SECTION 26 2713 – ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes equipment for metering of the electrical power system.

B. Related Sections:

1. Section 26 2300 for metering installed in Low Voltage Switchgear.
2. Section 26 2413 for metering installed in Switchboards.
3. Section 26 3600 for metering installed in Transfer Switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power metering features to illustrate coordination among related equipment and power metering.

B. Shop Drawings: For power metering equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components.
2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Other Informational Submittals: System installation and setup guides, with data forms to plan and record options and setup decisions.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data:

1. Operating and applications software documentation.
2. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Software Backup: On a magnetic media or compact disc, complete with Owner-selected options.

C. Software Upgrade Kit: For Owner to use in modifying software to suit future power system revisions or power metering revisions.

D. Software upgrades required by and installed for operating and programming digital and analog devices.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with most current edition of the Northwestern University Design Standards.

1.6 WARRANTY

A. The meter shall have a Manufacturer’s standard 4-year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Electro Industries/Gauge Tech “Nexus 1500” (mains on unit substations and switchboards).
2. Electro Industries/Gauge Tech “Shark 200 V-5” (feeders).

2.2 FUNCTIONAL DESCRIPTION

A. Metering Devices: Monitor and record load profiles and chart energy consumption patterns.

1. Measure and Record Metering Data for the Following:

a. Electricity.

B. The meter shall be designed for Multifunction Electrical Measurement on 3 phase power systems. The meter shall perform to spec in harsh electrical applications in high and low voltage power systems.

1. The meter shall support 3-Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.
2. The meter shall accept universal voltage input.
3. The meter's surge withstand shall conform to IEEE C37.90.1 *and ANSI C62.41*.
4. The meter shall be user programmable for voltage range to any PT ratio.

5. The meter shall accept a burden up to 0.36VA per phase, Max at 600V, and 0.014VA at 120 Volts.
6. The meter shall accept a voltage input range of up to *576* Volts Line to Neutral, and up to *721* Volts Line to Line.
7. The meter shall accept a current reading of up to 11 Amps continuous.
8. The meter shall have color-coordinated voltage and current inputs.
9. The meter shall have a phasor diagram that clearly shows wiring status.

C. The meter shall use a dual input method for current inputs. Method one shall allow the CT to pass directly through the meter without any physical termination on the meter, ensuring the meter cannot be a point of failure on the CT circuit. The second method shall provide additional termination pass-through bars, allowing the CT lead to be terminated on the meter. The meter must support both termination methods.

1. Fault Current Withstand shall be 100 Amps for 10 seconds, 300 Amps for 3 seconds, and 500 Amps for 1 second.
2. The meter shall be programmable for current to any CT ratio. DIP switches or other fixed ratios shall not be acceptable.
3. The meter shall accept a burden of 0.005VA per phase, Max at 11 Amps.
4. The meter shall begin reading at 5mA pickup current.
5. Pass through wire gauge dimension of 0.177” / 4.5 mm shall be available.
6. All inputs and outputs shall be galvanically isolated to 2500 Volts AC.
7. The meter shall accept current inputs of class 10: (0 to 10) A, 5 Amp Nominal, and class 2 (0 to 2) A, 1A Nominal Secondary.

D. The meter shall have an accuracy of +/- 0.1% or better for Volts and Amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC62053-22 (Class 0.2%) and ANSI C12.20 (Class 0.2%). The meter shall have a Frequency measurement accuracy of not less than 0.001 Hz.

1. The meter shall provide true RMS measurements of voltage, - phase to neutral and phase-to-phase; and current, per phase and neutral.
2. The meter shall calculate RMS readings, sampling at over 400 samples per cycle on all channels measured readings continuously with no cycle blind spots.
3. The meter shall utilize 24 bit Analog to Digital conversion.
4. The meter shall provide %THD (% of Total Harmonic Distortion). Harmonic magnitude recording to the 40th order shall be available for voltage and current harmonics.

