**Eaton Guide Specification**

**Notes and instructions to Spec writer**

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SECTION 26 28 11

CIRCUIT BREAKERS – low voltage

# PRODUCTS

## MANUFACTURERS

### Eaton

### \_\_\_\_\_\_\_\_\_\_\_

### \_\_\_\_\_\_\_\_\_\_\_

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

## UL 1066 – magnum pxr BREAKERS

### All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17, C37.50, UL 1066 and NEMA SG-3 standards. The circuit breakers shall carry a UL label.

### Power circuit breakers shall be low-voltage power circuit breakers, Eaton type Magnum PXR or approved equal. All frame sizes shall have a common height and depth. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

### Breakers shall be manually operated (MO) or electrically operated (EO) as indicated on the drawings.

### Electrically operated breakers shall be complete with [close/open pushbuttons] [control switch], plus red and green indicating lights to indicate breaker contact position [24 Vdc] [48 Vdc] [120 Vac/125 Vdc] [240 Vac/250 Vdc] [208-277 Vac] motor operators; the charging time of the motor shall not exceed 6 seconds. [dc source shall be supplied from a remote battery system] [ac source shall be taken from a [remote source] [control power transformer internal to the switchgear assembly]].

### All circuit breakers shall have a minimum symmetrical interrupting capacity of [42,000] [50,000] [65,000] [85,000] [100,000] amperes. To ensure a selective system, all circuit breakers shall have 30-cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 85,000 amperes, regardless of whether equipped with instantaneous trip protection or not.

### The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.

### The power circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage. The accessories shall be plug and lock type and UL listed for easy field installation. They shall be modular in design and shall be common to all frame sizes and ratings.

### The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a “Positive On” feature. The breaker flag will read “Closed” if the contacts are welded and the breaker is attempted to be tripped or opened.

#### [The breaker shall include pad-lockable pushbutton covers.]

### Each power circuit breaker shall offer front mounted dedicated secondary wiring points. Each wiring point shall have finger safe contacts, which will accommodate #10 AWG maximum field connections with ring tongue or spade terminals or bare wire.

### For draw-out applications the breaker cell shall be equipped with draw-out rails and primary and secondary disconnecting contacts.

#### A position indicator shall be located on the faceplate of the breaker and on the side of the cassette. This indicator shall provide color indication of the breaker position in the cell. These positions shall be Connect (Red), Test (Yellow), and Disconnect (Green) and shall all permit closing the compartment door. The levering door shall be interlocked so that when the breaker is in the closed position, the breaker levering-in door shall not open. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell.

#### The breaker shall include padlocking provisions to prevent levering which is capable of securing the breaker in the connected, test or disconnected position.

#### The secondary disconnecting devices shall consist of plug-in connectors mounted on the removable unit and engaging floating plug-in connectors at the front of the compartment. The secondary disconnecting devices shall be gold-plated, and pin and socket contact engagement shall be maintained in the “connected” and “test” positions.

#### To facilitate lifting, the power circuit breaker shall have integral handles on the side of the breaker.

#### [Provide a safety shutter in the cell when the circuit breaker is withdrawn, which automatically covers the line and load stabs and protects against incidental contact.]

#### The circuit breaker door design shall be such that the following functions may be performed without the need to open the circuit breaker door: lever circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit, and read circuit breaker rating nameplate.

#### The secondary disconnecting devices shall consist of floating terminals mounted on the stationary unit and engaging mating contacts at the front of the breaker. The breaker secondary disconnecting devices shall be maintained in the “connected” and “test” positions.

#### The removable power circuit breaker element shall be equipped with disconnecting contacts and interlocks for draw-out application. It shall have four positions, “connected,” “test,” “disconnected” and “removed.” The breaker draw-out element shall contain a worm gear levering “in” and “out” mechanism with removable lever crank. Levering shall be accomplished via the use of conventional tools. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell.

#### Breaker shall be ready to accept connection of remote racking device without modification of breaker, cell, or door.

#### Key interlocks shall be provided as indicated on the drawings. These interlocks shall keep the circuit breakers trip-free when actuated.

#### Breakers shall include [shall include provisions for] integral motorized racking within the breaker which meets Supplement SC of the UL 1066 standard. The integral motorized racking capability allows a means for remotely racking the breaker without the need to interface external accessories. The integral motorized racking shall have the following features:

##### Allow moving the breaker between the connect, test, and disconnect positions from a distance of up to 30 feet via a handheld pendant, with the breaker compartment door closed.

##### Breaker position shall be indicated on the pendant by LED lights. A blinking light indicates that the circuit breaker is in the motion through the selected position. A solid (non-blinking) light indicates that the circuit breaker has reached and stopped in the selected position. In case normal operation fails, the appropriate error code is displayed on the pendant in a separate 2-character LED display window.

##### The system shall be designed such that it allows manual racking of the circuit breaker using the levering crank accessory. Manual racking operation shall disable the motorized racking accessory.

##### It shall be possible to enable/disable operation of the motorized racking accessory via Purchaser’s external interlocking/permissive contacts.

##### 120 Vac power for the motorized racking accessory shall be [derived from a control power transformer mounted in the switchgear] [supplied by purchaser from an external source].

##### The handheld pendant shall also include “Open” and “Close” pushbuttons to allow remote operation of the circuit breaker.

##### Provide a discrete I/O interface module mounted in each circuit breaker control compartment for control of the motorized racking accessory via external hard-wired dry contacts, for example, via push buttons located at a remote control panel. The I/O interface module to provide output terminals for connections of remote 24 Vdc LEDs for indication of breaker position status at the remote panel. With this I/O interface, the circuit breaker can be moved from disconnect to connect or from connect to disconnect positions from a remote control panel. Whenever the hand-held pendant is in use, the pendant becomes the master and will override the customer’s remote control signals.

-- OR --

##### Provide a discrete I/O interface module mounted in each circuit breaker control compartment, daisy chained, for control of the motorized racking accessory via Purchaser’s SCADA system or Dashboard interface using Modbus communications. Whenever the hand-held pendant is in use, the pendant becomes the master and will override the Modbus interface.

##### The color of the racking mechanism door shall differ to easily distinguish breakers with internal racking mechanisms from those without integral racking mechanisms.

### Microprocessor-Based Trip Units

#### [PXR 20, PXR 25, and PXR 35]



##### 

#### Each power circuit breaker shall be equipped with a true RMS sensing, solid-state tripping system consisting of at least three current sensors, microprocessor-based trip device, and flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. Current sensors shall be of Rogowski coil type. The continuous current rating (In) shall be established via trip device firmware.

#### The nominal current rating (In) sets the maximum continuous ratings of the breaker and can be changed by changing the firmware-based rating plug only. Replacing physical rating plug and current sensors shall not be required.

#### The nominal current rating (ln) shall be displayed so that is visible when the trip unit is powered off as well as shown on the trip unit when powered on to verify.

#### Trip units shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.

#### The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession. Breakers with ground fault protection shall include an additional thermal memory for the ground fault pick-up for enhanced protection from intermittent or arcing line-to-ground faults.

#### Trip units shall include the following individually adjustable time/current curve shaping solid-state elements:

##### Programmable long-delay pick-up setting (Ir) – 0.4 to 1.0 x (In)

##### Programmable long-delay time 0.5 to 24 sec with selectable I0.5t, It, I2t, or I4t slope

##### Programmable short-delay pick-up setting – 1.5 to 10 x (Ir)

##### Programmable short-delay time 0.05 to 0.5 sec with selectable flat or I2t curve shaping

##### Programmable instantaneous setting – 2 to 15 x (In) including OFF position

##### [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall have individually adjustable ground fault current pickup (0.2 to 1.0 x (In)) and time (0.05 to 1.0 sec), with selectable flat or I2t curve shaping. Provide ground fault trip or ground alarm only as shown on the drawings. The trip device shall include user selectable ground fault detection options of OFF, GF alarm, or GF trip.

##### [PXR 35 ONLY] [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall have four protection sets that include all the protection and alarm settings. The protection sets can be switched using hardwired inputs to the trip unit (ex: a four-position selector switch) or over communications.

#### [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall include an Arc Flash Reduction Maintenance System (ARMS)

##### The ARMS technology shall be provided to reduce arc energy during periods of maintenance. The system shall engage an independent, reduced instantaneous pickup and reduce total clearing time when activated. ARMS shall provide a separate trip circuit. Maintenance mode systems that only alter short time and/or instantaneous protection settings are not acceptable.

##### The pick-up value shall be adjustable with a minimum of (5) settings (1.5 to 10 x (In)) to allow the greatest arc energy reduction without nuisance tripping.

##### With the ARMS technology active, total clearing time shall not exceed 40 msec for any fault currents above the pick-up value.

##### Activation and deactivation of the ARMS technology and local indication shall be accessible from the face of the trip unit without opening the circuit breaker door and exposing operators to energized parts. Recalibration or adjustment of trip unit parameters shall not be required when enabling / disabling the ARMS technology.

###### [Breakers shall include a separate, local, lockable ARMS activation selector switch and pilot light indication.]

###### [Breakers shall include interposing relay to allow for remote ARMS activation from a remote contact closure and remote indication of ARMS status via an output relay.]

#### Trip units shall provide zone selective interlocking (ZSI) for the short-time delay and ground fault delay trip functions for improved system protection and arc energy reduction. For faults within the protected zone, the zone interlocking system shall override programmed time delays to allow the upstream breaker to trip with minimal time delay.

##### ZSI function shall be capable of being enabled/disabled through the programming of the trip unit. The face of the trip unit shall include a constant indication showing when ZSI is enabled.

###### [PXR 35 ONLY] ZSI for short-time delay and ground fault delay can be separately enabled/disabled.

##### To allow for easy inspection, testing, and troubleshooting, the trip unit shall display an indication when it has received a ZSI input signal from a downstream device(s). The indication can be reset with the reset button on the face of the trip unit.

##### Factory shall wire for zone selective interlocking for the circuit breakers within the switchgear using [twisted pair wiring] [PXR 35 ONLY Ethernet connections for ZSI over IEC 61850].

