

Date: March 26, 2019

Classification: GE Information

Publication Number: PRBT-0410

Multifunction Platform

The device platform shall be designed in such a way that it'll consolidate functions such as ethernet communications, time synchronization, Human Machine Interface, Server applications and substation data concentrator or controller to optimize the number of assets and reduce the total deployment cost. This is important because having separate hardware for different functions increases the complexity and total cost of ownership. For example: different hardware types may require different maintenance services and schedule, staff may need to be trained on the different hardware systems, different system or architecture drawings may have to be updated and maintained as well as countless other related deployment and management costs.

This hardware platform shall support at least twenty serial ports, six Ethernet ports, IRIG-B input for time synchronization, Precision Timing Protocol (PTP) and IEC 62439-3 (Edition 2) compliant Parallel Redundancy Protocol (PRP). It shall support at least 3 manufacturer-supplied expansion modules (PCIe) for future expansion.

The platform shall support modern and robust cybersecurity features such secure boot, secure firmware upgrade, storage encryption, human in front of unit confirmation for local maintenance actions, and chassis intrusion detection.

Hardware Overview

CPU

The CPU of the device shall be built based on a high-performance x86 compatible CPU with at least 2.2GHz frequency. It shall support both dual or quad core.

The CPU shall support virtualization instruction set.

Cyber Security

The device shall be equipped with TPM (Trusted Platform Module) for cyber security applications and Operating System integration.

Memory

The device shall have DDR3-1600 or faster RAM memory, with ECC support as an option. RAM size shall be 8GB for the dual core and 16GB for the quad core.

The device shall have up to 2 MBytes of high-performance non-volatile RAM without use of battery.

Storage

The device shall support M.2 SATA SED (Solid state Encrypted Drives), minimum 3 slots, and at least one SATA interface for 2.5 drives.

Two of the M.2 slots shall support RAID 1 configuration.



The front of the device shall support one SD card slot.

Chassis Intrusion Detection and Physical Presence

The device shall support chassis intrusion detection circuitry, which logs any event of an opening enclosure regardless of power status. It shall also support physical presence detection to confirm that someone is in front of the unit when performing cyber security related maintenance actions, locally to the unit.

Power Supplies

The device shall be equipped with dual redundant hot swappable power supplies, which ensures continuous uptime. Each power supply can be connected to a different source. As an example, power supply 1 can be connected to Mains, while power supply 2 is connected to the battery system. The device shall also support the ability to monitor Power Supply Health to raise a SCADA point alarm when either power supply fails. This allows an alarm to be transmitted to the EMS / OMS or DMS system, where a field personnel can be dispatched to replace the failed supply, all without service disruption.

The device shall not require internal batteries (“super-cap” or similar technology shall be used).

Ethernet Interfaces

Minimum 6 (six) Ethernet interfaces shall be available through SFP cages. Each cage supports the following SFP transceivers, to be ordered/configured individually (or empty cage):

- 100/1000BASE-T (RJ45 copper medium)
- 100BASE-FX (LC fiber multimode)
- 1000BASE-SX (LC fiber multimode)

Serial Ports

The serial ports in the device shall be modular and expandable. The device shall have 8 native serial ports and be configurable for an additional 12 expansion serial ports. Ports are supported through individual RJ45 connectors on the backplane and can be expanded through PCIe modules. Each port shall be galvanically isolated and individually configured for RS-232 and RS-485 communication via software.

The 8 native serial ports shall support IRIG-B (TTL).

Minimum 2 serial ports shall support +12V output, electronically protected for minimum 6W (no fuses).

PCIe Modules

The device shall support up to 3 manufacturer-supplied expansion modules (PCIe) for various compatible and allowed applications such as additional serial ports.

Monitoring

The device shall have Hardware Watchdog support for monitoring HW resources and trigger automated actions.

Time Sync Support

The device shall have provision for extensive support for various time sync methodologies and can be configured for: NTP, IEEE1588 PTP, IRIG-B. The device shall support the distribution of time sync information through its built-in IRIG-B distribution interface, SCADA protocols, and/or through the native RS232 ports directly.

Displays and Display Ports

The device shall support 2x display ports (DP++ Dual-mode DisplayPort) with multi-stream, available on the rear of the chassis.

Each DP++ shall support up to two multi-stream displays.

The resolution shall be up to UHD (4k, 3840x2160) for single displays connected to each port, and QHD (2560x1440) for multi-stream connected displays.

The displays to be used shall have digital input capability (i.e. DVI-D, HDMI, DP – and not VGA).

DP to DVI-D and DP to HDMI cables and converters shall be listed in the manuals.

Audio Ports

The device shall have a built-in high pitch (+77dB) audio buzzer.

The device shall have one analog audio output, minimum 2 channels (L+R), line out level compatible.

USB Ports

The device shall support at least 7 USB ports for different uses such as storage or access to a keyboard as follows:

- 2x USB 3.0 on front of the unit
- 4x USB 2.0 on rear of the unit
- 1x USB 2.0 internal - for software license keys

Maintenance Ports

The device shall support 1x USB Type B port to provide serial access to the console for maintenance support.

There shall be an additional Ethernet maintenance port accessible on the front via a 100/1000BASE-T port. This Ethernet port shall be separate from the other 6 ethernet ports dedicated to communication.

