SECTION 260913 - ELECTRICAL POWER MONITORING AND CONTROL

Latest Update 5-6-2017 See underlined text for Edits.

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all "Underlines".)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. Section includes the following for monitoring and control of electrical power system:

1. Communication network and interface modules for [RS-232] [RS-485, Modbus TCP/IP] [IEEE 802.3] data transmission protocols.
2. Power monitoring equipment (Power Monitors).
3. Programming and Software.

1.3 DEFINITIONS

A. Ethernet: Local area network based on IEEE 802.3 standards.

B. 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.

C. HTML: Hypertext markup language.

D. I/O: Input/output.

E. KY Pulse: A term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay changing status in response to the rotation of the disk in the meter.

F. LAN: Local area network; sometimes plural as "LANs."

G. LCD: Liquid crystal display.

H. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.

I. Modbus TCP/IP: An open protocol for exchange of process data.

J. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

K. PC: Personal computer; sometimes plural as "PCs."

L. 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.

M. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.

N. RS-485: A TIA standard for multipoint communications using two twisted-pairs.

O. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

P. THD: Total harmonic distortion.

Q. UPS: Uninterruptible power supply; used both in singular and plural context.

R. WAN: Wide area network.

1.4 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 monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

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

1. Outline Drawings: Indicate arrangement of components and clearance and access requirements.

2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
5. UPS sizing calculations for workstation.
6. Surge suppressors: Data for each device used and where applied.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified [Installer] [manufacturer].

B. Field quality-control reports.

C. Other Informational Submittals:

1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Operating and applications software documentation.
2. Software licenses.
3. Software service agreement.
4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
5. 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:

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

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Addressable Relays: One for every 10 installed. Furnish at least one of each type.
2. Data Line Surge Suppressors: One for every 10 of each type installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing power monitoring and control equipment similar to that indicated for this Project and with a record of successful in-service performance.

C. 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.

1.9 COORDINATION

A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of specified functions.

B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

1.10 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.11 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one (1) of the following:
   1. Schneider Electric - Power Management Operation.

2.2 FUNCTIONAL DESCRIPTION

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

   1. Calculate and Record the Following:

      a. Load factor.
      b. Peak demand periods.

   2. Measure and Record Metering Data for the Following:

      a. Electricity.

B. Software: Calculate allocation of utility costs.

   1. Automatically Import Energy Usage Records to Allocate Energy Costs for the Following:

      a. At least fifteen (15) departments.
      b. At least thirty (30) tenants.
      c. At least five (5) buildings.

C. Power Quality Monitoring: Identify power system anomalies and measure, display, and record trends and alarms of the following power quality parameters:

   1. Voltage regulation and unbalance.

2. Continuous three-phase rms voltage.
3. Periodic max./min./avg. voltage samples.
4. Harmonics.
5. Voltage excursions.

D. Emergency Load Shedding. Preserve critical loads or avoid total shutdown due to unforeseen loss of power sources according to the following logic:

1. Determine system topology.
2. Evaluate remaining loads and sources.
3. Shed loads in less than 100 ms.

E. Demand Management:

1. Peaking or co-generator control.
2. Load interlocking.
3. Load shedding.
4. Load trimming.

F. System: Report equipment status and power system control.

2.3 SYSTEM REQUIREMENTS

A. Monitoring and Control System: Include [PC-based workstation] [multiple PC-based workstations] [multiple PC-based workstations with graphics capability and Web access], with its operating system and application software, connected to data transmission network.

B. 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.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.

C. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.

D. BAS Interface: Provide factory-installed hardware and software to enable the BAS to monitor, display, and record data for use in processing reports.

1. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical energy consumption (kilowatt-hours), [power factor] <Insert monitoring point> .
2. [ASHRAE 135 (BACnet)] [LonTalk] [Modbus] [Industry-accepted, open-protocol] <Insert type of interface> communication interface with the BAS shall enable the BAS operator to remotely monitor meter information from a BAS operator workstation. Control features and monitoring points displayed locally at metering panel shall be available through the BAS.

2.4 OPERATING SYSTEM

A. Software: Configured to run on a portable laptop computer, a single PC, with capability for accessing a single meter at a time. System is not connected to a LAN. Modbus TCP/IP, RS-232, and RS-485 digital communications.

B. Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously. Modbus TCP/IP, RS-232, and RS-485 digital communications.

C. Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously. Ethernet, Modbus TCP/IP, RS-232, and RS-485 digital communications.

D. Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously. Software shall include interactive graphics client and shall be Web enabled. Workstations and portable computers shall not require any software except for an Internet browser to provide connectivity and full functionality. Include a firewall recommended by manufacturer. 100 Base-T Ethernet, Modbus TCP/IP RS-232, and RS-485 digital communications.

E. Operating System Software: Based on thirty two (32) bit, Microsoft Windows workstation operating system. Software shall have the following features:

1. Multiuser and multitasking to allow independent activities and monitoring to occur simultaneously at different workstations.
2. Graphical user interface to show pull-down menus and a menu tree format.
3. Capability for future additions within the indicated system size limits.

F. Peer Computer Control Software: Shall detect a failure of workstation and associated server, and shall cause other workstation and associated server to assume control of all system functions without interruption of operation. Drivers shall be provided in both central computers to support this mode of operation.

2.5 APPLICATIONS SOFTWARE

A. Basic Requirements:

1. Fully compatible with and based on the approved operating system.
2. Password-protected operator login and access; three levels, minimum.
3. Password-protected setup functions.
4. Context-sensitive online help.
5. Capability of creating, deleting, and copying files; and automatically maintaining a directory of all files, including size and location of each sequential and random-ordered record.
6. Capability for importing custom icons into graphic views to represent alarms and I/O devices.
7. Automatic and encrypted backups for database and history; automatically stored at [central control PC] [selected workstation] <insert location> and encrypted with a nine-character alphanumeric password, which must be used to restore or read data contained in backup.
8. Operator audit trail for recording and reporting all changes made to user-defined system options.

B. Workstation Server Functions:

1. Support other client PCs on the LAN [and WAN].
2. Maintain recorded data in databases accessible from other PCs on the LAN [and WAN].

C. Data Formats:

1. User-programmable export and import of data to and from commonly used Microsoft Windows spreadsheet, database, billing, and other applications; using dynamic data exchange technology.
2. Option to convert reports and graphics to HTML format.
3. Interactive graphics.
4. Option to send preprogrammed or operator designed e-mail reports.

D. Metered Data: Display metered values in real time.

E. Remote Control:

1. Display circuit-breaker status and allow breaker control.
2. User defined with load-shedding automatically initiated and executed schemes responding to programmed time schedules, set points of metered demands, utility contracted load shedding, or combinations of these.

F. Equipment Documentation: Database for recording of equipment ratings and characteristics; with capability for graphic display on monitors.

G. Graphics: Interactive color-graphics platform with pull-down menus and mouse-driven generation of power system graphics, in formats widely used for such drafting; to include the following:

1. Site plan.
2. Floor plans.
3. Equipment elevations.
4. Single-line diagrams.

H. User-Defined Monitoring and Control Events: Display and record with date and time stamps accurate to 0.1 second, and including the following:

1. Operator log on/off.
2. Attempted operator log on/off.
3. All alarms.
4. Equipment operation counters.
5. Out-of-limit, pickup, trip, and no-response events.

I. Trending Reports: Display data acquired in real-time from different meters or devices, in historical format over user-defined time; unlimited as to interval, duration, or quantity of trends.

1. Spreadsheet functions of sum, delta, percent, average, mean, standard deviation, and related functions applied to recorded data.
2. Charting, statistical, and display functions of standard Windows-based spreadsheet.

J. Alarms: Display and record alarm messages from discrete input and controls outputs, according to user programmable protocol.

1. Functions requiring user acknowledgment shall run in background during computer use for other applications and override other presentations when they occur.

K. Waveform Data: Display and record waveforms on demand or automatically on an alarm or programmed event. Include the graphic displays of the following, based on user-specified criteria:

1. Phase voltages, phase currents, and residual current.
2. Overlay of three-phase currents, and overlay each phase voltage and current.
3. Waveforms ranging in length from [two (2)] <Insert number> cycles to [five (5)] <Insert number> minutes.
4. Disturbance and steady-state waveforms up to 512 points per cycle.
5. Transient waveforms up to 83,333 points per cycle on 60-Hz base.
6. Calculated waveform, based on recorded data, on a minimum of four (4) cycles of data of the following:

a. THD.
b. rms magnitudes.
c. Peak values.

d. Crest factors.
e. Magnitude of individual harmonics.

L. Data Sharing: Allow export of recorded displays and tabular data to third-party applications software.

1. Tabular data shall be in the comma-separated values.

M. Activity Billing Software:

1. Automatically compute and prepare activity demand and energy-use statements based on metering of energy use and peak demand integrated over user-defined interval.
2. Intervals shall be same as used by electric utilities, including current vendor.
3. Import metered data from saved records that were generated by metering and monitoring software.
4. Maintain separate directory for each activity's historical billing information.
5. Prepare summary reports in user-defined formats and time intervals.

N. Reporting: User commands initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.

1. Print a record of user-defined alarm, supervisory, and trouble events on workstation printer.
2. Sort and report by device name and by function.
3. Report type of signal (alarm, supervisory, or trouble), description, date, and time of occurrence.
4. Differentiate alarm signals from other indications.
5. When system is reset, report reset event with same information concerning device, location, date, and time.

2.6 Retain paragraph below for local display if needed in addition to power monitors

A. Separately mounted, permanently installed instrument for power monitoring and control, complying with UL 1244.

1. Enclosure: NEMA 250, Type [1] [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 0^0F to 122^0F dry bulb and 20% to 90% relative humidity, noncondensing.

C. rms Real-Time Measurements:

1. Current: Each phase, neutral, average of three phases, percent unbalance.
2. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
3. Power: Per phase and three-phase total.
4. Reactive Power: Per phase and three-phase total.
5. Apparent Power: Per phase and three-phase total.
6. Power Factor: Per phase and three-phase total.
7. Displacement Power Factor: Per phase and three-phase total.
8. Frequency.
9. THD: Current and voltage.
10. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
11. Incremental Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
12. Conditional Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).