#### Two user programmable high load alarm outputs shall be available from 50% to 120% of the long delay pickup setting (Ir).

#### Trip units shall have an integral, [high resolution liquid-crystal display (LCD)][PXR 35 ONLY color touchscreen display] capable of displaying the trip unit programming, status, and monitoring information.

#### Trip units shall be capable of metering phase, neutral, and ground current with an accuracy of [+/- 0.50%][PXR 35 ONLY +/- 0.25%] of reading.

#### Trip units shall include embedded Modbus RTU communication capability. All monitored parameters and statuses shall be available over the chosen protocol(s).

##### In addition, the trip units shall simultaneously support the following additional protocol:

###### [Modbus TCP with HTML5 embedded webpages]

###### [PXR 20/25 ONLY Profibus DP]

###### [PXR 35 ONLY IEC 61850 (GOOSE messaging)]

##### Trip units shall allow remote open and closing of the breaker across the specified communication protocol.

#### Trip units shall be capable of supporting dual communications.

##### [PXR 20/25 ONLY]: via the use of optional integral Modbus RTU and an external communication adapter module.

##### -- OR –

##### [PXR 35 ONLY]: via the integral Modbus RTU and integral Ethernet connectivity.

#### Breaker Health Monitoring and Diagnostics

##### The trip units shall collect and store pertinent information to the trip unit and circuit breaker health and event history. The trip unit shall also include diagnostic features to allow the user to investigate events and dynamically monitor the health of the trip unit and the breaker.

##### Breaker Health

###### The trip unit shall contain a circuit breaker health monitoring system that collects information pertaining to the health and life of the breaker.

Number of operations (load and no-load).

Number of trips (overload trips, short circuit trips).

Run time.

Breaker ambient temperature.

Breaker remaining life – Then the trip unit shall utilize an algorithm that applies a weighted value to all of these inputs to determine the remaining life of the breaker. The remaining life of the breaker shall be displayed or communicated in calculated percentage of life remaining.

All breaker health information shall be available via local display and via communications.

##### Breaker Diagnostics

###### Trip units shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

###### Trip units shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

Cause-of-trip LED indications shall include battery backup to indicate mode of trip following an automatic trip operation. Battery charge status shall be displayed on the face of the trip unit and available via alarm relay.

###### The trip unit shall capture and record information surrounding events, alarms, and trips into a set of time-stamped logs. The trip unit shall store a minimum of 200 time-stamped log events. Log events shall be categorized as follows:

Event Log – system events, user interactions, programming changes, breaker operations, causes, and descriptions.

Alarm Log – trip unit and circuit breaker alarm conditions indicating an abnormal operating or user specified condition.

Trip Log – any event resulting in the automatic trip of the circuit breaker.

Alarm and Trip Log events shall capture and store the following information:

Real-time Current (IA, IB, IC, IN, IG), Temperature, Frequency, Power Factor, Operations Count

[PXR 25/35 ONLY]: Real-time Voltages (VAB, VBC, VCA, VAN, VBN, VCN), Power and Demand (Watts, Vars, VA)

###### The trip unit shall perform a waveform capture on trip, alarm, or user-initiated events.

Any breaker trip event shall capture a 10-cycle waveform; (6) pre-event cycles and (4) post-event cycles. The trip unit shall store the most recent trip event waveform.

Any alarm event shall capture a 10-cycle waveform; (6) pre-event cycles and (4) post-event cycles. The trip unit shall store the most recent alarm event waveform.

Any user-initiated waveforms shall capture a 1-cycle waveform.

Waveform events shall capture and store the following information:

Cause-of-trip

All phase, neutral, and ground currents

Temperature, operations count

Time and date

[PXR 25/35 ONLY] Phase-to-phase and phase-to-neutral voltage waveforms, power, energy, power factor, frequency

##### The trip unit shall contain an integral trip test capability. The user can initiate a breaker trip from the keypad to confirm breaker trip actuator and breaker mechanism functionality.

#### Trip unit shall include (3) programmable alarm relays. Relay activation can be programmed to any of 30 various status, alarm, health, or trip conditions.

#### Trip units shall be capable of being programmed and tested with an industry standard USB cable using a software tool available from the manufacturer’s website. The software shall provide the follow functionality:

##### Setting / Saving / Uploading / Downloading of trip unit setpoints including a setpoint wizard.

##### Time current curve displays including upstream and downstream breakers to analyze coordination.

##### View, download, export (.csv) and trigger waveform captures for troubleshooting and diagnostics.

##### Zone Selective Interlocking testing capability.

##### Breaker current sensor continuity testing capability.

##### Breaker trip actuator testing capability.

##### Trip unit secondary injection testing without the need for dedicated test equipment with automatic test reporting capability. Trip units without software secondary injection test / reporting capability must be provided with the required dedicated trip unit test equipment.

#### Advanced Trip Unit features

#### [PXR 25 ONLY]

##### Trip units shall include high accuracy power, energy, and power quality metering capable of delivering ANSI C12.1 accurate energy readings. Metering accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 0.5% of reading for current and voltage values.

##### The unit shall be capable of monitoring the following data:

###### Individual phase, neutral, and ground current.

###### Voltage phase-to-phase and phase-to-neutral.

###### Minimum and maximum current and voltage values.

###### Watts, Vars, VA, Watthours, Varhours, VA hours, peak demand, present demand, and energy consumption.

###### Power Factor.

##### The unit shall include the following enhanced protection features which can be configured for trip or alarm, or set to off:

###### Over and undervoltage.

###### Current and voltage unbalance.

###### Phase loss (current based).

###### Reverse active power.

-- OR --

#### [PXR 35 ONLY]

##### Trip units shall include high accuracy power, energy, and power quality metering capable of delivering ANSI C12.1 accurate energy readings. Metering accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 0.25% of reading for current and voltage values.

##### The unit shall be capable of monitoring the following data:

###### Individual phase, neutral, and ground current.

###### Voltage phase-to-phase and phase-to-neutral for line and load.

###### Minimum and maximum current and voltage values.

###### Watts, Vars, VA, Watthours, Varhours, VA hours, peak demand, present demand, and energy consumption.

###### Power Factor.

###### Frequency.

##### The unit shall include the following enhanced protection features which can be configured for trip or alarm, or set to off:

###### Over and undervoltage.

###### Current and voltage unbalance.

###### Phase rotation.

###### Phase loss (current based).

###### Reverse active and reactive power.

###### Real, apparent, and reactive power.

###### Real, apparent, and reactive power demand.

###### Power factor.

###### Over and under frequency.

##### The unit shall additionally include the ability to configure alarms for:

###### Total harmonic distortion current and voltage.

##### The unit shall include synchronism-check functionality for live and dead bus.

## UL 1066 – high interrupting / current limiting - above 100kaic POWER CIRCUIT BREAKERS – (magNum-dsx and magnum-dsl with digitrip)

### All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17, C37.50, UL 1066 and NEMA SG-3 standards. The circuit breakers shall carry a UL label.

### Power circuit breakers shall be low-voltage power circuit breakers, Eaton type Magnum DSX or DSL or approved equal. All frame sizes shall have a common height and depth. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

### Breakers shall be manually operated (MO) or electrically operated (EO) as indicated on the drawings.

### Electrically operated breakers shall be complete with [close/open pushbuttons] [control switch], plus red and green indicating lights to indicate breaker contact position [24 Vdc] [48 Vdc] [120 Vac/125 Vdc] [240 Vac/250 Vdc] [208-277 Vac] motor operators; the charging time of the motor shall not exceed 6 seconds. [dc source shall be supplied from a remote battery system] [ac source shall be taken from a [remote source] [control power transformer internal to the switchgear assembly].

### All circuit breakers shall have a minimum symmetrical interrupting capacity of 200,000 amperes.

### [MAGNUM DSX] Power circuit breakers, where indicated on the drawings, shall be Magnum MDSX fuse-less current limiting type with fast opening reverse loop contacts. Current limiting power circuit breakers shall have a 200,000-ampere RMS symmetrical interrupting capacity at 508 volts and below.

#### Power circuit breakers which rely on fuses for current limiting protection are not acceptable.

### [MAGNUM DSL] Power circuit breakers, where indicated on the drawings, shall be Magnum MDSL and include current limiters. Limiters shall be integrally mounted on 800-, 1200- 1600- and 2000-ampere breakers. Current limiters shall be coordinated with the breaker trip device, so as to avoid unnecessary blowing of the current limiters.

#### Breakers shall include an anti-single-phase device that will:

##### Trip the breaker in the event of a blown limiter

##### Indicate from the front of the breaker that a limiter is blown, and

##### Prevent the breaker from being re-closed on a single-phase condition due to missing or blown limiters.

#### Power circuit breakers with current limiting fuses shall have a 200,000-ampere RMS symmetrical interrupting capacity at 600 volts and below.

### The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.

### The power circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage. The accessories shall be plug and lock type and UL listed for easy field installation. They shall be modular in design and shall be common to all frame sizes and ratings.

### The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a “Positive On” feature. The breaker flag will read “Closed” if the contacts are welded and the breaker is attempted to be tripped or opened.

#### The breaker shall include pad-lockable pushbutton covers.

### The current sensors shall have a back-cover window that will permit viewing the sensor rating on the back of the breaker. A rating plug will offer indication of the rating on the front of the trip unit.

### Each power circuit breaker shall offer sixty (60) front mounted dedicated secondary wiring points. Each wiring point shall have finger safe contacts, which will accommodate #10 AWG maximum field connections with ring tongue or spade terminals or bare wire.

### For draw-out applications the breaker cell shall be equipped with draw-out rails and primary and secondary disconnecting contacts.

#### A position indicator shall be located on the faceplate of the breaker and on the side of the cassette. This indicator shall provide color indication of the breaker position in the cell. These positions shall be Connect (Red), Test (Yellow), and Disconnect (Green) and shall all permit closing the compartment door. The levering door shall be interlocked so that when the breaker is in the closed position, the breaker levering-in door shall not open. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell.

#### The breaker shall include padlocking provisions to prevent levering which is capable of securing the breaker in the connected, test or disconnected position.

