# GENERAL

## SECTION INCLUDES

### Low voltage, front-accessible and front/rear-accessible switchboards with circuit breakers for main devices and feeder devices and/or fusible switches for main devices, as specified below and shown on the contract drawings.

## RELATED SECTIONS

### [16415] [26 36 23] Automatic Transfer Switches.

### [16479] [26 43 13] Surge Protective Devices

## REFERENCES

### The low voltage switchboards and protection devices in this specification are designed and manufactured according to latest revision of the following standards (unless otherwise noted).

#### ANSI 61

#### NEMA PB 2, Dead Front Distribution Switchboards

#### ANSI/NEMA PB 2.1, General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less

#### ANSI/NFPA 70, National Electrical Code

#### NEMA AB 1, Molded Case Circuit Breakers and Molded Case Switches

#### NEMA KS 1, Fused and Non-fused Switches

#### UL 489, Molded Case Circuit Breakers

#### UL 891, Dead Front Switchboards

#### UL 98, Enclosed and Dead Front Switches

#### UL 977, Fused Power Circuit Devices

#### [IEEE C37.13-Low-Voltage AC Power Circuit Breakers Used in Enclosures]

#### [ANSI C37.50-Test Procedures for Low-Voltage AC Power Circuit Breakers]

#### [UL 1066, Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures]

## DEFINITIONS

### Front-accessible shall be as defined by UL 891 standard as an enclosure in which all line and load connections for phase, neutral, and ground conductors can be made and maintained from the front of the switchboard without access to the rear. If necessary, a limited number of barriers or covers shall be permitted to be removed to achieve this accessibility.

## SYSTEM DESCRIPTION

### The power system feeding switchboard (insert designation) is [208][240] [480] [600] volts, [50] [60] Hertz, 3 phase, [3-] [4-]wire, [solidly grounded wye] [ungrounded delta] [corner grounded delta] [mid - phase grounded delta] [low resistance grounded wye] [high resistance grounded wye].

## SUBMITTALS

### Manufacturer shall provide [3] copies of the following documents to the owner for review and evaluation in accordance with general requirements of Division [1] [01] and Division [16] [26]:

#### Product data on specified product.

#### Shop drawings on specified product.

## INSTALLATION, OPERATION, AND MAINTENANCE DATA

### Manufacturer shall provide [3] copies of installation, operation, and maintenance procedures to owner in accordance with general requirements of Division [1] [01] and Division [16] [26].

## QUALITY ASSURANCE (QUALIFICATIONS)

### Manufacturer shall be specialized in the manufacture and assembly of low voltage switchboards for at least 35 years.

### Low voltage switchboards shall be listed and/or classified by Underwriters Laboratories in accordance with standards listed in Article 1.03 of this specification.

### Equipment shall be qualified for use in seismic areas as follows:

#### High seismic loading as defined in IEEE Std 693-2018.

#### Building code: CBC-2019/IBC-2018 SDS, 2.0 for z/h = 1.0, 2.5 for z/h = 0.0, IP = 1.5

#### Seismic compliance shall be qualified only through shake table testing. Compliance by calculation is not acceptable.

## DELIVERY, STORAGE, AND HANDLING

### Contractor shall store, protect, and handle products in accordance with recommended practices listed in manufacturer's Installation, Operation, and Maintenance Manuals.

### Ship each switchboard section in individual shipping splits for ease of handling. Each section shall be mounted on shipping skids and wrapped for protection.

### Contractor shall inspect and report concealed damage to carrier within 48 hours.

### Contractor shall store in a clean, dry space. Cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation.

### Contractor shall handle in accordance with manufacturer's recommendations to avoid damaging equipment, installed devices, and finish. Manufacture shall provide lifting hooks on each section and installer shall only lift by manufacturers recommended procedures.

## PROJECT CONDITIONS (SITE ENVIRONMENTAL CONDITIONS)

### Follow (standards) service conditions before, during, and after switchboard installation.

### Low voltage switchboards shall be located in well-ventilated areas, free from excess humidity, dust, and dirt, and away from hazardous materials. Ambient temperature of area shall be between minus 25 and plus 40 degrees Celsius. Indoor locations shall be protected to prevent moisture from entering enclosure.

## WARRANTY

### Manufacturer warrants equipment to be free from defects in materials and workmanship for one year from date of installation or 18 months from date of purchase, whichever occurs first.

## FIELD MEASUREMENTS

### Contractor shall make all necessary field measurements to verify that equipment shall fit in allocated space in full compliance with minimum required clearances specified in the National Electrical Code (NEC).

# PRODUCTS

## MANUFACTURER

### ABB products have been used as the basis for design. Other manufacturers' products of equivalent quality, dimensions, and operating features may be acceptable, at the engineer's discretion, if they comply with all requirements specified or indicated in these contract documents.

## EQUIPMENT

### Furnish ABB ReliaGear™ SB switchboards (or approved equal).

## COMPONENTS

### Refer to contract drawings for actual layout and location of equipment and components, current ratings of devices, bus bars, and components; voltage ratings of devices, components, and assemblies, interrupting and withstand ratings of devices, buses, and components; and other required details.

### Standard Features

#### Switchboards shall be fully self-supporting structures with 90-inch-tall vertical sections (excluding lifting hooks and pull boxes) bolted together to form the required arrangement.

#### Switchboard frame shall be die formed, 12-gauge steel with reinforced corner gussets. Frame shall be rigidly bolted to support cover plates (code gauge steel), bus bars and installed devices during shipment and installation.

#### All sections may be rolled, moved, or lifted into position. Switchboards shall be capable of being bolted directly to the floor without the use of floor sills.

#### All switchboard sections shall have open bottoms and removable top plate(s) to install conduit.

#### Switchboard(s) shall [be] [have] [front connected and rear aligned for mounting against a wall] [front and rear access]. [Switchboards shall be front and rear aligned.]

#### Switchboards shall be UL listed.

#### Switchboards that are series rated to short circuit requirements shall be appropriately labeled. Tested UL listed combination ratings shall be included in UL recognized Component Directory (DKSY2).

#### All covers shall be fastened by hex head bolts and gutter doors must be hinged.

#### Provide hinged doors over metering compartments and individually mounted device compartments. All doors shall have concealed hinges and be fastened by hex head bolts.

#### Switchboard protective devices shall be furnished as listed on drawings and specified herein, including interconnections, instrumentation, and control wiring. Switchboards and devices shall be rated for the voltage and frequency listed on the drawings.

#### Switchboard current ratings, including all devices, shall be based on a maximum ambient temperature of 40 degree Celsius per UL Standard 891. With no derating required, temperature rise of switchboards and devices shall not exceed 65 degrees Celsius in a 40 degree Celsius ambient environment.

#### Switchboard Service Entrance sections shall comply with UL Service Entrance requirements including a UL service entrance label, incoming line isolation barriers, and a removable neutral bond to switchboard ground for solidly grounded wye systems.

#### The group mounted feeder circuit breaker and/or main devices within the switchboards shall be circuit breakers as indicated on the drawings. Mounting for group mounted circuit breakers shall be by ReliaGear plug-in connections including required one or two securing screws.

### INCOMING SECTION

#### Incoming section shall be (pick one)

[utility pull section]

[bused pull section]

[blank pull section]

[direct cable connection to main circuit breaker]

[busway stub-in entering [the top] [the bottom] [the side] [as shown on drawings]

#### Furnish switchboard(s) arranged for [bottom entry of incoming cable.] [top entry of incoming cable.]

#### Provide [mechanical] [crimp compression type] lugs in the quantity and size required per the contract drawings. All lugs shall be [tin-plated aluminum] [tin-plated copper] and UL listed for use with [copper cable.] [aluminum cable.] Lugs shall be rated for 75 degree C cable, unless otherwise noted.

#### [Furnish switchboard(s) [List each by designation] [where indicated on the drawings] with a transition for close-coupled connection to a transformer.]

### BUS BARS

#### Bus bars shall be [tin-plated aluminum] [silver-plated copper] [tin-plated copper]. The bus bars shall have sufficient cross-sectional area to meet UL 891 thermal requirements. Phase and neutral bus ampacity shall be as shown on the plans. The neutral bus shall [have the same ampacity as the phase bus.] [be rated 200% of the phase bus.]

#### Bus bars shall be mounted on high impact, non-tracking insulated supports. Joints in the vertical bus are not permitted.

#### Bus bars shall be braced to withstand mechanical forces exerted during short circuit conditions as indicated in drawings, but in no case less than [65 standard] [100] [150] [200] KA RMS SYM.

#### Bus joints shall be bolted with high tensile steel Grade 5 bolts and integrated, captive swing-down splice plates. Belleville type washers shall be provided with aluminum bus.

#### Ground bus shall be sized to meet UL 891. Ground bus shall extend the full length of switchboard. [Ground bus shall be copper]

#### A-B-C bus arrangement (left to right, top to bottom, front to rear) shall be used throughout to assure convenient and safe testing and maintenance. Where special circuitry precludes this arrangement, bus bars shall be labeled.

#### All feeder device line and load connection straps shall be rated to carry current rating of device frame (not trip rating).

#### The main incoming bus bars shall be rated for the main protection device frame size or, if there is no main device, the main incoming conductors.

#### Main horizontal bus bars shall be [standard fully rated] [and arranged for future extensions (standard)].

### ENCLOSURE

#### Switchboard(s) shall be [NEMA 1] [NEMA 3R non-walk-in] [NEMA 3R walk-in] deadfront construction or as indicated on drawings.

#### NEMA 3R construction shall be as listed below.

##### Consist of standard indoor cubicles with a front frame and sloped roof assembly to provide a weather resistant structure. Filtered front and rear roof vents. [with space heaters] [fed from control power transformer in switchboard.] [fed from separate source as indicated on drawings.]

##### Front hinged doors with 3 point catch with padlocking provision and wind stop. Bolted rear covers.

##### Walk-in construction shall have a [minimum 35-inch] [40-inch] wide clear walk-through space.

##### [Front to rear full depth lifting beams.]

##### Include the following options

###### [Thermostatic control for space heaters.]

###### Gasketing.

###### [Fluorescent or LED lighting and convenience outlets.]

### UTILITY METERING SECTION

#### Provide utility metering section where indicated on drawings. Pull section and metering compartment shall comply with [EUSERC and] [utility name] requirements.

#### Compartment shall be barriered from the rest of the section, have a hinged lockable front cover, removable bus links with provisions for mounting current transformers, and when required, provisions for mounting voltage transformers. Current and voltage transformers shall be supplied and installed by the utility company.

### [USER METERING] (user metering is optional)

#### Provide a UL listed digital multifunction power monitor. The monitor case shall be fully enclosed and shielded.

#### The monitor shall accept a voltage monitoring range of up to 600 volts, phase to phase.

##### The monitor shall withstand 200% rated current continuously. It shall withstand 10X rated current for at least 3 seconds. Isolation shall be no less than 2500V AC.

##### Surge withstand shall conform to IEEE C37.90.1, 62.41, and IEEE 1000-4

##### Shall have a standard ANSI C39.1 case mount.

#### The monitor shall provide true RMS measurements of voltage, phase to neutral, and phase to phase; current, per phase, and neutral; real power, reactive power, apparent power, power factor, and frequency.

##### The monitor must be capable of providing readings for both instantaneous and average readings.

##### The monitor must also be capable of providing all single phase real, apparent, reactive power, and power factor values.

##### The monitor shall record and store total bi-directional energy. It shall include separate registers for positive and negative energy.

##### The monitor shall record and store total bi-directional accumulated energy and total accumulated apparent energy.

##### The monitor shall monitor maximum and minimum average demand values for all current and power readings. The demand interval shall be user programmable. [Maximum and minimum values shall be stored with a date and time stamp.]

***NOTE TO SPECIFIER: THE FOLLOWING REFLECTS THE CAPABILITIES OF THE RGM2200:***

1. The meter shall be UL listed and CE marked. Meter shall have third party lab testing or certification for the following standards:
	* + 1. IEC 62053-22 0.5S Class Accuracy
			2. IEC 61326-1, IEC 61000-6-2, IEC 61000-6-4, and subordinate standards Certification
			3. IEEE C37.90.1
			4. IEEE C62.41
2. Meter shall meet environmental (EMC) as well as accuracy requirements for 0.5 accuracy class. Meter shall pass all emissions and immunity tests for its class.
3. Meter shall have accuracy of +/- 0.4% or better for voltage and current, and 0.5% for power and energy. Meter shall meet accuracy requirements of IEC 62053-22 (Class 0.5S) and ANSI C12.20 (Class 0.5 CL).
	* + 1. Meter shall provide sampling at 400+ samples per cycle on all channels measured readings simultaneously.
			2. Meter shall have an anti-dither algorithm to improve reading stability.
			3. Meter shall measure voltage, current, kW, kVAR, power factor, kVA, frequency, kWh, kVAh, and kVARh at an update rate of 100 ms for power parameters and 1 s for other parameters.
4. Meter shall be designed for electrical measurement on 3 phase power systems.
	* + 1. Voltage inputs shall be user programmable for voltage range to any PT ratio.
			2. Voltage burden shall be .36 VA per phase Max at 600 volts and 0.014 VA at 120 volts.
			3. Absolute voltage input range shall be (20-416) V L-N and (0- 721) Volts L-L.
			4. Voltage and current inputs shall be color-coordinated.
			5. Phasor diagram clearly showing wiring status shall be available.
			6. There shall be a dual input method for current inputs:
				1. CT allowed to pass directly through meter without any physical termination on meter.
				2. Provides additional termination pass-through bars, allowing CT leads to be terminated on meter.
			7. Fault current withstand shall be 100 A for 10 seconds, 300 A for 3 seconds, and 500 A for 1 second.
			8. Current shall be programmable to any CT ratio.
			9. Current burden shall be 0.005VA per phase, Max at 11 A.
			10. Pick up current shall be a 5 mA.
			11. Inputs and outputs shall be galvanically isolated to 2500 V AC.
			12. Current inputs for Class 10 shall be: 5 A Nominal CT with over-range to 10 amps secondary
			13. Current for Class 2 shall be: 1 A Nominal CT with over-range to 2 A secondary.
5. Meter shall have a three-line, 4 digits per line bright red, .56” LED display, which presents a scrolling display of measured readings.
	* + 1. Meter shall display a 10 segment % of Load bar on the front panel to provide an analog feel.
6. Meter shall be a traceable revenue meter, containing a utility-grade test pulse on the front panel for energy accuracy verification.
7. Meter shall offer an optional RS485 Com port through its back plate.
	* + 1. RS485 port shall support Modbus RTU and Modbus ASCII; and baud rates from 9,600 to 57,600.
			2. Optional port shall have a KYZ fixed energy pulse output, mapped to positive energy.
8. Meter shall provide user configured fixed window or rolling window demand so the user can set up the specific utility demand profile.
	* + 1. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features. All other parameters shall offer max and min capability over the user selectable averaging period.
			2. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.
9. Meter shall install in standard ANSI or DIN cutouts.
10. Meter shall be field-upgradeable after installation. Upgrade packs shall allow the base model (V1) to be upgraded to measure Power and Frequency (V2) and to enable Energy Counters (V3).
11. Meter shall integrate with energy usage analysis and billing module and with cloud-based energy management system for Enterprise-wide power quality and usage analysis, predicted usage and demand, reporting, and email alarms.

