

GRID SOLUTIONS

# MULTILIN G500

## Advanced Substation Gateway

GE Vernova's Multilin G500 is a member of the advanced Multi-function Controller Platform (MCP). This platform offers a high-capacity, secure, future-proof, and substation-hardened set of modular and scalable hardware and software components designed to simplify deployment, operation and maintenance of automation systems for a variety of applications including:

- Centralized automation for transmission & distribution substations
- Industrial substation automation systems
- Asset performance management
- Distribution automation & microgrid
- Secure substation automation systems
- Retrofit of substation automation systems

The MCP makes it possible for a single device to host multiple functions and applications such as Supervisory Control and Data Acquisition (SCADA) Concentrator, Remote terminal Unit (RTU), Human Machine Interface, Advanced Cyber Security Features, and Non-Operational Data Storage. Consolidation of functions reduces the cost of deployment and operation while increasing system reliability through a reduced number of devices in the system.

The G500 is designed to provide a reliable and accurate collection of data (metering, status, events and faults) from serial or LAN-based intelligent substation devices to master applications such as SCADA, EMS, DMS, DCS or other enterprise applications. With its modern and robust cyber security features, the G500 is designed for smooth integration into NERC CIP and cyber security environments while consolidating functions such as Ethernet communications, time synchronization, HMI and SCADA applications.

### Key Benefits

- Standardize substation architectures with a cost-effective, IEC 61850-3 compliant platform, scalable for small to large systems with up to 200,000 data points
- Seamlessly operate in both new Digital Substation or IEC 61850 substations and older legacy substations. Perfect for hybrid and retrofit installations
- Simplify engineering and operations through consolidation of functions
- Reduce system cost by eliminating dedicated HMI computers, external Ethernet switches and leveraging the built-in configurable PRP
- Improve time synchronization performance with Precision Time Protocol (PTP/IEEE1588)
- Expand serial connectivity to up to 20 physical ports with the three PCIe expansion modules and up to 120 virtual ports
- Cost-effective retrofit solutions where individual automation and communication components can be replaced by only one device
- Ease of use and configuration and standardization with graphical configurations, drop down menus, pre-configured device maps, and single platform DS Agile Studio software
- Run D2x applications (such as those from D20M++, D20ME and D20MX devices) natively and transparently on MCP



### Applications

- Advanced Substation Gateway with customizable HMI for multiple floating windows and dual monitors
- IEC 61850 client and server Ed.1 and Ed.2 certified
- D.20 I/O Module Support
- Advanced IEC 61131-3 compliant automation engine
- Simultaneous and comprehensive protocol support
- Comprehensive logging facilities for substation data including events, user actions, cyber security, connectivity
- Automatic or manual acquisition of any type of files from Intelligent Electronic Devices (IEDs)
- Single setup and configuration tool across the platform
- Support for redundant substation systems

### Security

- Storage Encryption and support for Trusted Platform Module (TPM)
- User access levels: Administrator, Supervisor, Operator, Observer, Pass through
- Remote Authentication (LDAP, TACACS+)
- Secure tunneling from master station via TLS for DNP3/TCP, Modbus/TCP and IEC 104
- Secure file transfer to enterprise server using RSYNC/ SSH, SFTP, FTP
- Secure Interactive Access using HTTPS and SSH
- Secure firmware upgrade, local maintenance confirmation, and chassis intrusion detection
- Built-in firewall

### Hardware

- High performance multi-core CPU
- Encrypted SSD (SED) Storage
- Hot Swappable Dual Power Supply
- 6 x SFP Ethernet ports [Single LAN, Redundant LAN and PRP modes]
- Compliant to IEC 61850-3 and IEEE 1613
- Standard time synchronization [PTP IEEE 1588 IN/OUT, IRIG-B IN/OUT, NTP]



GE VERNOVA

**Overview**

GE's G500 is a secure, hardened, advanced substation gateway that collects metering, status, event, and fault report data from serial or LAN based substation devices. The G500 summarizes and transforms data from the substation devices. The G500 allows visualization of the data locally and remotely through a secure (HTTPS) web HMI application, and supports transferring data via serial and LAN connections to SCADA masters and control centers.

**Advanced Gateway**

The G500 collects data from substation protection, control, monitoring, RTU, PLC, and other intelligent devices, pre-processes the data and moves it up to EMS and DMS SCADA systems providing centralized substation management. Gateway features include:

- Data collection, concentration and visualization
- Protocol conversion
- IEC 61850 Gateway
- RTU functionality with D.20 IO Modules
- Device Redundancy
- Built-in Media Support

- File retrieval capabilities
- Built-in HMI

**Advanced Automation**

The G500 provides the computing platform necessary to automate intricate substation procedures and processes safely and efficiently. The advanced and customized automation programs are created using IEC 61131 compliant tools, and math functions are performed on data points using the built-in calculator tools. Automation features include:

- HMI, One Line Viewer and Annunciator
- Math, Logical, Timer Control Logic
- Programmable Logic (using LogicLinx)
- Control Lockout
- Accumulator Freeze
- Analog Value Selection
- Input Point Suppression
- Redundant I/O
- Alarm Management
- Hardware Asset Management Application
- System Status Manager
- Load Shedding and Curtailment

**Fault Recording/Data Logging**

Using pass-through connections, users can extract valuable non-operational data such as digital fault records (DFR), event and oscillography files. The user can also access the historical log files and upload the archived data for trending and analysis. Fault recording features include:

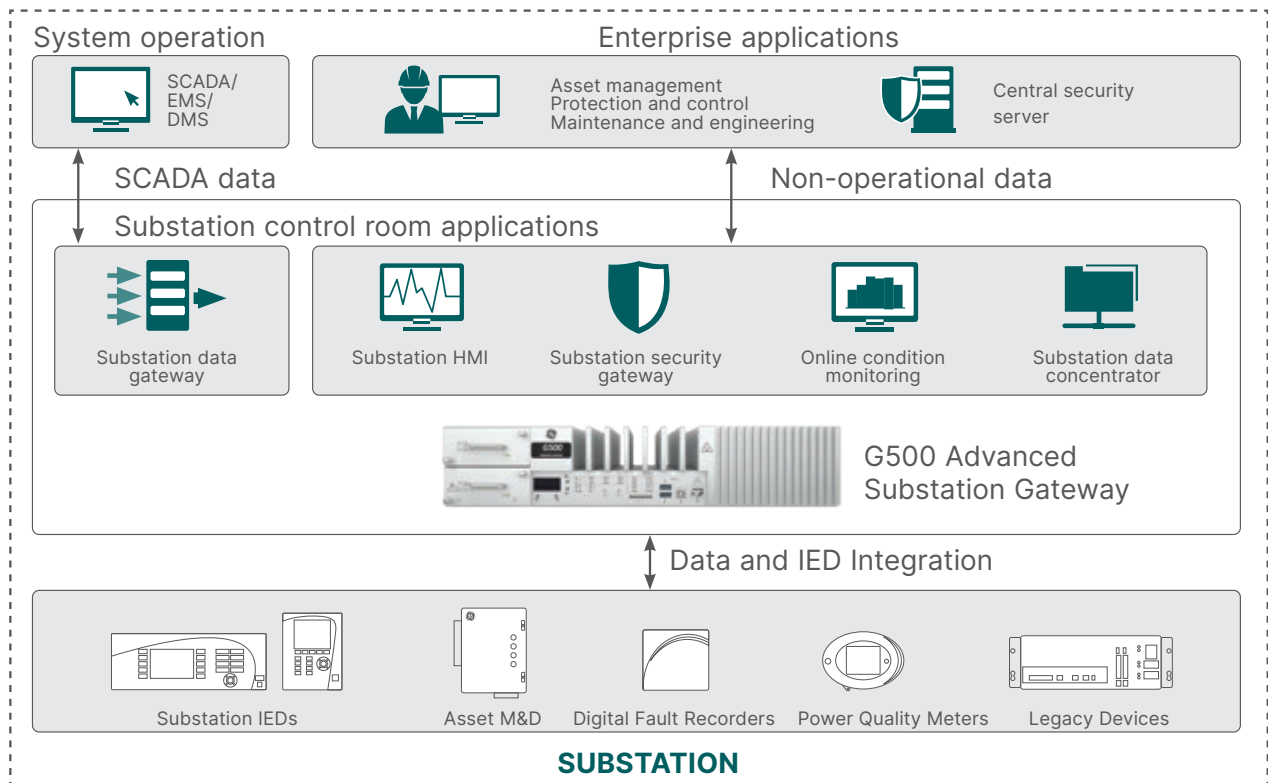
- Automatic Record Retrieval Manager
- Sync Manager
- Data Logger and Analog Reports
- Trend Viewer
- Database Exporter