User indications

The device shall support indications in form of multi-color LED and a front interactive small display, as following:

1. Individual Multi-color LEDs, normally showing green when all is running correctly, for:
 - a. CPU and HW health
 - b. Temperature alarm
 - c. User application-controlled device status (2x LED)
 - d. SED activity

2. Individual Multi-color LEDs, for:
 - a. LAN ports (6x LED)
 - b. Base serial ports (8x LED)
 - c. IRIG-B time sync input
3. Small OLED/LCD display, at minimum mono-chrome and 128x64 resolution, with multi-page navigation (back/forth) and confirmation/abort buttons for showing device/asset information and basic status messages.

Cyber Security

Secure Web Access and System Security

The device shall be Achilles level 1 certification ready. It shall provide security features to authenticate its identity and to maintain the privacy of information to user's computer when communicating over the network. It shall support the use of digital signatures and secure Web access using transport layer security (TLS).

The device shall support a secure TLS tunnel authenticated with certificates or SSH for pass-through and terminal server applications.

User Accounts and Authentication

The device shall support both User Access Levels and User Authentication Modes.

User Access Levels

The following shall be supported for the three levels of access:

- Observer:** View only privileges for all runtime screens.
- Operator:** Substation operation privileges to operate controls, force points and do maintenance tagging.
- Supervisor:** Full privileges to access and modify all configuration, runtime, operation and system administration screens. Administrator level users who log into the HMI are given Supervisor level permissions.

User Authentication Modes

The device shall be configurable with two modes:

- Local Mode:** Local authentication shall make use of files stored locally to control user authentication, as opposed to connecting to a remote server to verify user name and password information.

Secure Remote Access

The device shall support a seamless integration with existing IT department policies. Secure Web Interface, Secure File Transfer, and extensive user activity logging provide a complete security toolkit required to achieve NERC-CIP compliance. It shall support the following secure remote access:

Pass-through/Terminal Server

A built-in terminal server emulator to allow pass-through connections to be initiated with substation device (relay, meter, RTU or another device). Once the connection is established, the local event records can be uploaded from the substation devices and viewed remotely. Remote access shall be secured with TLS or SSH.

Virtual Serial Ports

Virtual serial ports eliminate copper wire communications to feeder bays when a serial-only device is in the bay. A small terminal server can be placed in the bay and connected to the Ethernet network, allowing all client applications to connect directly to the serial device.

Network Security Protocols

The device shall support and not be limited to the following secure network protocols:

- HTTPS
- SFTP/SCP
- SSH

Built-in Firewall

The device unit shall be equipped with a built-in firewall for enhanced device cyber security. Firewall shall be designed to drop unsolicited or invalid routed packets.

The firewall shall be preconfigured to block outbound traffic on external interfaces and inbound traffic on both internal and external interfaces. The device shall automatically generate rules allowing inbound traffic on internal interfaces for all configured services. The rules are user configurable for inbound/outbound traffic customization.

Human Machine Interface (HMI)

The device shall support a built-in HMI (human machine interface). Through the HMI a user can monitor the status of the substation network, view data, execute control commands, configure devices and SCADA masters, and change the system set-up.

The HMI shall include the following components:

Runtime HMI

- Used to view and control the operation of the power network.
- Includes the optional One Line Viewer for viewing one-line diagrams.
- Accessed from the Power bar buttons to view the display screens and utilities.

Configuration Tool

- Used to manage configuration settings directly in the device.
- Includes the One Line Designer for creating and editing one-line diagrams.
- Accessed from the Configuration Power bar button.

Command line interface

- Used to configure platform-level components.
- Accessed from the Utilities Power bar button.

The Following features shall be available to system administrators and operators through device's embedded HMI:

- System security

- One-line viewer
- Digital event management
- Viewing data
- Executing commands
- Operator Notes
- Analog reports
- System utilities
- Internationalization
- Retrieve system logs
- Browse files and folders from a local USB

HMI, One Line and Annunciator

The device HMI/Annunciator shall be accessible through a secure application or through a display port on the unit. The display port shall support up to 2x4k monitors, keyboard and mouse connection. Users shall have access to all data points in the systems, alarm screens, communications status screens and dynamic one-line diagrams.

Multiple floating windows for different screen views shall be supported. This is important because being able to access multiple floating windows or screens improves the productivity of operators.

The HMI screen shall support user-customization for different views to match different background colors or background layout to suit different preferences. The background layouts created for each screen shall be retained to the last layout size or position. This is very useful in that users should not have to keep recreating the same layout each time he or she access the HMI screen.

The embedded HMI shall support the following security features to ensure secure remote or local access:

- Configurable auto logout/login for Remote and Local HMI access
- Disabling of Remote HMI Non-Observer Privileges
- Login to specific custom screens for added security to sensitive displays
- Remote access to Redundant or Active HMI screens
- Commissioning support of database points (local forcing of points, feedback and acknowledgement of individual/group of alarms from one-line diagram)

Internationalization

The HMI design shall support Internationalization to adapt to different languages, regional settings and ready to be localized to reflect regional languages, number formats, and date/time formats.

Externalization

The HMI design shall support the externalization of text and labels to resource bundle files so that they may be localized without the involvement of a manufacturer's engineering team.