#### The secondary disconnecting devices shall consist of plug-in connectors mounted on the removable unit and engaging floating plug-in connectors at the front of the compartment. The secondary disconnecting devices shall be gold-plated, and pin and socket contact engagement shall be maintained in the “connected” and “test” positions

#### To facilitate lifting, the power circuit breaker shall have integral handles on the side of the breaker.

#### [Provide a safety shutter in the cell when the circuit breaker is withdrawn, which automatically covers the line and load stabs and protects against incidental contact.]

#### The circuit breaker door design shall be such that the following functions may be performed without the need to open the circuit breaker door: lever circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit, and read circuit breaker rating nameplate.

#### The secondary disconnecting devices shall consist of floating terminals mounted on the stationary unit and engaging mating contacts at the front of the breaker. The breaker secondary disconnecting devices shall be maintained in the “connected” and “test” positions.

#### The removable power circuit breaker element shall be equipped with disconnecting contacts and interlocks for draw-out application. It shall have four positions, “connected,” “test,” “disconnected” and “removed.” The breaker draw-out element shall contain a worm gear levering “in” and “out” mechanism with removable lever crank. Levering shall be accomplished via the use of conventional tools. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell.

#### Breaker shall be ready to accept connection of remote racking device without modification of breaker, cell or door.

#### Key interlocks shall be provided as indicated on the drawings. These interlocks shall keep the circuit breakers trip-free when actuated.

### Microprocessor-based Trip Units

#### Each power circuit breaker shall be equipped with a true RMS sensing, solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker.

#### Trip units shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

#### Trip units shall be provided with a display panel, including a representation of the time/current curve, that will indicate the protection functions.

#### Trip units shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

#### Trip units shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.

#### The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession. Breakers with ground fault protection, shall include an additional thermal memory for the ground fault pick-up for enhanced protection from intermittent or arcing line-to-ground faults.

#### Trip units shall include the following individually adjustable time/current curve shaping solid-state elements:

##### Programmable long-time setting

##### Programmable long-time delay with selectable I2t [and I4t curve shaping – DT-1150+ only]

##### Programmable short-time setting

##### Programmable short-time delay with selectable flat or I2t curve shaping

##### Programmable instantaneous setting including OFF position

##### [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall have individually adjustable ground fault current pickup and time, with selectable flat or I2t curve shaping. Provide ground fault trip or ground alarm only as shown on the drawings.

#### [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall include an Arc Flash Reduction Maintenance System (ARMS)

##### The ARMS technology shall be provided to reduce arc energy during periods of maintenance. The system shall engage an independent, reduced instantaneous pickup and reduce total clearing time when activated.

##### The pick-up value shall be adjustable with a minimum of (5) settings to allow the greatest arc energy reduction without nuisance tripping.

##### With the ARMS technology active, total clearing time shall not exceed 40 msec for any fault currents above the pick-up value.

##### Activation and deactivation of the ARMS technology and local indication shall be accessible from the face of the trip unit without opening the circuit breaker door and exposing operators to energized parts. Recalibration or adjustment of trip unit parameters shall not be required when enabling / disabling the ARMS technology.

###### [Breakers shall include a separate, local, lockable ARMS activation selector switch and pilot light indication.]

###### [Breakers shall include interposing relay to allow for remote ARMS activation from a remote contact closure and remote indication of ARMS status via an output relay.]

#### Trip units shall provide zone selective interlocking (ZSI) for the short-time delay and ground fault delay trip functions for improved system protection and arc energy reduction. For faults within the protected zone, the zone interlocking system shall override programmed time delays to allow the upstream breaker to trip with minimal time delay.

##### Factory shall wire for zone interlocking for the circuit breakers within the switchgear.

#### Cause-of-trip LED indications shall include battery backup to indicate mode of trip following an automatic trip operation. A test pushbutton shall energize an LED to indicate the battery status.

#### Trip units shall have provisions for a single test kit to test each of the trip functions.

#### Advanced Trip Unit Features

##### [Digitrip 520MC]

##### Trip units shall have a 4-character LCD display showing phase, neutral, and ground current. The accuracy of these readings shall be +/- 2% of full scale.

##### Trip units shall be equipped to permit communication via a network twisted pair to for remote monitoring. All monitored parameters and statuses shall be transmitted.

-- OR --

##### [Digitrip 1150+]

##### The display for the trip units shall be a 24-character LED display.

##### Trip units shall be equipped to permit communication via a network twisted pair to the LAN system provided in the equipment for remote monitoring and control. All monitored parameters and statuses shall be transmitted.

##### Trip units shall include power, energy, and power quality metering. Metering accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 1% of full scale for current and voltage values. Metering accuracy of the complete system shall be +/- 2% of full scale for power and energy values.

##### The unit shall be capable of monitoring the following data:

###### Individual phase, neutral, and ground current

###### Voltage

###### Minimum and maximum current values

###### Watts, Vars, VA, Watthours, Varhours, VA hours, Peak demand, Present demand, and energy consumption.

###### Crest Factor, Power Factor, Total Harmonic Distortion, and harmonic values of all phases through the 31st harmonic.

##### The trip unit shall capture waveforms after a trip event or at the command of the user.

##### The trip unit shall include a voltage transformer module, suitable for operation up to 600V, 50/60 Hz. The primary of the power relay module shall be connected internally to the line side of the circuit breaker through a dielectric test disconnect plug.

##### An adjustable high load alarm shall be provided, adjustable from 50 to 100% of the long delay pickup setting.

##### The trip unit shall contain an integral test pushbutton. A keypad shall be provided to enable the user to select the values of test currents within a range of available settings. The protection functions shall not be affected during test operations. The breaker may be tested in the TRIP or NO TRIP test mode.

##### The trip unit shall include a power/relay module, which shall supply control power to the readout display. Following an automatic trip operation of the circuit breaker, the trip unit shall maintain the cause of trip history and the mode of trip LED indication as long as its internal power supply is available. An internal relay shall be programmable to provide contacts for remote ground alarm indication.

##### Programming may be done via a keypad at the faceplate of the unit or via the communication network.

##### The trip unit shall offer a three-event trip log that will store the trip data, and shall time and date stamp the event.

##### The trip unit shall have the following advanced protective features integral to the trip unit:

###### Adjustable undervoltage release

###### Adjustable overvoltage release

###### Reverse power and fault current

###### Reverse sequence voltage alarm

###### Underfrequency

###### Overfrequency

###### Voltage phase unbalance and phase loss during current detection

###### Where the above protection(s) are not available as an integral part of the trip unit, provide separate relay(s) factory mounted and wired to a breaker shunt trip.

## UL 1066 – Power circuit breakers – series nrx (800A max)

### All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17, C37.50, UL 1066 and NEMA SG-3 standards. The circuit breakers shall carry a UL label.

### Protective devices shall be low-voltage power circuit breakers, Eaton type Series NRX or approved equal. Frame ratings shall be 800 amps. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

### Breakers shall be [manually operated (MO)] [electrically operated (EO)] as indicated on the drawings.

### Electrically operated breakers shall be complete with [close/open pushbuttons] [control switch], with a [24 Vdc] [48 Vdc] [60 Vdc] [110-125 Vac/dc] [110-125 Vdc] [208-250 Vac/Vdc] [220-250 Vdc] rated motor operator. The charging time of the motor shall not exceed 6 seconds. [[dc source shall be supplied from a remote battery system] [ac source shall be taken from a [remote source] [control power transformer internal to the switchgear assembly]].

### All circuit breakers shall have a minimum symmetrical interrupting capacity of [42,000] [50,000] [65,000] amperes at 480V. To ensure a selective system, all circuit breakers shall have 30-cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 42,000 amperes, regardless of whether equipped with instantaneous trip protection or not.

### The power circuit breaker shall have a closing time of not more than 3 cycles. The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.

### The power circuit breaker shall have a nameplate clearly marking any electrical accessories that are mounted in the breaker at the time of sale. The accessory shall have a label that will indicate its function and voltage. All accessories shall be modular, plug and lock type, and UL listed for easy field installation.

### The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a “Positive On” feature. The breaker flag will read “Closed” if the contacts are welded and the breaker is attempted to be tripped or opened.

#### The breaker shall include pad-lockable pushbutton covers.

### The nominal current rating (In) can be changed by changing the rating plug only. A rating plug on the trip unit will offer indication of the rating on the front of the trip unit. No current sensor change-outs are necessary.

### Each power circuit breaker shall offer a maximum of fifty-four (54) front mounted dedicated secondary wiring points, with the option to be individually populated. Each wiring point shall be a tension clamp type with finger safe contacts, which accommodates one - #12 AWG per connection point, with bare wire.

### For draw-out applications the breaker cell shall be equipped with draw-out rails and primary and secondary disconnecting contacts.

#### A flag position indicator shall be located on the faceplate of the breaker. This indicator shall provide color indication of the breaker position in the cell. These positions shall be Connect (Red), Test (Yellow), and Disconnect (Green) and shall all permit closing the compartment door. The levering door shall be interlocked so that when the breaker is in the closed position, the breaker levering-in door shall not open. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell.

#### The breaker shall include padlocking provisions to prevent levering which is capable of securing the breaker in the connected, test or disconnected position.

#### The secondary disconnecting devices shall consist of plug-in connectors mounted on the removable unit and engaging floating plug-in connectors at the front of the compartment. The secondary disconnecting devices shall be pin and socket contact engagement shall be maintained in the “connected” and “test” positions

#### To facilitate lifting, the power circuit breaker shall have integral handles on the side of the breaker.

#### [Provide a safety shutter in the cell when the circuit breaker is withdrawn, which automatically covers the line and load stabs and protects against incidental contact. Provide pad-lockable breaker door to prevent access to shutter when breaker is removed from cell.]

#### The circuit breaker door design shall be such that the following functions may be performed without the need to open the circuit breaker door: lever circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit, and read circuit breaker rating nameplate.

#### The secondary disconnecting devices shall consist of floating terminals mounted on the stationary unit and engaging mating contacts at the front of the breaker. The breaker secondary disconnecting devices shall be maintained in the “connected” and “test” positions.