**Secure Remote Access**

The G500 allows maintenance and relay engineers to securely access substation devices, locally or remotely, through advanced visualization and communication tools, increasing operational efficiency. Secure remote access features include:

- Access to Operational and Non-operational Data
- Pass-through/Terminal Server
- Role Based Access Control
- Virtual Serial Ports
- Build-in Firewall
- Local Authentication, Authorization and Auditing (Syslog)
- Electronic Access Point (EAP)
- OpenVPN

**G500 Multifunction Controller Platform Applications**



## Advanced Gateway

### Data Collection, Concentration and Visualization

The G500 advanced substation gateway, when operating as a SCADA host, collects, filters, and sorts data from a wide range of intelligent devices (RTUs, relays, meters) in the substation and preserves original data time stamp for accurate sequence of event. Data can be presented to multiple SCADA hosts. The G500 comes with a built-in suite of protocols and security applications to facilitate communication with various substation devices and SCADA hosts, including:

- DNP3 serial and TCP/IP (client & server)
- IEC 61850 (client & server)
- D.20 IO Modules (client)
- Modbus™ serial & TCP/IP (client & server)
- IEC60870-5-101/103/104 (client)
- IEC60870-5-101/104 (server)
- SEL Fast Meter/SEL ASCII
- Generic ASCII protocols

### IEC 61850

The IEC 61850 Client application enables the gateway to function as an IEC 61850 data aggregator. By using the IEC 61850 Server application, a complete IEC 61850 data concentrator can be created.

This includes valuable features such as Dynamic Data Sets, Buffered Control Blocks, and Enhanced Security Controls. These functionalities not only support smart grid solutions but also enhance the reliability and efficiency of substations by turning them into interconnected systems.

The IEC 61850 Client, Server, and the IEC 61850 Loader Configuration tool are certified for Ed.2 and are compatible with both Ed.1 and Ed.2 devices.

### Gateway Redundancy

In addition to operating as a standalone unit, two G500 units can be easily and quickly configured to operate in redundant mode, to improve the reliability of the substation device monitoring and control.

When configured in Redundant mode, one G500 is active and the other is a standby or backup. The standby continuously monitors the health of the active unit and takes over automatically if needed. To prevent unnecessary switchovers, this unit then continues to be active even if the other unit comes back up.

Configured in seconds, the G500 supports three modes of redundancy:

1. Warm standby: Data synchronization from active to standby unit is minimal, restricted to field Accumulator points, local command quality, and configurations.
2. Hot standby: The two MCP units are kept in constant data synchronization with respect to their real-time databases. DNP3 (only) communications to master(s) offer a seamless transition during redundancy switch-over.
3. Hot-hot: The two MCP units are kept in constant data synchronization with respect to their real time databases. Depending on configured parameters at communication protocol and port level – either each MCP unit communicates independently and simultaneously with the IEDs (assuming IEDs allow this), or one MCP unit (active) communicates with the IEDs and then synchronizes its data constantly to the other MCP unit. DNP3 (only) communications to master(s) offer a seamless transition during redundancy switch-over.

Not all protocols are supported in the various Redundancy modes. Carefully review product documentation and configure Redundancy accordingly.



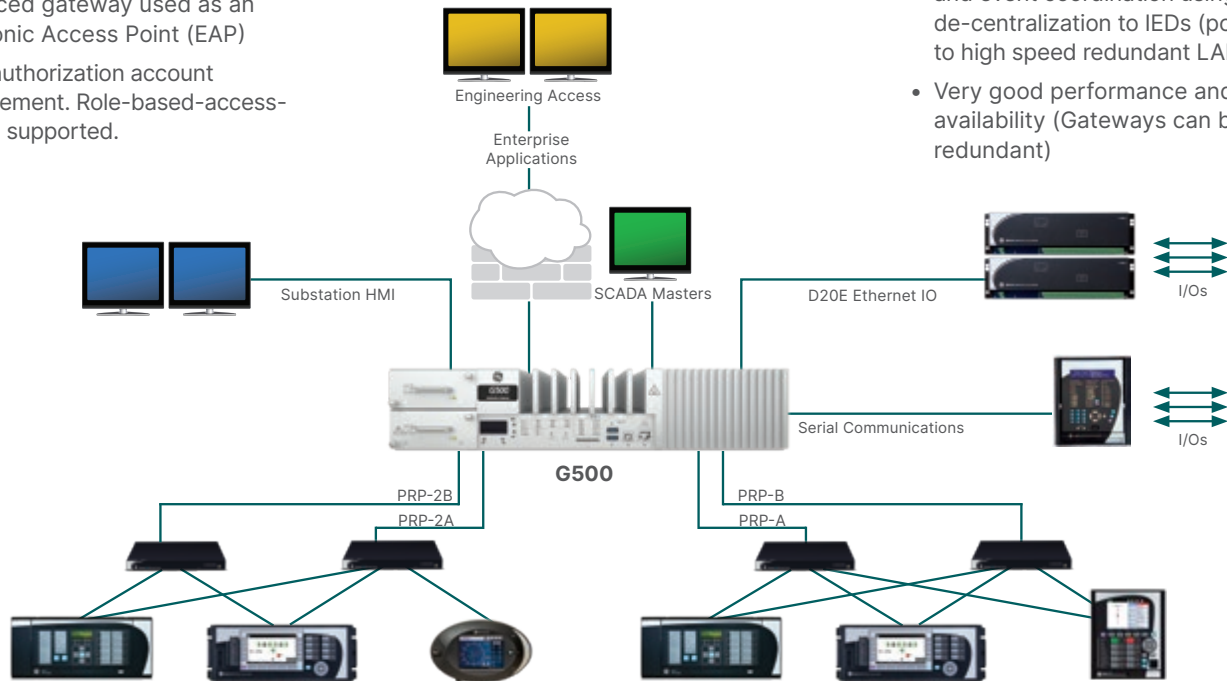
## Scalable from Small to Very Large Applications

### Typical Applications

- Advanced substation automation application (interlocking, alarm grouping/reduction, data conversion)
- Online Asset Management and condition monitoring
- Enhanced gateway used as an Electronic Access Point (EAP)
- Local authorization account management. Role-based-access-control supported.

