

Multilin™ G60

Comprehensive Protection for Generators

The Multilin G60 generator protection system provides comprehensive protection for medium and large generators, including large steam and combustion turbines, combined-cycle generators and multi-circuit hydro units.

The G60 includes advanced automation and communication capabilities, extensive I/O options, and powerful fault recording features that can simplify postmortem disturbance analysis and help minimize generator downtime.

Key Benefits

- Secure, high-speed protection elements for complete generator protection, compliant with IEEE® C37.102, extending asset life
- Available Ethernet Global Data (EGD) to ease integration with new and existing GE control systems
- Embedded Synchrophasor measurement capabilities (per IEEE® C37.118), eliminating the need for dedicated PMUs and support for synchrophasor multi-cast (per IEC® 61850-90-5) reducing bandwidth and communications infrastructure costs
- Advanced IEC 61850 Ed. 2 implementation, complete settings via SCL files and IEC 61850-9-2 process bus solution enable resource and platform managing optimization and reduce cost of ownership
- Increased network availability via failover time reduced to zero through IEC® 62439-3 “PRP” support
- CyberSentry™ provides high-end cyber security aligned to industry standards and services (NERC® CIP, AAA, Radius, RBAC, Syslog)
- Advanced fault and disturbance recording, including internal relay operating signals, eliminating the need for external recording devices

Applications

- Medium to large generators typically driven by steam, gas, or hydraulic turbines
- Pumped storage generators used as pumping motors for reservoir storage
- Stand-alone protection or component in automated substation control systems
- Standard protection product offering on new GE generator installations



Protection and Control

- 100% Stator and Field Winding Ground Fault Protection (GPM-S & FPM-F Modules)
- Generator stator differential, loss of excitation, overexcitation and generator unbalance protection, and breaker failure
- Power swing blocking and out-of-step tripping
- Reverse/low forward power
- Restricted ground fault, thermal overload protection, directional, time, instantaneous, phase, neutral, negative sequence and ground overcurrent protection

Communications

- 3 independent Ethernet ports for simultaneous & dedicated network connections with IEEE 1588 support
- Supported industry protocols: IEC 61850 Ed. 2, SFTP, MMS File Transfer Service, DNP 3.0, Modbus Serial/TCP, IEEE 1588, IEC 60870-5-104 and 103, PRP, SNTP, HTTP, TFTP

Cyber Security

- CyberSentry™ provides high-end cyber security aligned to industry standards and services (NERC® CIP, AAA, Radius, RBAC, Syslog)
- Setting for security audit trails, tracking changes to device configurations

Monitoring & Metering

- P & M class synchrophasors of voltage, current and sequence components
- Advanced recording capabilities with high-capacity event recorder, configurable and extended waveform capture and data logger
- Metering: current, voltage, power, energy, frequency, and harmonics



Protection and Control

As part of the UR family of Protection & Control devices, the G60 offers a high degree of modularity in its design and functionality, providing superior performance while meeting the toughest requirements of the marketplace. Advanced protection and control features of this relay includes:

Generator Stator Differential

High-speed stator differential protection provides sub-cycle detection and high-speed clearing of stator phase faults. Advanced CT saturation and failure detection algorithms maintain immunity to high current AC and low current DC saturation conditions that may occur due to external disturbances, such as transformer inrush or near generator faults, without sacrificing speed or sensitivity.