Localization

The HMI shall support localization for different languages so that local-specific components and translated texts can be added. It shall support:

- Translating resource bundle files into specific language

- Installing resource bundle files to device
- Configuring Local settings

Advanced Automation

The device shall act as the centralized, substation-hardened secure computing platform providing advanced substation automation of substation assets. It shall support user-configurable logic that allows for a variety of electric power applications such as:

- Sequence Switching
- Interlocking
- Auto-sectionalizing
- Auto-reclosing
- Load Tap Changer Control
- Capacitor Bank Control
- Reactor Switching
- Alarm Management

Mathematical Control Logic

Through a graphical interface, the device shall support mathematical calculator functions such as: addition, multiplication, logarithm, greater than, less than, as well as other Boolean functions for logical or timer-based operations on data points stored in the device. It shall support advanced automation applications for the grouping, managing and controlling of points.

Programmable Logic Controller

For more advanced applications, the device shall support IEC 61131-3 compliant programmable logic software. This shall host a wide range of range of arithmetic, boolean and logical operations as well as support for sequential functions chart, Instruction list, structured text, ladder diagram and function block diagram.

Accumulator Freeze

The device shall support accumulator freeze, which define groups of points and associates peculiar action(s) to the group based on predefined conditions. The accumulator freeze function is used to define a group of points whose values are to be frozen periodically or upon demand. This additional level of automation increases the visibility required when monitoring certain important processes for specific conditions.

Analog Value Selection

The device shall support an analog value selection functionality, which enables the user to define a group of analog input points with priority. This is valuable especially in a system with numerous points and events. It may be important to identify what's most critical to report.

Control Lockout

The device shall support a control lockout feature to ensure that only a single master station can access a group of controls at one time. Lockout of groups of controls shall be supported to allow for safer local maintenance. Users can create up to 8 remote control groups and up to 256 local control groups. Any digital output can be included in one remote and one local group. This provides a coordinated control of outputs and ensures that the right control actions are executed by the appropriate devices.

Product Bulletin

Double Point

The device shall support the use of two digital input points to form double points, which are also known as 4-state points. This is very useful in situations where a user would like to represent and report the different states of a device. Instead of the typical binary "on", or "off" states, other states could be, "intermediate-state" or "bad-state" or whatever the specified states represent. This provides additional visibility of the condition of the asset.

Input Point Suppression

The device shall support Input Point Suppression. This is useful during maintenance operations to prevent spurious OFFLINE alarms and false readings while devices are powered off or disconnected. Users can disable groups of analog and digital input points by ignoring their real-time data or quality changes within selected applications. While points are suppressed, a predefined suppression value and the point suppressed quality flags are provided instead.

Redundant I/O

The device shall support redundant I/O. To improve the reliability and availability of data for critical processes, it is useful to specify a secondary data point for any point. Just as it is important to have a back-up (redundant) device, it is also useful to have a back-up (redundant) point that represents a real primary point. The value and quality of the redundant point is reported when the associated primary point is invalid or questionable.

Alarm Management

The device Alarm groups shall be user-definable, with up to 256 groups allowed. Each group has its own descriptive and display parameters. Alarms may belong to more than 1 group, or none. "Critical" and "Default" groups are built-in. SCADA points for the alarm groups remain on-line if component alarm points go offline. SCADA points are provided to acknowledge a group of alarms. Individual alarms must be acknowledged via the Device GUI.

Fault Recording/ Data Logging

The device shall support the automatic retrieval of event and oscillography files from devices such as Protective Relays, Controllers, and IEC 61850 server devices. Using IEEE file naming standards, these event files are renamed and can be stored locally or securely sent to corporate servers using RSYNC, FTP or SFTP.

Data Logger

The device shall support the log of analog data locally. This analog data logger shall provide a variety of means to monitor and record analog input point value changes into data files that can be retrieved by the user. While records are triggered by a change in the state of a point, a variety of recording methodologies shall be supported including and not limited to continuous (all changes), periodic, time-weighted, and out of range.

Trend Viewer

The device shall support trend viewing. All data recorded by the Analog/Digital data logger can be viewed by the Digital event recorder using the built-in web-based trend viewer. Users can select the range of data to be used by time and date, alternately a real time streaming view can be displayed. The display of up to 8 data points (pens) shall be supported on a single view. Support for curve fitting shall be available.

Database Exporter

The device shall support database exporting capabilities. Such a tool shall allow users to save analog data logger and digital event recorder points from the device to a local PC in comma-separated values (CSV) format.

Automatic Record Retrieval Manager (ARRM)

The device shall support automatic record retrieval, storage and management of record files from devices connected through IEC61850 MMS, FTP, SFTP, TFTP, and some selective third-party protocols.

ARRM shall support a configurable interval for polling connected devices.

ARRM shall support file archival of events (EVE) and compressed event (CEV) files from the SEL IEDs via serial or TCP connections.

Substation Controller Configuration Tool

Operating System

The manufacturer shall have a plan for supporting future operating systems before existing ones become obsolete.

The software configuration software tool used to configure the device shall support:

- Microsoft Windows 10 Professional, all versions with a minimum of 4 GB RAM
- Microsoft Windows 7 Professional, Enterprise and Ultimate 32-bit with a minimum of 4 GB RAM

One-Line Designer

The device shall support the creation of substation one-line diagrams and digital event manager panel. One-line designer shall support built-in, drag and drop One-Line designer applications for configuring alarm and alarm groups in a simplified tree view point selection tool.