#### The removable power circuit breaker element shall be equipped with disconnecting contacts and interlocks for draw-out application. It shall have four positions, “connected,” “test,” “disconnected” and “removed.” The breaker draw-out element shall contain a worm gear levering “in” and “out” mechanism with removable lever crank. Levering shall be accomplished via the use of conventional tools. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell.

#### Breaker shall be ready to accept connection of remote racking device without modification of breaker, cell or door.

#### Key interlocks shall be provided as indicated on the drawings. These interlocks shall keep the circuit breakers trip-free when actuated.

### Microprocessor-Based Trip Units

#### Each power circuit breaker shall be equipped with a true RMS sensing, solid-state tripping system consisting of at least three current sensors microprocessor-based trip device and flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. Current sensors shall be of Rogowski coil type. The continuous current rating (In) shall be established via a rating plug.

#### Trip units shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.

#### The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession. Breakers with ground fault protection, shall include an additional thermal memory for the ground fault pick-up for enhanced protection from intermittent or arcing line-to-ground faults.

#### Trip units shall include the following individually adjustable time/current curve shaping solid-state elements:

##### Programmable long-delay pick-up setting (Ir) – 0.4 to 1.0 x (In)

##### Programmable long-delay time 2 to 24 sec with I2t slope or 1 to 5 seconds with I4t slope

##### Programmable short-delay pick-up setting – 2 to 10 x (Ir)

##### Programmable short-delay time 0.1 to 0.5 sec with selectable flat or I2t curve shaping

##### Programmable instantaneous setting – 2 to 12 x (In) including OFF position

##### [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall have individually adjustable ground fault current pickup (0.24 – 1.0 x (In)) and time (0.1 – 0.5 sec), with selectable flat or I2t curve shaping. Provide ground fault trip or ground alarm only as shown on the drawings.

#### [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall include an Arc Flash Reduction Maintenance System (ARMS)

##### The ARMS technology shall be provided to reduce arc energy during periods of maintenance. The system shall engage an independent, reduced instantaneous pickup and reduce total clearing time when activated. ARMS shall provide a separate trip circuit. Maintenance mode systems that only alter short time and/or instantaneous protection settings are not acceptable.

##### The pick-up value shall be adjustable with a minimum of (5) settings (1000A, 2000A, 3000A, 4000A, 5000A) to allow the greatest arc energy reduction without nuisance tripping.

##### With the ARMS technology active, total clearing time shall not exceed 40 msec for any fault currents above the pick-up value.

##### Activation and deactivation of the ARMS technology and local indication shall be accessible from the face of the trip unit without opening the circuit breaker door and exposing operators to energized parts. Recalibration or adjustment of trip unit parameters shall not be required when enabling / disabling the ARMS technology.

###### [Breakers shall include a separate, local, lockable ARMS activation selector switch and pilot light indication.]

###### [Breakers shall include interposing relay to allow for remote ARMS activation from a remote contact closure and remote indication of ARMS status via an output relay.]

#### Trip units shall provide zone selective interlocking (ZSI) for the short-time delay and ground fault delay trip functions for improved system protection and arc energy reduction. For faults within the protected zone, the zone interlocking system shall override programmed time delays to allow the upstream breaker to trip with minimal time delay.

##### Factory shall wire for zone selective interlocking for the circuit breakers within the switchgear.

#### An adjustable high load alarm shall be provided, adjustable from 50 to 100% of the long delay pickup setting.

#### The display for the trip units shall be a 24-character LED display.

#### Trip units shall include power, energy, and power quality metering. Metering accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 1% of reading for current and voltage values. Metering accuracy of the complete system shall be +/- 2% of reading for power and energy values.

#### The unit shall be capable of monitoring the following data:

##### Individual phase, neutral, and ground current

##### Voltage

##### Minimum and maximum current values

##### Watts, Vars, VA, Watthours, Varhours, VA hours, Peak demand, Present demand, and energy consumption.

##### Crest Factor, Power Factor, Total Harmonic Distortion, and harmonic values of all phases through the 31st harmonic.

#### Trip units shall be equipped to handle a flexible and modular system of communication adapter modules for INCOM, Modbus RTU, Profibus DP, or Web-enabled communications. All monitored parameters and statuses shall be available over the chosen protocol(s).

##### Trip units shall allow remote open and closing of the breaker across the specified communication protocol.

#### Breaker Diagnostics

##### Trip units shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

##### Trip units shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

###### Cause-of-trip LED indications shall include battery backup to indicate mode of trip following an automatic trip operation.

##### The trip unit shall offer a three-event trip log that will store the trip data, and shall time and date stamp the event.

##### The trip unit shall capture waveforms after a trip event or at the command of the user.

#### Trip unit shall include (2) programmable alarm relays that can be used for ARMS enabled indication, ground fault trip or alarm indication, as well as other options.

#### The trip unit shall contain an integral test pushbutton. A keypad shall be provided to enable the user to select the values of test currents within a range of available settings. The protection functions shall not be affected during test operations. The breaker may be tested in the TRIP or NO TRIP test mode.

#### The trip unit shall have the following advanced protective features integral to the trip unit:

##### Adjustable undervoltage release

##### Adjustable overvoltage release

##### Reverse power

##### Phase rotation voltage alarm

##### Underfrequency

##### Overfrequency

##### Voltage phase unbalance

###### Where the above protection(s) are not available as an integral part of the trip unit, provide separate relay(s) factory mounted and wired to a breaker shunt trip.

##### The trip unit shall require an external voltage transformer module designed specifically for use with the trip unit, suitable for operation up to 600V, 50/60 Hz.

## Insulated case CIRCUIT BREAKERS – Power defense sB

### Protective devices shall be insulated case low-voltage power circuit breakers, Eaton type Power Defense SB or approved equal.

### All frame sizes shall have a common height and depth. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

### Breakers shall be manually operated (MO) or electrically operated (EO) as indicated on the drawings.

### Electrically operated breakers shall be complete with [close/open pushbuttons] [control switch], plus red and green indicating lights to indicate breaker contact position [24 Vdc] [48 Vdc] [120 Vac/125 Vdc] [240 Vac/250 Vdc] [208-277 Vac] motor operators; the charging time of the motor shall not exceed 6 seconds. [dc source shall be supplied from a remote battery system] [ac source shall be taken from a [remote source] [control power transformer internal to the switchgear assembly]].

### All insulated case circuit breakers shall have a minimum symmetrical interrupting capacity of [50,000] [65,000] [100,000] amperes. To ensure a selective system, all circuit breakers shall have 30-cycle short-time withstand ratings equal to 18 times their frame ratings. Insulated case circuit breakers shall be equipped with a fixed internal instantaneous override set at that level.

### The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.

### The insulated case circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage. The accessories shall be plug and lock type and UL listed for easy field installation. They shall be modular in design and shall be common to all frame sizes and ratings.

### The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The insulated case circuit breaker shall have a “Positive On” feature. The breaker flag will read “Closed” if the contacts are welded and the breaker is attempted to be tripped or opened.

#### The breaker shall include padlockable pushbutton covers.

### Each insulated case circuit breaker shall offer front mounted dedicated secondary wiring points for connection to the internal accessories. Each wiring point shall have finger safe contacts, which will accommodate #10 AWG maximum field connections with ring tongue or spade terminals or bare wire.

### For draw-out applications the breaker cell shall be equipped with draw-out rails and primary and secondary disconnecting contacts.

#### A position indicator shall be located on the faceplate of the breaker and on the side of the cassette. This indicator shall provide color indication of the breaker position in the cell. These positions shall be Connect (Red), Test (Yellow), and Disconnect (Green) and shall all permit closing the compartment door. The levering door shall be interlocked so that when the breaker is in the closed position, the breaker levering-in door shall not open. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell.

#### The breaker shall include padlocking provisions to prevent levering which is capable of securing the breaker in the connected, test or disconnected position.

#### The secondary disconnecting devices shall consist of plug-in connectors mounted on the removable unit and engaging floating plug-in connectors at the front of the compartment. The secondary disconnecting devices shall be gold-plated, and pin and socket contact engagement shall be maintained in the “connected” and “test” positions.

#### To facilitate lifting, the insulated case circuit breaker shall have integral handles on the side of the breaker.

#### [Provide a safety shutter in the cell when the circuit breaker is withdrawn, which automatically covers the line and load stabs and protects against incidental contact.]

#### The circuit breaker door design shall be such that the following functions may be performed without the need to open the circuit breaker door: lever circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit, and read circuit breaker rating nameplate.

#### The secondary disconnecting devices shall consist of floating terminals mounted on the stationary unit and engaging mating contacts at the front of the breaker. The breaker secondary disconnecting devices shall be maintained in the “connected” and “test” positions.

#### The removable insulated case circuit breaker element shall be equipped with disconnecting contacts and interlocks for draw-out application. It shall have four positions, “connected,” “test,” “disconnected” and “removed.” The breaker draw-out element shall contain a worm gear levering “in” and “out” mechanism with removable lever crank. Levering shall be accomplished via the use of conventional tools. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell.

#### Breaker shall be ready to accept connection of remote racking device without modification of breaker, cell or door.

#### Key interlocks shall be provided as indicated on the drawings. These interlocks shall keep the circuit breakers trip-free when actuated.

#### Breakers shall include [shall include provisions for] integral motorized racking within the breaker which meets Supplement SC of the UL 1066 standard. The integral motorized racking capability allows a means for remotely racking the breaker without the need to interface external accessories. The integral motorized racking shall have the following features:

#### Allow moving the breaker between the connect, test, and disconnect positions from a distance of up to 30 feet via a handheld pendant, with the breaker compartment door closed.

#### Breaker position shall be indicated on the pendant by LED lights. A blinking light indicates that the circuit breaker is in the motion through the selected position. A solid (non-blinking) light indicates that the circuit breaker has reached and stopped in the selected position. In case normal operation fails, the appropriate error code is displayed on the pendant in a separate 2-character LED display window.

#### The system shall be designed such that it allows manual racking of the circuit breaker using the levering crank accessory. Manual racking operation shall disable the motorized racking accessory.

#### It shall be possible to enable/disable operation of the motorized racking accessory via Purchaser’s external interlocking/permissive contacts.