E. The meter shall provide a simultaneous voltage and current waveform recorder.

1. The meter shall be capable of recording 512 samples per cycle for voltage sag or swell or a current fault event.
2. The meter shall provide pre- and post-event recording capability.
3. The meter shall have a programmable sampling rate for the waveform recorder.
4. The meter shall have an advanced DSP design that allows power quality triggers to be based on a 1 cycle updated RMS.
5. The meter shall allow up to 170 events to be recorded.
6. The meter shall store waveform data in a first-in, first-out circular buffer to insure that data is always being recorded.

F. The meter shall include a three-line, bright red, .56” LED display.

1. The meter shall fit in both DIN 92mm and ANSI C39.1 round cut-outs.

2. The meter must display a % of Load Bar on the front panel to provide an analog feel. The % Load bar shall have not less than 10 segments.

G. The meter shall be available in transducer only version, with no display.

1. The meter shall mount directly to a DIN rail and provide RS485 Modbus or DNP 3.0 output.

H. The meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.

I. Power meter shall include virtual measurement upgrade packs, which shall allow user to upgrade in field without removing installed meter.

1. The six Virtual Upgrade packs shall be:

a. Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh, and I/O Expansion - V1
b. Above with 2 Megabytes of memory for Data-logging - V2
c. Above with Power Quality Harmonics - V3
d. Above, with Limit and Control Functions - V4
e. Above, with 64 samples per cycle Waveform Recorder and 3 Megabytes of memory for Data-logging - V5
f. Above, with 512 samples per cycle Waveform Recorder and 4 Megabytes of memory for Data-logging - V6

2. These Virtual Upgrade packs must be able to be implemented without physically removing the installed meter.

J. The meter shall include 2 independent communications ports on the back and face plate, with advanced features.

1. One port shall provide RS485 communication speaking Modbus ASCII, Modbus RTU, or DNP 3.0 protocol through back plate.
2. Baud rates shall be from 1200 baud to 57600 baud for the RS485 port.
3. The meter shall provide an optical IrDA port (through faceplate), as the second communication port, which shall allow the unit to be set up and programmed using a remote laptop without need for a communication cable.
4. The meter shall have an Ethernet connection card and support Modbus TCP or DNP TCP protocols.
5. *The meter shall have Pocket PC based software available for remote programming and integration*.

K. The meter shall provide user configured fixed window or rolling window demand. This shall allow the user to set up the particular utility demand profile.

1. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.
2. All other parameters shall offer max and min capability over the user selectable averaging period.
3. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.
4. The meter shall provide an update rate of every 6 cycles for Watts, VAR and VA. All other parameters shall be every 60 cycles.

L. The meter shall support a power supply of 90 to 265 Volts AC and 100 to 370 Volts DC. Universal AC/DC Supply shall be available and shall have a burden of less than 11VA. An optional power supply of 18-60 Volts DC shall be available.

M. The meter shall provide Limits Alarms and Control Capability as follows:

1. Limits can be set for any measured parameter.
2. Up to 16 limits can be set.
3. Limits shall be based on % of Full Scale settings.
4. Manual Relay Control shall be available through software.
5. Relay set delays and reset delays shall be available.
6. Relay control shall be available through DNP over Ethernet with the Ethernet Option card.

N. The meter shall have data-logging capability with the 2, 3, and 4 Megabyte memory upgrade (Virtual Upgrade packs 2-6). The meter shall have a real-time clock that allows for time stamping of all the data in the meter when log events are created. The meter with Virtual Upgrade packs 2-4 shall have six logs; the meter with Virtual Upgrade packs 5 and 6 shall also have the Waveform Log:

1. The meter shall have three historical logs for trending profiles. Each log shall be capable of being programmed with up to 64 parameters. The user shall have the ability to allocate memory between the three historical logs in order to increase or decrease the memory allotted to each of the logs.
2. The meter shall have a log for Limits Alarms. The Limits log shall provide magnitude and duration of an event, time-stamp, and log value. The log must be capable of recording to 2048 events.
3. The meter shall have a log for System Events. The System Events log shall record the following occurrences with a time-stamp: Demand Resets, Password Requests, System Startup, Energy Resets, Log Resets, Log Reads, and Programmable Settings Changes.
4. The meter shall have a log for I/O changes. The I/O Change log shall provide a time-stamped record of any Relay Outputs and any Input Status changes. The log must be capable of recording up to 2048 events.
5. The meter with Virtual Upgrade packs 5 and 6 shall have a log which is capable of recording a waveform both when a user-programmed value goes out of limit and when the value returns to within limit.

O. 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 0-1mA Output Card; Four Channel 4-20mA Output Card; Two Relay Outputs/2 Status Inputs Card; Four Pulse Output/4 Status Inputs Card; Fiber Optic Card; IEC 61850 Protocol Ethernet Network Card.
4. The meter shall be capable of accepting any combination of up to two cards.

    a. When two Ethernet cards are installed in the meter, an independent IP address and MAC address shall be assignable to each card.

5. The Ethernet Option Card shall provide the meter with 100BaseT Ethernet functionality. The Ethernet Option card shall:

a. Allow the meter to speak with 12 simultaneous sockets of Modbus TCP, so that multiple requests for data can be received simultaneously.
b. Allow the meter to speak with 5 simultaneous sockets of DNP over TCP/IP so that multiple requests can be handled simultaneously.
c. Allow the meter to speak with both Modbus TCP and DNP over Ethernet simultaneously.
d. Process data at not more 0.6 KBs to 1.5 KBs.
e. Allow auto transmit/receive detection for straight or null RJ45 cables.
f. Provide an embedded Web server that allows access to metered readings through the Internet, using any standard Web browser from a PC, smart phone, or tablet PC.

6. The 1mA Option Card shall provide the following features:

a. 4 channel, bi-directional 0-1mA outputs.
b. Assignable to any measured parameter.
c. 0.1% of Full Scale accuracy throughout range and load.
d. Maximum load impedance to 10k Ohms, with no accuracy losses.

7. The 20mA Option Card shall provide the following features:

a. 4 channel, 4-20mA outputs.
b. Assignable to any measured parameter.
c. 0.1% of Full Scale accuracy throughout range and load.
d. Maximum load impedance to 850 Ohms, with no accuracy losses.
e. Loop powered using up to 24 Volts DC.

8. The Relay Output/Status Input Option Card shall provide the following features:

a. 2 Relay outputs, 2 Status inputs.
b. Status Inputs – Wet/Dry Auto Detect up to 150 Volts DC.
c. Trigger on User Set Limits/Alarms (with Virtual Upgrade pack 4).
d. Set delays and Reset delays.

9. The Pulse Output/Digital Input Option Card shall provide the following features:

a. 4 KYZ pulse/4 Status inputs.
b. Programmable to any energy parameter and pulse value.
c. Programmable to End of Interval pulse.
d. Can function for manual relay control and limit based control (with Virtual Upgrade pack 4).
e. 120mA continuous load current.
f. DNP input.

10. The Fiber Optic Option Card shall provide the following features:

a. Built in logic to mimic RS485 half-duplex bus, allowing the user to daisy chain meters for low installation cost.
b. ST Terminated Option.
c. Versatile Link Terminated Option.
d. Modbus and DNP 3.0 protocols available.

11. The IEC 61850 Protocol Ethernet Network Option Card shall provide the following features:

a. Integrates into any IEC 61850 network.
b. Provides support for Modbus and IEC 61850 protocols simultaneously.
c. Configurable for multiple logical nodes.
d. Provides buffered and un-buffered reporting.
e. Provides dual Ethernet IEC 61850 Protocol Network option cards.
f. Is certified by a 3rd party Authorized IEC61850 Test Laboratory.
g. Is capable of supporting two Ethernet /IP connections with separate /IP address, each running IEC 61850 protocol.