Online Configuration Tool

The device shall support an online configuration tool for remote configuration changes. The configuration shall support pre-configured (template) map files. The following shall be customizable by the user:

- Security settings
- User management

Offline Configuration Tool

The device shall also support an offline configurator. It shall support an excel-based editor to increase productivity when making configuration changes that require a large or bulk database points or settings.

The following shall be customizable by the user:

- Communication connections
- Master Station data presentation
- Data calculation
- Operational (one-line) diagrams (optional)
- HMI preferences
- Device data collection
- Alarm annunciation
- Data logging
- E-mail notification

IEC 61850 Configurator

The device shall support a PC-based software program that is specifically designed to configure the device to communicate to IEC 61850 compliant server devices using the IEC 61850 client application.

System Utilities

The device shall support the initial set-up of network connections, system date and time, and administrator passwords.

Maintenance Facility

Self-Diagnostics and Troubleshooting

The device shall support memory self-diagnostics including system hardware and I/O initialization. Diagnostic tools shall support and not be limited to monitoring functions, memory checks and communication port loop back tests, modem communication port settings, checks for CPU usage, local forcing of data inputs/outputs, display of messages in the error log to identify problems, and checks of change of states and sequence of events.

Watchdog Task

The device shall support low-priority watchdog task to monitor the device and to prevent a continuous restarting of applications.

Hot swappable and Modular Hardware for maintenance

The device shall support in some cases the disconnect of IO cables, cards or related accessories while the device is powered on without affecting the general operation of the substation controller.

- ***Field replaceable power supply***

Power supply shall be field replaceable without the need to disconnect power or communications wiring

- ***Field upgradable firmware***

The firmware that resides in the unit shall be field upgradeable

Safe mechanical design

The device hardware design shall be such that it is mechanically impossible to install a circuit board to a connector which could cause damage to the hardware and send erroneous data to a SCADA master station, or inadvertently operate an output point.

Maintenance Port

The maintenance port shall require a user-defined password for access.

- The maintenance port shall be available to allow users to configure the database and program any substation controller function without the aid of the Vendor
- The maintenance port shall communicate in a "local mode", a software selectable switch to disable supervisory control from master computer

- The maintenance port shall allow downloading and uploading of all programmable parameters from data files generated by the device configuration system described in the configuration tool section
- The maintenance port shall provide the ability to monitor and change the real-time state of all types of digital and analog, input and output points
- The maintenance port shall provide the ability to monitor the status of the device and indicate any alarm condition
- The maintenance port shall provide access to SOE data for individual points
- The maintenance port shall provide a command to "warm start" the device. The "warm start" shall consist of operating the substation controller through all initialization and diagnostic routines which are performed during power-up.

Remote I/O modules

Support for Distributed Architecture

Substation devices or controllers designed along distributed processing principles are likely to have real-time data acquisition and control software that interfaces with actual field points installed on the external peripheral I/O modules, rather than in the main processor unit. This is particularly the case where the peripheral I/O must be located away from the substation controller within the station's vicinity, and whose data then is multiplexed back to the substation controller serving as a sub-master.

The peripheral I/O modules provide specialized processing and storing/buffering functions for digital inputs, analog inputs, control outputs, analog outputs, pulse accumulator inputs and combinations of the above, by gathering data from field sources or acting as an output unit to interface with field devices.

The peripheral I/O modules are intelligent modules containing an on-board microprocessor and are configured as slaves (servers) to the substation controller's main processor. The specific I/O processing is distributed throughout the substation controller to the appropriate I/O module.

Support for Ethernet IO Expansion

The device shall support communication with ethernet Inputs/Output modules with the following configurations types:

- 64 Digital Inputs organized in eight groups of eight electrically isolated inputs, each group with a common return.
- 32 Digital Outputs
- 32 Analog Inputs with support for voltage ranges 1, 5 or 10-volt full scale unipolar or bipolar.
- Combination of 16 Digital Inputs, 8 Digital Outputs, 16 Analog Inputs

These Ethernet I/O modules shall not support vendor-specific protocols. Instead, shall support DNP3 and IEC 61850.

Digital (Status) Inputs

Shall support optional 64 status input modules for collection and processing of digital input status signals from field devices.

Status input types

Shall support configuration of any status point in the database as one of the following status input point types:

- Status and alarm inputs

- Status inputs with change of state detection (COS)
- Sequence of events (SOE) using time-tagged COS
- Binary-Coded Decimal or parallel inputs
- Pulse accumulator or counter inputs
- Pulse duration inputs

Status input signals processing

Shall support, as a minimum, the following status signal processing features and functions:

- **De-bouncing:** De-bounce period shall be configurable in 1 millisecond steps from 4 to 250 milliseconds
- **Report and Chatter filtering:** Method to reduce nuisance alarms caused by devices that may change state quickly but do not need to be reported each time the state changes. Parameters shall be downloadable on a per point basis.
- **Scan frequency:** All status inputs shall be scanned at 1 millisecond intervals.
- **Electrical isolation:** Each input shall be optically isolated from controller internal electronics and capable of accepting DC inputs of any polarity
- **Field connections:** Status inputs shall support separate common connections minimum per group of 8 inputs. The field contact input to the substation controller is either a Form "A" or a Form "B" contact. The input circuitry shall can accept either a Form "A" or Form "B" contact as a normal condition, or as supported by the host protocol.
- **Momentary Change Detection (MCD):** The substation controller/device shall support momentary change detection (also referred to as status with memory) points; points with two states (alarm/normal, opened/closed, etc.) for which the present state and change history is reported. To provide detection between SCADA master station scan cycles, momentary change detection shall be software selectable for all digital input (DI) points. Between scans, each MCD point shall can detect and reporting at least two contact transitions for any contact input, in the order in which they occur.
- **Wetting voltages:** The following digital input wetting voltages shall be supported:
 - 24VDC
 - 48VDC
 - 110VDC
 - 220VDC