- Extremely large size database, high speed remote IO, IEDs (serial and redundant LAN PRP)
- High performance substation level HMI integrated to the gateway
- Distribution automation applications

- Digital Substation and IEC 61850 substation applications
- Automated file collection from IEDs and provision to enterprise stations through a push mechanism
- Complex custom logic automation and event coordination using high de-centralization to IEDs (possible due to high speed redundant LAN).
- Very good performance and availability (Gateways can be redundant)



### D.20 I/O Module Support

GE's D.20 I/O Modules are popular due to their reliability, flexibility and functionality. With hundreds of thousands of modules shipped over the life of the product, the ability for G500 to communicate, retrieve information, and control these modules has been a very important feature to make available.

D.20 I/O modules are intelligent modules containing an on-board microprocessor. They are configured as slaves to the G500. In this way, specific I/O processing is distributed throughout the G500 to the appropriate I/O module.

There are four types of I/O peripherals supported by the G500:

- D20A analog input
- D20S digital inputs
- D20K digital output
- D20C combination input/output

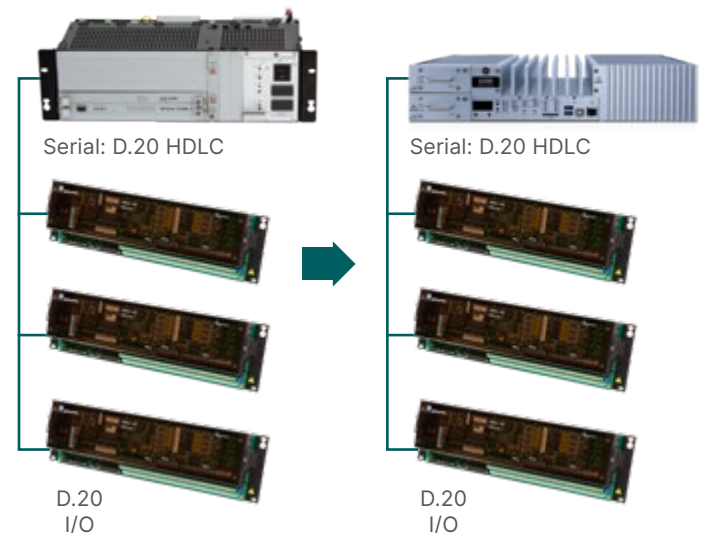
Optional high-voltage peripherals and fiber optic communication extenders are also available. D.20 client redundancy is supported by connecting D.20 IO with redundant G500 devices.

### D2x application support

With D2x application support, applications originally written for products such as D20M++, D20ME and D20MX can be run natively on the G500.

The advanced D2x virtualization technology will upgrade the end of life of these applications, preserve all communications to existing control centers and IEDs, and preserve all automation.

By migrating and preserving applications as they are today, any dependent devices and systems will be unaffected by the hardware upgrade, saving extensive engineering hours and cost.



## Advanced Automation

The G500 acts as a centralized, substation-hardened computing platform within an advanced automation system. With its advanced IEC 61131 compliant programmable logic tool, users can create simple to complex custom programs for a variety of automation applications such as but not limited to:

- Sequence Switching
- Interlocking
- Auto-sectionalizing
- Auto-reclosing
- Load Tap Changer Control
- Cap. Bank Control
- Reactor Switching
- Alarm Grouping

## Math, Logical, Timer Control Logic

Using the calculator tool, users can create advanced solutions that group, manage and control points to produce the required automation results.

The calculator tool can perform mathematical, logical, or timer based operations on data points stored in the G500. Using a graphical interface, users can define logical expressions using mathematical functions such as addition, multiplication, logarithm, greater than, less than, as well as other boolean functions.

## IEC 61131-3 Compliant Programmable Logic

For more advanced applications, programmable logic (LogicLinx) software provides PLC functionality on the G500 platform. LogicLinx offers textual and graphical languages defined in the IEC 61131-3 standard for PLC programming environments, including Sequential Functions Chart, Instruction List, Structured Text,

Ladder Diagram and Function Block Diagram. In addition, a wide range of arithmetic, boolean and logical operations are supported.

## Advanced Database Points Management

The flexibility of the G500 configuration system enables users to create and manage database points for control or reporting by leveraging the following:

**Accumulator Freeze** - It might be useful to define groups of points and associate peculiar action(s) to the group based on certain 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 Analog value selection functionality enables the user to define a group of analog input points that have 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. For example: Within the prioritized group, a valid and highest priority point can be reported to a single analog input point.

**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.

## Control Lockout

The control lockout feature ensures that only a single master station can access a group of

controls at one time. Can lock out groups of controls 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.

## 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.

## IEC 62439-3 (Edition 2), Parallel Redundancy (PRP) Protocol

Substation LAN redundancy has been traditionally accomplished by reconfiguring the active network topology in case of failure. Parallel Redundancy Protocol is an IEC 62439-3 data communication network standard which is often used to overcome single network failure without affecting the data transmission. PRP is independent of the communication protocols and provides no packet loss ("zero recovery time") availability by using connected nodes which transmit and receive over two independent network active paths.

The G500 natively supports multiple communication modes for its ethernet ports: single LAN, redundant LAN, and PRP. This aids in implementing PRP in brown field installations, taking advantage of possible spare ports on existing managed switches LAN infrastructure.