***NOTE TO SPECIFIER: THE FOLLOWING REFLECTS THE CAPABILITIES OF THE RGM6000:***

1. The meter shall be UL listed and CE marked.

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

1. The meter shall support 3-Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.
2. The meter shall accept universal voltage input.
3. The meter's surge withstand shall conform to IEEE C37.90.1.
4. The meter shall be user programmable for voltage range to any PT ratio.
5. The meter shall accept a burden up to 0.36 VA per phase max at 600 V, and 0.014 VA at 120 volts.
6. The meter shall accept a voltage input range of (20 to 416) Volts Line to Neutral, and up to 721 Volts Line to Line.
7. The meter shall have color-coordinated voltage and current inputs.
8. The meter shall have a phasor diagram that clearly shows wiring status.
9. Power meter shall use a dual input method for current inputs. Method one shall allow the CT to pass directly through the meter without any physical termination on the meter, ensuring the meter cannot be a point of failure on the CT circuit. The second method shall provide additional termination pass-through bars, allowing the CT leads to be terminated on the meter. The meter must support both termination methods.
	* 1. Fault Current Withstand shall be 100 A for 10 seconds, 300 A for 3 seconds, and 500 A for 1 second.
		2. Meter shall be programmable for current to any CT ratio. DIP switches or other fixed ratios shall not be acceptable
		3. Meter shall accept burden of 0.005 VA per phase max at 11 A.
		4. Meter shall begin reading at a 5 mA pickup current.
		5. Pass through wire gauge dimension of 0.177” / 4.5 mm shall be available.
		6. All inputs and outputs shall be galvanically isolated to 2500 volts AC.
		7. The meter shall accept current inputs of class 10: 5 A Nominal CT Secondary and class 1 A Nominal CT Secondary.

D. The meter shall have an accuracy of +/- 0.1% or better for voltage and current, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC 62053-22 (0.2S Class) and ANSI C12.20 (0.2 Class Accuracy).

1. The meter shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral.
2. The meter shall provide sampling at 400+ samples per cycle on all channels measured readings simultaneously.
3. The meter shall utilize 24-bit Analog to Digital conversion.
4. Meter shall provide THD (% of Total Harmonic Distortion).

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

1. The meter shall fit in both DIN 92 mm and ANSI C39.1 round cutouts.
2. The meter must display a % of Load Bar on the front panel to provide an analog feel. The % Load bar shall have not less than 10 segments.
	1. Meter shall be available in transducer only version, without a display.
	2. The meter shall provide RS485 Modbus or DNP3 output.
	3. The meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its
	rated accuracy.

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

1. One port shall provide RS485 communication speaking Modbus ASCII, Modbus RTU, or DNP3 protocol through back plate.
2. Baud rates shall be from 9,600 baud to 57,600 baud.
3. The meter shall provide an optical IrDA port (through faceplate), as the second communication port, which shall allow the unit to be set up and programmed using a remote laptop.
4. Meter shall have 8 Bit, No parity.

 J. The meter shall have optional 100BaseT Ethernet communication capability.

 1. Ethernet communication shall consist of Modbus protocol over TCP/IP.

2. The optional module shall replace the RS485 port.

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

1. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.
2. All other parameters shall offer max and min capability over the user selectable averaging period.
3. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.

L. The meter shall support universal power supply of (90 to 265) volts AC @50/60 Hz and (100 to 370) volts DC and a low voltage (18-60) V DC power supply.

1. Meter power supply shall accept burden of 10 VA max.

 M. Meter shall provide update rate of every 6 cycles for Watts, Var, and VA. All other
 parameters shall be every 60 cycles.

***NOTE TO SPECIFIER: THE FOLLOWING REFLECTS THE CAPABILITIES OF THE RGM7000:***

1. The meter shall be UL listed, CE marked, and ANSI C12.20 certified.

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

1. The meter shall support 3 Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.
2. The meter shall accept universal voltage input.
3. The meter's surge withstand shall conform to IEEE C37.90.1.
4. The meter shall be user programmable for voltage range to any PT ratio.
5. The meter shall accept a burden up to 0.36VA per phase, Max at 600 V, and 0.014 VA at 120 volts.
6. The meter shall accept a voltage input range of up to 576 volts Line to Neutral, and up to 721 volts Line to Line.
7. The meter shall accept a current reading of up to 11 Amps continuous.
8. The meter shall have color-coordinated voltage and current inputs.
9. The meter shall have a phasor diagram, through software, that clearly shows wiring status.
10. The meter shall use a dual input method for current inputs. Method one shall allow the CT to pass directly through the meter without any physical termination on the meter. The second method shall provide additional termination pass through bars, allowing the CT leads to be terminated on the meter. The meter must support both termination methods.
	* 1. Fault Current Withstand shall be 100 A for 10 seconds, 300 A for 3 seconds, and 500 A for 1 second.
		2. The meter shall be programmable for current to any CT ratio. DIP switches or other fixed ratios shall not be acceptable.
		3. The meter shall accept a burden of 0.005 VA per phase, Max at 11 A.
		4. The meter shall begin reading at 0.1% of the nominal current.
		5. Pass through wire gauge dimension of 0.177” / 4.5 mm shall be available.
		6. All inputs and outputs shall be galvanically isolated to 2500 volts AC.
		7. The meter shall accept current inputs of class 10: (0 to 10) A, 5 A Nominal, and class 2 (0 to 2) A, 1 A Nominal Secondary.

D. The meter shall have an accuracy of +/- 0.1% or better for voltage and current, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC 62053-22 (Class 0.2S) and ANSI C12.20 (0.2 Accuracy Class). ANSI C12.20 shall have a third-party certification. The meter shall have a Frequency measurement accuracy of not less than 0.007 Hz.

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

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

 1. The meter shall be capable of recording 512 samples per cycle for a voltage sag or

 swell, or for a current fault event.

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

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

1. The meter shall fit in both DIN 92 mm and ANSI C39.1 round cut-outs.
2. The meter must display a % of Load Bar on the front panel to provide an analog feel. The % Load bar shall have not less than 10 segments.
	1. The meter shall be available in transducer only version, with no display.
	2. The meter shall mount directly to a DIN rail and provide RS485 Modbus or DNP 3.0 output.
	3. The meter shall be a traceable revenue meter, which shall contain a utility grade test
	 pulse allowing power providers to verify and confirm that the meter is performing to its
	 rated accuracy.

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

1. One port shall provide RS485 communication speaking Modbus ASCII, Modbus RTU, or DNP3 protocol through back plate.
2. Baud rates shall be from 1200 baud to 57600 baud for the RS485 port.
3. The meter shall provide an optical IrDA port (through faceplate), as the second communication port, which shall allow the unit to be set up and programmed using a PDA or remote laptop without need for a communication cable.

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

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

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

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

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

N. The meter shall have data logging capability with the 2-, 3-, and 4-Megabyte memory
 upgrade. The meter shall have a real-time clock that allows for time stamping of all the data in the meter when log events are created.

* + - 1. The meter shall have I/O expandability through two Option card slots on the back.
	1. The cards shall be capable of being installed in the field, without removing the meter from installation.
	2. The meter shall auto-detect the presence of any I/O Option cards.
	3. The Option card slots shall accept I/O cards in all of the following formats: 100BaseT Ethernet Communication Card; Four Channel Bi-directional 0-1mA Output Card; Four Channel 4-20mA Output Card; Two Relay Outputs/2 Status Inputs Card; Four Pulse Output/4 Status Inputs Card; Fiber Optic Card; IEC 61850 Protocol Ethernet Network Card.
	4. The meter shall be capable of accepting any combination of up to two cards.

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

* 1. The Ethernet Option Card shall provide the meter with 100BaseT Ethernet functionality. The Ethernet Option card shall:
		1. Allow the meter to speak with 12 simultaneous sockets of Modbus TCP, so that multiple requests for data can be received simultaneously.
		2. Allow the meter to speak with 5 simultaneous sockets of DNP over TCP/IP so that multiple requests can be handled simultaneously, using standard and optional ports.
		3. Allow the meter to speak with both Modbus TCP and DNP over Ethernet simultaneously.
		4. Allow auto transmit/receive detection for straight or null RJ45 cables.
		5. Provide an embedded Web server that allows access to metered readings through the Internet, using any standard Web browser from a PC, smart phone, or tablet PC.
		6. Provide email on configured alarms.
		7. Provide email notification of meter status and readings data on a programmed schedule.
		8. Provide data push of up to 15 meter readings to a cloud server with the JSON structure.
		9. Provide heightened security by allowing setup of an exclusive TCP/IP client. When the client is communicating though the meter’s network card, no other communication to that network card will be allowed, to protect against unauthorized programming.
		10. The meter shall be programmable to shut down unused network services to protect against meter tampering.
	2. The 1mA Output Option Card shall provide the following features:
		1. 4 channel, bi-directional 0-1 mA outputs.
		2. Assignable to any measured parameter.
		3. 0.1% of Full-Scale accuracy throughout range and load.
		4. Maximum load impedance to 10k Ohms, with no accuracy losses.
	3. The 20mA Output Option Card shall provide the following features:
		1. 4 channel, 4-20 mA outputs.
		2. Assignable to any measured parameter.
		3. 0.1% of Full-Scale accuracy throughout range and load.
		4. Maximum load impedance to 850 Ohms, with no accuracy losses.
		5. Loop powered using up to 24 volts DC.
	4. The Relay Output/Status Input Option Card shall provide the following features:
		1. 2 Relay outputs, 2 Status inputs.
		2. Status Inputs – Wet/Dry Auto Detect up to 150 volts DC.
		3. Trigger on User Set Limits/Alarms (with Virtual Upgrade pack 4).
		4. Set delays and Reset delays.
	5. The Pulse Output/Digital Input Option Card shall provide the following features:
		1. 4 KYZ pulse/4 Status inputs.
		2. Programmable to any energy parameter and pulse value.
		3. Programmable to End of Interval pulse.
		4. Can function for manual relay control and limit-based control (with Virtual Upgrade pack 4).
		5. 120 mA continuous load current.
		6. DNP input.
	6. The Fiber Optic Option Card shall provide the following features:
		1. Built in logic to mimic RS485 half-duplex bus, allowing the user to daisy chain meters for low installation cost.
		2. ST Terminated Option.
		3. Versatile Link Terminated Option.
		4. Modbus and DNP3 protocols available.
	7. The IEC 61850 Protocol Ethernet Network Option Card shall provide the
	 following features:
		1. Integrates into any IEC 61850 network.
		2. Provides support for Modbus and IEC 61850 protocols simultaneously.
		3. Configurable for multiple logical nodes.
		4. Provides buffered and unbuffered reporting.
		5. Provides dual Ethernet IEC 61850 Protocol Network option cards.
		6. Is certified by a 3rd party Authorized IEC61850 Test Laboratory.
		7. Is capable of supporting two Ethernet /IP connections with separate /IP addresses, each running IEC 61850 protocol.
		8. Provide heightened security by allowing setup of an exclusive TCP/IP client. When the client is communicating though the meter’s network card, no other communication to that network card will be allowed, to protect against unauthorized programming.
			1. The meter shall have transformer loss, line loss, and total substation loss compensation.

1. Substation losses shall be programmable for Watts and VARs, and for Ferris and Copper losses.

 2. The meter shall have CT and PT compensation to set compensation factors for errors in CTs and PTs connected to the meter.