Wetting voltage selection shall be configurable though hardware jumper settings and wetting voltage inputs shall be fused. Status digital inputs shall allow optional supply of contacts wetting from the substation controller or from an external power source:

- Contact wetting from on-board isolated supply at 24 V DC
- Capable of external wetting: 24, 48, or 130 VDC
- **Pulse Inputs (PI) – Accumulator Type:** Shall support the collection of Accumulator-type pulse inputs and transfer of flow information to the master station on a periodic basis. The PI-accumulator points shall indicate the total number of pulses received from meters. As a minimum, each accumulator shall be capable of totalizing no less than 4,095 counts with an automatic "roll-over" capability. Each accumulator shall be able to accumulate any input occurring while the accumulator is being read, so that no input counts are lost. Each accumulator shall accept counts at a maximum rate of 10 counts per second. The present count shall be transferred to a storage register on receipt of a FREEZE command.

Digital Outputs

The device shall support 32 control output modules for secure operation of control signals.

Digital Output Types

Shall support the following digital output types:

- Momentary (fixed)
- Latched
- Raise/Lower
- Control Signal Processing

Momentary (Fixed): Each DO momentary control point shall comprise a paired control output consisting of an open output and a corresponding close output. These outputs shall be isolated from the substation controller internal logic. Separate control output relays shall be furnished for each OPEN and each CLOSE function.

These output relays shall close for a definite time interval upon an output command. The time interval shall be adjustable from 100 milliseconds to 12.75 seconds. The interval shall be accomplished by software on a point-by-point basis. These relays shall be de-energized in the event of substation controller malfunction.

The relay contacts shall be rated for at least 2 amps at 30 VDC, 60 VA. The relay contacts must be able to withstand the impression of at least 130 volts. These are used to drive supplied interposing relay in the equipment bays. The contact arrangement for each output relay shall be Form "C". Each of the contacts shall be wired to terminal blocks for external wiring of each control output relay. (Customer shall define interposer relay requirements).

Latched: Shall provide information as to latching output points' availability, compliance, and pricing based on hardware latching relay. Each DO latch control point shall comprise a paired control output of an open output and a close output (set/reset). These outputs shall be isolated from the substation controller/device internal logic. The output relay shall be electrically or magnetically latched. These output relays shall transfer contacts upon an output command and shall maintain that condition until receiving a new command.

The relay contacts shall be rated for at least 10 amps at 28 VDC. The contact arrangement for each output relay shall be form "C".

Raise/Lower: Each DO raise/lower point shall comprise a paired control output of one raise output and one lower output.

These outputs shall be isolated from the internal logic of the substation controller/device. Separate control output relays shall be furnished for each RAISE and each LOWER function. It shall not be possible to perform a raise and a lower output simultaneously.

Each output relay shall close for a definite but adjustable time interval based on the command and closure time transmitted from the master station. The time interval shall be software adjustable from 100 milliseconds to 2 seconds. These relays shall remain de-energized in the event of substation controller malfunction.

Control Signal Processing: Shall support, as a minimum, the following control signal processing features and functions:

Contact Rating: The relay contacts shall be rated for 2 amps at 30 VDC. The contact arrangement for each output relay shall be Form "A". Each of the contacts shall be wired to terminal blocks for external wiring of each control output relay.

Select-Check-Execute: All control operations shall incorporate select-check-execute transmission and single-point security. When a control point command is received, the substation controller/device shall arm the selected control point (separately encodes the address or the point that has been armed) and transmit the encoded address to the master station.

After selection (point arming), the substation controller/device shall automatically reset (cancel) the point within a predetermined time if it has not received a valid execute command transmission.

Any message that fails a comparison check or attempts to select more than one point shall initiate a control failure alarm and cancel the control actions.

After comparing the check-back message with the original command, the master station transmits an operate command. On receipt of operate command, substation controller energizes selected relay for specified period.

Each substation controller/device shall be equipped with a local/remote switch to disconnect the power to all digital output relays or otherwise inhibit all digital output points without shutting off the substation controller or otherwise affecting its operation. Each output relay module shall be optionally configurable to allow disabling of the module's output relays. An auxiliary contact shall be provided on each disable switch with all switches factory wired to one substation controller digital input point to provide remote indication of the switch(s) status. The required digital input point is included in the specified point count.

Analog Inputs

Shall support 32 analog input modules for continuous collection and processing of DC analog voltage and DC current signals.