D. Demand Current Calculations, per Phase, Three-Phase Average and Neutral:

1. Present.
2. Running average.
3. Last completed interval.
4. Peak.

E. Demand Real Power Calculations, Three-Phase Total:

1. Present.
2. Running average.
3. Last completed interval.
4. Predicted.
5. Peak.
6. Coincident with peak kVA demand.
7. Coincident with kVAR demand.

F. Demand Reactive Power Calculations, Three-Phase Total:

1. Present.
2. Running average.
3. Last completed interval.
4. Predicted.
5. Peak.
6. Coincident with peak kVA demand.
7. Coincident with kVAR demand.

G. Demand Apparent Power Calculations, Three-Phase Total:

1. Present.
2. Running average.
3. Last completed interval.
4. Predicted.
5. Peak.
6. Coincident with peak kVA demand.
7. Coincident with kVAR demand.

H. Average Power Factor Calculations, Demand Coincident, Three-Phase Total:

1. Last completed interval.
2. Coincident with kW peak.
3. Coincident with kVAR peak.
4. Coincident with kVA peak.

I. Power Analysis Values:

1. THD, Voltage and Current: Per phase, three phase, and neutral.
2. Displacement Power Factor: Per phase, three phase.
3. Fundamental Voltage, Magnitude and Angle: Per phase.
4. Fundamental Currents, Magnitude and Angle: Per phase.
5. Fundamental Real Power: Per phase, three phase.
6. Fundamental Reactive Power: Per phase.
7. Harmonic Power: Per phase, three phase.
8. Phase rotation.
9. Unbalance: Current and voltage.
10. Harmonic Magnitudes and Angles for Current and Voltages: Per phase, up to 31st harmonic.

J. Power Demand Calculations: According to one of the following calculation methods, selectable by the user:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from one (1) minute to sixty (60) minutes.
2. Block Interval with Optional Subintervals: Adjustable for one (1) minute intervals, from one (1) minute to sixty (60) minutes. User-defined parameters for the following block intervals:

    a. Sliding block that calculates demand every second, with intervals less than fifteen (15) minutes, and every fifteen (15) seconds with an interval between fifteen (15) minutes and sixty (60) minutes.
    b. Fixed block that calculates demand at end of the interval.

c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a Synchronization Signal:

a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
b. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
c. Demand can be synchronized with clock in the power meter.

K. Sampling:

1. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
2. Power monitor shall provide continuous sampling at a rate of 256 samples per cycle on all voltage and current channels in the meter.

L. Minimum and Maximum Values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:

1. Line-to-line voltage.
2. Line-to-neutral voltage.
3. Current per phase.
4. Line-to-line voltage unbalance.
5. Line-to-neutral voltage unbalance.
6. Power factor.
7. Displacement power factor.
8. Total power.
9. Total reactive power.
10. Total apparent power.
11. THD voltage L-L.
12. THD voltage L-N.
13. THD current.
14. Frequency.

M. Harmonic Calculation: Display and record the following:

1. Harmonic magnitudes and angles for each phase voltage and current through 31stharmonic. Calculate for all three phases, current and voltage, and residual current. Current and voltage information for all phases shall be obtained simultaneously from same cycle.
2. Harmonic magnitude reported as a percentage of the fundamental or as a percentage of rms values, as selected by user.

N. Current and Voltage Ratings:

1. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
2. Withstand ratings shall not be less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
3. Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.

O. Accuracy:

1. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters. Accuracy from Light to Full Rating shall meet the following criteria:

    a. Power: Accurate to 0.25% of reading, plus 0.025% of full scale.
    b. Voltage and Current: Accurate to 0.075% of reading, plus 0.025% of full scale.
    c. Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.
    d. Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.

2. For meters that are circuit-breaker accessories, metering accuracy at full-scale shall not be less than the following:

    a. Current: Plus or minus 2.5%.
    b. Voltage: Plus or minus 1.5%.
    c. Energy, Demand, and Power: Plus or minus 4.0%.
    d. Frequency: Plus or minus 1 Hz.

P. Waveform Capture:

1. Capture and store steady-state waveforms of voltage and current channels; initiated manually. Each capture shall be for 24 cycles, 256 data points for each cycle, allowing resolution of harmonics to 31st harmonic of basic 60 Hz.
2. Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.

Q. Input: One digital input signal(s).

1. Normal mode for on/off signal.
2. Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.
3. Conditional energy signal to control conditional energy accumulation.

R. Outputs:

1. Operated either by user command sent via communication link, or set to operate in response to user-defined alarm or event.
2. Closed in either a momentary or latched mode as defined by user.
3. Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.
4. One digital KY pulse to a user-definable increment of energy measurement. Output ratings shall be up to 120-V ac, 300-V dc, 50 mA, and provide 3500-V rms isolation.
5. One relay output module(s), providing a load voltage range from 20- to 240-V ac or from 20- to 30-V dc, supporting a load current of 2 A.
6. Output Relay Control:

    a. Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.
    b. Normally open and normally closed contacts, field configured to operate as follows:

        1) Normal contact closure where contacts change state for as long as signal exists.
        2) Latched mode when contacts change state on receipts of a pickup signal; changed state is held until a dropout signal is received.
        3) Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.
        4) End of power demand interval when relay operates as synchronization pulse for other devices.
        5) Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
        6) Output controlled by multiple alarms using Boolean-type logic.

S. Onboard Data Logging:

1. Store logged data, alarms, events, and waveforms in 32 MB of onboard nonvolatile memory.
2. Stored Data:

    a. Billing Log: User configurable; data shall be recorded every fifteen (15) minutes, identified by month, day, and fifteen (15) minute interval. Accumulate twenty four (24) months of monthly data, thirty two (32) days of daily data, and between two (2) and fifty two (52) days of fifteen (15) minute interval data, depending on number of quantities selected.
    b. Custom Data Logs: Three (3) user-defined log(s) holding up to ninety six (96) parameters. Date and time stamp each entry to the second and include the following user definitions:

        1) Schedule interval.

2) Event definition.
3) Configured as "fill-and-hold" or "circular, first-in first-out."

c. Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.
d. Waveform Log: Store captured waveforms configured as "fill-and-hold" or "circular, first-in first-out."

3. Default values for all logs shall be initially set at factory, with logging to begin on device power up.

T. Alarms.

1. User Options:

a. Define pickup, dropout, and delay.
b. Assign one of four severity levels to make it easier for user to respond to the most important events first.
c. Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.

2. Alarm Events:

a. Over/undercurrent.
b. Over/undervoltage.
c. Current imbalance.
d. Phase loss, current.
e. Phase loss, voltage.
f. Voltage imbalance.
g. Over kW demand.
h. Phase reversal.
i. Digital input off/on.
j. End of incremental energy interval.
k. End of demand interval.

U. Control Power: 90- to 457-V ac or 100- to 300-V dc.

V. Communications:

1. Power monitor shall be permanently connected to communicate via [Modbus TCP via a 100 Base-T Ethernet] [RS-485 Modbus TCP/IP]. Insert square D EGX 100
2. Local plug-in connections shall be for RS-232 and 100 Base-T Ethernet.

W. Display Monitor:

1. Backlighted LCD to display metered data with touch-screen selecting device.

2. Touch-screen display shall be a minimum 12-inch diagonal, resolution of 800 by 600 RGB pixels, 256 colors; NEMA 250, Type 1 displays enclosure.
3. Display four values on one screen at same time.

    a. Current, per phase rms, three-phase average and neutral.
    b. Voltage, phase to phase, phase to neutral, and three-phase averages of phase to phase and phase to neutral.
    c. Real power, per phase and three-phase total.
    d. Reactive power, per phase and three-phase total.
    e. Apparent power, per phase and three-phase total.
    f. Power factor, per phase and three-phase total.
    g. Frequency.
    h. Demand current, per phase and three-phase average.
    i. Demand real power, three-phase total.
    j. Demand apparent power, three-phase total.
    k. Accumulated energy (MWh and MVARh).
    l. THD, current and voltage, per phase.

4. Reset: Allow reset of the following parameters at the display:

    a. Peak demand current.
    b. Peak demand power (kW) and peak demand apparent power (kVA).
    c. Energy (MWh) and reactive energy (MVARh).

2.7 STANDALONE, WEB-ENABLED MONITORING AND CONTROL INSTRUMENT

A. Separately mounted, permanently installed instrument for power monitoring and control.

1. Enclosure: NEMA 250, Type [1] [12] <Insert number>.

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 0^0F to 122^0F dry bulb and 20% to 90% relative humidity, noncondensing.

C. Power-Distribution Equipment Monitor: Web enabled, with integral network port and embedded Web server with factory-configured firmware and HTML-formatted Web pages for viewing of power monitoring and equipment status information from connected devices equipped with digital communication ports.

D. LAN Connectivity: Multipoint, RS-485 Modbus serial communication network, interconnecting all breaker trip units, protective relays, drives, and metering devices equipped with communications. Serial communication network connected to Ethernet server that functions as a gateway and server, providing data access via 10 Base-T LAN.

E. Communication Devices within the Equipment: Addressed at factory and tested to verify reliable communication with network server.

F. Server Configuration:

1. Initial network parameters set using a standard Web browser. Connect via a local operator interface, or an RJ-45 port accessible from front of equipment.
2. Network server shall be factory programmed with embedded HTML-formatted Web pages that are user configurable and that provide detailed communication diagnostic information for serial and Ethernet ports as status of RS-485 network; with internal memory management information pages for viewing using a standard Web browser.
3. Login: Password protected; password administration accessible from the LAN using a standard Web browser.
4. Operating Software: Suitable for local access; firewall protected.

G. Data Access:

1. Network server shall include embedded HTML pages providing real-time information from devices connected to RS-485 network ports via a standard Web browser.

H. Equipment Monitoring Options: Login shall be followed by a main menu for selecting summary Web pages that follow.

I. Summary Web pages shall be factory configured to display the following information for each communicating device within the power equipment lineup:

1. Provide for the lineup, showing status-at-a-glance of key operating values.
2. Circuit Summary Page: Circuit name, three-phase average rms current, power (kW), power factor, and breaker status.
3. Load Current Summary Page: Circuit name, Phase A, B, and C rms current values.
4. Demand Current Summary Page: Circuit name, Phase A, B, and C average demand current values.
5. Power Summary Page: Circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
6. Energy Summary Page: Circuit name, energy (kWh), reactive energy (kVARh), and time/date of last reset.
7. Transformer Status Page: Transformer tag, coil temperatures, and cooling fan status.