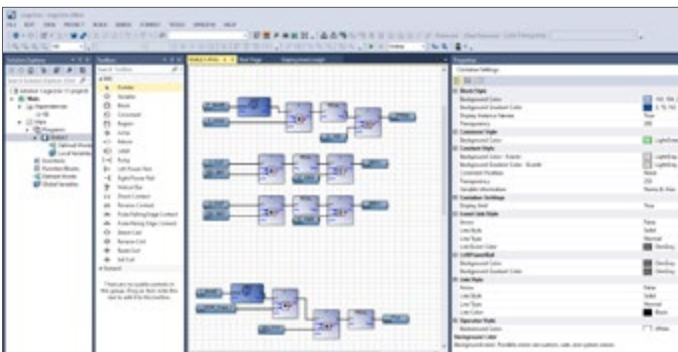


Figure 1 - IEC 61131-3 Logic

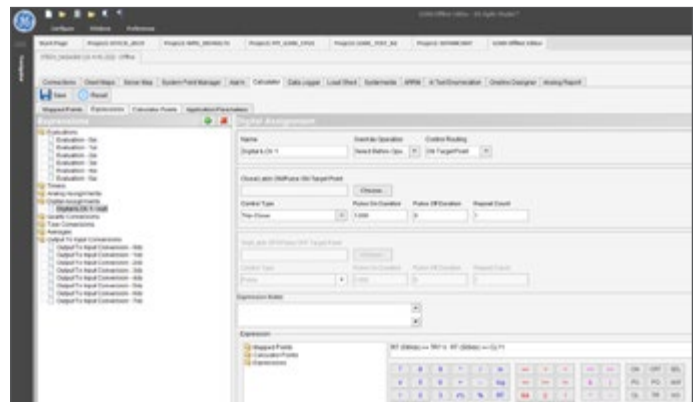


Figure 2 - Math, Logical, Timer Logic

## HMI, One-Line, Annunciator

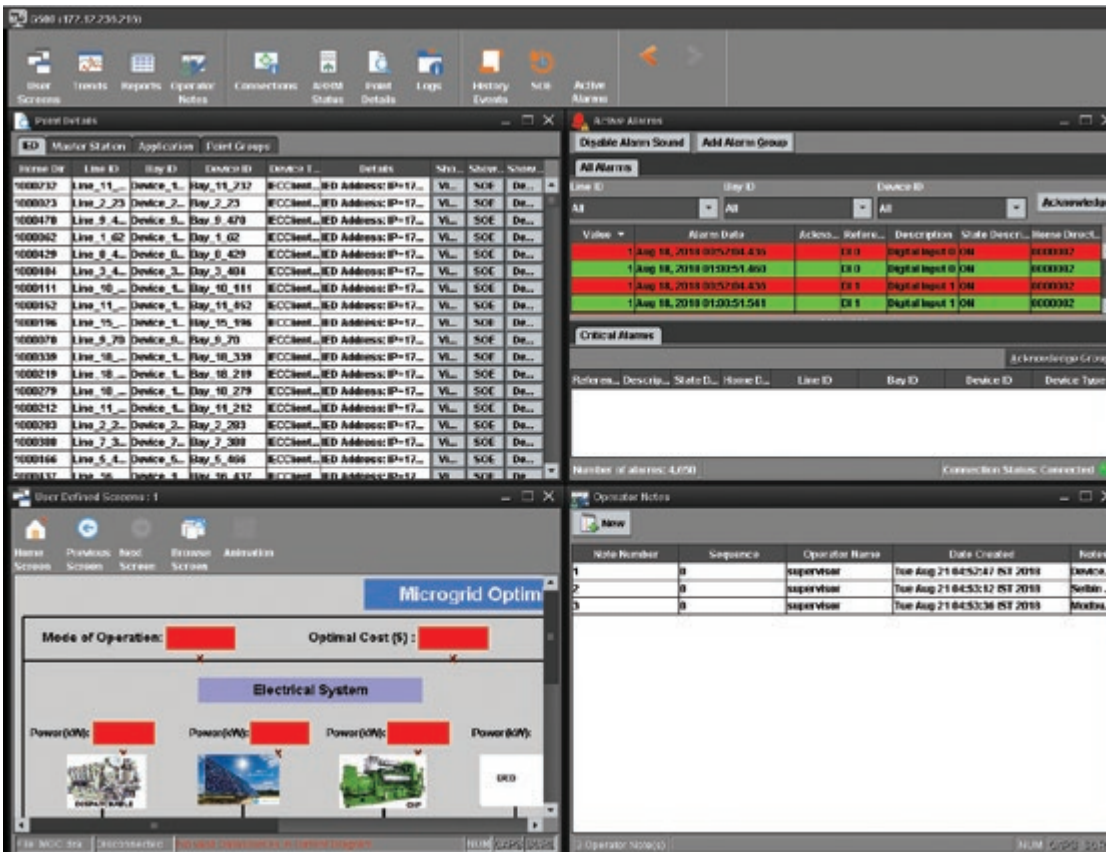
The G500 supports an embedded HMI/ Annunciator functionality, that The G500 supports an embedded HMI/ Annunciator functionality, that is accessible through a secure application. Alternatively, the HMI could be accessed with the use of up to 2x4k keyboard and mouse directly connected to the G500's display ports. Optionally, the HMI can also be accessed remotely through a remote desktop client. Users have access to all data points in the systems, alarm screens, communications status screens and dynamic one-line diagrams, all through a secure protocol.

Multiple floating windows for different screen views are supported. Being able to access multiple floating windows or screens improves the productivity of operators. Users are able to customize the different views to match different background colors or skins to sooth different mood. For every screen type, the layouts created are

persistent to the last layout size or position. This is very useful in that users do not have to keep recreating the same layout.

The HMI supports 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
- Support for commissioning forcing control/ feedback and acknowledge individual/group alarms from one-line diagram



## Alarm Management

The G500 Alarm groups are 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 at all. "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 G500 GUI.



## Fault Recording / Data Logging

The G500 can automatically retrieve event and oscillography files from devices such as Multilin UR Protective Relays, GE's D25 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.

## Automatic File and Record Retrieval

The Automated Record Retrieval Manager (ARRM) retrieves and stores record files from devices connected to the G500.

ARRM uses the Distributed Network Protocol (DNP) and the IEC 61850 protocol to communicate with a variety of devices, and uses the Trivial File Transfer Protocol (TFTP) SFTP, FTP, SEL Bin/GEN ASCII or IEC 61850 MMS to transmit the files from the IED to the device over a Local Area Network (LAN) or serial connection.

You can also retrieve downloaded records from the G500 using any FTP/SCP/SFTP client as needed or on a scheduled basis.

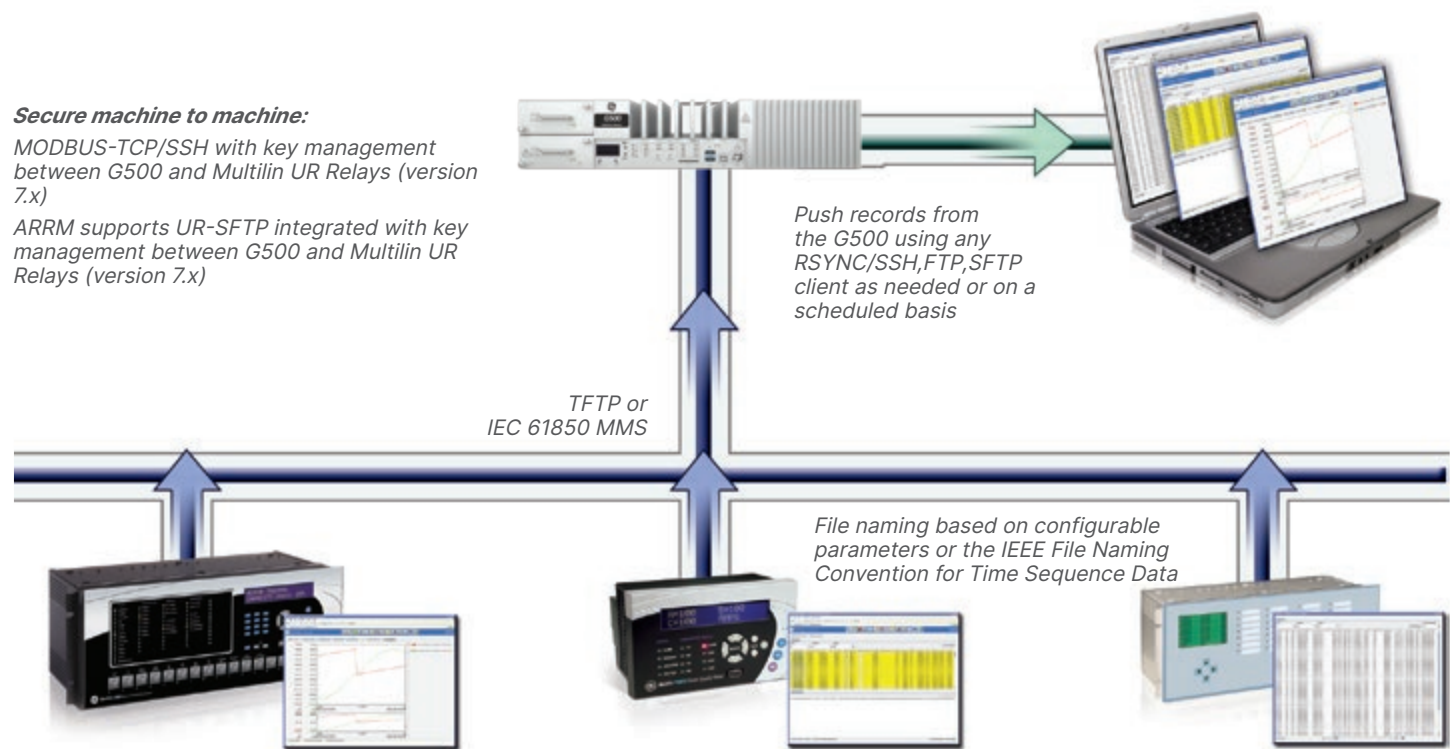
ARRM supports a configurable interval for polling connected devices. This can be activated or deactivated through the runtime viewer display screen.