Analog Input Types

The substation controller shall support the following analog input types:

- ± 1 VDC
- ± 10 VDC
- -1 mA to 1 mA
- 4 to 20 mA
- ± 5 VDC
- 0 to 1 mA
- 0 to 5 VDC
- 0 to ± 5 mA

Analog input signals processing

The device shall support, as a minimum, the following analog signal processing features and functions:

- **Signal conditioning:** The A/D converter and associated signal conditioning shall meet the following minimum characteristics over 0°C and plus (+) 60°C temperature range:
 - Automatic self-calibration
 - Full scale accuracy of $\pm 0.1\%$
 - Linearity of 0.05 per cent full scale
- **Resolution:** Fourteen-bit binary resolution or better; plus, one sign bit.
- **Scan Rate:** The substation controller/device must scan all analog inputs at a rate of at least once per second and support analog dead-band reporting limits.
- **Common-mode noise rejection:** 90 dB minimum, 0 to 60 Hz

Product Bulletin

- **Normal-mode noise rejection:** 60 dB minimum at 60 Hz.
- **Terminations:** two connections plus optional shield per input.
- **Loop Supply:** capable of being supplied at 24 VDC via on-board supply or externally and be fused.
- **Calibration:** the analog input subsystem shall recalibrate automatically to correct for any effects of temperature changes and component aging.
- **Report-by-Exception:** The substation controller/device shall support report-by-exception with programmable dead-band for individual analog points, as supported by the host protocol. The substation controller/device shall use a separate analog reporting dead-band for each analog quantity to minimize data transfers to the Master.

The most recent value of the sampled analog value must be compared to the reporting dead-band to determine if the value should be sent to the Master. This feature allows the analog quantities to be treated in a report-by-exception manner, thereby reducing the data transferred to the Master than would normally be transferred whenever a single bit change occurred because of the analog-to-digital process.

Analog Outputs

Each analog output point shall consist of a digital-to-analog (D/A) converter and signal conditioning. The output of the analog output point shall settle to within ± 0.15 per cent of the digitally encoded value within 100 microseconds of an updated input. Overall accuracy of the D/A converters shall be ± 0.15 per cent of full scale over a minus 20°C and plus 60°C temperature range. In the event of a substation controller malfunction, the analog outputs shall remain as last set.

SWC isolation must be available as an option. Analog outputs are bipolar voltage or unipolar current outputs.

Support for Centralized or Distributed I/O

Input / Output Modules may be installed following a centralized or distributed substation automation topology. Communication between the peripheral modules shall support the following options:

- **RS485:** Generally, an RS-485 serial link is used for short distances, such as between I/O modules located close together on a rack or mounted in a group. Maximum distance for serial communications between peripheral modules and the platform shall be 1000ft (300m).
- **Redundancy:** Dual Ethernet communication links between the platform and the peripheral modules shall be supported.

Technical Specifications

The Substation controller device shall meet the following technical specifications:

Processor, Memory and Storage	
CPU	AMD Embedded R-Series CPU (2.2GHz 2core / 2.7GHz 4core)
Memory	DDR3 SDRAM (8GB / 16GB)
Storage	Self-encrypted Solid-State Drive (128 GB / 256 GB) expandable to 3
Operating System	
	Predix Edge OS 2.2 (Linux Kernel 4.14)
Communications	

Product Bulletin

Ethernet	6 Ethernet ports, configurable as independent LAN, Redundant LAN and/or PRP Accessible via SFP modules: <ul style="list-style-type: none"> • 100/1000BASE-T (RJ45 copper) • 1000BASE-FX (LC fiber multimode) • 1000BASE-SX (LC fiber multimode)
Serial (RS-232/485)	<ul style="list-style-type: none"> • 8x serial interfaces accessible via individual RJ45 connectors on rear of the unit • Additional serial interfaces can be adding using PCIe expansion cards • Serial interfaces use 16550 compatible UART • Support baud rates 300, 600, 1200, 2400, 4800, 9600, ... 115.2k • RS232 mode supports flow control and handshaking signals (RTS, CTS, DCD) • Software controlled mode of operation between RS232 or RS485 2/4 wires • Software controlled termination resistor (120 ohm) for RS485 mode • All software selection persists when power cycled • IRIG-B available on all native serial interfaces • +12V output @ 6W max available on serial interfaces 4 and 8
Time Synchronization (HW support)	
PTP	Can be configured for IEEE1588 PTP IN and OUT
IRIG-B input	Available as 3 positions removable Phoenix terminal block on rear of the unit Supports IRIG-B TTL
Video Output	
Display Port	2x DP++ (Dual-mode DisplayPort) available on the rear of the chassis Each DP++ supports up to two multi-stream displays (Windows support only) Resolution: <ul style="list-style-type: none"> • up to UHD (4k, 3840x2160) for single displays connected to each port
Audio Output	
	3.5 mm audio jack for substation alarms
	Built in high (+77dB) pitch audio buzzer
USB Ports	
	2x USB 3.0 on front of the unit 4x USB 2.0 on rear of the unit 1x USB 2.0 internal - for software license keys
SD card (Windows support only)	
	SD, SDHC and SDXC SD-Cards according to Version 1.0, Version 2.0 and Version 3.0 Maximum SDXC size 64GB SD card slot accessible on front of the unit, uses push-pull mechanism
Maintenance ports	
Console port	1x USB Type B port on front of chassis Connected to internal USB to Serial bridge, allows access to Console for debug
Local Ethernet	100/1000BASE-T maintenance Ethernet port accessible via front of the unit
Power Supply	
	Dual/ Redundant hot-swappable power supplies, each with individual removable Phoenix terminal block
Low Voltage	20–54 VDC @10.2A
High Voltage	110-270VDC @ 1.8A 100-240VAC @ 2.1A
Physical	
Dimensions	19 Inch rack mount (482.59 mm) 2U (3.47" / 88.12 mm) in height / 3U with Rack mounting kit installed 12.20"(310.00 mm) in depth Rack mount kit included: 6 mounting holes, 2 slotted for easy installation
Weight	0 serial ports, without PSU 10.2 Kg 4 serial ports 10.4 Kg