#### 120 Vac power for the motorized racking accessory shall be [derived from a control power transformer mounted in the switchgear] [supplied by purchaser from an external source].

#### The handheld pendant shall also include “Open” and “Close” pushbuttons to allow remote operation of the circuit breaker.

#### Provide a discrete I/O interface module mounted in each circuit breaker control compartment for control of the motorized racking accessory via external hard-wired dry contacts, for example, via push buttons located at a remote control panel. The I/O interface module to provide output terminals for connections of remote 24 Vdc LEDs for indication of breaker position status at the remote panel. With this I/O interface, the circuit breaker can be moved from disconnect to connect or from connect to disconnect positions from a remote control panel. Whenever the hand-held pendant is in use, the pendant becomes the master and will override the customer’s remote control signals.

#### -- OR --

#### Provide a discrete I/O interface module mounted in each circuit breaker control compartment, daisy chained, for control of the motorized racking accessory via Purchaser’s SCADA system or Dashboard interface using Modbus communications. Whenever the hand-held pendant is in use, the pendant becomes the master and will override the Modbus interface.

#### The color of the racking mechanism door shall differ to easily distinguish breakers with internal racking mechanisms from those without integral racking mechanisms.

### Microprocessor-Based Trip Units

#### [PXR 20, PXR 25, and PXR 35]

A close up of a control panel

Description automatically generatedA close up of a device

Description automatically generated

##### A screenshot of a phone Description automatically generated

#### Each power circuit breaker shall be equipped with a true RMS sensing, solid-state tripping system consisting of at least three current sensors, microprocessor-based trip device, and flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. Current sensors shall be of Rogowski coil type. The continuous current rating (In) shall be established via trip device firmware.

#### The nominal current rating (In) sets the maximum continuous ratings of the breaker and can be changed by changing the firmware-based rating plug only. Replacing physical rating plug and current sensors shall not be required.

#### The nominal current rating (ln) shall be displayed so that is visible when the trip unit is powered off as well as shown on the trip unit when powered on to verify.

#### Trip units shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.

#### The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession. Breakers with ground fault protection shall include an additional thermal memory for the ground fault pick-up for enhanced protection from intermittent or arcing line-to-ground faults.

#### Trip units shall include the following individually adjustable time/current curve shaping solid-state elements:

##### Programmable long-delay pick-up setting (Ir) – 0.4 to 1.0 x (In)

##### Programmable long-delay time 0.5 to 24 sec with selectable I0.5t, It, I2t, or I4t slope

##### Programmable short-delay pick-up setting – 1.5 to 10 x (Ir)

##### Programmable short-delay time 0.05 to 0.5 sec with selectable flat or I2t curve shaping

##### Programmable instantaneous setting – 2 to 15 x (In) including OFF position

##### [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall have individually adjustable ground fault current pickup (0.2 to 1.0 x (In)) and time (0.05 to 1.0 sec), with selectable flat or I2t curve shaping. Provide ground fault trip or ground alarm only as shown on the drawings. The trip device shall include user selectable ground fault detection options of OFF, GF alarm, or GF trip.

##### [PXR 35 ONLY] [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall have four protection sets that include all the protection and alarm settings. The protection sets can be switched using hardwired inputs to the trip unit (ex: a four-position selector switch) or over communications.

#### [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall include an Arc Flash Reduction Maintenance System (ARMS)

##### The ARMS technology shall be provided to reduce arc energy during periods of maintenance. The system shall engage an independent, reduced instantaneous pickup and reduce total clearing time when activated. ARMS shall provide a separate trip circuit. Maintenance mode systems that only alter short time and/or instantaneous protection settings are not acceptable.

##### The pick-up value shall be adjustable with a minimum of (5) settings (1.5 to 10 x (In)) to allow the greatest arc energy reduction without nuisance tripping.

##### With the ARMS technology active, total clearing time shall not exceed 40 msec for any fault currents above the pick-up value.

##### Activation and deactivation of the ARMS technology and local indication shall be accessible from the face of the trip unit without opening the circuit breaker door and exposing operators to energized parts. Recalibration or adjustment of trip unit parameters shall not be required when enabling / disabling the ARMS technology.

###### [Breakers shall include a separate, local, lockable ARMS activation selector switch and pilot light indication.]

###### [Breakers shall include interposing relay to allow for remote ARMS activation from a remote contact closure and remote indication of ARMS status via an output relay.]

#### Trip units shall provide zone selective interlocking (ZSI) for the short-time delay and ground fault delay trip functions for improved system protection and arc energy reduction. For faults within the protected zone, the zone interlocking system shall override programmed time delays to allow the upstream breaker to trip with minimal time delay.

##### ZSI function shall be capable of being enabled/disabled through the programming of the trip unit. The face of the trip unit shall include a constant indication showing when ZSI is enabled.

###### [PXR 35 ONLY] ZSI for short-time delay and ground fault delay can be separately enabled/disabled.

##### To allow for easy inspection, testing, and troubleshooting, the trip unit shall display an indication when it has received a ZSI input signal from a downstream device(s). The indication can be reset with the reset button on the face of the trip unit.

##### Factory shall wire for zone selective interlocking for the circuit breakers within the switchgear using [twisted pair wiring] [PXR 35 ONLY Ethernet connections for ZSI over IEC 61850].

#### Two user programmable high load alarm outputs shall be available from 50% to 120% of the long delay pickup setting (Ir).

#### Trip units shall have an integral, [high resolution liquid-crystal display (LCD)][PXR 35 ONLY color touchscreen display] capable of displaying the trip unit programming, status, and monitoring information.

#### Trip units shall be capable of metering phase, neutral, and ground current with an accuracy of [+/- 0.50%][PXR 35 ONLY +/- 0.25%] of reading.

#### Trip units shall include embedded Modbus RTU communication capability. All monitored parameters and statuses shall be available over the chosen protocol(s).

##### In addition, the trip units shall simultaneously support the following additional protocol:

###### [Modbus TCP with HTML5 embedded webpages]

###### [PXR 20/25 ONLY Profibus DP]

###### [PXR 35 ONLY IEC 61850 (GOOSE messaging)]

##### Trip units shall allow remote open and closing of the breaker across the specified communication protocol.

#### Trip units shall be capable of supporting dual communications.

##### [PXR 20/25 ONLY]: via the use of optional integral Modbus RTU and an external communication adapter module.

##### -- OR –

##### [PXR 35 ONLY]: via the integral Modbus RTU and integral Ethernet connectivity.

#### Breaker Health Monitoring and Diagnostics

##### The trip units shall collect and store pertinent information to the trip unit and circuit breaker health and event history. The trip unit shall also include diagnostic features to allow the user to investigate events and dynamically monitor the health of the trip unit and the breaker.

##### Breaker Health

###### The trip unit shall contain a circuit breaker health monitoring system that collects information pertaining to the health and life of the breaker.

Number of operations (load and no-load).

Number of trips (overload trips, short circuit trips).

Run time.

Breaker ambient temperature.

Breaker remaining life – Then the trip unit shall utilize an algorithm that applies a weighted value to all of these inputs to determine the remaining life of the breaker. The remaining life of the breaker shall be displayed or communicated in calculated percentage of life remaining.

All breaker health information shall be available via local display and via communications.

##### Breaker Diagnostics

###### Trip units shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

###### Trip units shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

Cause-of-trip LED indications shall include battery backup to indicate mode of trip following an automatic trip operation. Battery charge status shall be displayed on the face of the trip unit and available via alarm relay.

###### The trip unit shall capture and record information surrounding events, alarms, and trips into a set of time-stamped logs. The trip unit shall store a minimum of 200 time-stamped log events. Log events shall be categorized as follows:

Event Log – system events, user interactions, programming changes, breaker operations, causes, and descriptions.

Alarm Log – trip unit and circuit breaker alarm conditions indicating an abnormal operating or user specified condition.

Trip Log – any event resulting in the automatic trip of the circuit breaker.

Alarm and Trip Log events shall capture and store the following information:

Real-time Current (IA, IB, IC, IN, IG), Temperature, Frequency, Power Factor, Operations Count

[PXR 25/35 ONLY]: Real-time Voltages (VAB, VBC, VCA, VAN, VBN, VCN), Power and Demand (Watts, Vars, VA)

###### The trip unit shall perform a waveform capture on trip, alarm, or user-initiated events.

Any breaker trip event shall capture a 10-cycle waveform; (6) pre-event cycles and (4) post-event cycles. The trip unit shall store the most recent trip event waveform.

Any alarm event shall capture a 10-cycle waveform; (6) pre-event cycles and (4) post-event cycles. The trip unit shall store the most recent alarm event waveform.

Any user-initiated waveforms shall capture a 1-cycle waveform.

Waveform events shall capture and store the following information:

Cause-of-trip

All phase, neutral, and ground currents

Temperature, operations count

Time and date

[PXR 25/35 ONLY] Phase-to-phase and phase-to-neutral voltage waveforms, power, energy, power factor, frequency

##### The trip unit shall contain an integral trip test capability. The user can initiate a breaker trip from the keypad to confirm breaker trip actuator and breaker mechanism functionality.

#### Trip unit shall include (3) programmable alarm relays. Relay activation can be programmed to any of 30 various status, alarm, health, or trip conditions.

#### Trip units shall be capable of being programmed and tested with an industry standard USB cable using a software tool available from the manufacturer’s website. The software shall provide the follow functionality:

##### Setting / Saving / Uploading / Downloading of trip unit setpoints including a setpoint wizard.

##### Time current curve displays including upstream and downstream breakers to analyze coordination.

##### View, download, export (.csv) and trigger waveform captures for troubleshooting and diagnostics.

##### Zone Selective Interlocking testing capability.

##### Breaker current sensor continuity testing capability.

##### Breaker trip actuator testing capability.

##### Trip unit secondary injection testing without the need for dedicated test equipment with automatic test reporting capability. Trip units without software secondary injection test / reporting capability must be provided with the required dedicated trip unit test equipment.

#### Advanced Trip Unit features

#### [PXR 25 ONLY]

##### Trip units shall include high accuracy power, energy, and power quality metering capable of delivering ANSI C12.1 accurate energy readings. Metering accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 0.5% of reading for current and voltage values.