***NOTE TO SPECIFIER: THE FOLLOWING REFLECTS THE CAPABILITIES OF THE RGM8000:***

1. The meter shall be UL listed and CE marked.

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

* + 1. The meter shall support 3 Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.
		2. The meter shall accept universal voltage input.
		3. The meter's surge withstand shall conform to IEEE C37.90.1.
		4. The meter shall be user programmable for voltage range to any PT ratio.
		5. The meter shall accept a burden up to 0.018 W at 120 V.
		6. The meter shall accept a voltage input range of up to 576 volts Line to Neutral, and up to 721 volts Line to Line.
		7. The meter shall accept a current reading of up to 11 Amps continuous.
		8. The meter shall have color-coordinated voltage and current inputs.
1. The meter shall use a dual input method for current inputs. Method one shall allow the CT to pass directly through the meter without any physical termination on the meter. The second method shall provide additional termination pass through bars, allowing the CT leads to be terminated on the meter. The meter must support both termination methods.
2. Fault Current Withstand shall be 100 A for 10 seconds, 300 A for 3 seconds, and 500 A for 1 second.
3. The meter shall be programmable for current to any CT ratio. DIP switches or other fixed ratios shall not be acceptable.
4. The meter shall accept a burden of 0.005 VA per phase, Max at 11 A.
5. The meter shall begin reading at 0.1% of the nominal current.
6. Pass through wire gauge dimension of 0.177” / 4.5 mm shall be available.
7. All inputs and outputs shall be galvanically isolated to 2500 V AC.
8. The meter shall accept current inputs of Class 10: (0.005 to 11) A, 5 A Nominal, 18 A max and Class 2 (0.001 to 2) A, 1 A Nominal Secondary, 2 A max.

D. The meter shall have an accuracy of +/- 0.1% or better for voltage and amperes, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC62053-22 (Class 0.2S) and ANSI C12.20 (0.1 Accuracy Class). The meter shall have a Frequency measurement accuracy of not less than 0.007 Hz.

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

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

 1. The meter shall be capable of recording 512 samples per cycle for a voltage sag or

 swell or for a current fault event.

1. The meter shall provide pre- and post-event recording capability.
2. The meter shall have a programmable sampling rate for the waveform recorder.
3. The meter shall have an advanced DSP design that allows power quality triggers to be based on a 1 cycle updated RMS.
4. Up to 319 events shall be recorded.
5. The meter shall store waveform data in a first-in, first-out circular buffer to ensure that data is always being recorded.

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

1. The meter shall fit in both DIN 92 mm and ANSI C39.1 round cut-outs.
2. The meter must display a % of Load Bar on the front panel to provide an analog feel. The % Load bar shall have not less than 10 segments.
	1. The meter shall be a traceable revenue meter, which shall contain a utility grade test
	 pulse allowing power providers to verify and confirm that the meter is performing to its
	 rated accuracy.
	2. The meter shall include virtual measurement upgrade packs (V-Switch™ keys), which shall allow user to upgrade in field without removing installed meter.

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

1. One port shall provide RS485 communication speaking Modbus ASCII, Modbus RTU, or DNP3 protocol through the back plate. Baud rates shall be from 1200 baud to 57600 baud for the RS485 port.
2. The meter shall have a USB port (through the faceplate) as the second standard communication port, which shall allow the unit to be set up and programmed using a laptop computer. Baud rate for the USB port shall be 57600; Modbus ASCII protocol, no Parity, 8 Data bits, and 1 Stop bit shall be supported.

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

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

 L. The meter shall support a power supply of (90 to 265) V AC or (100 to 370) V DC.
 Universal AC/DC Supply shall have a burden of 10 VA max. An optional power supply
 of (18 to 60) V DC shall be available.

M. The meter shall provide Limits/Alarms and control capability as follows:

1. Limits can be set for any measured parameter.
2. Up to 16 limits can be set.
3. Limits shall be based on % of Full-Scale settings.
4. Manual relay control shall be available through software.
5. Relay set delays and reset delays shall be available.
6. Relay control shall be available through DNP3 over Ethernet with the Ethernet Option card.

N. The meter shall have data logging capability of up to 128 MB memory. The meter shall
 have a real-time clock that allows for time stamping of all the data in the meter when log
 events are created.

1. The meter shall have up to six historical logs for trending profiles. Each log shall be capable of being programmed with up to 64 parameters. The user shall have the ability to allocate memory between the three historical logs in order to increase or decrease the memory allotted to each of the logs. The duration of a historical log with 4 data channels being recorded at 15-minute intervals shall be 76 months.
2. The meter shall have a log for Limits/Alarms. The Limits log shall provide magnitude and duration of an event, time-stamp, and log value. The log must be capable of recording up to 2048 events.
3. The meter shall have a log for System Events. The System Events log shall record the following occurrences with a time-stamp: Demand Resets, Password Requests, System Startup, Energy Resets, Log Resets, Log Reads, Programmable Settings Changes, and Critical Data Repairs.
4. The meter shall have a log for I/O changes. The I/O Change log shall provide a time-stamped record of any Relay Outputs and any Input Status changes. The log must be capable of recording up to 2048 events.
5. The meter with Virtual Upgrade packs 3 and 4 shall have a log which is capable of recording a waveform both when a user-programmed value goes out of limit and when the value returns to within limit. Up to 319 waveform events can be stored.
6. The meter shall have a log for PQ events, with millisecond recording of waveform events.
	* + 1. The meter shall have I/O expandability through two Option card slots on the back.
	1. The cards shall be capable of being installed in the field, without removing the meter from installation.
	2. The meter shall auto-detect the presence of any I/O Option cards.
	3. The Option card slots shall accept I/O cards in all of the following formats: 100BaseT Ethernet Communication Card; Four Channel Bi-directional 0-1mA Output Card; Four Channel 4-20mA Output Card; Two Relay Outputs/2 Status Inputs Card; Four Pulse Outputs/4 Status Inputs Card; Fiber Optic Card; IEC 61850 Protocol Ethernet Network Card; RS232/RS485 Serial Communication Card.
	4. The meter shall be capable of accepting any combination of up to two cards.

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

* 1. The Ethernet Option Card shall provide the meter with 100BaseT Ethernet functionality. The Ethernet Option card shall:
		1. Allow the meter to speak with 12 simultaneous sockets of Modbus TCP, so that multiple requests for data can be received simultaneously.
		2. Allow the meter to speak with 5 simultaneous sockets of DNP3 over TCP/IP.
		3. Allow the meter to speak with both Modbus TCP and DNP3 over Ethernet simultaneously.
		4. Allow auto transmit/receive detection for straight or crossover RJ45 cables.
		5. Provide an embedded Web server that allows access to metered readings through the Internet, using any standard Web browser from a PC, smart phone, or tablet PC.
		6. Provide email on configured alarms.
		7. Provide email notification of meter status and reading data on a programmed schedule.
	2. The 1mAO Option Card shall provide the following features:
		1. 4 channel, bi-directional 0-1 mA outputs.
		2. Assignable to any measured parameter.
		3. 0.1% of Full-Scale accuracy throughout range and load.
		4. Maximum load impedance to 10 kΩ, with no accuracy losses.
1. The 20mAO Option Card shall provide the following features:
	* 1. 4 channel, 4-20 mA outputs.
		2. Assignable to any measured parameter.
		3. 0.1% of Full-Scale accuracy throughout range and load.
		4. Maximum load impedance to 850 Ω, with no accuracy losses.
		5. Loop powered using up to 24 V DC.
2. The Relay Output/Status Input Option Card shall provide the following features:
	* 1. 2 Relay outputs, 2 Status inputs.
		2. Status Inputs – Wet/Dry Auto Detect up to 150 V DC.
		3. Trigger on user-set Limits/Alarms.
		4. Set delays and Reset delays.
3. The Pulse Output/Digital Input Option Card shall provide the following features:
	* 1. 4 KYZ pulse/4 Status inputs.
		2. Programmable to any energy parameter and pulse value.
		3. Programmable to End of Interval pulse.
		4. Can function for manual relay control and limit-based control.
		5. 120 mA continuous load current.
		6. DNP3 input.
4. The Fiber Optic Option Card shall provide the following features:
	* 1. Built in logic to mimic RS485 half-duplex bus, allowing the user to daisy chain meters for low installation cost.
		2. ST Terminated Option.
		3. Versatile Link Terminated Option.
		4. Modbus and DNP3 protocols available.
5. The IEC 61850 Protocol Ethernet Network Option Card shall provide the
 following features:
	* 1. Integrates into any IEC 61850 network.
		2. Provides support for Modbus TCP and IEC 61850 protocols simultaneously.
		3. Configurable for multiple logical nodes.
		4. Provides buffered and unbuffered reporting.
		5. Is certified by a 3rd party Authorized IEC 61850 Test Laboratory.
		6. Is capable of supporting two Ethernet cards with separate /IP addresses, each running IEC 61850 protocol.
6. The RS1S Communication card adds another serial communication port - either RS232 or RS485.
	* + 1. The meter shall have transformer loss, line loss, and total substation loss compensation.

1. Substation losses shall be programmable for Watts and VARs, and for Ferris and

 Copper losses.

* + - 1. The meter shall compensate for errors in current transformers and potential
			 transformers.
1. Errors shall include voltage, multipoint current, multiphase angle, and better than .01% resolution.
	* + 1. The meter shall internally record and store Time of Use data in a perpetual TOU
			 calendar.

 1. The following Time of Use parameters must be included:

a. Bi-directional consumption and demand.

b. Configurable accumulators.

c. Up to four seasons and 12 months.

 2. The meter must provide the following TOU information for all rates in
 real time:

* + - 1. Current month accumulations.
			2. Previous month accumulations.
			3. Current season (or weekly, or daily) accumulations.
			4. Previous season (or weekly, or daily) accumulations.
			5. Total accumulations to date.
			6. Cumulative Demand.
			7. Continuous cumulative demand shall be available.

S. The meter shall provide multi-level Cyber Security:

1. The meter shall have highly secure encrypted passwords of up to 30 characters in length.
2. The meter’s security shall allow for 9 user IDs and passwords.
3. There shall be one admin level and up to 8 customizable user levels.
4. There shall be password fail timeouts.
5. Password restriction shall be available for most meter functions.
6. The meter shall be able to be stored in (-20 to +70) oC.
7. Operating temperature shall be (-20 to +70) oC.
8. NEMA 1 faceplate rating shall be available.
9. Humidity rating to 95% R.H.
10. Standard conformal coating on PCBs.

***NOTE TO SPECIFIER: THE FOLLOWING REFLECTS THE CAPABILITIES OF THE RGM9700:***

1. Power meter shall be multi-function 3 phase solid state unit with ability to connect to either 3 phase, 4 wire Wye or 3 phase, 3 wire delta circuits.
2. Power meter shall include two 10-character, alphanumeric passwords, which shall protect the unit from unauthorized tampering.

C. Voltage and current inputs to the meter shall conform to the following at a minimum:

 1. Monitor shall accept input of four (4) independent voltage inputs and four (4) independent current inputs of the stated capacity.

 2. Voltage input shall be 120 volts AC with available option for direct connection to voltage circuits of up to 600 V AC without the use of potential transformers.

 3. Voltage input shall be optically isolated to 2500 volts DC. Shall meet or exceed ANSI C37.90.1 (Surge Withstand Capability)

 4. Current input shall be rated for 5 Amps with inputs 2x continuous programmable to any CT range.

 5. Current inputs shall be solid U-Bolt stud inputs with a ten-second over-current rating of 100 Amps, a three second over-current rating of 300 Amps, and a one-second over-current rating of 500 Amps; at 23 oC.

D. Power meter shall measure and report the following quantities at a minimum:

 1. Voltage, both phase to neutral and phase to phase, for all three phases; Auxiliary voltage; Phase angles for each voltage relative to each other. One cycle, 200 milliseconds and one second readings shall be available simultaneously.

1. Current, phase A, B, C, N-measured, and N-calculated; Phase angles for each current relative to voltages. One cycle, 200 milliseconds and one second readings shall be available simultaneously.

 3. Watts (total and per phase), VARs (total and per phase), VA (total and per phase), Power Factor (total and per phase) and Frequency. 200 milliseconds and one second readings shall be available simultaneously.

 4. Accumulated Watt-hr, VA-hr, and VAR-hr; Watt-hr received; Watt-hr delivered. VAR-hr and VA-hr reading shall be stored in each of the 4 quadrants of power.

 5. Power demand shall be calculated using four (4) different averaging methods: Thermal Average, Block Window Average, Rolling Window Average, and Predicted Average. Values for all averaging intervals must be available simultaneously.

 6. Power meter shall provide updates of all voltage and current readings at intervals of 1 cycle, 200 milliseconds, and 1 second. Readings shall be available for both metering and control. All specified readings shall be made available via the RS485 ports.

 7. Power meter shall provide time-stamped maximum and minimum readings for every measured parameter.

 8. Power meter shall provide coincident VAR readings for all maximum Watt readings.

E. Power meter shall provide the following accuracies:

 1. Voltage accuracy shall be within less than 0.05% for the 1 second readings and less than 0.1% for the 200 millisecond readings.

 2. Current accuracy shall be within less than 0.025% for the 1 second readings and less than 0.10% for the 200 millisecond readings.

 3. Power and energy accuracy shall be within less than 0.06% at unity PF and within 0.10% at 0.50 PF.

 4. Frequency accuracy shall be within less than 0.01 Hz for the 1 second readings and less than 0.03 Hz for the 200-millisecond reading.

1. The unit shall have an auto-calibration circuit designed to calibrate the readings using an internal reference. The calibration shall commence upon temperature change.

 F. Auto-calibration components:

1. 8 Channel sample/hold, for each at the voltage and current channels.
2. Precision internal references with real-time auto calibration for voltage and current channels.
3. The voltage inputs shall be optically isolated to 2500 volts.
4. Dual 16-bit A/D converters.

G. Power meter shall provide multiple digital communication ports and support multiple open protocols.

 1. Meter shall include four (4) independent, digital communication ports. Each port shall be RS485 architecture. Port 1 shall be user selectable as either RS232 or RS485 architecture.

