceptions A or B above, the patch cord must be labeled on each end listing the termination point on the opposite end.

EXAMPLE:

Switch name and port #..................to…………. equipment name

s-weeks-156-1-access, port 22…………….….MS-SECVT0 north wall**]**

***Use the following sentence for all project locations other than UW Madison. Delete the following sentence if the project is at UW-Madison, or if meter communication to the BAS system is not required.***

[Provide a Meter Interface Gateway as described in the “Meter Interface Gateway” subsection of this specification.]

***No editing is required for the following paragraphs describing Services below 600A or above 800A. The text is intended to be used for all situations without editing.***

**Electricity Meters for Services 600 Amps and Below**

Electronic meter with digital display shall accept input from standard current transformers rated 5 amperes. Sub-meters may use 0-2V Current Sensors or 0-0.333V Current Transducers in lieu of Current Transformers. Meter shall be suitable for connection to a three-phase, four-wire wye system, a three-phase, three-wire delta system, or a 120/240V single-phase system. Meter specification is based on Electro Industries/GaugeTech Shark 100 or equal.

Meter accuracy shall be 1.0% of actual reading (not full-scale measurement).

**Electricity Meters for Services 800 Amps and Above**

Meter shall be field-upgradable via firmware and I/O slots in order to cover a full range of applications: Electro Industries/GaugeTech Shark 250 or equal.

* The meter shall have an accuracy of +/- 0.1% or better for voltage and amperes, and 0.2% for power and energy functions. The meter shall meet accuracy requirements of IEC62053-22 (Class 0.2S) and ANSI C12.20 (0.1 Accuracy Class). The meter shall have a Frequency measurement accuracy of not less than 0.007 Hz.
* The meter shall be available with virtual measurement upgrade packs (V-Switch keys), which shall allow user to upgrade in field without removing installed meter.
	1. Provide meter with Virtual Upgrade pack II as indicated below.
	2. The four Virtual Upgrade packs available are:
		1. Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh, and I/O Expansion – V1
		2. Above with 2 Megabytes of memory for Data-logging – V2
		3. Above with 128 samples per cycle waveform recording and 10 Megabytes memory – V3
		4. Above, with 512 samples per cycle waveform recording and 128 Megabytes memory – V4.
* The meter shall include 2 independent communication ports on the back and faceplate, with advanced features.
	1. One port shall provide RS485 communication speaking Modbus ASCII, Modbus RTU, or DNP3 protocol through the back plate. Baud rates shall be from 1200 baud to 57600 baud for the RS485 port.
	2. The meter shall have USB port (through the faceplate) as the second standard communication port, which shall allow the unit to be set up and programmed using a laptop computer. Baud rate for the USB port shall be 57600; Modbus ASCII protocol, no Parity, 8 Data bits, and 1 Stop bit shall be supported.
* The meter shall have I/O expandability through two Option card slots on the back.
	1. The cards shall be capable of being installed in the field, without removing the meter from installation.
	2. The meter shall auto-detect the presence of any I/O Option cards.
	3. The Option card slots shall accept I/O cards in all of the following formats: 100BaseT Ethernet Communication Card; Four Channel Bi-directional 0-1 mA Output Card; Four Channel 4-20mA Output Card; Two Relay Outputs/2 Status Inputs Card; Four Pulse Outputs/4 Status Inputs Card; Fiber Optic Card; IEC 61850 Protocol Ethernet Network Card; RS232/RS485 Serial Communication Card.

**METER TEST SWITCH**

Provide a 600 volt ten-pole (4 potential and 6 current shorting) test switch with cover, ABB Type FT-1, or approved equal, connected between each meter and the CT and potential leads. The six leads (2 per phase) from the CT’s shall be connected to the current shorting terminal positions on the test switch. The four leads ((3) phase and (1) neutral) from the PT’s or bus shall be connected to the potential terminal positions. The test switch shall be located on the face of the switchgear adjacent to the meter or behind a panel cover in an easily accessible location.

Meter test switch is required on all meter installations at switchboards and main distribution panels. Meter test switch is not required for sub-meters, or meters installed at branch panels, automatic transfer switches, and other downstream locations.

***Use the following section for metering of distribution panels, etc. Some LEED meters do not require displays. The data is collected by the BAS and may be displayed on a kiosk elsewhere. Determine whether individual meter displays are needed and edit accordingly. If displays are desired for dormitory residence suites, the displays shall be LCD type in the suites. Delete this section if not needed.***

**SUB-METER(S)**

Electronic meter with digital display shall accept input from standard current transformers rated 5 amperes. Sub-meters may use 0-2V Current Sensors or 0-0.333V Current Transducers in lieu of Current Transformers. Meter shall be suitable for connection to a three-phase, four-wire wye system, a three-phase, three-wire delta system, or a 120/240V single-phase system. Meter specification is based on Electro Industries/GaugeTech Shark 100 or equal.