##### The unit shall be capable of monitoring the following data:

###### Individual phase, neutral, and ground current.

###### Voltage phase-to-phase and phase-to-neutral.

###### Minimum and maximum current and voltage values.

###### Watts, Vars, VA, Watthours, Varhours, VA hours, peak demand, present demand, and energy consumption.

###### Power Factor.

##### The unit shall include the following enhanced protection features which can be configured for trip or alarm, or set to off:

###### Over and undervoltage.

###### Current and voltage unbalance.

###### Phase loss (current based).

###### Reverse active power.

-- OR --

#### [PXR 35 ONLY]

##### Trip units shall include high accuracy power, energy, and power quality metering capable of delivering ANSI C12.1 accurate energy readings. Metering accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 0.25% of reading for current and voltage values.

##### The unit shall be capable of monitoring the following data:

###### Individual phase, neutral, and ground current.

###### Voltage phase-to-phase and phase-to-neutral for line and load.

###### Minimum and maximum current and voltage values.

###### Watts, Vars, VA, Watthours, Varhours, VA hours, peak demand, present demand, and energy consumption.

###### Power Factor.

###### Frequency.

##### The unit shall include the following enhanced protection features which can be configured for trip or alarm, or set to off:

###### Over and undervoltage.

###### Current and voltage unbalance.

###### Phase rotation.

###### Phase loss (current based).

###### Reverse active and reactive power.

###### Real, apparent, and reactive power.

###### Real, apparent, and reactive power demand.

###### Power factor.

###### Over and under frequency.

##### The unit shall additionally include the ability to configure alarms for:

###### Total harmonic distortion current and voltage.

##### The unit shall include synchronism-check functionality for live and dead bus.

## UL 489 - Insulated Case circuit breakers – Power DEFENSE (PD-NF and PD-RF FRames)

### All insulated case circuit breakers shall be constructed and tested in accordance with UL 489. The circuit breakers shall carry a UL label.

### Protective devices shall be low-voltage insulated case circuit breakers, Eaton Power Defense PD-NF and PD-RF frames or approved equal. Frame ratings shall be 800 – 3000 amps. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

### Breakers shall be [manually operated (MO)] [electrically operated (EO)] as indicated on the drawings.

### Electrically operated breakers shall be complete with [close/open pushbuttons] [control switch], with a [24 Vdc] [48 Vdc] [60 Vdc] [110-125 Vac/dc] [110-125 Vdc] [208-250 Vac/Vdc] [220-250 Vdc] rated motor operator. The charging time of the motor shall not exceed 6 seconds. [dc source shall be supplied from a remote battery system] [ac source shall be taken from a [remote source] [control power transformer internal to the switchgear assembly]].

### All circuit breakers shall have a minimum symmetrical interrupting capacity of [42,000] [50,000] [65,000] amperes at 480V. To ensure a selective system, all circuit breakers shall have 30-cycle short-time withstand capability equal to their symmetrical interrupting ratings through 42,000 amperes, regardless of whether equipped with instantaneous trip protection or not.

### The insulated case circuit breaker shall have a closing time of not more than 3 cycles.

### The insulated case circuit breaker shall have a nameplate clearly marking any electrical accessories that are mounted in the breaker at the time of sale. The accessory shall have a label that will indicate its function and voltage. All accessories shall be modular, plug and lock type, and UL listed for easy field installation.

### The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The insulated case circuit breaker shall have a “Positive On” feature. The breaker flag will read “Closed” if the contacts are welded and the breaker is attempted to be tripped or opened.

#### The breaker shall include pad-lockable pushbutton covers.

### Each insulated case circuit breaker shall offer a maximum of fifty-six (56) for NF frame and ninety-six (96) for RF frame front mounted dedicated secondary wiring points, with the option to be individually populated. Each wiring point shall be a tension clamp type with finger safe contacts, which accommodates one - #26-#12 AWG per connection point, rated up to 600 volts, 10 amps.

### For draw-out applications the breaker cell shall be equipped with draw-out rails and primary and secondary disconnecting contacts.

#### A flag position indicator shall be located on the faceplate of the breaker. This indicator shall provide color indication of the breaker position in the cell. These positions shall be Connect (Red), Test (Yellow), and Disconnect (Green) and shall all permit closing the compartment door. The levering door shall be interlocked so that when the breaker is in the closed position, the breaker levering-in door shall not open. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell.

#### The breaker shall include an optional provision for key locking open to prevent manual or electric closing. Padlocking shall secure the breaker in the connected, test or disconnected position by preventing levering.

#### The secondary disconnecting devices shall consist of plug-in connectors mounted on the removable unit and engaging floating plug-in connectors at the front of the compartment. The secondary disconnecting device’s pin and socket contact engagement shall be maintained in the “connected” and “test” positions

#### To facilitate lifting, the power circuit breaker shall have integral handles on the side of the breaker.

### Microprocessor-Based Trip Units

#### [PXR 20 and PXR 25]

##### 



#### Each power circuit breaker shall be equipped with a true RMS sensing, solid-state tripping system consisting of at least three current sensors microprocessor-based trip device and flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. Current sensors shall be of Rogowski coil type. The continuous current rating (In) shall be established via trip device firmware.

#### The nominal current rating (In) sets the maximum continuous ratings of the breaker and can be reduced by changing the firmware-based rating plug only. Replacing physical rating plug and current sensors shall not be required.

#### The nominal current rating (ln) shall be displayed so that is visible when the trip unit is powered off as well as shown on the trip unit when powered on to verify.

#### Trip units shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.

#### The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession. Breakers with ground fault protection, shall include an additional thermal memory for the ground fault pick-up for enhanced protection from intermittent or arcing line-to-ground faults.

#### Trip units shall include the following individually adjustable time/current curve shaping solid-state elements:

##### Programmable long-delay pick-up setting (Ir) – 0.4 to 1.0 x (In)

##### Programmable long-delay time 0.5 to 24 sec with selectable I0.5t, It, I2t, or I4t slope

##### Programmable short-delay pick-up setting – 1.5 to 10 x (Ir)

##### Programmable short-delay time 0.0 to 0.5 sec with selectable flat or I2t curve shaping

##### Programmable instantaneous setting – 2 to 15 x (In) including OFF position

##### [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall have individually adjustable ground fault current pickup (0.2 – 1.0 x (In)) and time (0.1 – 0.5 sec), with selectable flat or I2t curve shaping. Provide ground fault trip or ground alarm only as shown on the drawings. The trip device shall include user selectable ground fault detection options of OFF, GF alarm, or GF trip.

#### [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall include an Arc Flash Reduction Maintenance System (ARMS)

##### The ARMS technology shall be provided to reduce arc energy during periods of maintenance. The system shall engage an independent, reduced instantaneous pickup and reduce total clearing time when activated. ARMS shall provide a separate trip circuit. Maintenance mode systems that only alter short time and/or instantaneous protection settings are not acceptable.

##### The pick-up value shall be adjustable with a minimum of (5) settings (2.5 to 10 x (In)) to allow the greatest arc energy reduction without nuisance tripping.

##### With the ARMS technology active, total clearing time shall not exceed 40 msec for any fault currents above the pick-up value.

##### Activation and deactivation of the ARMS technology and local indication shall be accessible from the face of the trip unit without opening the circuit breaker door and exposing operators to energized parts. Recalibration or adjustment of trip unit parameters shall not be required when enabling / disabling the ARMS technology.

###### [Breakers shall include a separate, local, lockable ARMS activation selector switch and pilot light indication.]

###### [Breakers shall include interposing relay to allow for remote ARMS activation from a remote contact closure and remote indication of ARMS status via an output relay.]

#### Trip units shall provide zone selective interlocking (ZSI) for the short-time delay and ground fault delay trip functions for improved system protection and arc energy reduction. For faults within the protected zone, the zone interlocking system shall override programmed time delays to allow the upstream breaker to trip with minimal time delay.

##### ZSI function shall be capable of being enabled/disabled through the programming of the trip unit. The face of the trip unit shall include a constant indication showing when ZSI is enabled.

##### To allow for easy inspection, testing, and troubleshooting, the trip unit shall display an indication when it has received a ZSI input signal from a downstream device(s). The indication can be reset with the reset button on the face of the trip unit.

##### Factory shall wire for zone selective interlocking for the circuit breakers within the switchgear.

#### A high load alarm shall be provided, fixed at 85% of the long delay pickup setting.

#### Trip units shall have an integral, high resolution liquid-crystal display (LCD) capable of displaying the trip unit programming, status, and monitoring information.

#### Trip units shall be capable of metering phase, neutral, and ground current with an accuracy of +/- 1% of reading.

#### Trip units shall include embedded Modbus RTU communication capability. All monitored parameters and statuses shall be available over the chosen protocol(s).

##### In addition, the trip units shall simultaneously support the following additional protocol:

###### [Modbus TCP with HTML5 embedded webpages]

###### [Profibus DP]

##### Trip units shall allow remote open and closing of the breaker across the specified communication protocol.

#### Trip units shall be capable of supporting dual communications via the use of optional integral Modbus RTU and an external communication adapter module.

#### Breaker Health Monitoring and Diagnostics

##### The trip units shall collect and store pertinent information to the trip unit and circuit breaker health and event history. The trip unit shall also include diagnostic features to allow the user to investigate events and dynamically monitor the health of the trip unit and the breaker.

##### Breaker Health

###### The trip unit shall contain a circuit breaker health monitoring system that collects information pertaining to the health and life of the breaker.

Number of operations (load and no-load).

Number of trips (overload trips, short circuit trips).

Run time.

Breaker ambient temperature.

Breaker remaining life – Then the trip unit shall utilize an algorithm that applies a weighted value to all of these inputs to determine the remaining life of the breaker. The remaining life of the breaker shall be displayed or communicated in calculated percentage of life remaining.

All breaker health information shall be available via local display and via communications.

##### Breaker Diagnostics

###### Trip units shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

###### Trip units shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

Cause-of-trip LED indications shall include battery backup to indicate mode of trip following an automatic trip operation. Battery charge status shall be displayed on the face of the trip unit and available via alarm relay.