 2. Each port shall be user configurable with regard to speed, protocol, address, and other communications parameters. All ports shall support a maximum communication speed of 115k baud simultaneously.

 3. Meter shall have an Ethernet port as an available option.

 a. Ethernet option shall enable Total Web Solutions (TWS) feature, which is a fully customizable Web server.

 b. TWS shall use XML to provide access to meter’s real time data through Internet Explorer.

 c. TWS shall allow 12 simultaneous sockets of TCP/IP to the meter.

 d. TWS shall be configurable to enable email alarm notification to up to nine recipients.

* 1. Meter shall offer both Modbus and DNP 3.0 level 2 plus, open protocols as standard configurations. All instantaneous data, logged data, event data, power quality analysis and waveform information shall be available using these open protocols.
1. Up to 136 measurements shall be able to be mapped to DNP Static points in the customizable DNP Point map.
2. Up to 16 relays and 8 resets shall be controlled through DNP.
3. Meter shall be able to hold 250 events of combinations, of four events that are shall be binary input change, frozen counter, counter change, analog change.
4. Flexible combinations of 4 events such as binary input change, frozen counter, counter change, and analog change shall be available for up to 250 events.
5. Meter shall allow freeze commands.
6. Third party certification shall be available.

 I. Power meter shall enable users to perform Flicker analysis according to IEC 61000-4-15.

1. The unit shall provide users with logging and monitoring for instantaneous short-term readings (PST-10min) and long-term readings (PLT-4 hour).
2. The meter shall be able to log Flicker readings.
3. Flicker shall be available for both 50 Hz and 60 Hz systems.
4. The Flicker algorithm shall support both 120- and 220-volts power systems.

 J. Meter shall be capable of recording time-stamped Flicker readings in an EN 50160 log.

 1. Log shall be viewable through a Log Viewer application.

 a. EN 50160 readings shall be viewable in chart format or displayed values format.

 b. Log shall be downloadable from Log Viewer application.

 c. Log shall be printable from Log Viewer application.

 K. The ability to view interharmonics, the discrete frequencies that lie between the harmonics of the power frequency voltage and current, shall be available.

1. Frequencies shall be able to be observed, which are not an integer multiple of the fundamental and shall be able to appear as discrete frequencies or as a wide-band spectrum.
2. User shall be able to set a starting point anywhere in the waveform, assuming there will be enough sample points available after the starting point.

L. Power meter shall provide sequence of events capture and recording.

 1. Meter shall have at least eight high-speed status inputs for capturing external events.

 2. All high-speed status inputs shall be monitored at a user set rate from 1 to 8 samples per millisecond.

 3. All changes in status shall be time stamped to the nearest millisecond and placed in an event log with time and event label information.

 4. Event log shall enable users to recreate sequence of events involving external status points.

 5. High-speed status inputs shall be able to trigger waveform recording to the waveform log.

 6. Status inputs shall be configurable for event monitoring, pulse accumulation, or pulse synchronizing.

M. Power meter shall provide a separate IRIG-B input for time synchronizing to GPS time signal.

 1. IRIG-B input shall accept un-modulated time signal input from a standard GPS satellite clock.

 2. Time input shall enable time synchronizing to one millisecond and shall not be subject to network or other delays.

N. Power meter shall provide an external display to accommodate access to readings locally and/or remotely.

1. Display shall be a three-line, LED format, P40N/P40N+ display.
2. The meter shall be capable of providing readings to a P40N/P40N+, P41N, and P43N series of LED displays simultaneously.
3. LED displays shall be 0.56-inch size and display shall include 10-character alphanumeric segment to provide legend and scaling information for displayed values. The LED display shall use one communication port.

 4. Display shall connect to Power Meter via RS485 communications architecture. The communication channel shall be isolated at the display to avoid the introduction of noise.

 5. Display shall be able to be powered directly from Power Meter or from an auxiliary power supply.

 6. Display shall communicate with Power Meter using Modbus protocol.

 7. Display must be capable of operating over common communications channels. It shall be capable of being connected up to 5,000 feet from the Power Meter.

 8. Display shall be surface mounted for ease of installation.

 9. P40N+ display shall have a USB port to allow direct data downloads to a PC from the display.

O. Power meter shall be equipped with non-volatile RAM for recording logs and programming information.

 1. Standard memory shall not be less than 4 MB.

 2. Meter shall store historical trending data, power quality data, and waveform recordings in memory.

 3. Memory shall be allocated to the various logging functions required. All logging features required shall be simultaneously available at the specified levels. Exercising any one feature at the specified level shall not limit exercising of any or all other features to their full, specified level.

 4. Meter shall store all programming and set-up parameters in non-volatile memory. In the event of loss of control power, meter programming data stored in memory shall be retained for at least 5 years.

P. Power meter shall provide historical data logging for trending of measured values.

 1. Power meter shall contain two independent data logs.

 2. Each historical log shall be user configurable. User may select measured quantities and reading intervals for each log.

 3. Each historical log shall record at least 170 days of data where 5 readings are being stored every 15 minutes.

1. One of the historical logs shall be configurable for time of use recording.

Q. The monitor shall internally record and store Time of Use.

 1. The following Time of Use parameters must be included:

* 1. Twenty-year calendar
	2. Four seasons
	3. Twelve Holidays per season
	4. Four TOU schedules per season
	5. Eight tariff registers

 2. The meter must display the following information in real-time when the TOU is enabled:

 a. Current month accumulations

1. Previous month accumulations
2. Current season accumulations
3. Previous season accumulations
4. Total accumulations to date
5. Full four quadrant accumulations for Watt-hr, VAR-hr, VA-hr and coincident VARs during peak watt demand including max demand, shall be available for each tariff schedule, each season and for total accumulations.

R. Power meter shall provide extensive power quality monitoring capability.

1. Power meter shall measure and record the magnitude and phase angle of all real time harmonics through the 128th for all voltages and currents. Meter shall provide THD and K-Factor for all channels.

 2. All harmonic magnitude values shall be available through the digital communications ports in real time.

 3. Power meter shall capture and record all ITIC/CBEMA quality events.

 4. ITIC/CBEMA events shall be date/time stamped to the millisecond. Entries to CBEMA log shall include date/time stamp, duration, and magnitude information. The CBEMA log shall be downloadable through the digital communications ports.

 5. The CBEMA log shall hold over 1024 events in a revolving FIFO format.

 6. Power meter shall capture and record out-of-limit conditions in a log. Entries to Limits log shall be made anytime a monitored quantity exceeds the user set limit assigned to that quantity.

 7. Entries to the Limits log shall be time stamped to the millisecond and include the measured quantity value and label.

 8. The Limits log shall hold over 1024 events in a revolving FIFO format.

S. Power meter shall provide waveform recording to capture and record transients and quality problems on current and voltage waveforms.

 1. Meter shall sample waveform at a user configurable rate of 16 to 512 samples per cycle (60 Hz cycle).

 2. Meter shall hold at least 96 records of waveform recording in non-volatile memory. Each record shall be a minimum of 8 cycles in duration at the highest sample rate or 64 cycles in duration at the lowest sample rate.

 3. Each waveform record shall include pre-event and post-event data.

 4. Waveforms shall be recorded with time resolution to within one (1) millisecond.

 5. A waveform record shall be taken whenever the RMS value of voltage or current exceeds user-set limits.

 6. User shall be able to configure meter so that a waveform record shall be taken whenever a status change occurs on any one of the eight high-speed status inputs.

T. Power meter shall have expandable auxiliary I/O capability.

 1. Meter shall allow connection of external I/O modules.

 2. Up to four (4) 8 channel external I/O modules shall be capable of being powered directly from the power meter. An auxiliary power supply shall be available to power additional I/O modules if needed.

 3. External I/O modules shall be isolated from the power meter and from each other.

 4. I/O modules shall connect to the power meter using RS485 communication architecture and shall be capable of being placed up to 5000 feet from the power meter.

 5. External I/O modules shall communicate with the power meter using Modbus protocol. Closed protocols shall not be accepted.

 6. External I/O modules shall include analog output modules that have four to eight channels each and shall allow the use of 0-1 mA outputs or 4-20 mA outputs; analog input modules that have 8 channels; digital pulse outputs; control relay outputs; and digital inputs.

 7. External I/O modules shall be able to be added to the meter after installation to provide upgrade capability after the initial installation is complete. Changing the power meter shall not be required to provide this upgrade capability.

U. Power meter shall be programmable by software supplied by the meter manufacturer.

 1. Software shall include capacity to program meter, download meter, and
analyze downloaded data files.

1. Software shall store all data in an ODBC compliant database. Data based
 storage shall include all log and waveform data.

V. Meter shall offer programmable logical protection and control.

 1. The 7000 values that the meter measures shall be programmable with limits and logic that trigger operations.

 2. The programmable logic structure shall allow users to develop up to three levels of logic control based on limits and status conditions.

 3. The logic structure shall be programmable through a graphical tree structure, and shall allow the user to set logical descriptors such as:

 a. AND/NAND/XAND gates

 b. OR/NOR/XOR gates

 c. Hysteresis/NHysteresis control

 4. The graphical programming structure shall be easily configurable to the user’s desired logical scheme.

 5. The control function shall be extendible to at least sixteen relay outputs.

W. Power meter shall be appropriately constructed to provide long life in abusive physical and electrical environments.

 1. Meter shall be housed in an all-metal enclosure with no visible openings and no exposed circuit boards.

 2. Meter shall operate successfully at temperature extremes from –30 oC to +70 oC.

 3. Meter shall be UL listed.

 4. Meter shall operate with control power from 90 to 276 Volts AC/DC; meter shall have a power supply option to operate with control power of 18 to 60 Volts DC.

***NOTE TO SPECIFIER: THE FOLLOWING REFLECTS THE CAPABILITIES OF THE RGM9900:***

1. The meter shall be UL listed and CE marked. Meter shall have third party testing and/or certification for the following standards:
	* + 1. IEC 61000-4-30 Class A Ed. 3 Certification.
			2. IEC 61326-1, IEC 61000-3-2, IEC 61000-3-3 and subordinate standards.
			3. CISPR11, CISPR22.
			4. FCC Part 15, Subpart B.
			5. ANSI C12.20 0.2 CL Certification.
			6. IEC 62053-22 0.2S Certification.
			7. IEC 61850 Level A Ed. 2 Certification.
2. Meter shall be designed for multifunction electrical measurement on 3 phase power systems.
	* + 1. Meter shall measure voltage and current, watts (total and per phase), VARs (total and per phase), VA (total and per phase), power factor (total and per phase), voltage max/min in the interval, and frequency.
			2. Meter shall accumulate readings for watt-hour, VA-hour, and VAR-hour. All readings shall be accumulated and stored for each of the 4 quadrants of power.
			3. Power demand shall be simultaneously calculated using four different averaging methods: Fixed Window (Block) Average, Sliding Window (Rolling Block) Average, Thermal Average, and Cumulative window demand.
			4. Meter shall provide high-speed readings updated every cycle, a programmable 2-20 cycles, and one second, simultaneously.
			5. Meter shall calculate readings that are CT and PT compensated and transformer/line loss compensated. Both compensated and uncompensated readings shall be available simultaneously.
			6. Meter shall offer perpetual time of use with configurable rates/seasons and cumulative/continuous cumulative demand.
3. Meter shall automatically perform self-calibration to an internal reference every ten seconds, for the meter’s life. Meter must stabilize its readings within ten seconds of powering up.
4. Meter shall provide the following accuracies, measured as percent of reading at standard meter test points.
	* + 1. ANSI C12.20 0.1 CL and IEC 62053-22 0.2S class accuracy.
			2. 0.06% energy accuracy.
			3. Voltage accuracy within less than 0.05% for one second reading and less than 0.1% for high-speed readings.
			4. Current accuracy within less than 0.025% for one second reading and less than 0.1% for high-speed readings.
			5. Meter shall provide a one cycle high-speed frequency reading with a frequency resolution of better than 10 mHz.
			6. Meter’s internal precision real time clock shall provide max accuracy of 3.5 ppm at full temperature range, with less than 10 seconds per month drift.
			7. Meter shall provide accuracy test mode via software and the two front KYZ pulses. Test mode shall support positive/negative Wh, positive/negative VARh, per quadrants; test with or without TLC and PT/CT Compensation.
			8. Meter shall support ability to pre-set accumulators to be used when swapping out a meter for accuracy testing and validation.
5. Meter shall measure power quality and be 3rd party certified in accordance with the IEC 61000-4-30 Class A Edition 3 standard.
	* + 1. Flicker measurements shall be performed in accordance with the IEC 61000-4-15 standard and calculate instantaneous, short term, and long-term measurements.
			2. Meter shall allow viewing of voltage and current harmonic magnitudes in real time to the 127th order. Meter’s harmonic measurement shall be in accordance with the IEC 61000-4-7 standard.
			3. Meter shall have 16-bit waveform and fault recorder, recording up to 1024 samples/cycle continuously on all 8 channels simultaneously.
			4. Meter shall capture transients on 4 voltage input channels with at least 800,000 samples/cycle or 50 MHz sampling speed.
			5. Meter shall support EN 50160 reporting with user customizable setpoints to meet jurisdictional requirements.
6. Meter shall have an integrated high-visibility 5.7-inch touch screen TFT LCD color display with over 60 display screens for real time readings, trending, alarms, power quality, and test mode screens.
	* + 1. The display shall support both a horizontal and vertical presentation to support horizontal or vertical meter installation.
			2. The display shall support the following languages: English, Spanish, Hebrew, Portuguese, French, Chinese, and Polish.
7. Meter shall provide six simultaneously operating communication ports and support multiple open protocols. Ports shall include:
	* + 1. ANSI Optical port.
			2. Two 10/100BaseT Ethernet ports - one standard and one optional, with unique IP/MAC addressing.
				1. Ethernet ports shall be separately configurable to enable or disable each port’s protocol and service.
				2. Ethernet ports shall support DNP3 Level 2 over Ethernet and Modbus TCP/IP. Up to 64 simultaneous connections shall be available.
				3. With V2-V3 and V5-V6 upgrade packs, either Ethernet port shall offer IEC 61850 Ed. 2. IEC 61850 protocol shall include GOOSE messaging and shall provide alarms and waveform capture in response to GOOSE messages. Meter shall support distributed fault recording using GOOSE cross-triggers.
				4. With V4-V6, either Ethernet port can be configured as a phasor measurement unit (PMU) in a synchrophasor system outputting IEEE C37.118.2-2011 real time exchange of synchronized phasor measurement data.