Meter accuracy shall be 1.0% of actual reading (not full-scale measurement).

Meter shall display actual numeric values without requiring the use of a multiplier. Meter shall measure and display the following:

* Current:
	+ Phase A Current
	+ Phase B Current
	+ Phase C Current
	+ Average Phase Current
* Voltage:
	+ Phase-to-Phase (A-B, B-C, C-A)
	+ Phase-to-Neutral (A-N, B-N, C-N)
* Real Power (kW):
	+ Phase A Real Power
	+ Phase B Real Power
	+ Phase C Real Power
	+ 3-Phase Real Power
	+ 3-Phase Real Power Maximum Demand
* Reactive Power (kVAR):
	+ 3-Phase Reactive Power
* Apparent Power (kVA):
	+ 3-Phase Apparent Power
	+ 3-Phase Apparent Power Maximum Demand
* Frequency (Hz)
* Power Factor
* Real Energy Usage (kWh): Three-Phase Total

 [Meters for dormitory suites [shall be provided with LCD displays.] [shall not be provided with displays.]]

***Delete the following sentence if meter communication to the BAS system is not required.***

[Provide Meter Interface Gateway per the paragraph included in this specification section.]

Provide additional fusible disconnect switch(es)/circuit breaker(s) and enclosures per the PROVISIONS FOR SUB-METERS paragraph included in this specification section.

MULTI-POINT SUB-METERING SYSTEM:

Where multiple sub-meters are desired in a common location, the following multi-point sub-metering system may be used: Electro Industries/GaugeTech MP200 or equal.

* The Unit shall consist of either of two circuit configurations: 8 multifunction electrical measuring points (meters) for 3 phase power systems or 24 multifunction electrical measuring points (meters) for single phase power systems. The Unit’s meters shall perform to spec in harsh electrical applications in high and low voltage power systems.
* Meter accuracy shall be 1.0% of actual reading (not full-scale measurement).
* The Unit shall have optional data-logging memory of up to 32MB. With data-logging, the Unit shall support:
1. Two pre-configured Historical logs: Log 1 for trending Voltage and Frequency, Log 2 for trending Energy use over time.
2. An Alarm/Limits log that records the state of the 16 limits that can be programmed for the meter
3. A System Events log to store events that happen in, or to the meter, including Startup, Reset commands, Log retrievals, and attempts to log on with a password.
4. An I/O Change log to record changes in the inputs and outputs of the Relay Output/Status Input board.
* The Unit’s meters shall be traceable revenue meters. The Unit which shall contain utility grade test pulses allowing power providers to verify and confirm that the meters are performing to their rated accuracy
* The Unit shall offer the following communication ports.
1. Com 1 shall support RS485 and optional RJ45 Ethernet/802.11b Wi-Fi. It shall support Modbus RTU, Modbus ASCII, and Modbus TCP; and baud rates from 9,600 to 57,600.
2. Com 2 shall be a USB Serial port. It shall support Modbus ASCII and a baud rate of 57,600.
3. Com 3 shall support RS485. It shall support Modbus RTU and Modbus ASCII; and baud rates from 9,600 to 57,600.
* The Unit shall have a Relay Output/Status Input board.
1. The board shall have 2 Relay Outputs for control applications. The relay outputs shall be able to be triggered by the user-programmed limits in the meters. The user shall be able to assign up to 16 limits, including below-and above-limit conditions for any value the meter measures.
2. The board shall have 4 KYZ Counting Inputs. The KYZ inputs shall be able to be configured to count pulses from gas, water, condensate, and other commodity measuring devices.
	* The Unit shall consist of an all-metal enclosure and shall have the following physical properties:
3. The Unit shall be able to be mounted within an electrical panel.
4. The Unit shall have a stud-base connection for current inputs

***Include the following Meter Interface specification for projects that require communication interface to the building automation system. Meters that require an interface for sub-metering should be clearly specified on the electrical plans. For large quantities of meters (more than 10) that are not located together, consider changing the communication protocol from BACnet MSTP (serial communication) to BACnet/IP (Ethernet communication). Show the meter interface gateway location on the plans. Do not include the following paragraph for UW Madison projects for the main building metering.***

**METER INTERFACE GATEWAY**

Provide a meter interface gateway to allow the meter(s) (daisy-chained to a single interface location) to communicate with the BAS system protocol listed below. The interface gateway shall convert the meter data from the meter’s native language to the BAS protocol.

If the meters can communicate with the BAS system without the use of an interface gateway, then no gateway is required.