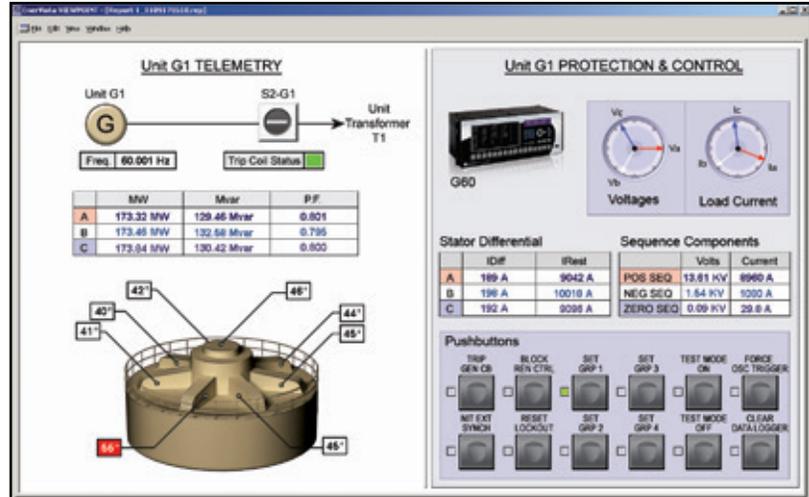
100% Stator Ground 3rd Harmonic

100% stator ground fault protection is provided through a voltage differential feature that responds to the unbalance of the third harmonic at the machine terminals and at the neutral point. This method is insensitive to the absolute value of the third harmonic and is easily set without the need for on-line measurements. For generators with delta connected PTs, a third harmonic undervoltage element is also offered for detecting a loss of the third harmonic voltage at the generator neutral.

Breaker Failure Protection

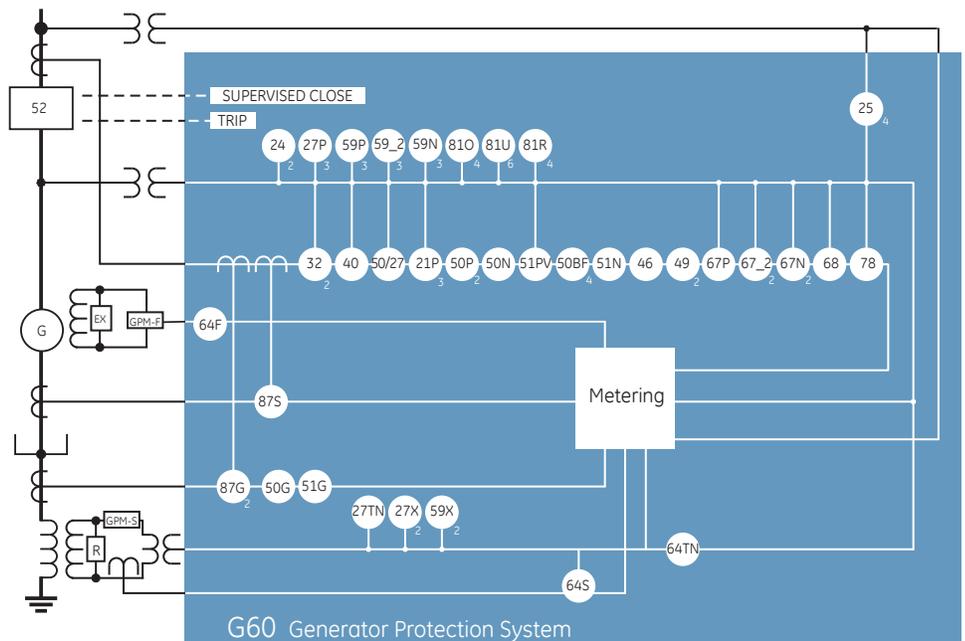
The breaker failure protection element monitors for timely operation of the connected breaker. If a trip command is not successful in operating the breaker and clearing the fault, the breaker failure element can be used to send trip signals to upstream breakers to clear the fault.

G60 - Protection, Metering, Monitoring and Control



The G60 is the single point for protection, control, metering, and monitoring in one integrated device that can easily be connected directly into DCS or SCADA monitoring and control systems like Viewpoint Monitoring as shown.