###### The trip unit shall capture and record information surrounding events, alarms, and trips into a set of time-stamped logs. The trip unit shall store a minimum of 200 time-stamped log events. Log events shall be categorized as follows:

Event Log – system events, user interactions, programming changes, breaker operations, causes, and descriptions.

Alarm Log – trip unit and circuit breaker alarm conditions indicating an abnormal operating or user specified condition.

Trip Log – any event resulting in the automatic trip of the circuit breaker.

Alarm and Trip Log events shall capture and store the following information:

Real-time Current (IA, IB, IC, IN, IG), Temperature, Frequency, Power Factor, Operations Count

[PXR 25 ONLY Real-time Voltages (VAB, VBC, VCA, VAN, VBN, VCN), Power and Demand (Watts, Vars, VA)]

###### The trip unit shall perform a waveform capture on trip, alarm, or user-initiated events.

Any breaker trip event shall capture a 6-cycle waveform. The trip unit shall store the most recent trip event waveform.

Any alarm event or user-initiated waveforms shall capture a 1-cycle waveform.

Waveform events shall capture and store the following information:

All phase, neutral, and ground currents

[PXR 25 ONLY Phase-to-phase and Phase-to-Neutral voltages]

##### The trip unit shall contain an integral trip test capability. The user can initiate a breaker trip from the keypad to confirm breaker trip actuator and breaker mechanism functionality.

#### Trip unit shall include (3) alarm relays:

##### ARMS Maintenance Mode enabled

##### Ground Fault (LSIG breakers only) or High Load alarm

##### Breaker Trip (Bell alarm)

#### Trip units shall be capable of being programmed and tested with an industry standard USB cable using a software tool available from the manufacturer’s website. The software shall provide the follow functionality

##### Setting / Saving / Uploading / Downloading of trip unit setpoints including a setpoint wizard

##### Time current curve displays including upstream and downstream breakers to analyze coordination

##### View, download, export (.csv) and trigger waveform captures for troubleshooting and diagnostics Zone Selective Interlocking testing capability

##### Breaker current sensor continuity testing capability

##### Breaker trip actuator testing capability

##### Trip unit secondary injection testing without the need for dedicated test equipment with automatic test reporting capability. Trip units without software secondary injection test / reporting capability must be provided with the required dedicated trip unit test equipment.

#### Advanced Trip Unit features [PXR 25 Trip Unit ONLY]

##### Trip units shall include high accuracy power, energy, and power quality metering capable of delivering ANSI C12.1 accurate energy readings. Metering accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 1% of reading for current and voltage values.

##### The unit shall be capable of monitoring the following data:

###### Individual phase, neutral, and ground current

###### Voltage phase-to-phase and phase-to-neutral

###### Minimum and maximum current and voltage values

###### Watts, Vars, VA, Watthours, Varhours, VA hours, Peak demand, Present demand, and energy consumption.

###### Power Factor

##### The trip unit shall require an external voltage transformer module designed specifically for use with the trip unit, suitable for operation up to 600V, 50/60 Hz.

## Molded case circuit breakers through 2500Amps [power defense]

### Protective devices shall be UL 489 Listed molded case circuit breakers with inverse time and instantaneous tripping characteristics and shall be Eaton or approved equal.

### Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

### Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.

### For enhanced load protection and safety, all molded-case circuit breakers from 15 – 600 amps with interrupting ratings of 65kAIC (480v) / 100kAIC (240v) and higher shall be UL listed as current limiting type.

### Provide accessories including shunt trips, bell alarms and auxiliary switches as shown on the contract drawings.

### Where indicated circuit breakers shall be UL listed for series application.

### Where indicated provide UL listed circuit breakers for applications at 100% of their continuous ampere rating in their intended enclosure.

### Circuit breakers [225-] [400-] [600-] [800-] ampere frame and below shall have thermal-magnetic trip units and inverse time-current characteristics.

### Circuit breakers [225-] [400-] [600-] [800-] ampere through 2500-ampere frame shall have microprocessor-based rms sensing trip units as specified below:

### Molded-Case Breakers

#### [**PXR 10** – Basic Protection (phase only) - PD2/PD3/PD4 Frame 800Amp and less only]

#### Each molded case circuit breaker microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit and a trip actuator. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached.

#### An adjustable trip setting dial mounted on the front of the trip unit shall establish the continuous trip ratings of each circuit breaker.

#### System coordination shall be provided by adjusting rotary switches for the following microprocessor-based time-current curve shaping adjustments:

##### Adjustable long-time setting (set by adjusting the trip setting dial or rating plug)

##### Minimum of (10) adjustable profile settings including:

###### Short delay pick-up settings from 2x – 10x.

###### Short delay time settings from Instantaneous to 300msec

###### Flat or I2t short delay response

One programmable setting for a custom user defined short delay pick-up and time

##### The switches shall be color coded to separately indicate overload protection settings and short circuit protection settings

##### The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession. Breakers with ground fault protection, shall include an additional thermal memory for the ground fault pick-up for enhanced protection from intermittent or arcing line-to-ground faults.

##### The trip unit shall be provided with an instantaneous override.

##### Trip units shall be capable of being programmed and tested with an industry standard USB cable using a software tool available from the manufacturer’s website. The software shall provide the follow functionality.

###### Cause-of-trip information

###### Breaker current sensor continuity testing capability

###### Breaker trip actuator testing capability

###### Setting / Saving / Uploading / Downloading of trip unit setpoints including a setpoint wizard

###### Trip unit secondary injection testing without the need for dedicated test equipment with automatic test reporting capability. Trip units without software secondary injection test / reporting capability must be provided with the required dedicated trip unit test equipment.

#### [**PXR 20** – Basic Protection (phase and ground), Breaker Health Monitoring (thru USB or Comms) + OPTIONAL Comms, ARMS, ZSI, Relays - PD2 thru PD6 Frames – 15Amps thru 2500Amps]

#### Each power circuit breaker shall be equipped with a true RMS sensing, solid-state tripping system consisting of at least three current sensors microprocessor-based trip device and trip actuator. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions.

#### The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession. Breakers with ground fault protection, shall include an additional thermal memory for the ground fault pick-up for enhanced protection from intermittent or arcing line-to-ground faults.

#### System coordination shall be provided by adjusting rotary switches for the following microprocessor-based time-current curve shaping adjustments:

##### Adjustable long-delay pick-up setting with minimum of 10 settings

##### Adjustable long-delay time – 0.5 to 24 sec

##### Adjustable short-delay pick-up setting – 1.5x to Max allowable by frame

##### Adjustable short-delay time 0.0 sec up to 0.5 sec depending on frame with selectable flat or I2t curve shaping

##### Adjustable instantaneous setting 2x to Max allowable by frame

##### [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall have individually adjustable ground fault current pickup (0.2 – 1.0 x (In) in 0.10x increments) and time (0.1 – 1.0 sec in 0.10 sec increments), with selectable flat or I2t curve shaping.

###### The trip device shall include user selectable ground fault detection options of OFF, GF alarm, or GF trip.

###### The trip device shall be capable of providing a GF alarm signal between 50 – 100% of the GF trip magnitude.

##### The switches shall be color coded to separately indicate overload protection settings, short circuit protection settings and ground fault protection settings.

#### Trip units shall be capable of metering phase, neutral, and ground current with an accuracy of +/- 2.0% of the reading.

#### [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall include an Arc Flash Reduction Maintenance System (ARMS)

##### The ARMS technology shall be provided to reduce arc energy during periods of maintenance. The system shall engage an independent, reduced instantaneous pickup and reduce total clearing time when activated. ARMS shall provide a separate trip circuit. Maintenance mode systems that only alter short time and/or instantaneous protection settings are not acceptable.

##### The pick-up value shall be adjustable with a minimum of (5) settings (2.5 to 10 x In) to allow the greatest arc energy reduction without nuisance tripping.

##### With the ARMS technology active, total clearing time shall not exceed 30 msec for any fault currents above the pick-up value.

##### Activation and deactivation of the ARMS technology and local indication shall be accessible from the face of the trip unit without opening the circuit breaker door and exposing operators to energized parts. Recalibration or adjustment of trip unit parameters shall not be required when enabling / disabling the ARMS technology.

###### [Breakers shall include a separate, local, lockable ARMS activation selector switch and pilot light indication.]

###### [Breakers shall include interposing relay to allow for remote ARMS activation from a remote contact closure and remote indication of ARMS status via an output relay.]

#### Trip units shall provide zone selective interlocking (ZSI) for the short-time delay and ground fault delay trip functions for improved system protection and arc energy reduction. For faults within the protected zone, the zone interlocking system shall override programmed short time delays to allow the upstream breaker to trip with minimal time delay.

##### ZSI function shall be capable of being enabled/disabled through the programming of the trip unit.

##### To allow for testing and troubleshooting, the trip unit shall provide relay output indication when it has received a ZSI input signal from a downstream device(s). The indication can be reset with the reset button on the face of the trip unit.

##### Factory shall wire for zone selective interlocking for the circuit breakers within the switchgear.

#### Trip units shall include configurable alarm relays. High load alarm relay outputs shall be available at 85% and 105% of the long delay pickup setting.

#### Trip units shall include embedded Modbus RTU communication capability. All monitored parameters and statuses shall be available over the chosen protocol(s).

##### In addition, the trip units shall simultaneously support the following additional protocol:

###### [Modbus TCP with HTML5 embedded webpages]

###### [Profibus DP]

#### Breaker Health Monitoring and Diagnostics

##### The trip units shall collect and store pertinent information to the trip unit and circuit breaker health and event history. The trip unit shall also include diagnostic features to allow the user to investigate events and dynamically monitor the health of the trip unit and the breaker.

##### Breaker Health

###### The trip unit shall contain a circuit breaker health monitoring system that collects information pertaining to the health and life of the breaker.

Number of operations (load and no-load)

Number of trips (overload trips, short circuit trips)

Run time

Breaker ambient temperature.