8. Motor-Control Center Status Page: Circuit name, three-phase average rms current, thermal capacity (percentage), and drive output frequency (Hz) contactor status.
9. Specific Device Pages: Each individual communicating device shall display detailed, real-time information, as appropriate for device type.

    a. Display historical energy data that shall be logged automatically for each device, as appropriate for device type.
    b. Display historical data logged from each device in graphical time-trend plots. Value to be displayed on time-trend plot shall be user selectable. Time interval to be displayed on scale shall be for previous day or week.

10. Export historical energy data to a PC or workstation through network using FTP (File Transfer Protocol). Format exported data in a CSV (Comma Separated Variable) file format for importing into spreadsheet applications.

J. Communications:

1. Power monitor: Permanently connected to communicate via Modbus TCP via a 100 Base-T Ethernet.
2. Local Plug-in Connections: RS-232 and 100 Base-T Ethernet.
3. Monitor Display: Backlighted LCD to display metered data with touch-screen selecting device.

2.8 WORKSTATION HARDWARE

A. 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 36^0F to 122^0F dry bulb and 20% to 90% relative humidity, noncondensing.

B. Computer: Standard unmodified PC of modular design, designed for the latest version of Windows operating system.

1. Memory: <Insert capacity> of usable installed memory.
2. Real-Time Clock. Automatic time correction once every twenty four (24) hours by synchronizing clock with the Time Service Department of the U.S. Naval Observatory.
3. Ports: Two RS-232-F serial ports for general use; one parallel port; four USB ports
4. Replaceable graphics board.
5. LAN Adapter Card.

6. Sound Card: For playback and recording of digital WAV sound files associated with audible warning and alarm functions.
7. Color Monitor: WXGA TFT, not less than 18 inches, LCD type.
8. Keyboard: US English.
9. Mouse: Standard.
10. Minimum Disk Storage: 7,200 rpm hard drive.
11. Magnetic Tape System: 4-mm cartridge magnetic tape system with minimum 12-GB formatted capacity per tape. Provide ten (10) tapes, each in a rigid cartridge with spring-loaded cover and operator-selectable write-protect feature.
12. Modem: <Insert number> bps, full duplex for asynchronous communications. With error detection, auto answer/autodial, and call-in-progress detection suitable for operating on unconditioned voice-grade telephone line.
13. CD-RW/DVD-ROM Drive.
14. Report Printer: Minimum resolution 600 dpi laser printer.

    a. Connected to central station and designated workstations.
    b. RAM: 2 MB, minimum.
    c. Printing Speed: Minimum twelve (12) pages per minute.
    d. Paper Handling: Automatic sheet feeder with two hundred fifty (250) sheet paper cassette and with automatic feed.

C. Redundant Central Computer: Connected in a hot standby, peer configuration; automatically maintains copies of system software, application software, and data files. System transactions and other activities that alter system data files shall be updated to system files of redundant computer in near real-time. If central computer fails, redundant computer shall assume control immediately and automatically.

D. UPS: Self-contained; complying with requirements in Division 26 Section "Static Uninterruptible Power Supply."

1. Size: Provide a minimum of six (6) hours of operation of workstation station equipment, including two (2) hours of alarm printer operation.
2. Batteries: Sealed, valve regulated, recombinant, lead calcium.
3. Accessories:

    a. Transient voltage suppression.
    b. Input-harmonics reduction.
    c. Rectifier/charger.
    d. Battery disconnect device.
    e. Static bypass transfer switch.
    f. Internal maintenance bypass/isolation switch.
    g. External maintenance bypass/isolation switch.
    h. Output isolation transformer.
    i. Remote UPS monitoring.
    j. Battery monitoring.
    k. Remote battery monitoring.

2.9 POWER MONITORING EQUIPMENT

A. [[CIRCUIT MONITORS – Advanced (CM4000&CM4000T)

1. Measured Values

a) The following metered values shall be measured by the Circuit Monitor. In addition, the circuit monitor shall record and save in nonvolatile memory the minimum and maximum values of all listed values since last reset. The circuit monitor shall also record and save in nonvolatile memory the interval minimum, maximum, and average of any of the values pre-defined over a user specified interval.

1) Real-Time Readings

(a) Current (Per-Phase, N, G, 3-Phase Avg, Apparent rms, %Unbalanced)
(b) Voltage (L–L Per-Phase, L-L 3-Phase Avg, L–N Per-Phase, 3-Phase Avg, Neutral to Ground, % unbalanced)
(c) Real Power (Per-Phase, 3-Phase Total)
(d) Reactive Power (Per-Phase, 3-Phase Total)
(e) Apparent Power (Per-Phase, 3-Phase Total)
(f) Power Factor (True)(Per-Phase, 3-Phase Total)
(g) Power Factor (Displacement)(Per-Phase, 3-Phase Total)
(h) Frequency
(i) Temperature (Internal Ambient)
(j) THD (Current and Voltage)
(k) K-Factor (Per-Phase)

2) Energy Readings

(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) Reactive Energy by Quadrant

3) Demand Readings

(a) Demand Current (Per-Phase present, 3-Phase Avg, Neutral)

(i) Last complete interval
(ii) Peak

(b) Demand Voltage (L-N, L-L, Per-Phase, 3-Phase avg.)

(i) Last complete interval
(ii) Minimum
(iii) Peak

4) Average Power Factor (True), (3-Phase total)

(a) Last complete interval
(b) Coincident with kW peak
(c) Coincident with kVAR peak
(d) Coincident with kVA peak

5) Demand Real Power (3-Phase Total)

(a) Last complete interval
(b) Predicted
(c) Peak
(d) Coincident kVA Demand
(e) Coincident kVAR Demand

6) Demand Reactive Power (3-Phase Total)

(a) Last complete interval
(b) Predicted
(c) Peak
(d) Coincident kVA demand
(e) Coincident kW demand

7) Demand Apparent Power (3-Phase Total)

(a) Last complete interval
(b) Predicted
(c) Peak
(d) Coincident kVA demand
(e) Coincident kW demand

8) Power Analysis Values

(a) THD – Voltage, Current (3-Phase, Per-Phase, Neutral)
(b) THD - Voltage, Current (3-Phase, Per-Phase, Neutral)
(c) Total Demand Distortion
(d) K-Factor (Per-Phase)
(e) Crest Factor (Per-Phase)
(f) Displacement Power Factor (Per-Phase, 3-Phase)
(g) Fundamental Voltage, Magnitude and Angle (Per-Phase)
(h) Fundamental Currents, Magnitude and Angle (Per-Phase)

(i) Fundamental Real Power (Per-Phase, 3-Phase)
(j) Fundamental Reactive Power (Per-Phase)
(k) Harmonic Power ((Per-Phase, 3-Phase)
(l) Phase Rotation
(m) Unbalance (Current and Voltage)
(n) Harmonic Magnitudes & Angles (Per-Phase)
(o) Distortion Power
(p) Distortion Power Factor

b) The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 255th harmonic (based on fundamental of 50/60 Hz).

c) The following metered values as well as the minimum and maximum instantaneous readings since last reset shall be communicated by the Circuit Monitor:

1) Frequency
2) Temperature
3) Current, per phase rms and neutral (if applicable)
4) Current, 3-phase average rms
5) Current, apparent rms
6) Voltage, phase-to-phase and phase-to-neutral
7) Voltage unbalance, phase-to-phase and phase-to-neutral
8) Power factor, per phase
9) Power factor, 3-phase total
10) Real power, per phase and 3-phase total
11) Reactive power, per phase and 3-phase total
12) Apparent power, per phase and 3-phase total
13) Demand current, per phase and three-phase average
14) Demand real power, three-phase average
15) Demand reactive power, three-phase average
16) Demand apparent power, three-phase average
17) Accumulated energy, (MWh, MVAH, and MVARh)
18) Reactive energy, (VARh by quadrant)
19) Total Harmonic Distortion (THD), voltage and current, per phase
20) K-factor, per phase

2. Demand

a) All power demand calculations shall be done by any one of the following calculation methods, selectable by the user:

1) Thermal demand is calculated using a sliding window and is updated every second. The sliding window length shall be defined by the user from one (1) minute to sixty (60) minutes, with one (1) minute increments.

2) Block interval, with optional sub-intervals. The window length shall be set by the user from one minute (1) to sixty (60) minutes in one (1) minute intervals. The user shall be able to set the sub-interval length from one (1) minute to thirty (30) minutes in one (1) minute intervals.
3) External Pulse Synchronization, utilizing a synch pulse provided externally. An optional status input shall be used to sense the pulse.
4) Sliding block interval with continuous sliding one (1) second subintervals.

b) The default demand calculation method shall be a fifteen (15) minute continuous sliding block.
c) The following demand readings shall be reported by the Circuit Monitor:

1) Average demand current, per phase
2) Peak demand current, per phase
3) Average demand for real power, reactive power, and apparent power
4) Predicted demand for real power, reactive power, and apparent power
5) Peak demand for real power, reactive power, and apparent power

d) The Circuit Monitor shall also provide a generic demand capability to provide demand calculation on any metered parameter.
e) Each Circuit Monitor shall be capable of receiving a broadcast message over the communications network that can be used to synchronize demand calculations by several Circuit Monitors. This message need not be addressed specifically to any one Circuit Monitor.

3. Sampling

a) The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 255th harmonic (fundamental of 60 Hz).
b) (CM4000)The circuit monitor shall provide continuous sampling at a minimum of up to 512 samples/cycle, simultaneously on all voltage and current channels in the meter.
c) (CM4000T)The circuit monitor shall have a 5 MHz per channel (83,333 points per cycle at 60 Hz or 100,000 points per cycle at 50 Hz) sampling rate.

4. Harmonics

a) Advanced harmonic information shall be available via the Circuit Monitor. This shall include the calculation of the harmonic magnitudes and angles for each phase voltage and current through the 255th harmonic.
b) This information shall be available for all three phases, current and voltage, plus the neutral current. To ensure maximum accuracy for analysis, the current and voltage information for all phases shall be obtained simultaneously from the same cycle.
c) The Circuit Monitor shall have a minimum of 16k of on board memory to log harmonic magnitudes and angles.
d) The harmonic magnitude shall be reported as a percentage of the fundamental or as a percentage of any Circuit Monitor may be applied in three-phase, three- or four-wire systems. A fourth CT input shall be available to measure neutral or ground current. If the fourth CT is not used, then a residual current shall be calculated by vectoral addition of the phase currents. In four-wire connections the Circuit Monitor shall utilize the circuit neutral common reference and not earth ground, to provide metering accuracy.
e) Harmonic power flows will be provided up to the 41st harmonic for real, reactive and apparent power.