 Synchrophasor functionality shall meet the IEEE C37.118.1a-2014 Class P and M standard. Either class shall be available.

Time synchronization methods of IRIG-B and IEEE 1588 PTPv2 shall be available.

Either port, but only one at a time, can be enabled for synchrophasor communication. PMU setting shall be available for Ethernet or Fiber Optic.

Meter as PMU measures and provides individual voltage/current phasors, symmetrical components phasors, frequency, rate of change of frequency, readings from built-in high-speed inputs, and analog data for fundamental power and displacement power factor.

Supported data frames shall be for 50 Hz 10/25/50 frames per second and for 60 Hz 10/12/15/20/30/60 frames per second.

Supported data formats shall be configurable float or integer, polar or rectangular.

Up to two simultaneous clients shall be able to communicate with meter as PMU.

* + - * 1. Ethernet ports shall support SNMP protocol. SNMP implementation shall support V1 and V2c standards; provide over 60 measurements; include traps for limits, input change, and power quality; and support cold start trap and authentication failure.
				2. Ethernet port 2 shall support IEEE PTPv2 as slave (for PMU functionality) or master (for master clock functionality).
				3. Ethernet ports shall act as a web server, providing real time reading, diagnostics, and firmware upgrades over the Internet.
				4. Ethernet ports shall provide email on alarm for over limit conditions, waveform captures, or periodic upload of data.
				5. Through a single Ethernet port, meter shall communicate simultaneously using Modbus ASCII/RTU/TCP, DNP3 Level 2, IEC 61850, SMTP, SNMP, HTTP, and IEEE C37.118.2 (PMU).
			1. Meter shall have two optional RS485 ports configurable for DNP3 Level 2 or Modbus TCP through the dual RS485/Pulse Output card. One of the RS485 ports can be configurable as an RTU Master to collect and trend data from slave Modbus devices. Each RS485 card also supports 4 KYZ pulse outputs configurable to any energy accumulation.
			2. Meter shall have high-speed USB port mounted on the front panel for configuration and data download.
1. Meter shall have 4 GB of non-volatile memory for extensive data and waveform recording.
	* 1. Meter shall have no less than eight historical logs with up to 128 parameters per log, a log for limits/alarms, an anti-tampering system events log, a log for high-speed input status changes, a waveform log, and a downloadable ITIC/CBEMA log.
		2. Memory shall be programmable for custom allocation of logging speed from 1 second to multiple hours. Memory depth can be allocated to assign a programmable length of time for more than one year of logging per log.
	1. Meter shall have input/output expandability through four internal I/O option card slots on the meter’s back and through optional external I/O modules.
2. Option cards shall be field-installable. Meter shall auto-detect the presence of any option cards. Option cards shall offer:
	1. RJ45 Ethernet expansion.
	2. Fiber optic Ethernet expansion.
	3. Dual RS485 / 4 pulse outputs.
	4. 6 relay outputs for limit-based control capability.
	5. 16 digital inputs.
3. Optional external I/O modules shall offer analog outputs, digital inputs, relay outputs, and pulse outputs. These modules are expandable for up to 256 points of I/O.
	1. Meter shall have eight built-in digital high-speed status inputs for event monitoring. Digital inputs shall be able to trigger waveform recording and/or send an IEC 61850 GOOSE message for distributed fault recording.
		1. High-speed inputs shall be configurable for pulse accumulation and pulse synchronization. For pulse accumulation, each input shall have an accumulating register to count incoming pulses.
	2. Meter shall have resilient cyber security, which shall provide:
		1. Meter firmware signed with a digital signature that has 512-bit encryption and is embedded in the firmware, to ensure firmware integrity.
		2. Customizable public key.
		3. 128-bit AES encryption of passwords and usernames. Passwords shall allow 24 complex characters.
		4. Admin level with full rights, that can enable/disable security, create users and assign roles, set expiration date for passwords and encryption key.
		5. Ten customizable user levels.
		6. Role-based authorization with eight configurable roles.
		7. Security lockout to prevent security from being disabled.
		8. Password fail timeouts to eliminate brute force hacking.
		9. System events log for all secured transaction attempts.
	3. Meter shall provide a sealing switch, consisting of physical lock on the meter and software setting to enable/disable sealing switch, for enhanced security.
	4. Meter shall include upgrade packs V1-V6 that enable field upgrades without removing meter from installation.
	5. Meter shall be programmable by software supplied by meter manufacturer. Meter shall integrate with cloud-based energy management system for Enterprise-wide power quality and usage analysis, predicted usage and demand, reporting, and email alarms.

***NOTE TO SPECIFIER: THE FOLLOWING REFLECTS THE CAPABILITIES OF THE PQMII:***

### Safety Certificate & Testing:

#### Meter shall be manufactured under an ISO9001 registered program.

#### The meter shall be UL listed and conform to CE EN 55011/CSPIR 11, EN50082-2, IEC 947-1, and IEC 1010-1 standards.

#### Meter shall conform to environment standard IEC 68-2-38 for temperature and humidity cycle.

#### Meter shall have a dielectric strength of 2.0 kV for 1 minute to relays, CTs, PTs and Power supply. Meter shall be able to withstand impulse rated at .5 Joules at 5kV

### Metering and Monitoring

#### Meter shall be panel mount design with integrated display. Display shall be a Liquid Crystal Display (LCD), minimum 40-character display capable of clearly displaying alphanumeric characters.

#### Meter shall provide separate LED indicators for Alarms, Relay Activation, Auxiliary and Communication (Rx,Tx) status

#### Set-point keys shall be provided on the front panel of the meter to program the meter. Meter shall be able to display all measured value on demand using the keys on meters front panel

#### For testing purposes meter shall be able to run in self-test and simulation mode. The meter shall simulate values for current, voltage, analog input, switches, and analog outputs.

#### Meter shall provide a true RMS monitoring of Ia, Ib, Ic, In, Van, Vbn, Vcn, Vab, Vbc, Vca, voltage/current unbalance, power factor, line frequency, watts, vars, VA, Wh, varh, VAh, and demand readings for A, W, vars, and VA. Maximum and minimum values of measured quantities shall also be recorded and date/time stamped.

#### Meter shall be able to provide demand metering for energy and power. Demand shall be programmable for Thermal or Rolling demand with the demand interval of 5-60 minutes in step of 1.

#### Meter shall be capable of calculating energy costs. User shall be able to program up to 3 different tariff rates for cost calculations.

#### Following minimum accuracy for the monitored parameters shall be provided:

Voltage: ±0.2% of full-scale

Current: ±0.2% of full-scale

Voltage unbalance: ±1% of full-scale

Current unbalance: ±1% of full-scale

kW: per curves ±1 digit on display

kvar: per curves ±1 digit on display

kVA: per curves ±1 digit on display

kWh: per curves ±1 digit on display

kvarh: per curves ±1 digit on display

kVAh: per curves ±1 digit on display

Power factor: ±1% of full-scale

Frequency: ±0.02 Hz

kW demand: ±0.4% of full-scale

kvar demand: ±0.4% of full-scale

kVA demand: ±0.4% of full-scale

Current demand: ±0.4% of full-scale

Current THD: ±2.0% of full-scale

Voltage THD: ±2.0% of full-scale

Crest factor: ±0.4% of full-scale

#### User shall be able to set Alarm conditions for all measured quantities. These include over-current, under-current, neutral current, current unbalance, voltage unbalance, phase reversal, over-frequency, under-frequency, power factor, switch inputs, etc. The alarm messages shall be displayed on the meter LCD display in a simple and easy to understand English format.

### Power Quality

#### Power analysis features shall include an event recorder, waveform capture, trace memory, harmonic spectrum display (through the 62nd harmonic with total harmonic distortion) and a data logger function. Meter shall be able to sample harmonic spectrum at 256 samples per cycle. All analysis data shall be non-volatile.

#### Meter shall have a Voltage Disturbance Recorder (VDR) function to monitor and record sag and swell disturbances. It shall record up to 500 sag/swell events for all voltages simultaneously and log them with a time stamp.

#### Meter shall be able to capture waveform for voltage and current channels. Meter shall simultaneously sample all channels at minimum 16 samples per cycle. Meter shall be able to automatically capture waveforms based on user-defined set-points.

#### Meter shall automatically generate log for alarms, triggers, and input/output events. 150 events records with time stamp shall be stored in the meter.

### Input/Outputs

#### Meter shall have built in input and output modules for control and transducer functions:

##### Four switch inputs (digital inputs) shall be provided which can be programmed for relay activation, counters, logic, demand sync, reset and alarms.

##### Four output relays shall be provided which can be programmed to activate on alarms, setpoints, switch inputs, kWh pulse, trace memory triggers or KYZ communications control. These output relays shall also be able to use demand-metering values of A, VAR, W and VA to control load shedding.

##### Four isolated 4-20mA or 0-1mA analog outputs assignable to all measured and calculated parameters for output to PLC and other such external devices.

### Communication:

#### Meter shall be able to communicate using Modbus and DNP 3.0 protocols over assignable RS 485 communication ports at minimum rate baud rate of 19200. Through the use of communication user shall be able to read/write set-points, read actual values, execute commands, and read device status loop-back test.

##### Meter shall have a RS232 9-pin computer interface port accessible from the front of the meters for interface with local computer.

##### Two RS485 ports shall be provided for communication with SCADA and other systems. Each port shall be able to communicate independently to different systems using Modbus or DNP protocols

##### Through the use of external Ethernet module meter shall be able to communicate over Local Area Network (LAN) using TCP/IP. The module shall support both 10BaseT (copper) and 10BaseF (fiber optic) connections. The module shall allow up to thirty additional RS-485/Modbus RTU devices to be connect to the Ethernet.

### METERING TRANSFORMERS

#### All instrument transformers shall be UL listed and classified as indicated in drawings.

#### Current transformers shall be as shown on drawings with burden and accuracy to support connected meters and relays as required by [ANSI/IEEE C57.13].

##### Potential transformers shall be provided where indicated on drawings with burden and accuracy to support connected meters and relays as required by [ANSI/IEEE C57.13].

### GROUP MOUNTED PLUG-IN CIRCUIT BREAKERS AND ACCESSORIES

#### Group mounted panel interior shall be designed and assembled such that circuit protective and other devices shall be connected to the distribution panel bus using the ReliaGear line side connectors. All plug-in devices shall use factory integrated line side connectors.

#### Group mounted panelboard interior shall be designed to provide IP20 (finger safe) protection per IEC 60529, even with branch devices disconnected.

#### Circuit breaker connectors shall be designed so that circuit breakers may be removed without disturbing adjacent devices. Circuit breaker line side connections to main bus shall be plug-in, held in place by 1 or 2 fastening screws, and shall not require annual torque inspection. No additional hardware including loose screws, bolts, nuts, or washers shall be required to connect circuit breakers.

#### Group mounted switchboard sections shall be rated as indicated in drawings. Sections shall have a maximum rating of 4000 amperes.

#### Bus shall be phase-sequenced and rigidly supported by tie bolts spaced at regular intervals.

#### All load terminations shall be suitable for [copper] [aluminum] UL listed wire or cable and shall be tested and listed in conjunction with appropriate UL standards. Terminations shall be rated for use with 75 degrees C cable; see circuit breaker testing approvals for additional temperature ratings, unless otherwise noted.

### MAIN DEVICES

#### Main device shall be [individually mounted, insulated case circuit breaker] [individually mounted, [power circuit breaker] [individually mounted, high pressure contact fusible switch] [individually mounted, molded case circuit breaker] [group mounted, molded case circuit breaker]. Provide device as specified in appropriate article below.

#### Tie device(s), if included, shall be the same as the main device.

#### Where indicated provide the following with the main device:

##### [Phase failure relay]

##### [shunt trip]

##### [undervoltage release]

##### [auxiliary contacts]

##### [bell alarm]

### TRANSFER SWITCHES

#### Where indicated on the drawings, provide a transfer switch between the main device and feeder devices. Transfer switch shall be an ABB Zenith or approved equal. Refer to Section [16415] [26 36 23], Automatic Transfer Switches.

#### Transfer switch shall be [3-pole] [4-pole], [manual transfer] [delayed transition] [closed transition].

#### Transfer switch shall transfer load from [utility to generator] [utility to utility].

### FEEDER DEVICES

####  [Feeder devices 1200 amps and smaller shall be group mounted with ReliaGear plug-in construction and/or individually mounted molded case circuit breakers.]

#### Feeder devices larger than 1200 amps shall be individually mounted [insulated case circuit breaker] [power circuit breaker] [HPC fusible switches] as indicated on the drawings.

#### All circuit protective devices shall have the following minimum symmetrical current interrupting capacity: [18kA] [25kA] [35kA] [50kA] [65kA] [100kA] [or as listed on the contract drawings].