ARRM supports file archival of EVE and CEV files from the SEL IEDs via serial or TCP connections. Secure Remote Access

G500 provides robust security environment, providing seamless integration with existing IT department policies. Role based Access Control, Secure Web Interface, Secure File Transfer, and extensive user activity logging provide a complete security toolkit required to achieve NERC-CIP compliance.

## Non-operational Data

Using pass-through connections, the utility user can extract valuable non-operational data such as digital fault recording (DFR) records and event files. The user can also access the historical log files and upload the archived data for trending and analysis.



Using SFTP, FTP, TFTP, IEC 61850 MMS, SEL Bin/GEN ASCII for automatic retrieval of: fault records, SOE and comtrade files, events, oscillography, settings, logs

### Data Logger

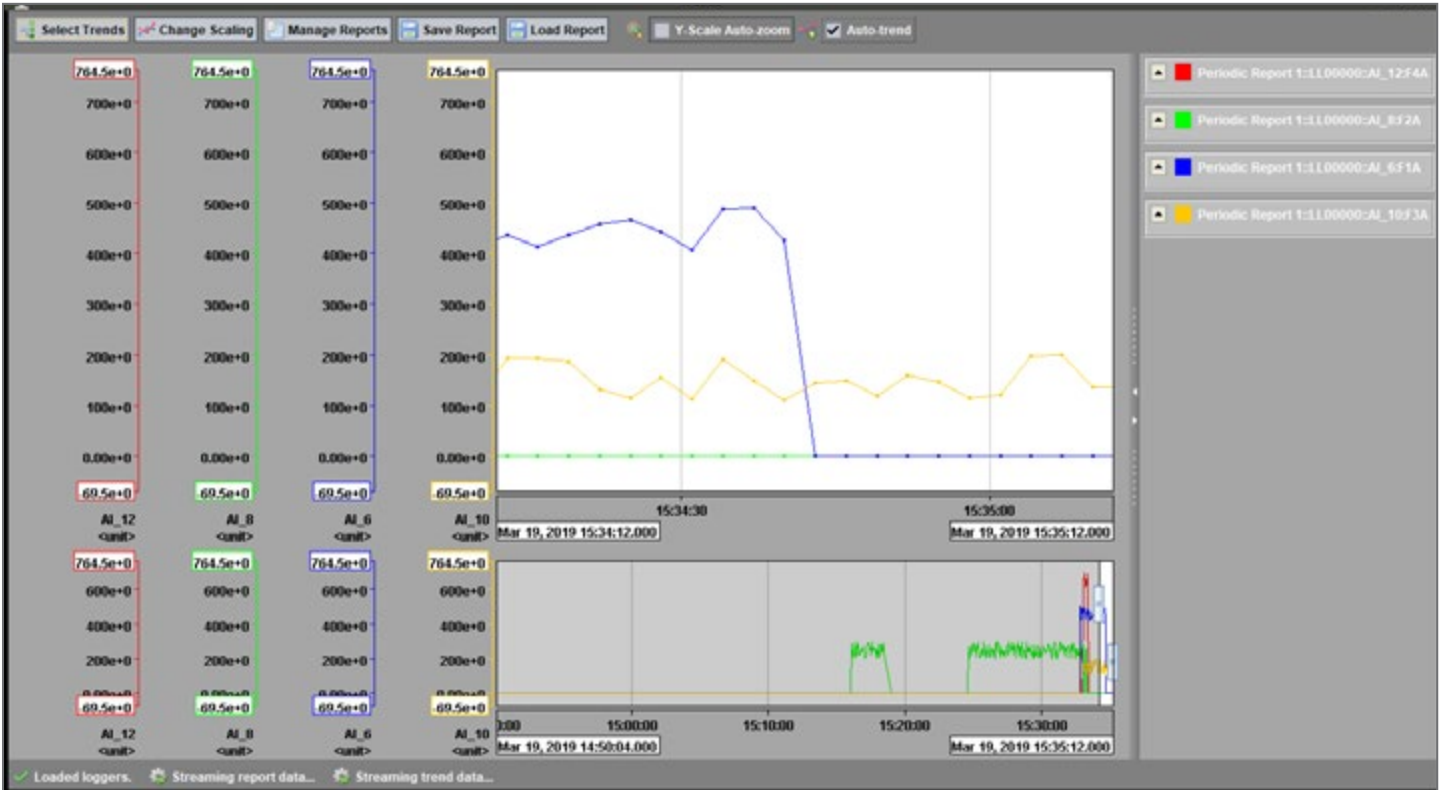
The Analog Data Logger provides a variety of means to monitor and record analog input point value changes into data files that can be retrieved by the user. A variety of recording methodologies are supported including, Continuous (all changes), Periodic, Time Weighted, Out of Range and Triggered by a digital input point.

### Trend Viewer

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. Up to 8 data points (pens) can be displayed on a single view and support for curve fitting is available.

### Database Exporter

The Database Exporter tool allows users to save Analog Data Logger and Digital event recorder points from the G500 to your local PC, using the WEB interface, in comma-separated values (CSV) format.



Use device software to obtain non-operational data such as trending and event records through the G500's secure remote access functionality.



**Pass-through/Terminal Server**

A built-in terminal server emulator allows pass-through connections to be initiated to substation device (relay, meter, RTU or other device). Once the connection is established, the local event records can be uploaded from the substation devices and viewed remotely. Remote access can 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 located in the bay. A small terminal server can be placed in the bay and connected to the Ethernet network, allowing all G500 serial client applications to connect directly to the

serial device. Virtual Serial ports can also be used to expand the number of serial ports that the G500 can communicate over.