5. Transients

a) The Circuit Monitor shall be able to detect and capture transients up to 10,000 Vpeak line to line with a duration as short as two hundred (200) nanoseconds when equipped with a Transient Module.

6. Flicker

a) The Circuit Monitor shall detect and measure the flicker (50Hz or 60Hz) of an electrical system based on the IEC Standard 61000-4-15 (or IEEE 1453) when equipped with a Transient Module.
b) The Circuit Monitor shall measure three levels of Flicker:

1) Instantaneous
2) Short-term
3) Long-term

c) The user shall have the ability to view the graphical time-trend of Flicker magnitude in a semi-logarithmic format when equipped with a communications card.

7. EN50160 Evaluation

a) The Circuit Monitor shall include EN50160 evaluations. This capability is characterized by the evaluation of certain power quality parameters: frequency, magnitude of the supply voltage, supply voltage variations, rapid voltage changes, supply voltage dips, short interruptions of the supply voltage, long interruptions of the supply voltage, temporary power frequency overvoltages, transient overvoltages, supply voltage unbalance, and harmonic voltage.

b) The Circuit Monitor shall be capable of reporting EN50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, detailed information for each abnormal event

c) The user shall be able to reset EN50160 evaluations statistics as required.

8. Accuracy

a) The Circuit Monitors shall accept metering inputs of up to 600Vac direct connection or from industry standard instrument transformers (120 VAC secondary PTs and 5 A secondary CTs). Connection to 480Y/277 VAC circuits shall be possible without use of PTs.

b) PT primaries through 1.2 MV shall be supported

c) CT primaries through 32 kA shall be supported

d) The Circuit Monitor shall be accurate to 0.04% of reading plus/minus 0.025% of full scale for voltage and current metering and 0.08% of reading plus 0.025% for power.

e) The Circuit Monitor's energy readings shall meet the revenue accuracy requirements of ANSI C12.20 0.2 class and IEC 60687 0.2S class metering.

f) No annual re-calibration by users shall be required to maintain published accuracy.

g) Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).

9. Waveform Capture

a) All Circuit Monitors shall include current and voltage waveform capture capability. Waveform capture shall be user selectable for sixteen (16) cycles to five hundred twelve (512) cycles of data. Or can be user specified up to thirty (30) seconds.

b) Waveform capture shall be initiated either from a Personal Computer Workstation (PCW) running the Power Monitoring and Control Systems software, or by the circuit monitor as a user defined response to an alarm condition.

c) Waveform capture manually triggered from the Power Monitoring and Control System software shall be captured at five hundred twelve (512) samples/cycle for one (1) cycle providing harmonic content up to the 255th harmonic for Ia, Ib, Ic, I4, Va, Vb, Vc, Vg.

d) Three types of waveform capture shall be available for response to an alarm condition:

1) Steady State shall be manually initiated and provide a resolution of five hundred twelve (512) samples/cycle.

2) Disturbance shall be initiated manually or by an alarm condition and allow the user to select a resolution of sixteen (16) to five hundred twelve (512) samples/cycle and a duration of nine hundred fifteen (915) to one (1) cycle.

3) Adaptive shall be initiated manually or by an alarm condition and allow the user to select a resolution of sixteen (16) to five hundred twelve (512) samples/cycle and a duration of one thousand three hundred twenty (1,320) to one (1) second.

e) The Circuit Monitor shall transmit the waveform samples over the network to the personal computer workstation for display, archival, and analysis.

f) Each voltage and current of all the phases shall be sampled concurrently so that proper phase relationships are maintained, so that harmonic flow analysis can be performed, and so that the effect of a disturbance can be observed on all phase voltages and currents.

g) Harmonic analysis performed on the captured waveforms shall resolve harmonics through the 255th using Power Monitoring and Control Software.

h) All waveforms must reflect actual circuit performance. Waveforms synthesized or composed over time shall not be acceptable.

10. Logging

a) Data logging may be accomplished either within the circuit monitor or at the PC Workstation, or both. Each circuit monitor shall be able to log data, alarms and events, and multiple waveforms. The monitors shall contain a minimum of 8MB of on-board nonvolatile memory, which can be field upgraded without requiring disassembly or removal the Circuit Monitor. On board data logs shall be communicated to the PC Workstation upon demand or at scheduled intervals. Logged information to be stored in each Circuit Monitor includes:

1) Up to fourteen (14) separate data logs shall be configurable by the user. Each log entry shall be date and time stamped. The type of data for the log shall be selected from a list of over one hundred fifty (150) monitored values. Each log entry shall be user configurable to consist of from one to over seventy five (75) values of instantaneous data. It shall be possible to set up each log to record data at independent user defined intervals. In addition, it shall be possible for a user to define an event or new min/max condition that will trigger log file entries.
2) Data logs can be configured by users to be Fill & Hold or Circular (FIFO).
3) A Min/Max log file shall include the time, date, and value for the minimum and maximum of each of the instantaneous metered values since last reset. As well as a Min/Max/Avg. log that records the minimum/maximum/average readings for pre-defined quantities at a user-specified interval.
4) An alarm and event log shall contain time, date, event information, and coincident information for each user defined alarm or event. This log shall have a capacity of up to one thousand (1,000) events.
5) Waveform logs shall store captured waveforms as defined by the user. Waveform log entries shall be scheduled at user defined interval, externally triggered, or forced in response to a user defined event. Waveform logs shall be either Fill & Hold or Circular (FIFO) as defined by the user.
6) The Power Monitoring and Control System software shall be available to enable the user to allocate onboard Circuit Monitor memory for each logging function.

11. Alarming

a) Alarm events shall be a combination of pre-configured from the factory events and user definable events Multiple levels of alarms can be configured for each metered parameter.
b) The following classes of events shall be available as alarm events:

1) Over/under current
2) Over/under voltage
3) Current imbalance
4) Phase loss, current
5) Phase loss, voltage
6) Wave Shape Alarm
7) Voltage imbalance
8) Over kVA
9) Over kW or kVAR into/out of load
10) Over/under frequency
11) Under power factor, true or displacement

12) Over THD
13) Over K-factor
14) Over demand, current or power
15) Reverse power
16) Phase reversal
17) Status Input change
18) End of incremental energy interval
19) End of demand interval
20) Over/under analog inputs
21) Current sag/swell
22) Voltage sag/swell
23) Transients (CM4000T)

c) For each over/under metered value alarm, the user shall be able to define a pick-up, drop-out, and delay.

d) The user will have the ability to alarm using a Waveshape Alarm feature based on user set thresholds by defining the following parameters:

1) Phase Voltage
2) Neutral Ground Voltage
3) Phase Current
4) Neutral Current

e) There shall be four alarm severity levels in order make it easier for the user to respond to the most important events first.

f) Indication of an alarm condition shall be given on the local display as well as reported to the Power Monitoring and Control System software.

g) The Circuit Monitor shall calculate key electrical parameters at 100ms intervals for the purpose of alarming and recording of data during an event. The recorded data shall be comprised of RMS readings for I, V, kW, kVAR, kVA, and True PF. 1-10 seconds of pre-event and up to five (5) minutes of post event data can be recorded.

12. Waveshape Alarm

a) The Circuit Monitor shall include waveshape alarm capability. This capability is characterized by the following features:

1) The Circuit Monitor shall be capable of continuously monitoring waveform anomalies in the following:

(a) Phase voltages
(b) Neutral to ground voltages
(c) Phase currents
(d) Neutral currents

b) Anomalous waveshape events less than 1/2 cycle in length shall be detected.

c) The user shall be able to set a threshold value and upper limit in the circuit monitor to determine if a waveshape event has occurred. The threshold and upper limit shall be user-defined values between zero (0) and one hundred (100). The threshold value is the limit at which a waveshape alarm will trigger. The upper limit defines the highest waveshape value that will trigger a waveshape alarm.

d) Upon detecting a disturbance, the Circuit Monitor shall be capable of:

1) Logging a waveform of the event all phase currents and voltages and/or a high-speed 100ms RMS event recording.
2) Recording the disturbance into an event log with a date and time stamp to the millisecond.
3) Causing an operator alarm at the PCW workstation.
4) Determining the source of the disturbance (upstream or downstream from the meter) and a statistical level of confidence (low, medium, high) of the accuracy of the source location.

13. Alarm Setpoint Learning (ASL)

a) Using SMS software (3.3.2 or greater), the user can enable the Series 4,000 Circuit Monitor to learn the characteristics of normal operation of metered values and select alarm setpoints based on this data.

b) The user is able to determine the quantities to be learned and the period of time for the learning process for standard-speed and high-speed analog alarms, disturbance alarms, and waveshape alarms.

c) The user can configure this feature using one of two (2) modes:

1) Fixed Learning: Initially configured user setpoints are used during the entire learning period.
2) Dynamic Learning: Initially configured user setpoints are temporarily replaced by learned setpoints at the interval specified by the user in SMS. The setpoints continue to be updated at the specified interval until the learning period expires.

d) The user can configure the duration of the learning period. If the learned setpoints do not change over a predefined period, the process can be stopped and the setpoints either installed or held for review.

14. Communications

a) The Circuit Monitor shall communicate via RS-232, RS-485, and Ethernet simultaneously.

b) The Circuit Monitor shall provide Modbus communications using Modbus TCP via an Ethernet network at 10/100Mbaud using UTP or Fiber connections. The Circuit Monitor shall provide the capability to communicate to thirty one (31) additional Modbus devices existing on RS-485 daisy chains and report data back to the PMCS application software or across the Ethernet network to other software applications.

c) The Circuit Monitor display shall provide an RS-232 communications port on board the metering module as well as an IR RS-232 communications port located on the display. The display port shall be completely accessible during normal operation and shall not require exposure of the operator to life-threatening voltage when in use. The operator shall be able to quickly connect a small Personal Computer (PC) to either the module port or the display port without use of tools or splices. Both the metering module port and the display port shall have all of the communication functionality of the standard hard-wired port. When a connection is made to either the metering module port or the display port, the Circuit Monitor shall continue simultaneous operation of all communication ports associated with the Circuit Monitor.

d) It shall be possible to field upgrade the firmware in the Circuit Monitor to enhance functionality. These firmware upgrades shall be done through either the display port or communication connection. No Circuit Monitor disassembly or changing of integrated circuit chips shall be required. It shall not be necessary to de-energize the circuit or the equipment to upgrade the firmware.

e) The circuit monitor shall allow communication to all ports simultaneously.

f) The circuit monitor shall have the option to serve data over the Ethernet network accessible through a standard web browser. Information shall be available from the circuit monitor and from Modbus slave devices connected downstream from the monitor. The monitor shall contain default pages from the factory and also have the ability for the user to create custom pages as needed.

g) The circuit monitor shall provide e-mail notification of any alarm condition that it detects.

h) Time synchronization to one (1) millisecond between monitors via GPS synchronization.