Functional Block Diagram



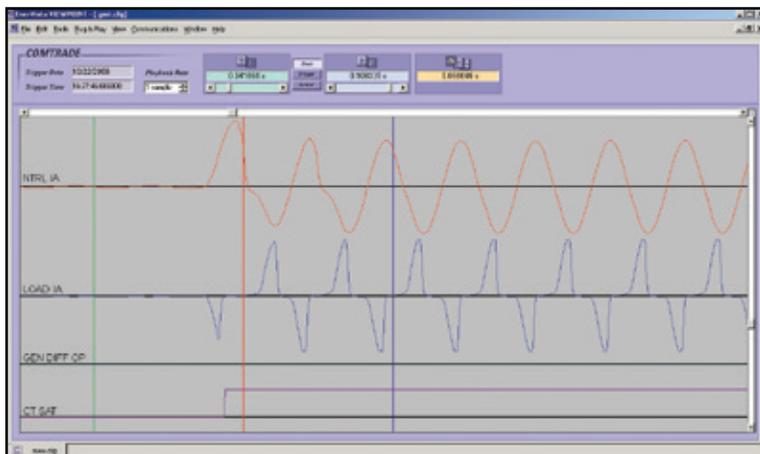
ANSI® Device Numbers & Functions

DEVICE NUMBER	FUNCTION
21P	Phase Distance Backup
24	Volts Per Hertz
25	Synchronism Check
27P	Phase Undervoltage
27TN	Third Harmonic Neutral Undervoltage
27X	Auxiliary Undervoltage
32	Sensitive Directional Power
40	Loss of Field Relay
46	Generator Unbalance
49	Thermal Overload
50G	Ground Instantaneous Overcurrent
50N	Neutral Instantaneous Overcurrent

DEVICE NUMBER	FUNCTION
50P	Phase Instantaneous Overcurrent
50SP	Split Phase Instantaneous Overcurrent
50BF	Breaker Failure
50/27	Accidental Energization
51G	Ground Time Overcurrent
51PV	Phase Time Overcurrent with Voltage Restraint
51N	Neutral Time Overcurrent
59N	Neutral Overvoltage
59P	Phase Overvoltage
59X	Auxiliary Overvoltage
59_2	Negative Sequence Overvoltage
64F	Field Ground Protection

DEVICE NUMBER	FUNCTION
64S	Sub-Harmonic Stator Ground Protection
64TN	100% Stator Ground
67_2	Negative Sequence Directional Overcurrent
67N	Neutral Directional Overcurrent
67P	Phase Directional Overcurrent
68	Power Swing Blocking
78	Out-of-Step Protection
81O	Overfrequency
81R	Rate of Change of Frequency
81U	Underfrequency
87G	Restricted Ground Fault
87S	Generator Stator Differential

G60 Percent Differential Element



The G60 percent differential element has enhanced saturation detection algorithms to provide additional security against AC and DC saturation that can occur during faults near the generator.

Field Ground Protection

Field ground protection identifies the occurrence of a ground fault in a generator field winding and helps to prevent serious damage to the generator, maximizing operational lifespan. The field ground protection module (GPM-F) works in combination with the G60 to detect ground faults in the field winding of the generator. The solution includes: two-stage field ground detection, injected voltage and current supervision, brush lift-off detection, field over and undercurrent elements and field ground fault location.

100% Stator Ground Fault Protection Using Sub-Harmonic Injection

Protecting the generator from internal faults is critical to maintaining the overall life of the generator. Using the 100% stator ground fault protection based on sub-harmonic injection, a 20Hz voltage is injected to detect ground faults at any point across 100% of the winding. The stator ground module (GPM-S) works in combination with the G60 to provide 100% stator ground fault protection that is operational during generator start-up, running and stopped conditions. The solution includes: two-stage stator ground detection, injected voltage and current supervision and ground overcurrent element.

Loss of Excitation

Generator loss of excitation protection is provided via two negative offset mho characteristics as per IEEE C37.102. Inadvertent

pickup time delay settings and blocking input provide security for blown VT fuses and power swing conditions.

Power Swing/Out-of-Step

The power swing blocking element provides blocking of the backup distance element and other protections under power swing conditions. Negative sequence current supervisors provide extended selectivity for detecting evolving faults that may appear as a power swing event (faults with slow moving impedance locus). Additionally, the out-of-step tripping element can be used for tripping the generator when an unstable power swing is detected.

Backup Phase Distance

Three separate phase distance elements provide time-delayed backup protection for generator faults that have not otherwise been cleared by the primary system and generator protection. Each zone can independently compensate for power transformers, so compensation can be applied for zones reaching out into the system through the unit transformer, while zones looking into the stator can remain uncompensated.

Sensitive Directional Power

Two separate directional power elements are provided to detect generator motoring to protect the prime mover from damage. Each element responds to either reverse or low forward power flow and can be used to provide independent alarm and trip settings.