P. The meter shall have transformer loss, line loss, and total substation loss compensation.

1. Substation losses shall be programmable for Watts and VARs, and for Ferris and Copper losses.
2. The meter shall have CT and PT compensation to set compensation factors for errors in CTs and PTs connected to the meter.

Q. The following options shall be available for ordering:

Model	Frequency	Current Input	V-Switch™ Pack	Power Supply	I/O Slot 1	I/O Slot 2
Shark®200: Meter/Transducer	-50: 50 Hz system	-10: 10A Secondary	-V1: Multi-function meter only	-D2: 90-265 Volts AC/DC	-X: None	-X: None
Shark®200T: Transducer	-60: 60 Hz system	-2: 2A Secondary	-V2: Above & 2 Megabytes Data-logging memory	-D: 18-60 Volts DC	-INP100S: 100BaseT Ethernet	-INP100S: 100BaseT Ethernet
			-V3: Above & Power quality Harmonics		-RO1S: 2 Relays/2 Status Inputs	-RO1S: 2 Relays/2 Status Inputs
			-V4: Above & Limit and control functions		-PO1S: 4 Pulses/4 Status Inputs	-PO1S: 4 Pulses/4 Status Inputs
			-V5: Above & 3 Megabytes Data-logging memory; 64 samples per cycle Waveform recorder		-1mAOS: 4 Channel Analog Output, 0-1 bi-directional	-1mAOS: 4 Channel Analog Output, 0-1 bi-directional
			-V6: Above & 4 Megabytes Data-logging memory; 512 samples per cycle Waveform recorder		-20mAOS: 4 Channel Analog Output, 4-20 mA	-20mAOS: 4 Channel Analog Output, 4-20 mA
					-FOSTS: Fiber Optic Output ST Terminated	-FOSTS: Fiber Optic Output ST Terminated
					-FOVPS: Fiber Optic Output Versatile Link Terminated	-FOVPS: Fiber Optic Output Versatile Link Terminated
					-INP300S: IEC 61850 Protocol Ethernet Network Card	-INP300S: IEC 61850 Protocol Ethernet Network Card

2.3 SYSTEM REQUIREMENTS

A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.

B. Provide fuses on each of the sense voltages and on the control power, use Electro Industries EI-CP Panel meter protective fuse kit.

2.4 POWER METERS

A. Separately mounted, permanently installed instrument for power metering, complying with UL 1244.

1. Enclosure and faceplate: NEMA 250, Type 12**.**

B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of (-20 to +70) degrees C.

2.5 LOW-VOLTAGE WIRING

A. Comply with University Standards for RS-485 cabling.

B. Comply with Section 26 0519 "Low - Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 CABLING

A. Comply with NECA 1, current edition.

B. Provide all communications wiring between remote metering communication modules and the University's SCADA network.

C. Wiring Method: Install wiring in raceway except within Switchgear, Switchboards and the like. Conceal raceway and wiring except in unfinished spaces.

3.2 IDENTIFICATION

A. Identify components and power and control wiring according to Section 26 0553 "Identification for Electrical Systems."

B. Label each power metering module with a unique designation.

3.3 GROUNDING

A. Comply with IEEE 1100, "Recommended Practice for Powering and Grounding Electronic Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Electrical Tests: Use caution when testing devices containing solid-state components.
2. Continuity tests of circuits.
3. Coordinate testing required by this Section with that required by Sections specifying equipment being metered.

a. Metering Test: Load feeders, measure loads on feeder conductor with an rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.

C. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

D. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

E. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

F. Remove and replace malfunctioning devices and circuits and retest as specified above.

3.5 DEMONSTRATION

A. Train the University’s maintenance personnel to adjust, operate, and maintain systems. See Division 1 Sections.

1. Train University’s management and maintenance personnel in interpreting and using metering displays and in configuring reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of 12 hours' training.

END OF SECTION 26 2713