15. I/O Options

a) Circuit Monitor Input/Output Options: Input/Output options/modules shall be field replaceable. Circuit Monitors shall provide pre-configured I/O options and also provide I/O options to be configured as applicable to each installation as shown on the project drawings:

1) One solid state output suitable for KYZ pulse initiation; four solid state status inputs; three (10A) mechanical output relays

2) Four solid state status inputs; four analog inputs (4-20 mA)
3) Four inputs (32Vdc); 2 solid state outputs (60Vdc); 1 analog input (0-5Vdc); 1 analog output (4-20mA)
4) Eight solid state status inputs (120Vac)
5) Circuit Monitor shall provide configurable I/O options to include solid state input modules for 120Vac, 200Vac, and 32Vdc; solid state outputs modules for 120Vac, 240Vac, 60Vdc, 240Vdc; analog input modules for 0-5Vdc, 4-20mA; analog output module for 4-20mA.

16. Output Relay Control

a) Relay outputs shall operate either by user command sent over the communication link, or set to operate in response to user defined alarm event.
b) Output relays shall close in either a momentary or latched mode as defined by the user.
c) Each output relay used in a momentary contact mode shall have an independent timer that can be set by the user.
d) It shall be possible for individual relay outputs to be controlled by multiple alarms in a wired "OR" configuration.

17. Disturbance Detection

a) All Circuit Monitors noted on the project drawings shall include sag and swell detection capability. This capability is characterized by the following features:

1) The Circuit Monitor shall continuously monitor for disturbances in the currents and incoming voltage. There shall be zero (0) blind time; each cycle shall be individually monitored.
2) Disturbance events less than one half (1/2) cycle in length shall be detected.
3) The user shall be able to set a threshold and delay which shall be used by the circuit monitor to determine if an event has occurred. The threshold shall be user defined as either a fixed set point or relative set point. When using the relative set point, the Circuit Monitor will set the nominal current or voltage equal to its present average value. The Circuit Monitor will automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.

b) Upon detecting a disturbance, the Circuit Monitor shall be capable of :

1) Logging a waveform of the event all phase currents and voltages and/or a high-speed 100ms RMS event recording.

2) Operating any output relay on an optional I/O module.
3) Recording the disturbance into an event log with a date and time stamp to the millisecond.
4) Determining the direction of the cause of disturbance and categorize as "Upstream" from the meter or "Downstream" from the meter with an assigned confidence factor in the algorithm, then annunciate this determination through software.
5) Causing an operator alarm at the PCW workstation.

c) The user shall have the ability to display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event with respect to accepted industry standards. If so desired the user shall also have the ability to view this information on custom web pages over the Internet when used with a communications card.

d) All data and waveform logs shall be communicated over the local area network or through the front panel communications port so that the user may view and analyze the data using the PMCS software and workstation.

e) The location of the source of the disturbance (upstream or downstream from the meter) may be provided for each event. A statistical level of confidence (low, medium, high) will be provided of the accuracy of the source's location.

18. Display

a) The Circuit Monitor display shall allow the user to select one (1) of six (6) languages to view on the screen:

1) English
2) French
3) Spanish.
4) Italian
5) Polish
6) German

b) The Circuit Monitor display shall also allow the user to select a date/time format and the ability to create additional screens for user-specified views and/or custom quantities without overwriting existing standard screens.

c) The Circuit Monitor display shall provide local access to the following metered quantities as well as the minimum and maximum value of each instantaneous quantity since last reset of min/max:

1) Current, per phase rms, 3-phase average and neutral (if applicable)
2) Voltage, phase-to-phase, phase-to-neutral, and 3-phase average (phase-to-phase and phase-to-neutral)
3) Real power, per phase and 3-phase total
4) Reactive power, per phase and 3-phase total

5) Apparent power, per phase and 3-phase total
6) Power factor, 3-phase total and per phase
7) Frequency
8) Demand current, per phase and three phase average
9) Demand real power, three phase total
10) Demand apparent power, three phase total
11) Accumulated Energy, (MWh and MVARh)
12) THD, current and voltage, per phase
13) K-factor, current, per phase

d) Reset of the following electrical parameters shall also be allowed from the Circuit Monitor display:

1) Peak demand current
2) Peak demand power (kW) and peak demand apparent power (kVA)
3) Energy (MWh) and reactive energy (MVARh)
4) Setup for system requirements shall be allowed from the Circuit Monitor display. Setup provisions shall include:
5) CT rating
6) PT rating
7) System type [three-phase, 3-wire] [three-phase, 4-wire]
8) Demand interval (5-60 min.)
9) Watt-hours per pulse

e) For ease in operator viewing, two displays are offered for local viewing of Circuit Monitor data. The liquid crystal display (LCD) shall include back lighting. The enhanced vacuum fluorescent display (VFD) shall be automatically activated by a proximity sensor as the operator approaches.

19. Programming

a) Where indicated on the drawings, the Circuit Monitors shall be designed to run customized programs to greatly expand the Circuit Monitor's functionality for the particular installation.
b) These programs shall be written in a circuit monitor programming language similar to a compiled "BASIC" language. It shall include the following capabilities:

1) Scheduled tasks
2) Event Tasks
3) Math functions including: add, subtract, multiple, divide, sine, cosine, square root, etc.
4) Logical functions including: AND, OR, XOR, NOT, shift, etc.
5) Loop commands
6) Compare statements

7) Counters and timers

c) The circuit monitor manufacturer shall offer custom programming services.

d) Changing programs shall not require any physical modifications to the Circuit Monitor, such as changing computer chips or cards. All changes shall be done via either of the communications ports.

e) Examples of custom programs would include:

1) Metering of specialized utility rate structures, including real time pricing and curtailable rates
2) Data reduction using smart data logging
3) Automatic monthly logging/reset of kWh and Peak Demand
4) Statistical profile analysis of metered quantities
5) ITIC/SEMI power quality analysis
6) Calculations for IEEE-519 verification
7) Metering of combined utilities: gas, water, steam, electric
8) Non-critical control schemes, such as load control or power factor correction, based on multiple conditions e.g. time of day and input status

20. Current/Voltage Inputs

a) The Circuit Monitors shall accept metering inputs of up to 600Vac direct connection or from industry standard instrument transformers (120 VAC secondary PTs and 5 A secondary CTs). Connection to 480Y/277 VAC circuits shall be possible without use of PTs.

b) PT primaries through 1.2 MV shall be supported

c) CT primaries through 32 kA shall be supported

d) The Circuit Monitor shall be accurate to 0.04% of reading plus/minus 0.025% of full scale for voltage and current metering and 0.08% of reading plus 0.025% for power.

e) The Circuit Monitor's energy readings shall meet the revenue accuracy requirements of ANSI C12.20 0.2 class metering.

f) No annual re-calibration by users shall be required to maintain published accuracy.

21. Feature Additions

a) It shall be possible to field upgrade the firmware in the Circuit Monitor to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly or changing of integrated circuit chips shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

b) The Circuit Monitors shall be rated for an operating temperature range of -25^{0}C to 70^{0}C and have an over current withstand rating of 500 amps for one (1) second.
c) All setup parameters required by the Circuit Monitors shall be stored in nonvolatile memory and retained in the event of a control power interruption.
d) The Circuit Monitor shall be capable of being applied without modification at nominal frequencies of 50, 60, or 400 Hz.

e) The Circuit Monitor (CM4250) shall include anti-aliasing filters on both voltage and current metering inputs. These anti-aliasing filters are capable of having the corner frequency adjusted between 50Ha, 60Hz, or "off" modes.
f) The Circuit Monitor (CM4250) shall have a Cat IV overvoltage withstand rating on the voltage metering inputs.

22. The Circuit Monitor shall operate properly over a wide range of control power including 100-305 VAC or 100-300 VDC. Connections to 18-60 VDC shall also be available.
23. Ride through capability shall be available for backup control power for up to two (2) seconds, the rms values, as selected by the user.
24. The Circuit Monitor shall provide a hardware security switch to protect all revenue related metering configuration from unauthorized/accidental changes. The Circuit Monitor shall support the use of a wire seal to further deter inadvertent configuration changes and provide visual tamper indication.
25. The Circuit Monitor shall be a PowerLogic CM4000(T) manufactured by Square D Company or equal.]

B. [Power Meters

1. 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. Also, Accumulated Energy, Peak Demand, Minimum and Maximum, and Usage Time quantities should be stored in nonvolatile memory and retained in the event of a control power interruption.
c. The Power Meter may be applied in three-phase, three- or four-wire systems as well as single phase
d. The Power Meter shall be capable of being applied without modification at nominal frequencies of 45 to 65 Hz.

2. Measured values

a. The Power Meter shall provide the following, true RMS metered quantities:

1) Real-Time Readings
2) Current (Per-Phase, N (calculated), 3-Phase Avg)
3) Voltage (L–L Per-Phase, L-L 3-Phase Avg, L–N Per-Phase, L-N 3-Phase Avg.)
4) Real Power (Per-Phase, 3-Phase Total)*
5) Reactive Power (Per-Phase, 3-Phase Total)*
6) Apparent Power (Per-Phase, 3-Phase Total)
7) Power Factor Signed (3-Phase Total)
8) Frequency
9) THD (Per-Phase, Current and Voltage)

b. Energy Readings

1) Accumulated Energy (Real kWh*, Reactive kVarh*, Apparent KVAh) (Absolute)

c. Demand Readings

1) Demand Current Calculations(Per-Phase):

a) Present
b) Peak

2) Demand Real Power Calculations(3-Phase Total):

a) Present
b) Peak

3) Demand Reactive Power Calculations(3-Phase Total):

a) Present
b) Peak

4) Demand Apparent Power Calculations(3-Phase Total):

a) Present
b) Peak

d. Power Analysis Values

1) THD - Voltage (Per-Phase, Line to Line, Line to Neutral
2) THD - Current (Per-Phase, Neutral)
3) Signed Power Factor (3-Phase)

e. Usage Time: The Power Meter should display the time that the device has been in service, displaying hours and minutes.