Restricted Ground Fault (87G)

RGF protection (also known as zero-sequence differential) extends protection coverage to the neutral point of the stator winding, where fault currents may be below the pickup of the main stator differential element. The low-impedance (87G) protection provided by the G60 uses an optimized adaptive restraint signal that provides security for external fault conditions that may cause CT saturation while still maintaining sensitivity for internal faults.

Pumped Storage Generator

The G60 can be used for protecting generators that are also run as pumped storage motors, without the need for switching the CT secondary circuitry. The G60 is able to automatically compensate for the phase reversal that occurs when the generator is being run as a motor.

Synchronism Check

The G60 provides four elements to monitor differences in voltage magnitudes, phase angles, and frequencies to perform synchronism checks across breakers (up to four). The G60 can be used in conjunction with an external synchronizer as an independent check of the synchronizer prior to closing the generator breaker.

Temperature Protection (RTD Module Option 5C)

The G60 RTD option provides 8 programmable RTD inputs per module that are used for temperature monitoring. Each RTD input has 2 operational levels: alarm and trip. The G60 supports RTD trip voting and provides open RTD failure alarming. Alternatively, a remote RTD module, "RRTD", which supports 12 RTD inputs, can also be used with the G60 for temperature monitoring. The RRTD provides cost savings compared with standard RTD wiring.

IEC 61850 Process Bus

The IEC 61850 Process Bus module is designed to interface with the Multilin HardFiber System, allowing bi-directional IEC 61850 fiber optic communications. The HardFiber System is designed to integrate seamlessly with existing UR applications, including protection functions, FlexLogic™, metering and communications.

The Multilin HardFiber System offers the following benefits:

- Communicates using open standard IEC 61850 messaging
- Drastically reduces P&C design, installation and testing labor by eliminating individual copper terminations
- Integrates with existing G60's by replacing traditional CT/VT inputs with the IEC 61850 Process Bus module
- Does not introduce new cyber security concerns

Visit the HardFiber System product page on the GE Digital Energy web site for more details.

Advanced Automation

The G60 incorporates advanced automation features including powerful FlexLogic programmable logic, communication, and SCADA capabilities that far surpass what is found in the average generator relay. The G60 integrates seamlessly with other UR relays for complete system protection, including unit and auxiliary transformers, and balance of plant protection.

FlexLogic

FlexLogic is the powerful UR-platform programming logic engine that provides the ability to create customized protection and control schemes, minimizing the need and associated costs of auxiliary components and wiring. Using FlexLogic, the G60 can be programmed to provide the required tripping logic along with custom scheme logic for generator breaker control (including interlocking with external synchronizers), transfer tripping schemes for remote breakers and dynamic setting group changes.

Scalable Hardware

The G60 is available with a multitude of I/O configurations to suit the most demanding application needs. The expandable modular design allows for easy configuration and future upgrades.

- Multiple CT/VT configurations allow for the implementation of many different schemes, including concurrent split-phase and differential protection
- Flexible, modular I/O covering a broad range of input signals and tripping schemes
- Types of digital outputs include trip-rated Form-A and Solid State Relay (SSR) mechanically latching, and Form-C outputs
- Form-A and SSR outputs available with optional circuit continuity monitoring and current detection to verify continuity and

health of the associated circuitry

- Mechanically latching outputs can be used to develop secure interlocking applications and replace electromechanical lockout relays
- RTDs and DCmA inputs are available to monitor equipment parameters such as temperature and pressure

Monitoring and Metering

The G60 includes high accuracy metering and recording for all AC signals. Voltage, current, and power metering are built into the relay as a standard feature. Current and voltage parameters are available as total RMS magnitude, and as fundamental frequency magnitude and angle.

Fault and Disturbance Recording

The advanced disturbance and event recording features within the G60 can significantly reduce the time needed for postmortem analysis of power system events and the creation of regulatory reports. Recording functions include:

- Sequence of Event (SOE)
 - 1024 time stamped events
- Oscillography
 - 64 digital & up to 40 analog channels
 - Events up to 45s in length
- Data Logger and Disturbance Recording
 - 16 channels up to 1 sample/cycle/channel
- Fault Reports
 - Powerful summary report of pre-fault and fault values

The very high sampling rate and large amount of storage space available for data recording in the G60 can eliminate the need for installing costly stand-alone recording equipment.