#### Where indicated provide the following with the feeder device(s):

##### [shunt trip]

##### [undervoltage release]

##### [auxiliary contacts]

##### [bell alarm]

### MOLDED CASE CIRCUIT BREAKERS (MCCB)

#### Furnish UL 489 listed ABB Tmax XT and/or Record Plus FB Molded Case Circuit Breaker (MCCB) or equal as the switchboard/panelboard main and/or feeder devices. MCCBs greater than 250A shall be capable of being individually or group mounted.

#### General Characteristics:

##### The MCCB trip amps shall be as shown on drawings.

##### MCCBs shall have double insulation between the live power parts (excluding the terminals) and the front of the apparatus where the operator works during normal operation of the device. The placement of each electrical accessory shall be completely segregated from the power circuit, preventing risk of contact with live parts.

##### MCCB operating mechanism shall include quick-make, quick-break, non-welding silver alloy contacts, and a common Trip, Open and Close mechanism such that all poles open and close simultaneously.

##### Arc Extinction shall be confined to arc chutes internal to the MCCB.

##### The MCCB handle shall indicate the precise position of the moving contacts of the MCCB, thereby providing safe and reliable indication. The MCCB operating mechanism shall be trip-free regardless of the pressure on the lever.

##### The MCCB handle shall reside in a tripped position between on and off to provide local trip indication. The MCCB escutcheon shall be clearly marked on and off.

##### The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and their corresponding interrupting ratings shall be clearly marked on the face of the MCCB.

##### Each MCCB shall be equipped with a test button, located on the face of the MCCB to mechanically operate the MCCB trip mechanism for maintenance and testing purposes.

##### Every MCCB must have a hologram on the front of the device, obtained using special anti-counterfeit techniques, which guarantees the quality and that the MCCB is an original ABB product.

##### MCCBs shall be UL listed for reverse fed.

##### Unless otherwise noted in the project drawings or specifications, MCCBs shall be UL listed for standard duty and are to be applied at 80% of their continuous current rating.

##### Factory installed CU/ALrated mechanical lugs shall be installed. Lugs shall be UL listed and rated 75 or 60/75 degrees C as appropriate.

##### [Molded Case Switches (MCSs) derived from the MCCB range shall be provided. MCSs up to 1200A will be able to be used in alternating current applications.]

##### [UL Current Limiting MCCBs up to 600A shall be provided. Current Limiting MCCB will be marked “Current Limiting” on the front and will have a label on the right-hand side specifying peak current and specific let through energy values.]

#### Trip unit(s)

1. Thermal Magnetic (800A Frame and Below):
	* 1. Basis of Design: ABB with Thermal Magnetic – Fixed (TMF) and Thermal Magnetic – Adjustable (TMA trip units.
		2. General:
			1. Thermal magnetic trip units shall be fitted with a bimetal thermal element for overload protection and magnetic element for short circuit protection.
			2. Circuit breakers rated greater than 125A shall be adjustable trip units, the overload protection shall be continuously adjustable from 70% to 100% of trip rating. The short circuit (instantaneous) protection shall be continuously adjustable from 5X-10X.
			3. Thermal magnetic trip units shall be available from 15A to 800A trip, fixed rating MCCBs shall be available up to 125A. MCCBs with both adjustable thermal and magnetic elements shall be available from 150A to 800A.
2. Basic electronic trip MCCB:
	* 1. Basis of Design: ABB Ekip DIP.
		2. Electronic trip unit must be unaffected by electromagnetic interference in compliance with the EMC directive and Annex F of IEC 60947-2.
		3. MCCB trip unit shall be electronic adjustable with true RMS sensing and thermal memory.
		4. The standard electronic trip unit shall be fitted with a dip switch interface to ensure accuracy while adjusting protection settings.
		5. The basic electronic trip unit shall have adjustable protection for Long-Time, Short-Time, Instantaneous, [and Ground Fault]. This protection is commonly referred to as LSI, LIG, or LSIG. All protective elements (LSIG) shall be independent of each other. Trip units with tracking short-time are not approved. Short circuit protection may be either Instantaneous type (function I) or, alternatively, with intentional delay (function S). The ability to disable the adjustable instantaneous trip is required. The adjustable instantaneous shall be capable of being disabled; an instantaneous override shall provide protection.
			1. (L) protection shall be adjustable from 40% to 100% **In** at increments of 4% **In**where **In** is the nominal current rating of the MCCB.
			2. (S) protection pickup shall allow fifteen settings from 1 to 10 times **In**.
			3. Both (L) and (S) protection shall be available in two different time delay curves.
			4. (I) protection pickup shall allow fifteen settings from 1 to 10 times **In**.
		6. Ground fault protection, (G) shall be provided where indicated on drawings or required by the NEC.
		7. Accuracy of electronic trip units shall not be affected by ambient temperature.

#### ***SPECIFIER NOTE: INCLUDE THE FOLLOWING FEATURES FOR TOUCH/HI-TOUCH TRIP UNIT OPTIONS:***

1. Advanced electronic trip unit(s):
2. Basis of Design: ABB Ekip Touch/Hi-Touch.
3. General:
	* + 1. MCCB trip system shall be an electronic trip unit with true RMS sensing and thermal memory.
			2. [Portable configuration and test unit shall be available for setting and testing each protective function.]
			3. Trip units shall [not] incorporate Bluetooth unit for wireless communication.
			4. The advanced electronic trip unit shall be fitted with protection functions against extended time overload (L function), high current overload or short circuit (S function), high short circuit current / instantaneous (I function) and optional Ground Fault (G function) or alarm. Instantaneous short circuit protection (I function) may be disabled allowing instantaneous override to provide UL required protection.
				1. The minimum pickup threshold for protection against overload will be 0.4 times **In**.
				2. (S) protection pickup shall allow fifteen settings from 1 to 10 times **In**.
				3. Both (L) and (S) protection will be available in five different time delay curves.
				4. Two different kinds of (S) protection (with inverse or definite time) shall be available.
				5. (I) protection pickup shall allow fifteen settings from 1 to 10 times In (Tmax XT7 has a setting from 1 to 15 times In).
				6. (G) protection pickup shall allow at least seven settings from 0.2 to 1 times **In** (G) protection shall be available with four different time delay curves. Two different kinds of (G) protection (with inverse or definite time) shall be available (as indicated on drawings).
			5. The trip thresholds on electronic trip units shall not be affected by ambient temperature.
			6. Trip units shall have the capability to be adjusted locally or remotely. Increments for pickup adjustments shall be 0.1% **In** for (L) and (G) protection, and 10% In for (S) and (I) protection.
			7. Electronic trip unit with the [Touch][Hi-Touch] shall have LEDs on the front to indicate the status of MCCB, pickup status, and cause of trip.
			8. Trip units shall be able to provide real time metering. Metering functions shall include, but shall not be limited to, the following:
				1. Current (phases, neutral, ground).
				2. [Voltage (phase to phase, phase to neutral, residual).
				3. Power (active [kW], reactive [kVAR], apparent [kVA]).
				4. Power factor.
				5. Energy (active [kWh], reactive [kVAR], apparent [kVA]).
				6. Frequency.
				7. Total harmonic distortion (current, voltage). The harmonic content of voltage and current should be measured to 50th harmonic order.]
			9. Trip Unit Auxiliary Power is [Direct Supply for 24V DC] [Ekip Supply for DC/AC] Metering Selection:
				1. Trip unit shall have a minimum metering accuracy of 1% current, 1% voltage, and 2% power and energy. These accuracies shall be the accuracy of the entire system including current transformers, potential transformers, etc.
				2. The measurements shall be displayed on the MCCB itself, remote display, and/or on a remote system via communication protocol with [Bluetooth enabled] [Bluetooth disabled].

[Trip unit shall have a minimum metering accuracy of 1.0% current, 0.5% voltage, and 2% power and energy.]

[Trip unit shall have a minimum metering accuracy of 0.5% current, 0.5% voltage, and 1% power and energy.]

[Voltage-related protection functions such as overvoltage, undervoltage, voltage unbalance, etc.]

[Reverse power protection]

1. Accessories
	* 1. Mechanical accessories:
			1. Different types of terminals (both front and rear) must be available for all the sizes, suitable for connection with copper, copper-aluminium cable, and compression lugs. Terminal covers and phase separators shall also be available. Terminals shall have laser marking on the surface, indicating the tightening torques for cables and compression lugs.
			2. Whole range of MCCBs up to 600A shall be able to be fitted with motor operator (this shall be stored energy type) for remote operation of the MCCB.
				1. It shall be possible to fit padlocks or key locks that prevent the circuit breaker from being closed and/or opened:
				2. directly on the front of the MCCB
				3. on the rotary handle operating mechanism
				4. on the front for lever operating mechanism
				5. on the motor
				6. on the front of the thermal-magnetic trip unit, to prevent the adjusting of the thermal part from being tampered with
				7. MCCB (800-1200A) shall be able to be fitted with stored energy motor operator for remote operation of the MCCB.
			3. In closed position, the locks do not prevent the mechanism from tripping due to the trip unit or a service release.

Accessories for electronic trip units must be available, including:

the test unit for checking functioning of the tripping coil

a trip signaling unit

a test and configuration unit which allows the electronic trip unit protective functions to be tested and configured

a battery unit which allows trip unit testing when the circuit breaker is under 20% load.

* + 1. Electric accessories:
			1. MCCBs may be equipped with auxiliary contacts that signal the status of the MCCB and can be routed outside the MCCB itself. The following information shall be available: status of the MCCB power contacts open/closed, signalling MCCB opening trip unit intervention, residual current device, undervoltage releases (due to, use of the emergency opening pushbutton of the motor operator, test button), trip unit tripping, under voltage or shunt opening activated.
			2. Auxiliary contacts for use at 250 V AC/DC, 400 V AC and 24 V DC (digital contacts) must be available.
			3. Dedicated bell alarm contact shall be available to indicate that the trip signalling, trip unit signalling, and under voltage release or shunt trip release has been activated.
			4. Shunt opening and under-voltage releases must be available with different power supply voltages both in AC and DC.
			5. Service releases shall be installed without screws and shall be available in cabled version suitable for all MCCB execution
			6. Addition of the auxiliary contacts and service releases shall not increase the volume of the MCCBs.
			7. For MCCBs with rated current from 800A-1200A closing release in addition to shunt opening release shall be available to allow remote control of MCCB.
		2. Communication
1. For MCCBs from 20A to 1200A communication must be available, making the following functions possible: Remote setting of the protection function parameters, unit configuration and communication, Transmission of measurements, states, and alarms from MCCB to system, Transmission of events to the system. Register point addresses and formats shall be the same for all MCCB frames and trip units.
2. Trip unit must be able to support various protocols without the use of third-party gateways and or protocol converters [Modbus RS485] [Modbus TCP] [Ethernet IP] [DeviceNet][Profibus] [Profinet] [IEC 61850] [Bluetooth][OPCUA][OPENADR].
3. When Bluetooth is included, function shall be embedded. Other communication protocols shall be available as internal modules (to be installed in dedicated accessory slot of MCCB) or as external module (to be installed on terminal box or in dedicated cartridge mounted on DIN rail and connected to circuit MCCB).
4. It shall be possible to install two different communication modules to ensure redundant communication.

1. [Optional cloud data storage shall be available.]
2. IEEE1588 v2 PTP for the synchronization shall be supported. Time stamping accuracy of 1 ms shall be available when the IEC 61850 communication module is used.

### INSULATED CASE CIRCUIT BREAKERS (ICCB)

#### Furnish ABB type Power Break II insulated case circuit breakers.

#### Insulated case circuit breakers shall be individually mounted.

#### Main and tie circuit breakers shall be [manually] [electrically] operated, [stationary] [drawout] mounted. Feeder circuit breakers (larger than 1200 amps) shall be [manually] [electrically] operated, [stationary] [drawout] mounted.

#### Circuit breakers shall be constructed of a high dielectric strength, glass reinforced insulating case. The interrupting mechanism shall be arc chutes. Steel vent grids shall be used to suppress arcs and cool vented gases. Interphase barriers shall isolate completely each pole.

#### Circuit breakers shall contain a true two-step stored energy operating mechanism which shall provide quick make, quick break operation with a maximum five cycle closing time. Circuit breakers shall be trip free at all times. Common tripping of all poles shall be standard.

#### Insulated case circuit breakers shall be rated to carry 100 percent of their frame ampacity continuously.

#### A charging handle, close push-button, open push-button, and Off/On/Charge indicator shall be located on the circuit breaker escutcheon and shall be visible with the circuit breaker compartment door closed.

#### Where drawout circuit breakers are specified, the drawout design shall permit the circuit breaker to be withdrawn from an engaged position, to a test position, and to a disengaged position.

#### Electronic trip unit(s) (ICCB)

##### Each insulated case Power Break II circuit breaker shall be equipped with an electronic trip unit. The trip unit shall provide protection from overloads, [and] short circuits [and ground faults]. The protective trip unit shall consist of a solid state, microprocessor-based programmer; tripping means; current sensors; power supply and other devices as required for proper operation. Furnish ABB EntelliGuard TU electronic trip units as specified below.

###### As a minimum, the trip unit shall have the following protective functions unless otherwise indicated on the drawings:

adjustable current setting or long-time pickup;

adjustable long-time delay (22 bands);

switchable, adjustable short-time pickup and delay (11 bands) with 3 I2t selectable slopes;

adjustable instantaneous pickup;

[adjustable ground fault pickup and delay] [Where indicated on the drawings provide GF alarm only function]

[Reduced Energy Let-Through (RELT) instantaneous trip. When specified this feature shall be provided to provide a temporary setting for the instantaneous trip setting of the circuit breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard.]