* kW, kVAR, kWh, and kVARh are signed net consumption values. The PM750 keeps a single registers with the net consumption values per each type of Energy and Power.

3. Demand: All power demand calculations shall use any one (1) of the following calculation methods, selectable by the user:

a. Block Interval Demand. The three following demand calculation modes shall be possible under Block Interval Demand: Sliding Block, Fixed Block, and Rolling Block.
b. Synchronized Demand
c. Thermal Demand

4. Sampling

a. The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 15th harmonic.
b. The Power Meter shall provide continuous sampling at a minimum of up to thirty two (32) samples/cycle, simultaneously on all voltage and current channels of the meter.

5. Minimum and Maximum Values

a. The Power Meter shall provide minimum and maximum values for the following parameters:

1) Voltage L-L
2) Voltage L-N
3) Current
4) Power Factor
5) Real Power Total
6) Reactive Power Total
7) Apparent Power Total
8) THD Voltage L-L
9) THD Voltage L-N
10) THD Current
11) Frequency

b. For each min/max value listed above, the Power Meter shall record the following attributes:

1) Min/Max. Value
2) Phase of recorded Min/Max (for multi-phase quantities)

c. Minimum and maximum values shall be available via communications and display.

6. Current Inputs

a. The Power Meter shall accept current inputs from standard instrument current transformers with 5 amp secondary output and shall have a metering range of 5mA-6 amps with the following withstand currents: 10 amp continuous, 50 amp 10 sec per hour, 120 amp 1 sec per hour.
b. Current transformer primaries adjustable from 5 - 32,767 A shall be supported.

7. Voltage Inputs

a. The circuit monitor shall allow connection to circuits up to 480 volts AC without the use of potential transformers. The Power Meter shall also accept voltage inputs from standard instrument potential transformers. The Power Meter shall support PT primaries through 1.6 MV.
b. The nominal full scale input of the Power Meter shall be 277 Volts AC L-N, 480 Volts AC L-L. The meter shall accept a metering over-range of 20%. The input impedance shall be greater than 2 Mohm (L-L) or 1 Mohm(L-N).

8. Accuracy

a. The Power Meter shall comply with IEC62053-22 Class 0.5S for Real Energy and IEC62053-23 Class 2 for Reactive Energy
b. Voltage shall be accurate to 03% from 50 to 227 V. Current shall be accurate to 0.4% from 1 to 6A. Power Factor shall be accurate from 1 to 6A. Power shall be accurate to 0.5%. Frequency metering shall be accurate to + 0.2 % from 45-65 Hz.
c. No annual calibration shall be required to maintain this accuracy.

9. Input/Output

a. The Power Meter shall include on-board two (2) Digital Inputs and One Digital Pulse Output. The Power Meter shall be capable of operating a solid state KY output relay to provide output pulses for a user definable increment of reported real energy. The standard KY output shall operate from 8–36 V DC max range, 24 V DC nominal. @ 25°C, 3.0 kV rms isolation, 28 Ω on-resistance @ 100 mA. It shall allow for the following operation modes:

1) External-This is the default setting. The output can be controlled by a command sent over the communications link.

2) Alarm-The output is controlled by the power meter in response to a Setpoint controlled alarm condition. When the alarm is active, the output will be ON. Multiple alarms can be associated with the same output simultaneously.
3) kWh Pulse-In this mode, the meter generates a fixed-duration pulse output that can be associated with the kWh consumption.

b. The Power Meter shall be capable of operating the two (2) Digital Inputs to provide all the following modes:

1) Normal-Use the normal mode for simple ON/OFF digital inputs.
2) Demand Interval Synch Pulse-Use this mode to configure a digital input to accept a demand synch pulse from a utility demand meter.
3) Digital Alarm-Use this mode to associate the input operation with any of the alarms. These alarms shall have a fixed pickup and dropout magnitude:
4) The two digital inputs shall operate from 12-36 V DC, 24 VDC nominal, impedance 12k Ohm, maximum frequency 25 Hz, response time 10 msec, and isolation 2.5kV rms

10. Upgrades

a. It shall be possible to field upgrade the firmware in the Power Meter to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly, changing of integrated circuit chips or kits shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

11. Control Power

a. The Power Meter shall operate properly over a wide range of control power including 100-415 VAC, +/-10%, 5VA; 50 to 60Hz. Or 125-250 VDC, +/-20%, 3W.

12. Communications

a. The Power Meter shall communicate via RS-485 Modbus protocol with a 2-wire connection at speeds up to 19.2 kBaud.

13. Alarms: The Power Meter shall detect 15 predetermined alarms. All alarms shall be configured with the following values when using the display:

a. Enable-disable (default) or enable.
b. Pickup Magnitude
c. Pickup Time Delay

d. Dropout Magnitude
e. Dropout Time Delay
f. Values that can also be configured over communications are:
g. Alarm Type
h. Test Register
i. Alarm Label

14. Display

a. The Power Meter display shall be back lit LCD for easy viewing, display shall also be anti-glare and scratch resistant.
b. The Display shall be capable of allowing the user to view four values on one screen at the same time. A summary screen shall also be available to allow the user to view a snapshot of the system.
c. The Power Meter display shall provide local access to the following metered quantities:

1) All quantities in Section B
2) Minimum and Maximum readings in Section E
3) Any of the Active Alarms from Section P
4) I/O Status

d. Reset of the following electrical parameters shall also be allowed from the Power Meter display:

1) Peak demand current
2) Peak demand real power (kW) and peak reactive demand (kVAR).
3) Energy (MWh) and reactive energy (MVARh)

e. Setup for system requirements shall be allowed from the Power Meter display. Setup provisions shall include:

1) CT rating
2) PT rating (Single Phase, 2-Wire)
3) System type [three-phase, 3-wire] [three-phase, 4-wire]
4) Watt-hours per pulse
5) Communication parameters such as address and baud rate
6) Alarms
7) Digital I/O
8) Demand calculation mode settings
9) Bar graphs
10) And Passwords for Setup and Reset]

C. [POWER METERS-Advanced

1. 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 three-phase, three- or four-wire systems.
c. The Power Meter shall be capable of being applied without modification at nominal frequencies of 50, 60, or 400 Hz.

2. Measured values

a. The Power Meter shall provide the following, true RMS metered quantities:

1) Real-Time Readings

a) Current (Per-Phase, N (calculated), 3-Phase Avg, %Unbalanced)
b) Voltage (L–L Per-Phase, L-L 3-Phase Avg, L–N Per-Phase, 3-Phase Avg, % unbalanced)
c) Real Power (Per-Phase, 3-Phase Total)
d) Reactive Power (Per-Phase, 3-Phase Total)
e) Apparent Power (Per-Phase, 3-Phase Total)
f) Power Factor (True)(Per-Phase, 3-Phase Total)
g) Power Factor (Displacement)(Per-Phase, 3-Phase Total)
h) Frequency
i) THD (Current and Voltage)

2) Energy Readings

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) Reactive Energy by Quadrant

3) Demand Readings

a) Demand Current Calculations(Per-Phase, 3-Phase Avg, Neutral):

(1) Present

(2) Running Average

(3) Last completed interval

(4) Peak

b) Demand Real Power Calculations(3-Phase Total):

(1) Present

(2) Running Average

(3) Last completed interval

(4) Predicted

(5) Peak

(6) Coincident with peak kVA Demand

(7) Coincident with kVAR Demand

c) Demand Reactive Power Calculations(3-Phase Total):

(1) Present

(2) Running Average

(3) Last completed interval

(4) Predicted

(5) Peak

(6) Coincident with peak kVA Demand

(7) Coincident kW Demand

d) Demand Apparent Power Calculations(3-Phase Total):

(1) Present

(2) Running Average

(3) Last completed interval

(4) Predicted

(5) Peak

(6) Coincident with peak kVA Demand

(7) Coincident kW Demand

e) Average Power Factor Calculations, Demand Coincident(True),(3-Phase Total):

(1) Last completed interval

(2) Coincident with kW peak

(3) Coincident with kVAR peak

(4) Coincident with kVA peak

f) Power Analysis Values

(1) THD – Voltage, Current (3-Phase, Per-Phase, Neutral)

(2) THD - Voltage, Current (3-Phase, Per-Phase, Neutral)

(3) Displacement Power Factor (Per-Phase, 3-Phase)

(4) Fundamental Voltage, Magnitude and Angle (Per-Phase)

(5) Fundamental Currents, Magnitude and Angle (Per-Phase)

(6) Fundamental Real Power (Per-Phase, 3-Phase)

(7) Fundamental Reactive Power (Per-Phase)

(8) Harmonic Power (Per-Phase, 3-Phase)

(9) Phase Rotation

(10) Unbalance (Current and Voltage)

(11) Harmonic Magnitudes & Angles for Current and Voltages (Per Phase) up to the 63rd Harmonic (31st on the PM810 plus PM810LOG and PM820).

3. Demand

a. All power demand calculations shall use any <u>one (1)</u> of the following calculation methods, selectable by the user:

1) Thermal demand using a sliding window updated every second for the present demand and at the end of the interval for the last interval. The window length shall be set by the user from 1-60 minutes in one minute increments.
2) Block interval, with optional sub-intervals. The window length shall be set by the user from one (1) minute to sixty (60) minutes in one (1) minute intervals. The user shall be able to set the sub-interval length from one (1) minute to sixty (60) minutes in one (1) minute intervals. The following Block methods are available:

    a) Sliding Block that calculates demand every second with intervals less than fifteen (15) minutes and every fifteen (15) seconds with an interval between fifteen (15) minutes and sixty (60) minutes.
    b) Fixed Block that calculates demand at the end of the interval
    c) Rolling Block that a subinterval is configured. Demand is calculated at the end of each subinterval and displays at the end of the interval.

3) Demand can be calculated using a Synchronization signal:

    a) Demand can be synchronized to an input pulse from an external source. The demand period begins with every pulse. A synchronized input can be configured to either a block or rolling block calculation
    b) Demand can be synchronized to a communication signal. This can be configured to either a block or rolling block calculation
    c) Demand can be synchronized to the clock in the Power Meter.