Breaker remaining life - Then the trip unit shall utilize an algorithm that applies a weighted value to all of these inputs to determine the remaining life of the breaker. The remaining life of the breaker shall be displayed or communicated in calculated percentage of life remaining.

All breaker health information shall be available via hard wire connection to a PC and via communications.

##### Breaker Diagnostics

###### Trip units shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

###### Trip units shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

Cause-of-trip LED indications shall include battery backup to indicate mode of trip following an automatic trip operation.

###### The trip unit shall capture and record information surrounding events, alarms, and trips into a set of time-stamped logs. The trip unit shall store a minimum of 200 time-stamped log events. Log events shall be categorized as follows:

Event Log – system events, user interactions, programming changes, breaker operations, causes, and descriptions.

Alarm Log – trip unit and circuit breaker alarm conditions indicating an abnormal operating or user specified condition.

Trip Log – any event resulting in the automatic trip of the circuit breaker.

Alarm and Trip Log events shall capture and store the following information:

Real-time Current (IA, IB, IC, IN, IG), Temperature, Frequency, Power Factor, Operations Count

###### The trip unit shall perform a waveform capture on trip, alarm, or user-initiated events.

Any breaker trip event shall capture a 10-cycle waveform. The trip unit shall store the most recent trip event waveform.

Any alarm event or user-initiated waveforms shall capture a 1-cycle waveform.

Waveform events shall capture and store the following information:

All phase, neutral, and ground currents

#### Trip units shall be capable of being programmed and tested with an industry standard USB cable using a software tool available from the manufacturer’s website. The software shall provide the follow functionality.

##### Setting / Saving / Uploading / Downloading of trip unit setpoints including a setpoint wizard

##### Time current curve displays including upstream and downstream breakers to analyze coordination

##### View, download, export (.csv) and trigger waveform captures for troubleshooting and diagnostics Zone Selective Interlocking testing capability

##### Breaker current sensor continuity testing capability

##### Breaker trip actuator testing capability

##### Trip unit secondary injection testing without the need for dedicated test equipment with automatic test reporting capability. Trip units without software secondary injection test / reporting capability must be provided with the required dedicated trip unit test equipment.

#### **PXR 25** – Advanced Protection, LCD Display, ANSI Accuracy Current / Voltage / Power / Energy Metering, Comms, Relays, Breaker Health Monitoring

##### PD2 thru PD6 Frames – 15Amps thru 2500Amps]

### Molded-Case Breakers – (15Amps thru 2500A)

#### Each circuit breaker shall be equipped with a true RMS sensing, solid-state tripping system consisting of at least three current sensors microprocessor-based trip device and trip actuator. The trip unit shall use microprocessor-based technology to provide highly adjustable time-current protection functions.

#### Trip units shall have an integral, high resolution liquid-crystal display (LCD) capable of displaying the trip unit programming, status, and monitoring information including bar graph display.

#### Trip units shall include high accuracy current metering +/- 0.5% of reading for the complete system, including current sensors, and the trip unit.

#### [PXR 25 Only] Trip units shall include high accuracy power, energy, and power quality metering capable of delivering ANSI C12.1 accurate energy readings. Metering accuracy of the complete system, including current sensors, and the trip unit, shall be +/- 0.5% of the reading for current and voltage values.

##### The unit shall be capable of monitoring the following data:

###### Individual phase, neutral, and ground current

###### Voltage phase-to-phase and phase-to-neutral

###### Minimum and maximum current and voltage values

###### Watts, Vars, VA, Watthours, Varhours, VA hours, peak demand, present demand, and energy consumption.

###### Power Factor

#### The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession. Breakers with ground fault protection, shall include an additional thermal memory for the ground fault pick-up for enhanced protection from intermittent or arcing line-to-ground faults.

#### Trip units shall include the highly adjustable time/current curve shaping solid-state elements:

##### Programmable long-delay pick-up setting in 1-amp increments (up to 600amp frames), or 10-amp increments (above 600amps)

##### Programmable long-delay time - 0.5 to 24 seconds in 0.1sec increments

##### Programmable short-delay pick-up setting – 1.5x to Max allowable by frame in 0.1x increments

##### Programmable short-delay time 0.0 sec up to 0.5 sec depending on frame with selectable flat or I2t curve shaping in 0.01sec increments

##### Programmable instantaneous setting 2x to Max allowable by frame in 0.1x increments

##### [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall have individually adjustable ground fault current pickup (0.2 – 1.0 x (In) in 0.01x increments) and time (0.1 – 1.0 sec in 0.01sec increments), with selectable flat or I2t curve shaping.

###### The trip device shall include user selectable ground fault detection options of OFF, GF alarm, or GF trip.

###### The trip device shall be capable of providing a GF alarm signal between 50 – 100% of the GF trip magnitude.

#### Trip units shall be capable of metering phase, neutral, and ground current with an accuracy of +/- 0.5% of reading.

#### [All circuit breakers] [Circuit breakers, where indicated on the drawings,] shall include an Arc Flash Reduction Maintenance System (ARMS)

##### The ARMS technology shall be provided to reduce arc energy during periods of maintenance. The system shall engage an independent, reduced instantaneous pickup and reduce total clearing time when activated. ARMS shall provide a separate trip circuit. Maintenance mode systems that only alter short time and/or instantaneous protection settings are not acceptable.

##### The pick-up value shall be adjustable with a minimum of (5) settings (2.5 to 10 x (In)) to allow the greatest arc energy reduction without nuisance tripping.

##### With the ARMS technology active, total clearing time shall not exceed 30 msec for any fault currents above the pick-up value.

##### Activation and deactivation of the ARMS technology and local indication shall be accessible from the face of the trip unit without opening the circuit breaker door and exposing operators to energized parts. Recalibration or adjustment of trip unit parameters shall not be required when enabling / disabling the ARMS technology.

###### [Breakers shall include a separate, local, lockable ARMS activation selector switch and pilot light indication.]

###### [Breakers shall include interposing relay to allow for remote ARMS activation from a remote contact closure and remote indication of ARMS status via an output relay.]

#### Trip units shall provide zone selective interlocking (ZSI) for the short-time delay and ground fault delay trip functions for improved system protection and arc energy reduction. For faults within the protected zone, the zone interlocking system shall override programmed short time delays to allow the upstream breaker to trip with minimal time delay.

##### ZSI function shall be capable of being enabled/disabled through the programming of the trip unit. The face of the trip unit shall include a constant indication showing when ZSI is enabled.

##### To allow for easy inspection, testing, and troubleshooting, the trip unit shall display an indication when it has received a ZSI input signal from a downstream device(s). The indication can be reset with the reset button on the face of the trip unit.

##### Factory shall wire for zone selective interlocking for the circuit breakers within the switchgear.

#### Trip units shall include configurable alarm relays. High load alarms relay outputs shall be available, adjustable from 50% to 120% of the long delay pickup setting. High load indication is via an LED indication and/or relay output.

#### Trip units shall be capable of supporting dual communications.

#### Trip units shall include embedded Modbus RTU communication capability. All monitored parameters and statuses shall be available over the chosen protocol(s).

##### In addition, the trip units shall simultaneously support the following additional protocol:

###### [Modbus TCP with HTML5 embedded webpages]

###### [Profibus DP]

###### [Modbus RTU]

#### Breaker Health Monitoring and Diagnostics

##### The trip units shall collect and store pertinent information to the trip unit and circuit breaker health and event history. The trip unit shall also include diagnostic features to allow the user to investigate events and dynamically monitor the health of the trip unit and the breaker.

##### Breaker Health

###### The trip unit shall contain a circuit breaker health monitoring system that collects information pertaining to the health and life of the breaker.

Number of operations (load and no-load)

Number of trips (overload trips, short circuit trips)

Run time

Breaker ambient temperature.

Breaker remaining life - Then the trip unit shall utilize an algorithm that applies a weighted value to all of these inputs to determine the remaining life of the breaker. The remaining life of the breaker shall be displayed or communicated in calculated percentage of life remaining.

All breaker health information shall be available via local display and via communications.

##### Breaker Diagnostics

###### Trip units shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

###### Trip units shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

Cause-of-trip LED indications shall include battery backup to indicate mode of trip following an automatic trip operation. Battery charge status shall be displayed on the face of the trip unit and available via alarm relay.

###### The trip unit shall capture and record information surrounding events, alarms, and trips into a set of time-stamped logs. The trip unit shall store a minimum of 200 time-stamped log events. Log events shall be categorized as follows:

Event Log – system events, user interactions, programming changes, breaker operations, causes, and descriptions.

Alarm Log – trip unit and circuit breaker alarm conditions indicating an abnormal operating or user specified condition.

Trip Log – any event resulting in the automatic trip of the circuit breaker.

Alarm and Trip Log events shall capture and store the following information:

Real-time Current (IA, IB, IC, IN, IG), Temperature, Frequency, Power Factor, Operations Count

[PXR 25 Only]: Real-time Voltages (VAB, VBC, VCA, VAN, VBN, VCN), Power and Demand (Watts, Vars, VA)

###### The trip unit shall perform a waveform capture on trip, alarm, or user-initiated events.

Any breaker trip event shall capture a 10-cycle waveform. The trip unit shall store the most recent trip event waveform.

Any alarm event or user-initiated waveforms shall capture a 1-cycle waveform.

Waveform events shall capture and store the following information:

All phase, neutral, and ground currents

[PXR 25 Only] Phase-to-phase and Phase-to-Neutral voltages

##### The trip unit shall contain an integral trip test capability. The user can initiate a breaker trip from the keypad to confirm breaker trip actuator and breaker mechanism functionality.

#### Trip units shall be capable of being programmed and tested with an industry standard USB cable using a software tool available from the manufacturer’s website. The software shall provide the following functionality.

##### Trip unit secondary injection testing without the need for dedicated test equipment with automatic test reporting capability. Trip units without software secondary injection test / reporting capability must be provided with the required dedicated trip unit test equipment.

##### Zone Selective Interlocking testing capability

##### Breaker current sensor continuity testing capability

##### Breaker trip actuator testing capability

##### Setting / Saving / Uploading / Downloading of trip unit setpoints including a setpoint wizard

##### View, download, or trigger waveform captures for troubleshooting and diagnostics