Product Bulletin

	8 serial ports 10.6 Kg Rack mounting bracket 1.2 Kg AC/DC PSU 1.2 Kg
SYSFAIL Output	
	Solid state relay of form NO-C-NC Available as 3 positions removable Phoenix terminal block on rear of the unit
Environmental	
Operating Temperature	-40°C to +70°C (2 core) -40°C to +60°C (4 core)
Humidity	5-95% relative humidity, non-condensing
Altitude	Maximum altitude is 3000 m
Ingress Protection	IP30 (Protected from tools and wires greater than 2.5 millimeters) + resistant to liquid falling vertically
Real Time Clock	
	When powered off, the real-time clock remains active for 7 days
Physical Presence	
	The physical presence button (recessed on front of the unit) and optionally configured password shall be required to enter UEFI mode.

Codes and Standards

The Substation controller device shall meet the following standards:

Emissions Standards	
CISPR 22: 2009 + A1: 2010	Radiated RF Emission
FCC Part 15	Conducted Emission
IEC 60255-25	Electromagnetic emission tests for measuring relays and protection equipment
IEC 61000-3-2	EMC-limits for harmonic current emissions (equipment input current <16A per phase)
IEC 61000-3-3	Voltage fluctuations and flicker (equipment input current <16A per phase)
Immunity Standards	
IEC 61000-4-2	Electrostatic discharge (ESD) immunity test
IEC 61000-4-3	Radiated, radio-frequency electromagnetic field immunity test
IEC 61000-4-4	Electrical fast transient/burst immunity test
IEC 61000-4-5	Surge immunity test
IEC 61000-4-6	Immunity to conducted disturbances, induced by radio-frequency fields
IEC 61000-4-8	Immunity to power frequency magnetic fields
IEC 61000-4-11	Immunity to Voltage Dip and Interrupt
IEC 61000-4-12	Ring wave immunity test
IEC 61000-4-16	Conducted Disturbances at Mains Frequencies
IEC 61000-4-18 IEC1613-6.3 Damped Oscillatory	Damped oscillatory wave immunity test
Safety Publications	
IEC 61010-1	Harmonized safety standard
IEC 60255-5	Insulation coordination for measuring relays and protection equipment requirements and tests
Power Supply Standards	
IEC 61000-4-17	Ripple on D.C. power supply
IEC 61000-4-29	Voltage dips, short interruptions and voltage variations on D.C. input power port immunity test

Environmental Standards	
IEC 60068-2-1 IEC 61850-3 IEEE 1613-2003 (Class 1)	Environmental testing cold
IEC 60068-2-2 IEC 61850-3 IEEE 1613-2003 (Class 1)	Environmental testing dry heat
IEC 60068-2-30	Environmental damp heat cyclic (12+12-hour cycle)
IEC 60068-2-6	Environmental testing vibration, Vibration tests (sinusoidal)
IEC 60068-2-27	Environmental testing shock Class 1 and Class 2
IEC 60068-2-29	Environmental testing bump
IEC 60068-2-31	Environmental testing drop and topple
IEC 60255-21-3	Seismic tests

Capabilities and Capacity

The performance, reliability, resiliency and robustness of the device shall be demonstrated, in part, through the following:

Maximum Performance Condition Verified

- The device shall be able to support standalone configuration with 120 IEDs, 18000 digital inputs points, 7200 analog input points, 3840 digital output points, 120 alarms are configured.
- Hot Standby configuration with 80 IEDs, 12000 digital inputs points, 4800 analog input points, 2560 digital output points, 120 alarms are configured.

Typical Performance Condition Expected

- Sustained event rate of 16 digital input changes, 1 alarm and 480 analog input changes per second.
- No event loss is reported when half of the configured points mapped to the Master station.
- The event latency is: minimum – 31 msec, maximum – 1.20 sec and average – 533 msec.
- The control latency is: minimum – 8 msec, maximum – 75 msec and average – 44 msec.

Avalanche Condition Verified

- Standalone configuration with 120 IEDs, 18000 digital inputs points, 7200 analog input points, 3840 digital output points, 120 alarms are configured.
 - Performance condition: Avalanche level testing for once at the event rate of 18000 digital input changes and 7200 analog input changes per second.
- No event loss is reported when half of the configured points mapped to the Master station
- Hot Standby configuration with 80 IEDs, 12000 digital inputs points, 4800 analog input points, 2560 digital output points, 120 alarms are configured.
 - Performance condition: Avalanche level testing for once at the event rate of 3000 digital input changes and 1200 analog input changes per second.
 - No event loss is reported when half of the configured points mapped to the Master station.

Product Bulletin

Communication Protocols and Applications List

The following applications shall be supported in the device.