**Role Based Access Control**

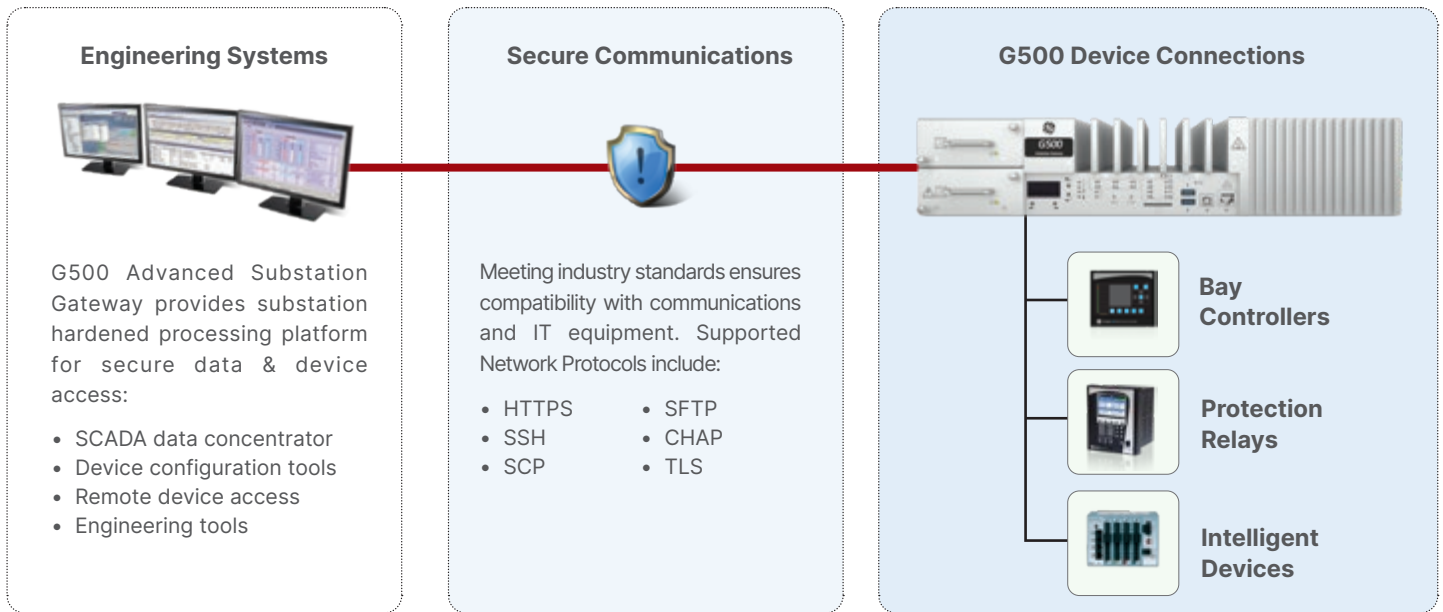
Local and Remote Authentication modes are supported to ensure that only authenticated and authorized users gain access the system. Each user is assigned one of four 4 pre-defined roles or privilege levels to control their access.

Supported Remote Authentication modes include Lightweight Directory Access Protocol (LDAP) and Cisco Terminal Access Controller Access-Control System Plus (TACACS+).

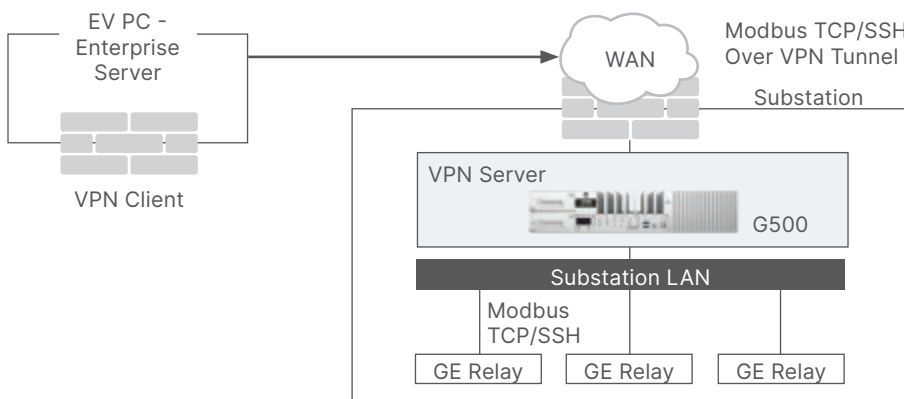
**Built-in Firewall**

The G500 is equipped with a built-in firewall for enhanced gateway cyber security. G500's firewall is designed to drop unsolicited or invalid routed packets. The firewall is preconfigured to inspect outbound traffic on external interfaces and inbound traffic on both internal and external interfaces. The G500 automatically generates rules allowing inbound traffic on internal interfaces for all configured services, and inbound/outbound traffic for configured secure services on external interfaces. The rules are user configurable for inbound/outbound traffic customization.

**Secure Remote Access**



**OpenVPN Architecture Example**



**Key Features:**

- Can configure up to 8 VPN Clients; Can at a maximum serve up to 3 VPN Clients.
- Certificate-key format support for openvpn client [Windows]
- Network interface combination available for Routing
- Support for 1024 Rules in Whitelist
- Rules includes support for:
  - Any ICMP
  - Useful ICMP
  - TCP & UDP
- Supports Redundancy (Warm/Hot)

## Hardware Overview

### Central Processing Unit

G500 is built on a high-performance multi-core AMD CPU and has two models:

- G500 2-core/2.2 GHz CPU with 8 GB of RAM and 256 GB Secure Encrypted SSD
- G500 4-core/2.7 GHz CPU with 16 GB of RAM and 512 GB Secure Encrypted SSD

### Ethernet Interfaces

G500 has six Ethernet interfaces available through SFP cages. Each cage supports the following SFP transceivers:

- 100/1000BASE-T (RJ45 copper),
- 100BASE-FX (LC fiber multimode),
- 1000BASE-SX (LC fiber multimode),
- 1000BASE-LX (LC fiber singlemode)

Each interface can be individually configured by software to operate in independent mode or in a Redundant LAN or PRP pair.

### Advanced Security

The G500 supports hardened cybersecurity features such as Encrypted SSD drives for storage and Trusted Platform Module (TPM) for securely storing artifacts. It also has a physical presence detection feature, to confirm that someone is physically at the unit for certain specific secure hardware maintenance operations.

### Time Sync Support

The G500 supports IEEE 1588 PTP, IRIG-B and NTP time sync input and output.

### Redundant Power Supplies

The G500 is equipped with dual redundant hot swappable power supplies, which ensures continuous uptime. Each power supply can be connected to different source of different voltages. For example, power supply 1 could be connected to Mains, while power supply 2 is connected to the battery system.

Power Supply Health information is available for SCADA operations and alarms, allowing for remote monitoring. This allows an alarm to be transmitted to the EMS / OMS or DMS system, allowing for field personnel to be dispatched to replace the failed supply, all without service disruption.

### Serial Ports

G500 is expandable. By default, it is configured with 8x serial interfaces, which are accessible via individual RJ45 connectors on the rear of the unit. IRIG-B is available on the first 8 serial interfaces.

+12V output is available on ports 4 and 8 in the first 8 serial interfaces. Additionally, serial ports can be expanded with the use of PCIe modules. Each port can be individually configured in software for RS-232 and RS-485 communication. There is no need to open the unit and change jumpers.

### PCIe Modules

The G500 supports 3x PCIe expansion modules for future expandability and customizability. Today, cards exist to expand the number of serial ports or to connect with D.20 I/O Modules.

### Display Ports

The G500 has two display ports on the rear of the chassis, capable of supporting up to 4k in resolution. This allows for the Local HMI to provide very large displays on very large monitors.