4) Sampling

    a) The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 63rd harmonic (fundamental of 60 Hz).

        (1) The Power Meter shall provide continuous sampling at a minimum of up to 128 samples/cycle, simultaneously on all voltage and current channels in the meter.

5) Minimum and Maximum Values

a) The Power Meter shall provide a monthly minimum and maximum values for the following parameters:

(1) Voltage L-L

(2) Voltage L-N

(3) Current per phase

(4) Voltage L-L Unbalance

(5) Voltage L-N Unbalance

(6) True Power Factor

(7) Displacement Power Factor

(8) Real Power Total

(9) Reactive Power Total

(10) Apparent Power Total

(11) THD Voltage L-L

(12) THD Voltage L-N

(13) THD Current

(14) Frequency

b) For each min/max value listed above, the Power Meter shall record the following attributes:

(1) Date/Time of the min/max value

(2) Min/Max. Value

(3) Phase of recorded Min/Max (for multi-phase quantities)

c) Minimum and maximum values shall be available via communications and display.

6) Harmonic Resolution

a) Advanced harmonic information shall be available via the Power Meter. This shall include the calculation of the

harmonic magnitudes and angles for each phase voltage and current through the 63rd harmonic (31st harmonic for the PM810 with PM810LOG and the PM820).

b) Harmonic information shall be available for all three phases, current and voltage, plus the residual current. To ensure maximum accuracy for analysis, the current and voltage information for all phases shall be obtained simultaneously from the same cycle.

c) The harmonic magnitude shall be reported as a percentage of the fundamental or as a percentage of the rms values, as selected by the user.

7) Current Inputs

a) The Power Meter shall accept current inputs from standard instrument current transformers with 5 amp secondary output and shall have a metering range of 0-10 amps with the following withstand currents: 15 amp continuous, 50 amp 10 sec per hour, 500 amp 1 sec per hour.

b) Current transformer primaries through 327 kA shall be supported.

8) Voltage Inputs

a) The circuit monitor shall allow connection to circuits up to 600 volts AC without the use of potential transformers. The Power Meter shall also accept voltage inputs from standard instrument potential transformers with 120 volt secondary output. The Power Meter shall support PT primaries through 3.2 MV.

b) The nominal full scale input of the circuit monitor shall be 347 Volts AC L-N, 600 Volts AC L-L. The meter shall accept a metering over-range of 50%. The input impedance shall be greater than 2 Ohm.

9) Accuracy

a) The Power Meter shall comply with ANSI C12.20 Class 0.2 and IEC 62053-22 Class 0.5S for Active Energy and revenue meters.

b) The Power Meter shall be accurate to 0.15% of reading + 0.015% of full scale for power. Voltage and current shall be accurate to 0.075% of reading plus 0.025% of full scale. Power factor metering shall be accurate to ±0.002 from 0.5 leading to 0.5 lagging. Frequency metering shall be accurate ±0.01 Hz at 45-67 Hz and 350-450Hz.

c) These accuracies shall be maintained for both light and full loads.
d) No annual calibration shall be required to maintain this accuracy.

10) Waveform Capture

The Power Meter shall provide waveform captures of the voltage and current channels. Waveform capability shall permit to configure the number of captured cycles depending on the sampling rate and channels. The waveforms shall be configurable from one hundred eighty five (185) cycles in one (1) channel at sixteen (16) samples/cycle up to three (3) cycles in six (6) channels at one hundred twenty eight (128) samples/cycle. Waveform captures can be initiated with alarms or manualusing software. (Waveform capture is three (3) cycles fixed at one hundred twenty eight (128) samples/cycle with PM850. And the PM820 or PM810 do not include waveform capability).

a) The Power Meter shall be able to capture, and store in internal non-volatile memory, one hundred twenty eight (128) digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard the circuit monitor shall be at least five (5).
b) The Power Meter shall transmit the waveform samples over the network to the personal computer workstation for display, archival, and analysis.
c) Harmonic analysis performed on the captured waveforms shall resolve harmonics through the 63rd (PM870 and PM850) or up to the 31st for the PM820 and PM810 with PM810Log module.
d) The data used for the three (3) cycle waveform capture display shall also be used to derive metered quantities in order to provide meaningful additional data.
e) All waveforms must reflect actual circuit performance. Waveforms synthesized or composed over time shall not be acceptable.

11) Input/Output

a) The Power Meter shall supply one (1) digital input and one (1) digital solid state output/KY pulse output as standard.
b) The Power Meter shall be capable of operating a solid state KY output relay to provide output pulses for a user definable increment of reported energy. Minimum relay life shall be in excess of one billion operations. The standard

KY output shall operate up to 240 volt AC, 300 volt DC, 96mA max, and provide 3750 volt rms isolation.

c) The Power Meter shall support multiple input/output options including digital inputs, mechanical relay outputs, analog inputs, and analog outputs. This optional I/O shall be in the form of an option module that can be field installable.

d) The digital inputs shall have four operating modes:

(1) Normal mode for simple on/off digital inputs

(2) Demand Interval Synch Pulse to accept a demand synch pulse from a utility demand meter

(3) Conditional Energy Control input to control conditional energy accumulation.

e) Input Metering Demand (WAGES) The power meter shall include five input pulse metering channels. Each channel shall be able to add the consumption signals from one of more digital inputs available in the unit.

f) The Power Meter shall be able to perform GPS time synchronization via any digital inputs.

g) The optional relay output module shall provide a load voltage range from 20 to 240 VAC or from 20 to 30 VDC. It shall support a load current of 2A.

12) Output Relay Control

a) Relay outputs shall operate either by user command sent over the communication link, or in response to a user defined alarm or event.

b) Output relays will have normally open and normally closed contacts and can be configured to operate in several modes:

(1) Normal contact closure where the contacts change state for as long as the signal exists

(2) Latched mode when the contacts change state when a pick-up signal is received and hold until a dropout signal is received.

(3) Timed mode when the contacts change state upon receipt of a pick-up signal and are held for a pre-programmed duration.

(4) End of Power Demand Interval when the relay operates as a synch pulse for other devices.

(5) Energy pulse output. The Relay will pulse quantities used for Absolute kWh, Absolute kVARh, kVAh, kWh In, kVARh In, kWh Out and kVARh Out

c) It shall be possible for individual relay outputs to be controlled by multiple alarms using Boolean type logic (PM850 & PM870).

13) Logging

a) The Power Meter shall provide for onboard data logging. Each Power Meter shall be able to log data, alarms and events, and waveforms. The Meter shall offer 800kB (80kb on PM820 and PM810 with PM810LOG) of on-board nonvolatile memory. Logged information to be stored in each Power Meter includes the following:

(1) Billing Log: The Power Meter shall store in non-volatile memory a configurable billing log that is updated every fifteen (15) minutes. Data shall be recorded by month, day and fifteen (15) minute interval. The log shall contain twenty four (24) months of monthly data, thirty two (32) days of daily data and between two (2) days to fifty two (52) days of fifteen (15) minute interval data depending on the number of quantities selected.

(2) Custom Data Logs: The Power Meter shall provide 1 data log (the PM810 with PM810LOG and the PM820) or up to four (4) separate data logs (PM850 & PM870), configurable by the user. Each log entry shall be date and time stamped to the second. Each log entry shall hold data of up to ninety six (96) parameters each. It shall be possible to set up each log to take data at a different user defined schedule interval. In addition, it shall be possible for a user to define an event. Data logs can be configured by users to be Fill & Hold or Circular (FIFO). At least one (1) data log shall support log intervals as short as one (1) second.

(3) Alarm Log: This log shall contain time, date, event information, and coincident information for each

user defined alarm or event. (PM810 with PM810LOG)

(4) Waveform Logs (PM850 and PM870 only): This log shall store captured waveforms. Waveform logs shall be either Fill & Hold or Circular (FIFO) as defined by the user.

b) The Power Meter shall have default values for all logs loaded at the factory and begin on device power up.

14) Alarming

a) Alarm events shall be user definable.
b) The user shall be able to define over fifty (50) alarm conditions.
c) The following shall be available as alarm events:

(1) Over/under current

(2) Over/under voltage

(3) Current imbalance

(4) Phase loss, current

(5) Phase loss, voltage

(6) Voltage imbalance

(7) Over kW Demand

(8) Phase reversal

(9) Digital Input OFF/ON

(10) End of incremental energy interval

(11) End of demand interval

(12) Voltage sag/swell (PM870)

d) For each over/under metered value alarm, the user shall be able to define a pick-up, drop-out, and delay.
e) There shall be four alarm severity levels in order make it easier for the user to respond to the most important events first.

f) Indication of an alarm condition shall be given on the front panel.
g) The Power Meter shall provide Boolean alarms in the form of combine up to four other alarms with NAND, NOT, OR, and XOR (PM850 & PM870 only)
h) The Power Meter shall perform Power Quality evaluations and issue alarms according to the EN50160, SEMI F47 or ITI(CBEMA) standards (PM850 and PM870 only).
i) The Power Meter shall provide Disturbance alarms for Sag and Swells and be able to enable I/O functionality, data log entry, and perform waveform captures (PM870 only).

15) Output Relay Control

a) Relay outputs shall operate either by user command sent over the communication link, or set to operate in response to user defined alarm event.
b) Output relays shall close in either a momentary or latched mode as defined by the user.
c) Each output relay used in a momentary contact mode shall have an independent timer that can be set by the user.
d) It shall be possible for individual relay outputs to be controlled by multiple alarms using Boolean type logic (PM850 & PM870).

16) Feature Addition

a) It shall be possible to field upgrade the firmware in the Power Meter to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly or changing of integrated circuit chips shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

17) Control Power

a) The Power Meter shall operate properly over a wide range of control power including 90-457 VAC or 100-300 VDC.

18) Communications

a) The Power Meter shall communicate via RS-485 Modbus or Jbus protocol with a 2-wire or 4-wire connection.

b) The Power Meter shall be able to communicate via RS-232 to a laptop or PC or a 4-wire RS-485 Modbus or Jbus protocols when a remote display is included.

c) Using an optional Ethernet Communication Card, the Power Meter shall provide 10/100baseTX Ethernet communications utilizing TCP/IP. Supported protocols shall include Modbus TCP/IP, HTTP, SMTP, SNMP, SNTP, UDP and FTP.