Application	Support in Standalone/ Warm Standby	Support in Hot Standby
DEVICE Runtime HMI	Available	Available
One Line Viewer	Available	Available
DEVICE Config GUI / Schemas	Available	Available
DEVICE NVRAM Subsystem Library	Available	Available
DEVICE System Library	Available	Available
DEVICE C++ System Library	Available	Available
DEVICE Connection Parser	Available	Available
Calculator	Available	Available
Modbus Client	Available	Available
Modbus TCP/SSH Client	Available * Not Available in Warm Standby	Not Available
SEL [®] Binary Client	Available	Not Available
Analog Data Logger	Available	Not Available
Generic ASCII Client	Available	Not Available
Modbus Server	Available	Not Available
DNP 3.0 Server	Available	Available
DNP 3.0 Client	Available	Available
Digital Event Manager	Available	Available
DB Server	Available	Available
DNP 3.0 TCP/IP Transport Layer	Available	Available
DNP 3.0 Server Serial Transport Layer	Available	Available
IEC 60870-5-101/104 Server	Available	Not Available
IEC 60870-5-103 Client	Available	Not Available
IEC 61850 Client	Available	Available
IEC 60870-5-101/104 Client	Available	Not Available
DEVICE Event Logger	Available	Available
DEVICE Real-Time Database	Available	Available
Logiclinx IEC 61131-3 Soft Logic	Available	Available

Product Bulletin

Application	Support in Standalone/ Warm Standby	Support in Hot Standby
DEVICE Redundancy Manager	Available	Available
System Point Manager	Available	Available
Load Shedding and Curtailment	Available	Not Available
Control Lockout Manager	Available	Available
DEVICE Software Watchdog	Available	Available
DEVICE Configuration Manager	Available	Available
DEVICE IP Changer	Available	Available
DEVICE MD5SUM Builder	Available	Available
DEVICE System Status Manager	Available	Available
Virtual Serial Ports	Available	Available
SNMP Client	Available	Not Available
Automated Record Retrieval Manager	Available	Not Available
DEVICE Software Licensing Subsystem	Available	Available
DEVICE Third-party components	Available	Available
DEVICE Terminal Services	Available	Available
DEVICE cfg utility	Available	Available
Emergency Access utility	Available	Available
DEVICE E-mail Utility	Available	Available
DEVICE IO Traffic Monitor	Available	Available
DEVICE Printer Drivers	Available	Available
DEVICE Help Files	Available	Available
IRIG-B Driver	Available	Available
DEVICE Driver Init	Available	Available
Firewall	Available	Available
Secure Enterprise Connectivity	Available	Available
Genconn	Available	Available
HMI Access Manager	Available	Available
DEVICE Sync Service Library	Available	Available
DEVICE Sync Server	Available	Available
Analog Report Generator	Available	Not Available

Product Bulletin

Application	Support in Standalone/ Warm Standby	Support in Hot Standby
OpenVPN	Available	Available

Additional Information

Manufacturer

The device shall be built and manufactured in Canada, North America

Warranty: 10-year Warranty

The device shall be robust, reliable and shall be backed-up with at least a 5-year warranty with the option to upgrade to 10-year warranty. Manufacturer shall have the warranty claim published online. The reliability data shall be made available in the hardware instruction manual.

Licensing

The device shall have a perpetual licensing model for applications packaged as part of the device. This means that a firmware in a device can be upgraded to a new firmware free of charge. This also implies that a license purchased for a device can be used perpetually on that device without any annual maintenance fee.

MTBF

Manufacturer shall provide an MTBF.

Technical Support

Manufacturer shall be available for 24 hours contact. Support shall be available seven days a week. There shall be a toll-free phone number and international phone number for support.

A valid technical support e-mail address shall be available in case more details about a support case is required to be documented. A support case and case number shall be created and issued to the reporter within 24 hours.

Product Returns

Manufacturer shall support a Return Merchandise Authorization (RMA) if a repair or service is required. Process for RMA shall be available and provided within 24 hours after request.

Copyright Notice

© 2019, General Electric Company. All rights reserved.

The information contained in this online publication is the exclusive property of General Electric Company, except as otherwise indicated. You may view, copy and print documents and graphics incorporated in this online publication (the "Documents") subject to the following: (1) the Documents may be used solely for personal, informational, non-commercial purposes;

(2) the Documents may not be modified or altered in any way; and (3) General Electric Company withholds permission for making the Documents or any portion thereof accessible via the internet. Except as expressly provided herein, you may not use, copy, print, display, reproduce, publish, license, post, transmit or distribute the Documents in whole or in part without the prior written permission of General Electric Company. If applicable, any use, modification, reproduction, release, performance, display, or

Product Bulletin

disclosure of the Software Product and Associated Material by the U.S. Government shall be governed solely by the terms of the License Agreement and shall be prohibited except to the extent expressly permitted by the terms of the License Agreement. The information contained in this online publication is subject to change without notice. The software described in this online publication is supplied under license and may be used or copied only in accordance with the terms of such license.

Trademark Notice

GE, Multilin DEVICE and the GE monogram are trademarks and service marks of General Electric Company.

* Trademarks of General Electric Company.

Other company or product names mentioned in this document may be trademarks or registered trademarks of their respective companies.

Modification Record

Version	Revision	Date	Author	Change Description
1.00	0	08 th March 2019	F. Iman	Initial Draft.