### USB Ports

For different uses such as storage or access to keyboards, the G500 supports 7x USB ports 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

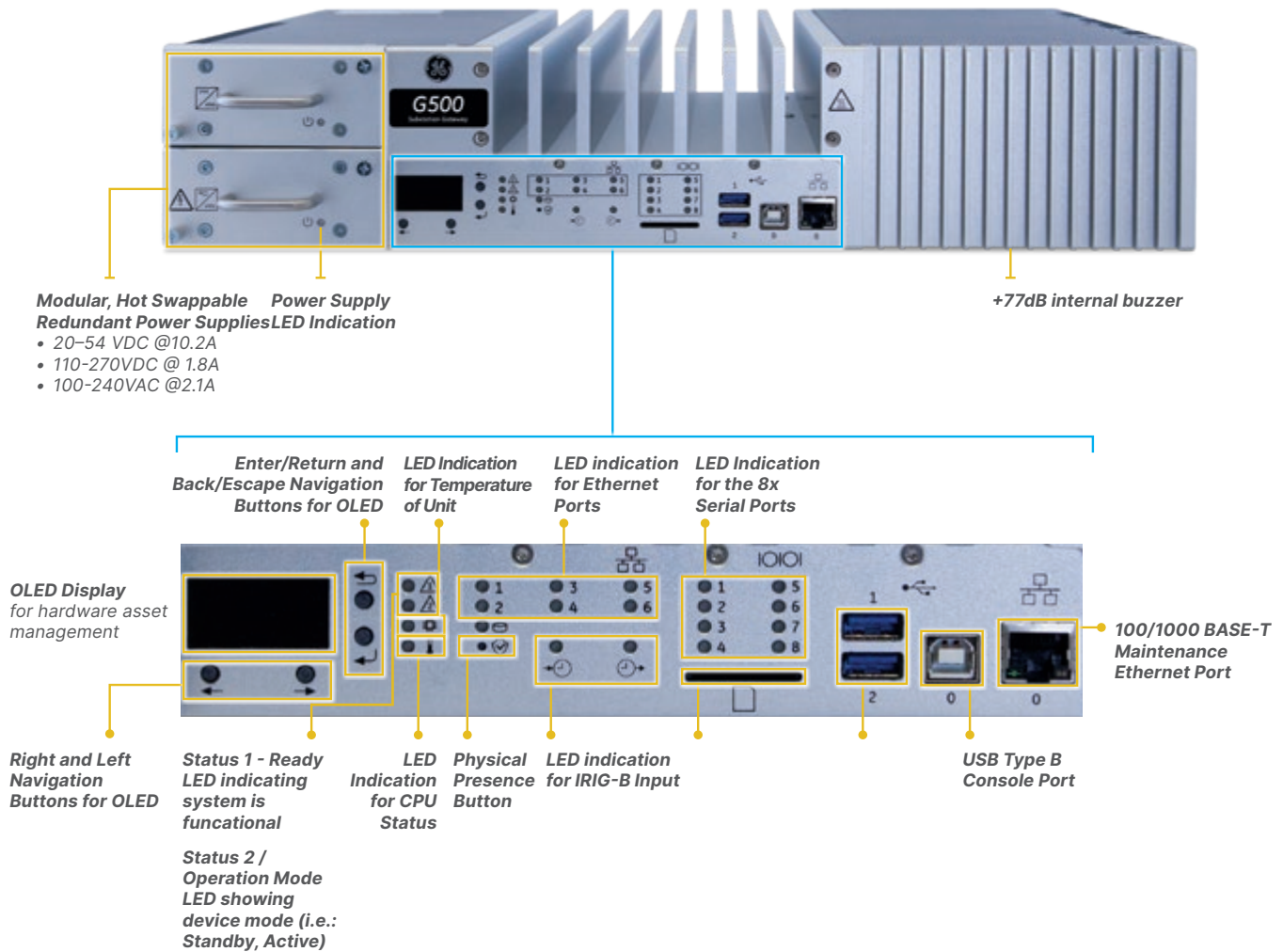
The G500 has one USB Type B port on the front of the chassis, providing local serial console access for maintenance support.

In addition, a separate 100/1000BASE-T maintenance port is available on the front of the unit. This maintenance port is independent from the six Ethernet ports on the rear of the unit and is intended for local only connections.