#### ***SPECIFIER NOTE: NEUTRAL PROTECTION MAY BE ADVISABLE IN 120/208V APPLICATION OR OTHER APPLICATIONS WHERE EXCESSIVE TRIPLEN HARMONICS MAY BE ENCOUNTERED. TRIPLE HARMONICS CAN CAUSE NEUTRAL CURRENTS TO EXCEED 150% OF THE PHASE CURRENT. IF THE NEUTRAL CONDUCTORS, INCLUDE EQUIPMENT BUS AND TERMINATIONS ARE NOT SUITABLY SIZED THIS COULD RESULT IN OVERLOADED CONDUCTORS OR EQUIPMENT.***

#### [Neutral Protection: Trip shall provide ability to protect against neutral conductor overload. Protection shall be the same as that for the phase conductors with settings at 50%, 100%, or 150% of phase conductor protection settings for long time and short time pickups and delays. Sensing shall be provided via a neutral current sensor or from a summation calculation using phase current sensor signals.]

#### ***SPECIFIER NOTE: ZSI IMPLEMENTATION REQUIRES AT LEAST TWO LEVELS OF CIRCUIT BREAKERS THAT HAVE ZSI CAPABILITY. THE DOWNSTREAM BREAKER THAT SENDS THE SIGNAL AND THE UPSTREAM BREAKER THAT RECEIVES IT AND ADJUSTS ITS PROTECTION TIMING ACCORDINGLY. TMAX XT FRAME CIRCUIT BREAKERS ARE ABLE TO PROVIDE ZSI FOR THE INSTANTANEOUS FUNCTION. INSTANTANEOUS ZSI ENABLES SELECTIVITY BETWEEN THESE MOLDED CASE CIRCUIT BREAKERS AND SIMILARLY EQUIPPED EMAX2 CIRCUIT BREAKERS UP TO THE FULL SHORT CIRCUIT RATING OR WITHSTAND RATING OF THE LINE SIDE DEVICE.***

#### [Zone Selective Interlocking for Short-Time and Ground Fault protection.] [Zone Selective Interlocking for Short-Time, Ground Fault and Instantaneous protection.]

####  ***SPECIFIER NOTE: ALSO KNOWN AS A MAINTENANCE SWITCH OR ALTERNATE SETTING GROUP. CALLED A RELT SETTING IN ABB LITERATURE. IN ABB SWITCHBOARDS IT WILL BE PROVIDED ON INDIVIDUALLY MOUNTED BREAKERS ONLY, NOT ON GROUP MOUNTED BREAKERS. A 3-POSITION SWITCH WILL BE PROVIDED THAT ALLOWS TESTING OF CONTROL POWER AND INDICATES TRIP PROTECTIVE STATUS VIA A CONTACT CLOSURE PROVIDED BY THE TRIP UNIT.***

#### [Reduced Energy Let-Through (RELT) Instantaneous trip. When specified this feature shall be provided on individually mounted breakers to provide a temporary setting for the instantaneous trip setting of the breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard. The switch shall be combined with an indicating light that positively indicates that the RELT is enabled or disabled.]

#### As a minimum, the trip unit shall include the following features:

Long-time and short-time protective functions, if provided, shall have true RMS sensing technology and thermal long-time memory.

Ground fault protective function, if provided, shall contain a memory circuit to integrate low level arcing fault currents with time, to sum the intermittent ground fault spikes.

High contrast liquid crystal display (LCD) unit shall display settings, trip targets, and the specified metering displays.

Multi-button keypad to provide local setup and readout of all trip settings on the liquid crystal display (LCD).

UL Listed interchangeable rating plug. It shall not be necessary to remove the trip unit to change the rating plug.

An integral test jack for testing via a portable test set and connection to a battery source.

A mechanism for sealing the rating plug and the trip unit.

Noise immunity shall meet the requirements of IEEE C37.90.2.

Display trip targets for long-time, short-time, and ground fault, if included.

The trip unit shall keep a log of the last ten events including overcurrent trips, protective relay trips. The log shall store rms currents, phase, type of trip, trip counter, time and date for each event.

Instantaneous trip shall utilize filtering which permits fully selective operation with downstream current limiting devices up to the short-time rating of the circuit breaker when the instantaneous pickup is set above the current limiting threshold.

***SPECIFIER NOTE: INCLUDE THE FOLLOWING FOR COMMUNICATION OPTION:***

####  [The trip unit shall include Modbus RTU communication capability. The trip unit, through dedicated secondary terminals on the circuit breaker, shall provide a communication port for communication with and access to a remote computer. All metering, setpoints, protective trip counts, and other event signaling shall be retrievable by the remote computer.]

#### The trip unit shall include the following metering functions, which shall be displayed on the liquid crystal display (LCD) (if the manufacturers trip unit cannot incorporate the specified functions, separate device(s) with equal function shall be provided for each circuit breaker):

###### Current, RMS, each phase (standard).

*SPECIFIER NOTE: INCLUDE THE FOLLOWING FOR METERING OPTION:*

###### [Voltage, RMS (V), line-to-line or line-to-neutral.

###### Energy (kWh, MWH, GWH), each phase and total, user resettable.

###### Peak Power Demand (KW, MW), user resettable.

###### Real power (KW, MW), each phase and total.

###### Reactive power (KVAR, MVAR), each phase and total.

###### Apparent power (KVA, MVA), each phase and total.

###### Frequency (Hz).

###### Power factor.

###### Waveform capture capability. Upon triggering, a total of eight cycles of voltage (each phase) and current (each phase) shall be recorded. The eight cycles shall include four pre-trigger and four post-trigger cycles. The waveform capture shall be configurable to trigger by manually over communications (when specified), by an overcurrent trip, by a protective relay trip (when specified), or by a current alarm. Waveform data shall be available in "Comtrade" file format via serial communications or at a front port at the trip unit.]

***SPECIFIER NOTE: INCLUDE THE FOLLOWING FOR PROTECTIVE RELAY OPTION:***

#### [The trip unit shall include all of the following protective functions. It shall be possible to disable, by user programming, any combination of unwanted protective functions. Except for reverse power, relay settings shall be in 1 percent steps over indicated range. Each function shall have a time delay, adjustable in 1-second increments (1 to 15 seconds) and shall be able to be switched OFF. If the manufacturers trip unit cannot incorporate thes

#### pecified functions, separate device(s) with equal function shall be provided for each circuit breaker.

#### Undervoltage, adj. pickup, 50 to 90 percent; 1% increment adj. delay, 1 to 15 seconds.

#### Overvoltage, adj. pickup, 110 to 150 percent; 1% increment adj. delay, 1 to 15 seconds.

#### Voltage unbalance, adj. pickup, 10 to 50 percent; adj. delay, 1 to 15 seconds.

#### Current unbalance, adj. pickup, 10 to 50 percent; 1% increment adj. delay, 1 to 15 seconds.

#### Reverse power, selectable direction, adj. pickup, 10 KW to 990 KW; 10kW increment adj. delay, 1 to 15 seconds.]

### **LOW VOLTAGE POWER CIRCUIT BREAKERS (LVPCB)**

#### Furnish UL 1066 listed ABB SACE Emax 2 Low Voltage Power Circuit Breaker (LVPCB) or equal in Switchboards. Circuit breaker shall be individually mounted. [Stationary] [Drawout] circuit breaker shall have [Standard] [Advanced] electronic trips as specified below.

#### General Characteristics:

##### The LVPCB shall be draw out type [manually][electrically] operated.

##### LVPCBs operating mechanisms are to be stored energy devices with a maximum of 50ms closing time. With the circuit breaker closed and the spring charged, the circuit breaker should be able to complete an Open-Close-Open (O-C-O) cycle without recharging.

##### Current-carrying components shall be completely isolated from the accessory mounting area and double insulated from the operator with accessory cover in place.

##### Each phase inside the LVPCB shall be completely isolated from other phases and grounded by polyester thermoset material.

##### LVPCBs must be equipped with an interlock to discharge the stored energy spring before the circuit breaker can be withdrawn from its cell.

##### Ready-to-close contact shall be available to indicate remotely that the LVPCB is open, spring mechanism is charged, a maintained closing order is not present, a maintained opening order is not present, and the circuit breaker is in an operational position.

##### Secondary wiring shall be front accessible and available in spring terminal connections. Secondary wiring must not be accessible when switchgear door is closed.

##### LVPCB shall be equipped with contact wear indication visible locally or from remote communications.

##### LVPCBs shall be UL listed for reverse feeding.

#### Electronic trip unit(s) (LVPCB)

##### General:

###### Trip ratings shall be as indicated on drawings.

###### Trip system shall be an ABB Ekip Touch or equal electronic trip unit.

###### Trip thresholds shall not be affected by ambient temperature.

###### Trip unit shall be electronic adjustable with true RMS sensing and thermal memory.

###### The trip unit shall include a trip indicator to display information about which protection function initiated the trip. The indicator shall be readable at any time after the trip.

###### A built-in trip test function shall be included.

###### A power on LED or equal signaling device shall indicate that control power is available, and the trip unit is operating.

##### Advanced electronic trip units (LVPCB):

###### Basis of Design: ABB Ekip Touch/Hi-Touch trip units.

###### General:

###### LVPCB trip unit shall be electronic type with color touch screen HMI. Protection and other settings shall be secured by a password that can be disabled or changed by the user.

###### Advanced trip unit shall have the ability to be upgraded via downloadable software packages.

###### [Trip units shall incorporate near field Bluetooth for wireless connection to Apple and Android devices (ABB EPiC App). Bluetooth shall have the capability to be switched on and off via local & remote trip unit controls.]

###### The advanced electronic trip unit shall be fitted with adjustable protection functions for long-time overcurrent (L function), short-time overcurrent (S function), instantaneous (I function) and optional Ground Fault (G function) or ground fault alarm (A function). Instantaneous short circuit protection (I function) may be disabled to allow for coordination with 30 cycle momentary rating.

(L) protection shall allow fine settings of long-time pickup values (l1) from 0.4 to 1 times the rated current (ln), with a resolution of 0.001 ln. Default curve shall be I2T with delay settings adjustable from 3 to 144 seconds with a resolution of 1s.

(L) Long-time protection shall include additional selectable delay curves including IEC Short Inverse, IEC Very Inverse, IEC Extremely Inverse, and I4T for enhanced selective coordination to relays and fuses.

(L) Long-time protection shall include a pre-alarm adjustable between 50% to 90% of I1 in 1% steps.

(S) Short-time protection shall allow settings from 0.6 to 10 times ln with a resolution of 0.1 ln. Delays shall be available from 0.05 to 0.4 seconds with a resolution of 0.01s. (S) protection shall selectable between definite time (I2T off) or inverse time (I2t on).

[Provide an additional second short-time (S2) function. S2 pickup and delay settings shall be completely independent of (S) short-time settings.]

[(S) Short-time protection shall include a startup time for which the startup threshold remains activated. This time shall be adjustable within the range of 0.1s to 30s in 0.01s steps.]

(I) Instantaneous protection shall have the ability to be disabled.

(I) Instantaneous pickup shall allow fifteen settings from 1.5 to 15 times In in 0.1 In steps.

(I) Instantaneous protection shall include a startup threshold adjustable in the range of 1.5 In to 15 In in 0.1 increments.

(I) Instantaneous protection shall include a startup time for which the startup threshold remains activated. This time shall be adjustable within the range of 0.1s to 30s in 0.01s steps.

[(G) Ground fault protection shall be residual type where the ground current is measured by summing current vectors A,B,C, and N. Ground fault pickup shall range from 0.1 In to 1 In, in 0.001 In steps with a maximum value of 1200A.]

[(G) Ground fault protection shall be configurable as either definite time or inverse time (I2T). Delay shall be adjustable from 0.1s to 1s in 0.05s increments.]

[(G) Ground fault protection shall include a pre-alarm adjustable between 50% to 90% of I1 in 1% steps.]

[(G) Ground fault protection shall include a startup threshold adjustable in the range of 0.2 In to 1 In in 0.1 increments.]

[(G) Ground fault protection shall include a startup time for which the startup threshold remains activated. This time shall be adjustable within the range of 0.1s to 30s in 0.01s steps.]

Trip unit settings shall have the capability to be adjusted locally via HMI or remote option.

[Trip units shall be able to provide real time metering. Metering functions shall include, but shall not be limited to, the following:

Current (phases, neutral, ground).

Voltage (phase to phase, phase to neutral, residual).

Power (active [kW], reactive [kVAR], apparent [kVA]).

Power factor.

Energy (active [kWh], reactive [kVAR], apparent [kVA]).

Frequency.

Total harmonic distortion (current, voltage). The harmonic content of voltage and current should be measured to 50th harmonic order.]