Existing Building Automation System (BAS) communication protocol:

***Coordinate with DFD and user agency. Typically, only one of the following two bullet points is used. Not all possible editing combinations are shown. Edit to suit the specific project.***

* BACnet/IP. Meters that have internal BACnet/IP communication interface: Electro Industries/GaugeTech Shark 100B series or equal.

[The Main Electric Service meter] [and all Sub-meters] shall have a BACnet/IP interface (either on-board or a separate gateway) to the BAS system.

The Division 26 electrical contractor shall be responsible for providing all communication wiring between the meters, between the meters and the interface gateway, and between the gateway and the telecom switch. Coordinate with the facility IT staff.

* BACnet/MSTP. Meters that have internal BACnet/MSTP communication interface: Electro Industries/GaugeTech 50B series or equal.

[The Main Electric Service meter] [and all Sub-meters] shall have a BACnet/MSTP interface (either on-board or a separate gateway) to the BAS system.

The Division 23 Controls contractor shall be responsible for providing all communication wiring between the meters, between the meters and the interface gateway, and between the gateway and the BAS system. Coordinate with HVAC controls.

Manufacturers of gateway devices that can provide a BACnet interface for electrical meters with other native protocols: Electro Industries/GaugeTech – ProtoCom Series; Industrial Control Communications, Inc. – Millennium Gateway Series; Real Time Automation – 460 Series; Delta Controls DSM-PWR; FieldServer; Tridium; or Johnson Controls. All programming of the gateway device to provide the BACnet objects to the building automation system shall be included.

The interface gateway shall transmit all of the measured values listed under the meter descriptions in this specification section.

**PROVISIONS FOR SUB-METERS**

OVERCURRENT PROTECTION FOR POTENTIAL LEADS AND CONTROL POWER LEADS

If the sub-meter(s) are located in the main switchboard, provide a fusible disconnect or circuit breaker in the metering section of the switchboard for the protection of the potential transformers or potential leads as required for the sub-meter(s). If the sub-meter(s) are located adjacent to a panelboard, then the contractor must provide a 3-pole 15-amp circuit breaker in that panelboard as required for the potential transformers or potential leads for the sub-meter(s).

All meter potential leads and control power leads shall be fuse protected. Provide fuses in the disconnecting device or downstream fuses from the circuit breaker for protection of the meter potential leads and control power leads. Fuses shall be sized per manufacturer’s recommendations.

ENCLOSURE(S)

If the sub-meters are located adjacent to the switchboard or panelboard, then:

The meters shall be provided in a common meter enclosure.

The meters shall be capable of being mounted in a common enclosure when there is more than one (1) meter.

The metering enclosure shall be provided with separate wiring troughs for line voltage and low voltage wiring.

The enclosure shall come equipped with a control power transformer.

The enclosure shall come with voltage fuses and a shorting block for use with current transformers.

The enclosure shall have a lockable door.

**ACCESSORIES**

Provide shorting block(s) for the CT leads.

**CURRENT TRANSFORMERS**

Current Transformers: ANSI C57.13; 5 ampere secondary, with primary/secondary ratio as shown on Drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hz.

Sub-meters may use 0-2V Current Sensors or 0-0.333V Current Transducers in lieu of Current Transformers.

Mount and brace transformers to withstand 100,000-amp short circuit current.

**POTENTIAL TRANSFORMERS**

Provide potential transformers (PT’s) only if required by the meter manufacturer. Most meters can measure 480V potential and below without the use of external PT’s.

Potential Transformers: ANSI C57.13; 120 volt secondary, burden and accuracy consistent with connected metering and relay devices, 60 Hz.

Potential transformers on 480/277-volt systems shall be rated 277 – 120 volts, connected phase-to-neutral, and installed on each phase.

**PART 3 – EXECUTION**

**INSTALLATION**

The meters shall be mounted in the locations indicated on the drawings. Mounting height shall be 5’-6” or less from finished floor.

New meters installed in existing equipment:

All unused openings shall be covered with a metal closure plate painted to match the existing enclosure.

Any extension of wiring needed to accommodate the meters shall be done using terminal blocks and #10 AWG stranded copper wire, 600-volt type SIS insulation. Splices are not allowed.

Provide a separate enclosure for the new meter if adequate space is not available in the existing panels.

Dangerous voltage will develop in the open circuit secondary windings of energized current transformers. De-energize the current transformers by short circuiting the secondary windings before disconnecting or connecting instruments to current transformers.

Verify the proper operation of all meters. Compare the meter display readings to measurements taken with a clamp on amp-meter and handheld voltmeter.

Provide all programming and field set-up of the meters required for measurement and communication of the electrical data.

BACnet/IP gateways that are provided shall be installed in the IT closet where the IT connection is provided for communications for the gateway to the BAS.

**CONSTRUCTION VERIFICATION**

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 26 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

# AGENCY TRAINING

All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 or 01 91 02.

END OF SECTION