(1) The Power Meter shall provide the capability to serve as a Modbus master and communicate to thirty one (31) additional Modbus devices connected to an RS-485 daisy chain. The Power Meter shall provide a direct connection between sub-devices and application software across the Ethernet network via ModbusTCP/IP.

(2) The Power Meter shall have the capability to serve data over the Ethernet network accessible through a standard web browser. Information shall be available from the Power Meter and from Modbus sub-devices connected downstream from the interface card. The Power Meter shall contain default web pages from the factory and also allow the user to create web pages as needed.

(3) The Power Meter shall provide an SNMP solution with meter specific custom MIB and MIB 2 support as well as traps for alarms.

(4) The Power Meter shall allow time synchronization via the Ethernet network to one (1) second accuracy or better utilizing SNTP.

(5) The Power Meter shall provide the ability to announce alarms via e-mail utilizing SMTP. The e-mail shall be compatible with paging and text messaging systems allowing users to receive alarm notification on a standard cellular phone. The e-mail notification shall support authentication providing a user defined user's name and password to the e-mail server.

(6) The Power Meter Ethernet Communication Card shall be fully upgradeable in the field across the Ethernet network utilizing FTP. No special software

shall be required to upgrade the Ethernet Communications Card. No disassembly or changing of integrated circuit chips shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

19) Display

a) The Power Meter display shall allow the user to select among five different languages to view on the screen.
b) The display shall include two different modes of visualization, IEEE and IEC for all quantities.
c) The Power Meter display shall be back lit LCD for easy viewing, display shall also be anti-glare and scratch resistant
d) The Display shall be capable of allowing the user to view four values on one screen at the same time. A summary screen shall also be available to allow the user to view a snapshot of the system.
e) The Power Meter display shall provide local access to the following metered quantities:

(1) Current, per phase rms, 3-phase average and neutral (if applicable)

(2) Voltage, phase-to-phase, phase-to-neutral, and 3-phase average (phase-to-phase and phase-to-neutral)

(3) Real power, per phase and 3-phase total

(4) Reactive power, per phase and 3-phase total

(5) Apparent power, per phase and 3-phase total

(6) Power factor, 3-phase total and per phase

(7) Frequency

(8) Demand current, per phase and three phase average

(9) Demand real power, three phase total

(10) Demand apparent power, three phase total

(11) Accumulated Energy, (MWh and MVARh)

(12) THD, current and voltage, per phase

f) Reset of the following electrical parameters shall also be allowed from the Power Meter display:

(1) Peak demand current

(2) Peak demand power (kW) and peak demand apparent power (kVA)

(3) Energy (MWh) and reactive energy (MVARh)

g) Setup for system requirements shall be allowed from the Power Meter display. Setup provisions shall include:

(1) CT rating

(2) PT rating

(3) System type [three-phase, 3-wire] [three-phase, 4-wire]

(4) Watt-hours per pulse

h) The Power Meter remote display shall be Type 12 compliant (remote display only).

20) The Power Meter shall comply with the following standards:

a) ANSI 12.20 Class 0.2 – Active Energy
b) IEC 62053-22 Class 0.5S– Active Energy
c) IEC 62053-23 Class 2.0 – Reactive Energy
d) IEC 61557-12 – PMD/SD/K70/0.5 and PMD/SS/K70/0.5
e) IEC 61010-1 – Safety
f) UL508 and CSA C22.2 No.14 – Safety
g) Emissions

(1) Radiated - FCC part 15 Class A, EN55011

(2) Conducted - FCC par 15 Class A, EN55011

(3) Harmonics – IEC 61000-3-2

(4) Flicker – IEC 61000-3-3

h) Immunity

(1) ESD IEC 61000-4-2 Level 3

(2) Radiated IEC 61000-4-3 Level 3

(3) EFT IEC 61000-4-4 Level 3

(4) Surges IEC 61000-4-5 Level 3

(5) Conducted IEC 61000-4-6 Level 3

(6) Magnetic Field IEC 61000-4-8 Level 3

(7) Voltage Dips IEC 61000-4-11 Level 3

(8) Ring Wave IEC 61000-4-12 Level 3

i) ANSI C37.90.1 – Surge withstand capability

j) The Power Meter shall be a PM800 series manufactured by Schneider Electric or equal.

2.10 ETHERNET GATEWAY COMMUNICATIONS

A. The Ethernet Gateway shall feature one 10/100 Mbit UTP port.

B. The Ethernet Gateway shall provide a web based interface for device configuration and diagnostics.

C. The Ethernet Gateway shall feature one serial port that is configurable for RS232 or RS485 with support for 2-wire and 4-wire daisy-chains.

D. A single Ethernet Gateway, assigned a single IP address, shall provide high speed Ethernet support for up to two hundred forty seven (247) Modbus devices or one hundred ninety nine (199) Power Logic (SY/MAX) devices. Device support for a daisy-chain of greater than thirty two (32) devices may require additional hardware.

E. The Ethernet Gateway shall feature the following protocols: Ethernet – ModbusTCP/IP, HTTP, FTP, SNMP (MIB2), TCP, UDP, IP, ICMP, and ARP. Serial - MODBUS, JBUS, and POWERLOGIC (SY/MAX).

F. The Ethernet Gateway shall provide the ability to control the access of ModbusTCP/IP master devices attempting to communicate with attached serial devices. The gateway shall be able to not allow access and shall have the ability to limit access to read-only or provide full access to the attached serial devices.

G. The Ethernet Gateway shall have an input voltage of 24 Vdc and a maximum burden of 4 Watts.

H. The Ethernet Gateway shall allow control power to be received through the Ethernet cable utilizing Power over Ethernet (PoE) according to IEEE 802.3af.

I. The Ethernet Gateway shall operate in ambient temperature of -25^{0}C to 70^{0}C, an ambient storage temperature of – 40^{0}C to 85^{0}C and will operate in relative humidity of 5 to 95%.

J. The Ethernet Gateway shall be a stand-alone product in an IP30 enclosure that is DIN-rail mountable.

K. The Ethernet Gateway shall be compliant with electromagnetic interference emissions according to EN 55022, EN 55011, FCC Class A, and for immunity according to EN 61000-6-2.

L. The Ethernet Gateway shall be compliant with regulatory and safety standards for the USA, Canada, Europe, Australia, and New Zealand according to IEC 60950 and UL 508.

M. The Ethernet Gateway shall be compatible with Ethernet TCP/IP.

N. The gateway shall provide a twisted pair connection to connect to the Ethernet backbone. The Ethernet twisted-pair port shall have: An RJ45 connector, support for 10/100BaseTx connection with auto-negotiate and user specified parameters of 10Mb or 100Mb, full-duplex or half duplex. LED's shall be provided to indicate Ethernet link, speed, and activity. At a minimum, there shall be the following LED's; One for Physical Ethernet Link (LK), one for Transmit (TX), one for Receive (RX), and one for the speed (10/100).

O. The Ethernet Gateway shall have a serial RS-485 port that is used to connect serial field devices to the LAN. The RS-485 serial port shall have the following specification: Support up to 32 serial devices without a repeater. Support for Modbus, Jbus, PowerLogic and mixed mode daisy chains. Support for both 2-wire or 4-wire daisy chains. Support for baud rates of 2400 to 38400. Support for parity values of Even and None. Provide pluggable screw terminal type connectors with a minimum of 5-positions. Provide LED's to indicate serial communication activity. At a minimum, there shall be the following LED's; One for Transmit (Tx), and one for Receive (Rx) per port.

P. The Ethernet Gateway shall have a minimum of one port that can be configured for either RS-485 or RS-232. An LED indicator shall be provided to indicate which port is active (RS485 / RS232).

Q. The serial port shall have configurable biasing and termination to support 2-wire and 4-wire communicating devices.

R. The Ethernet Gateway shall provide internal jumpers to support 2-wire daisy-chains that can be applied or removed from the communication lines.

S. The Ethernet Gateway shall allow a Modbus serial master on its serial port to request data from devices on a TCP/IP network. A minimum of 16 remote IP addresses shall be

supported across the entire Modbus address range of 1 to 247. A minimum of 128 remote devices shall be supported.

T. The Ethernet Gateway shall be configurable by either RS-232 connection via Hyper Terminal® interface or Ethernet connection via standard web browser.

U. The Ethernet Gateway shall provide a user interface that includes English, French, German, and Spanish languages.

V. Setup of the Ethernet Gateway shall be accomplished via the on-board Ethernet port and a web browser. No software shall be required for configuration of the gateway that is not a standard component in Microsoft's off-the-shelf operating systems.

W. The Ethernet Gateway shall support field upgradeable firmware without need of any special software not; present in Microsoft's standard operating systems to accommodate new system features.

2.11 LAN CABLES

A. Comply with Division 27 Section "Communications Horizontal Cabling."

B. RS-485 Cable:

1. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, shielded, and fluorinated-ethylene-propylene jacket, and NFPA 70, Type CMP. Belden #8723 or approved equal.

C. Unshielded Twisted Pair Cables: Category [6] as specified for horizontal cable for data service in Division 27 Section "Communications Horizontal Cabling."

2.12 LOW-VOLTAGE WIRING

A. Comply with Division 26 Section "Control-Voltage Electrical Power Cables."

B. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.

1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
2. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CABLING

A. Comply with NECA 1.

B. Install cables and wiring according to requirements in Division 27 Section "Communications Horizontal Cabling."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Install LAN cables using techniques, practices, and methods that are consistent with specified category rating of components and that ensure specified category performance of completed and linked signal paths, end to end.

E. Install cables without damaging conductors, shield, or jacket.

3.3 IDENTIFICATION

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

B. Label each power monitoring and control module with a unique designation.

3.4 GROUNDING

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

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. 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.

D. Tests and Inspections:

1. Electrical Tests: Use caution when testing devices containing solid-state components.
2. Continuity tests of circuits.
3. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.

    a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
    b. Test LANs according to requirements in Division 27 Section "Communications Horizontal Cabling."
    c. System components with battery backup shall be operated on battery power for a period of not less than 10% of calculated battery operating time.
    d. Verify accuracy of graphic screens and icons.
    e. 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.
    f. Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.

E. Power monitoring and control equipment will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

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

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

I. Reports: Submit written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

J. Remove and replace malfunctioning devices and circuits and retest as specified above and note corrective action in report.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train owner's maintenance personnel to adjust, operate, and maintain systems. See Division 01 Section "Demonstration and Training."

1. Train owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of two (2) hours training.
2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

3.7 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within twenty four (24) months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 260913