Trip Unit Auxiliary Power is [directly supplied 24V DC] [Ekip power supply module for 24-48VDC] [Ekip power supply module for 110-240VAC/DC]

Generator circuit breakers shall be provided with the Hi-Touch G trip unit or approved equal that complies with all of the following:

Residual overvoltage protection

Active overpower protection

Reactive overpower protection

Active underpower protection

Loss of field / reverse reactive power protection

[Voltage controlled overcurrent protection]

[Rate of change of frequency protection]

Trip Unit shall have upgradeable software packages:

Voltage protections: Undervoltage, Overvoltage, 2nd Undervoltage, 2nd Overvoltage, Phase Sequence, Voltage Unbalance

Frequency protections: Underfrequency, Overfrequency, 2nd Underfrequency, 2nd Overfrequency

Power protections: Reverse active power, Power factor, Directional current, Loss of Field / Reverse reactive power, Reactive overpower, Active overpower, Active underpower, 2nd Loss of field / Reverse reactive power

Advanced voltage protections: Voltage controlled overcurrent, 2nd Voltage controlled overcurrent, Residual voltage

ROCOF protections: Rate of change of frequency

Adaptive protections: Dual setting

Measuring package: Phase-to-phase voltage, Phase-to-neutral voltage, Phase sequence, Frequency, Active power, Reactive power, Apparent power, Power factor, Peak factor, Active energy, Reactive energy, Apparent energy

Data logger: Currents, Voltages, Sampling rate, Maximum recording duration, Recording stop delay, Number of registers

Network analyzer: Hourly average voltage value, Short voltage interruptions, Short voltage spikes, Slow voltage sags and swells, Voltage unbalance, Harmonic analysis

Interface protection: Check of main grid voltage and frequency

Adaptive load shedding: Enable islanding transition to avoid blackouts and actively controls power consumption

Embedded ATS Main-Tie-Main closed transition: Load is switched from one power source to another and for a short, transitionary time the two power sources both supply the load, in a parallel fashion.

Embedded ATS Main-Gen open transition: Monitors the voltage of the main line and generator lone and reacts to the following faults: Maximum and minimum voltage, Maximum and minimum frequency.

Synchrocheck logics: Automatic re-closing based on voltage and frequency detection

Power controller: Load management of a list of loads defined by the user

Metering Selection:

Trip unit shall have a minimum metering accuracy of 1% current, 1% voltage, and 2% power and energy. These accuracies shall be the accuracy of the entire system including current transformers, potential transformers, etc.

The measurements shall be displayed on the circuit breaker itself, remote display, and/or on a remote system via communication protocol [and/or Bluetooth].

Optional features for applications:

Trip unit shall have metering accuracy compliant with IEC 61557-12. Accuracy shall be [1.0% current, 0.5% voltage, 2.0% power/energy, and 0.2% frequency] [0.5% current, 0.5% voltage, 1.0% power/energy, and 0.1% frequency].

Metering shall record the last 24 values of average power, maximum power, max/min current, max/min voltage. The time interval may be adjusted from 5 min to 120 min.

Ekip multimeter display option. Local meter display unit should be available for Ekip touch/Hi-touch trip units to enable measurement data to be displayed on larger screen. Voltage-related protection functions such as overvoltage, undervoltage, voltage unbalance, etc.

##### Accessories

###### General:

LVPCBs shall be equipped with the below listed accessories. All accessories shall be UL Listed as field-installable and be interchangeable between frame sizes. Secondary wiring shall be front accessible and available in spring terminal connections. Secondary wiring should not be accessible when switchgear door is closed.

###### Mechanical accessories:

A mechanical trip signaling device shall be provided to visually indicate the trip status of the circuit breaker. The signaling device must be manually restored to its original position prior to resetting the circuit breaker. This device shall meet the requirements of ANSI 67T standard.

An anti-insertion lock shall be provided for all draw out LVPCBs to prevent LVPCBs from being racked into non-matching circuit breaker cubical.

[Mechanical operation counter visible from the front of the LVPCB]

[Key lock in open position. Provide keyed lock to fix the circuit breaker in the open position. [An individual key number shall be provided for each circuit breaker] [All circuit breakers shall be keyed with the same key number]

[Padlock provision in open position. Provide provision for a maximum of [(1x) 7mm lock] [(2x) 8mm locks] [(3x) 4mm locks]

[Racking key lock: Provide key lock to fix the draw-out circuit breaker in either connect position, test position, or withdrawn position. [An individual key number shall be provided for each circuit breaker] [All circuit breakers shall be keyed with the same key number]]

[Racking pad lock hasp: Provide pad lock provisions to fix the draw-out LVPCB in either connect position, test position, or withdrawn position. Pad lock shall have provisions for (3x) 8mm padlocks.]

Shutter lock – While the LVPCB is in test position, shutters shall be closed to provide isolation between the energized bus and the circuit breaker. The shutter shall be comprised of an upper and lower part and each part shall include padlock provisions for up to (3x) 8mm padlocks.

All draw out LVPCBs shall include a device that prevents the LVPCB from being racked out while the springs are charged.

All draw out LVPCBs shall include a device that prevents the circuit breaker from being racked in or out while in the closed position.

[Door lock – racking: Provide a device to prevent the LVPCB from being racked in or out while the door is open.]

[Door lock – connect or test: Provide a device to prevent the LVPCB door from being opened while the circuit breaker is in connect or test position.]

[Door lock – circuit breaker closed: Provide a device to prevent the door from being opened while the LVPCB is closed.]

[Remote racking device (RRD). Provide corded 120VAC RRD to remotely rack LVPCB in or out. Cord length shall be 10 meters. RRD shall be investigated by UL in accordance with UL 2876]

[Open and close pushbutton cover. Provide [keyed] [pad-lockable] cover to block operation of LVPCB pushbuttons.]

###### Electric accessories:

Neutral CT: For all 4 wire ground fault applications, an external neutral CT shall be provided.

Trip contact: A contact shall be provided to indicate the LVPCB trip status. The contact shall be Form C [power rated 5A @ 250VAC / 0.3A @ 125VDC] [low energy rated 0.1A at 24VDC].

[Second trip contact: A second trip contact shall be provided to indicate the LVPCB trip status. The contact shall be Form C [power rated 5A @ 250VAC / 0.3A @ 125VDC] [low energy rated 0.1A at 24VDC].]

[Spring charging motor: Provide spring charging motor to automatically charge closing spring when power is present. If no power is present, the springs shall be charged with manual lever. Motor supply power shall be [24V] [48V] [120V] [240V] [480V] [AC] [DC]. Motor inrush shall not exceed 500VA for 200ms. Continuous power shall not exceed 150VA and charging time shall not exceed 10 seconds.]

[Auxiliary contacts: Provide [standard 4][6][15] From C open / closed aux contacts that indicate the open or closed position of the LVPCB. Contacts shall be [power rated 5A @ 250VAC / 0.3A @ 125VDC] [low energy rated 0.1A at 24VDC] [mixed power and digital rated]]

[Auxiliary position contacts: Provide [5] Form C contacts that indicate the racking position of the LVPCB connected or withdrawn. Contacts shall be [power rated 5A @ 250VAC / 0.3A @ 125VDC] [low energy rated 0.1A at 24VDC] [mixed power and digital rated]]

[Ready to close contact: Provide Form C contact indicating all the following conditions are true: LVPCB is open, springs are charged, no open command, trip unit is reset, and under voltage release (YU) is energized. Contacts shall be [power rated 3A @ 250VAC / 0.3A @ 125VDC] [low energy rated 0.1A at 24VDC.]

[Opening and closing coil: Provide [24V] [48V] [120V] [240V] [AC] [DC] open and close (YO/YC) module to allow for remote open and closing of the LVPCB.]

[Second opening and closing coil: Provide a second [24V] [48V] [120V] [240V] [AC] [DC] open and close (YO2/YC2) module to allow for remote open and closing of the LVPCB.]

[Undervoltage release: Provide [24V] [48V] [120V] [240V] [480V] [AC] [DC] undervoltage release (YU) that automatically opens the LVPCB when voltage drops below 70% of nominal. [Provide a delay device to delay undervoltage release. Delay shall be adjustable from 0.5 to 3 seconds]]

[Remote reset: Provide a remote reset coil (YR) to allow LVPCB reset from trip position. Coil shall be [24V] [120V] [240V] [AC] [DC].

[Reduced Energy Let-Through (RELT)]

[I/O module: [(2x) input & (2x) output] [(4x) input and (4x) output]

[Analog input module: (3x) inputs for PT100/PT1000 temperature sensors. (1x) input for 4-20mA external sensors]

[Synchrocheck module: compares two phases from external source and two phases from the LVPCB load side. Has one output contact 4A at 250VAC]

[Configuration and test kit: Provide portable configuration and trip unit test unit. Ekip T&P or equal shall be provided for setting and testing each protective function.]

###### Communication

Bluetooth communication shall be provided to allow remote viewing of LVPCB status, logs, metering data, and settings (view and modify). Both Android and Apple devices shall be supported. Bluetooth shall be password protected and encrypted. Useable range shall be less than 10 meters. Bluetooth functionality may be disabled using circuit breaker HMI.

Circuit breakers shall be capable of connection to multiple industrial communication networks. Communication hardware shall be modular and have the ability for field installation.

When connected to Ethernet type infrastructure, the communication module shall support 100Mbit/s transmission.

The LVPCB shall be capable of accepting two modules (ports) to allow for redundant communications.

***SPECIFIER NOTE: INCLUDE THE FOLLOWING FOR COMMUNICATION OPTION:***

#### [Communication module (A) shall be configured to [Modbus RTU] [Modbus TCP] [Profibus] [Profinet] [Devicenet] [Ethernet] [IEC61850] protocol.]

#### [Communication module (B) shall be configured to [Modbus RTU] [Modbus TCP] [Profibus] [Profinet] [Devicenet] [Ethernet] [IEC61850] protocol.]

#### Register point map shall be the same for all LVPCBs frames and trip units.

#### IEEE 1588 v2 Precision Timing Protocol (PTP) for the synchronization should be supported. Time stamping accuracy of 1 ms shall be available when the IEC 61850 communication module is used.

#### Communication shall support the following:

##### Remote LVPCB control (open & close).

##### Status: open/close, local/remote, racked position.

##### Settings: ability to view and change the settings for all available protection elements.

##### Alarms, view and reset.

##### Trip log

##### Event log

##### Metering: all electrical measurements recorded by the LVPCB.

##### Maintenance: number of operations, number or trips, contact wear.

### HIGH PRESSURE CONTACT FUSIBLE SWITCHES

#### Furnish ABB type HPCII high pressure contact fusible switches.

#### High pressure contact fusible switches shall be butt type contact construction with multiple, spring loaded main arms and an arcing arm per pole. An over-center toggle mechanism shall provide quick make, quick break operation.

#### Switches shall have a molded insulating case and cover with integrally molded interphase partitions. All current carrying parts shall be silver plated copper.

#### Fusible switches shall be equipped with mounting provisions for UL class L fuses. Switches shall have an interrupting rating of 200 kAIC RMS SYM at 600V when used with class L fuses. Provide a complete set of UL class L fuses for each switch.

#### Switches shall be rated for making and breaking 12 times nameplate rating current at 600 VAC. Switches shall be rated to carry 100 percent of their frame ampacity continuously.

#### Each high contact pressure switch shall be equipped with a digital electronic trip unit. The trip unit shall provide protection from overloads, [and] short circuits [and ground faults]. The protective trip unit shall consist of a solid state, microprocessor-based programmer; tripping means; current sensors; power supply and other devices as required for proper operation. Furnish ABB EntelliGuard TU digital electronic trip units as specified below.

#### As a minimum, the trip unit shall have the following protective functions unless otherwise indicated on the drawings:

##### adjustable current setting or long-time pickup;

##### adjustable long-time delay (22 bands);

##### switchable, adjustable short-time pickup and delay (11 bands) with 3 I2t selectable slopes;

##### adjustable instantaneous pickup;

##### [adjustable ground fault pickup and delay] [Where indicated on the drawings provide GF alarm only function]

##### [Reduced Energy Let-Through (RELT) instantaneous trip. When specified this feature shall be provided to provide a temporary setting for the instantaneous trip setting of the circuit breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard.]

#### Switches shall be manually operated and stationary mounted. Switches shall have a front mounted operating handle for charging the closing springs and closing the switch and a push-button for opening the switch. Switches shall include a visible external ON - OFF indicator.

#### Switches shall have defeatable, front access, coin proof interlocks. Interlocks shall prevent opening switch door when switch is ON and prevent turning switch ON when door is open. Switches shall include provisions for padlocking the switch in the open position.

#### Provide the following UL listed accessories:

##### [120] [240] [480] VAC Electric trip [and control power transformer].

##### [Blown - fuse Protector.]

##### [Provision for Key Interlock.]

##### [Auxiliary Switches with [1] [2] [3] [4] single-pole, double-throw elements.]

##### [Ground fault protection relay with mechanical ground fault indicator, test function, adjustable current pick - up and time delay, and current sensors as required. Ground fault relay shall have an internal memory circuit that integrates intermittent arcing ground faults with time.]

### FINISH

#### All steel surfaces shall be chemically cleaned prior to painting.

#### Exterior paint color shall be ANSI 61 Light Gray over phosphate - type rust inhibitor.

### ACCESSORIES

#### Fuses

##### Manufacturer: Mersen (or equal).

##### Interrupting Rating of all fuses shall be [200,000] RMS amperes.

#### [Furnish adhesive [white plastic, screw on] [blue plastic, screw on] [white plastic, adhesive] [blue plastic, adhesive] strip mimic bus for switchboards.]

#### [Furnish nameplates for each device} as indicated in drawings. Color schemes shall be as indicated on drawings.]

#### [Provide Surge Protective Device system as specified in Section [16479] [26 43 13].]

# EXECUTION

## EXAMINATION

### The following procedures shall be performed by the contractor.

#### Examine installation area to assure there is enough clearance to install switchboard.

#### Check concrete pads for uniformity and level surface.

#### Verify that switchboards are ready to install.

#### Verify field measurements are as [shown on Drawings] [instructed by manufacturer].

#### Verify that required utilities are available, in proper location and ready for use.

#### Beginning of installation means installer accepts conditions.

## LOCATION

## INSTALLATION

## Additional provisions and editing may be required for this part.

### A. Installation shall be performed by the Contractor.

#### Install per manufacturer's instructions.

#### Install required safety labels.

## FIELD QUALITY CONTROL N/A

## ADJUSTING N/A

## CLEANING N/A

END OF SECTION