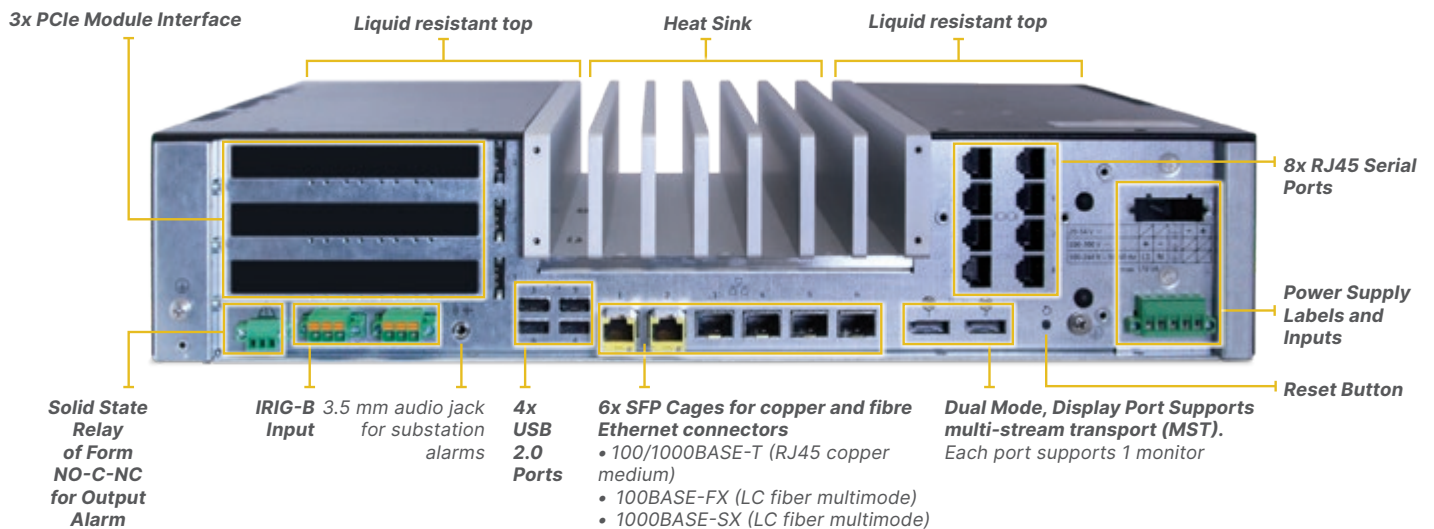


*Redundant, hot-swappable power supplies.*

## Front Panel



## Back Panel



## Technical Specifications

Processor, Memory, and Storage	
CPU	AMD Embedded R-Series CPU (2.7GHz 4core)
Memory	DDR3 SDRAM (16GB)
Storage	Self-encrypted Solid-State Drive (256 GB)
Operating System	
	Predix Edge OS
Communications	
Ethernet	6 Ethernet ports, configurable as independent LAN, Redundant LAN and/or PRP Accessible via SFP modules: <ul style="list-style-type: none"> <li>100/1000BASE-T (RJ45 copper)</li> <li>1000BASE-FX (LC fiber multimode)</li> <li>1000BASE-SX (LC fiber multimode)</li> <li>1000BASE-LX (LC fiber single mode)</li> </ul>
Serial (RS-232/485)	<ul style="list-style-type: none"> <li>8x serial interfaces accessible via individual RJ45 connectors on rear of the unit</li> <li>Additional serial interfaces can be adding using PCIe expansion cards</li> <li>Serial interfaces use 16550 compatible UART</li> <li>Support baud rates 300, 600, 1200, 2400, 4800, 9600, ... 115.2k</li> <li>RS232 mode supports flow control and handshaking signals (RTS,CTS,DCD)</li> <li>Software controlled mode of operation between RS232 or RS485 2/4 wires</li> <li>Software controlled termination resistor (120 ohm) for RS485 mode</li> <li>All software selection persist when power cycled</li> <li>IRIG-B available on all native serial interfaces</li> <li>+12V output @ 6W max available on serial interfaces 4 and 8</li> </ul>
D.20 Link HDLC	<ul style="list-style-type: none"> <li>Optional 2x D.20 Link DB9 ports</li> <li>Terminal block to provide power to the D.20 Link</li> </ul>
Time Synchronization (HW support)	
PTP	Can be P for IEEE1588 PTP IN and OUT
IRIG-B Input and Output	<ul style="list-style-type: none"> <li>Available as 3 positions removable Phoenix terminal block on rear of the unit</li> <li>Supports IRIG-B TTL</li> </ul>
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"> <li>up to UHD (4k, 3840x2160) for single displays connected to each port</li> </ul>
Audio output	
	3.5 mm audio jack for substation alarms Built in high (+77dB) pitch audio buzzer
USB ports	
	<ul style="list-style-type: none"> <li>2x USB 3.0 on front of the unit</li> <li>4x USB 2.0 on rear of the unit</li> <li>1x USB 2.0 internal - for software license keys</li> </ul>
SD card (Windows support only)	
	<ul style="list-style-type: none"> <li>SD, SDHC and SDXC SD-Cards according to Version 1.0, Version 2.0 and Version 3.0</li> <li>Maximum SDXC size 64GB</li> <li>SD card slot accessible on front of the unit, uses push-pull mechanism</li> </ul>
Maintenance ports	
Console port	<ul style="list-style-type: none"> <li>1x USB Type B port on front of chassis</li> <li>connected to internal USB to Serial bridge, allows access to Console for debug</li> </ul>
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	<ul style="list-style-type: none"> <li>110-270VDC @ 1.8A</li> <li>100-240VAC @ 2.1A</li> </ul>
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	<ul style="list-style-type: none"> <li>0 serial ports, without PSU 10.2 Kg</li> <li>4 serial ports 10.4 Kg</li> <li>8 serial ports 10.6 Kg</li> <li>Rack mounting bracket 1.2 Kg</li> <li>AC/DC PSU 1.2 Kg</li> </ul>
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SYSFAIL output	
	<ul style="list-style-type: none"> <li>Solid state relay of form NO-C-NC</li> <li>Available as 3 positions removable Phoenix terminal block on rear of the unit</li> </ul>

Operating Environment	
Operating Temperature	-40° 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

Test	Reference Standard	Test Level
Insulation Resistance Test	EN 60255-27	500 Vdc
Dielectric voltage withstand	EN 60255-27	2.0 kV
Impulse voltage withstand	EN 60255-27	5 kV
Damped Oscillatory	IEC 61000-4-18	100kHz & 1MHz 2.5kV CM, 1kV DM
Electrostatic Discharge	IEC 61000-4-2	Level 4
RF immunity	IEC 61000-4-3	Level 3
Fast Transient Disturbance	IEC 61000-4-4	Level 4
Surge Immunity	IEC 61000-4-5	Level 3 & 4
Conducted RF Immunity	IEC 61000-4-6	Level 3
Radiated & Conducted Emissions	CISPR22 & CISPR32	Class A
Sinusoidal Vibration	IEC 60255-21-1	Class 1
Shock & Bump	IEC 60255-21-2	Class 1
Seismic	IEC 60255-21-3	Class 2
Power magnetic Immunity	IEC 61000-4-8	Level 5
Voltage Dip & interruption	IEC 61000-4-11	0,40,70,80% dips, 250/300cycle interrupts
Conducted RF Immunity 0-150khz	IEC 61000-4-16	Level 4
Voltage Ripple	IEC 61000-4-17	15% ripple
Ingress Protection	IEC 60529	IP30
Environmental (Cold)	IEC 60068-2-1	-40°C 16 hrs. (Storage and Operational)
Environmental (Dry heat)	IEC 60068-2-2	60°C 16hrs for Quad Core 85°C 16 hrs. Storage (both models)
Relative Humidity Cyclic	IEC 60068-2-30	6day, variant 2, 55°C/95%RH
Change of Temperature	IEC 60068-2-14	Quad Core: -40°C to 60°C Method Nb
Damp Heat Steady State	IEC 60068-2-78	40°C & 93%RH for 240 hrs
Damped Oscillatory	IEEE/ANSI C37.90.1	2.5kV@1MHz CM/DM
RF Immunity	IEEE/ANSI C37.90.2	20V/m 80-1GHz + Spot Freqs
ESD	IEEE/ANSI C37.90.3	8kV CD, 15kV AD
IEEE Standard Environmental and Testing Requirements for Communications Networking Devices Installed in Electric Power Substations	IEEE 1613:2009	Per Standard
Communication Networks and systems for power Utility Automation-Part 3	IEC 61850-3:2013	Per Standard
SAFETY	EN/IEC 60950-1: 2005	Per standard
UL marking	UL60950-1 2nd Ed /CSA C22.2 60950-1-07	NWQG2 & NWQG8

## Order Code

Hardware Configuration	G500 * * * 8 - * * * * * - * U U U - * * * - U U U - S - CA * * * * - U U U U U U Description															
<b>CPU</b>	A															2.70 GHz 4 core APU, 16 GB DDR3 SDRAM
<b>Power Supply</b>	H	H														H: 110-270 VDC / 100-240 VAC (Conformal Coated) L: 20-54 VDC (Conformal Coated) U: Not Required
<b>Serial Port</b>			8													Standard: 8x Serial Ports, RS-232/ RS-485 independently configurable and isolated
<b>Ethernet Interface</b> (Slots 2-6 are configurable as T, F, S, U)				T	T	T	T	T								T: 100/1000BASE-TX (RJ45 copper medium) [580-3786] F: 100BASE-FX (LC fiber multimode) [580-3784] S: 1000BASE-SX (LC fiber multimode) [580-3785] L: 1000BASE-LX (LC fiber single-mode) [580-3787] U: Not Required
<b>Storage*</b>								A								B: 256 GB Self encrypted Solid State Drive
<b>PCIe Expansion</b>									4	4	4					4: 4x Serial Ports, RS-232/ RS-485 independently configurable and isolated D: 2x D.20 Link Ports [528-1002LF] U: Not Required
<b>Firmware Version</b>									00							Latest Firmware Version
									A0							v1.0
									B0							v2.0
									B1							v2.1
									B5							v2.5
									B6							v2.6
									B8							v2.8
									C1							v3.0
									C2							v3.1
									D1							v4.0
<b>Software Configuration</b>																
<b>Application Licenses *</b>														XXX		License (Tejas V server, IEC 61131-3 Logic Engine, IEC61850 Ed.2 (Server), IEC61850 Ed.2 (Client), Automatic Record Retrieval Manager (ARRM), Remote Desktop HMI, D2x Apps)

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