Advanced Device Health Diagnostics

The G60 performs comprehensive device health diagnostic tests at startup and continuously during run-time to test its own major functions and critical hardware. These diagnostic tests monitor for conditions that could impact security and availability of protection, and present device status via SCADA communications and front panel display. Providing continuous monitoring and early detection of possible issues help improve system uptime.

- Comprehensive device health diagnostic performed at startup
- Monitors the CT/VT input circuitry to validate the integrity of all signals

Cyber Security – CyberSentry UR

CyberSentry UR enabled UR devices deliver full cyber security features that help customers to comply with NERC CIP and NIST® IR 7628 cyber security requirements.

This software option delivers the following core features:

AAA Server Support (Radius/LDAP)

Enables integration with centrally managed authentication and accounting of all user activities and uses modern industry best practices and standards that meet and exceed NERC CIP requirements for authentication and password management.

Role Based Access Control (RBAC)

Efficiently administrate users and roles within UR devices. The new and advanced access functions allow users to configure up to five roles for up to eight configurable users with independent passwords. The standard "Remote Authentication Dial In User Service" (Radius) is used for authentication.

Event Recorder (Syslog for SEM)

Capture all cyber security related events within a SOE element (login, logout, invalid password attempts, remote/local access, user in session, settings change, FW update, etc), and then serve and classify data by security level using standard Syslog data format. This will enable integration with established SEM (Security Event Management) systems.

Communications

The G60 provides advanced communications technologies for remote data and engineering access, making it easy and flexible to use and integrate into new and existing infrastructures. Direct support for fiber optic Ethernet provides high-bandwidth communications allowing for low-latency controls and high-speed file transfers of relay fault and event record information. The available three independent Ethernet ports, redundant Ethernet option and the embedded managed Ethernet switch provide the means to create fault tolerant communication architectures in an easy, cost-effective manner without the need for intermediary communication hardware. The G60 supports the most popular industry standard protocols enabling easy, direct integration into DCS and SCADA systems.

- IEC 61850 Ed. 2 with 61850-9-2 and 61850-90-5 support
- DNP 3.0 (serial & TCP/IP)
- Ethernet Global Data (EGD)
- IEC 60870-5-103 and IEC 60870-5-104
- Modbus RTU, Modbus TCP/IP
- HTTP, TFTP, SFTP and MMS file transfer
- SNTP and IEEE 1588 for time synchronization
- PRP as per IEC 62439-3

Interoperability with Embedded IEC 61850 Edition 2

The new IEC 61850 implementation in the UR Family positions GE as an industry leader in this standard.

- Implements Edition 2 of the standard across the entire family of UR devices
- Provides full relay setting management via standard SCL files (ICD, CID and IID)
- Enables automated relay setting management using 3rd party tools through standard file transfer services (MMS and SFTP)
- Increases the number of Logical Devices and data mapped to them, GOOSE messages, and reports to support different organizational needs for data transfer and reduce dependency on generic logical nodes

- Configures GE Systems based on IEC 61850 using universal 3rd party tools
- Multicast IEEE C37.118 synchrophasor data between PMU and PDC devices using IEC 91850-90-5

Direct I/O Messaging

Direct I/O allows for the sharing of high-speed digital information between multiple UR relays via direct back-to-back connections or multiplexed through a standard DS0 multiplexer channel bank. Regardless of the connection method, direct I/O provides continuous real-time channel monitoring that supplies diagnostics information on channel health.

Direct I/O provides superior relay-to-relay communications that can be used in advanced interlocking, generation rejection and other special protection schemes.

- Communication with up to 16 UR relays in single or redundant rings rather than strictly limited to simplistic point-to-point configurations between two devices
- Connect to standard DS0 channel banks through standard RS422, G.703 or IEEE C37.94 interfaces or via direct fiber optic connections

- No external or handheld tester required to provide channel diagnostic information

LAN Redundancy

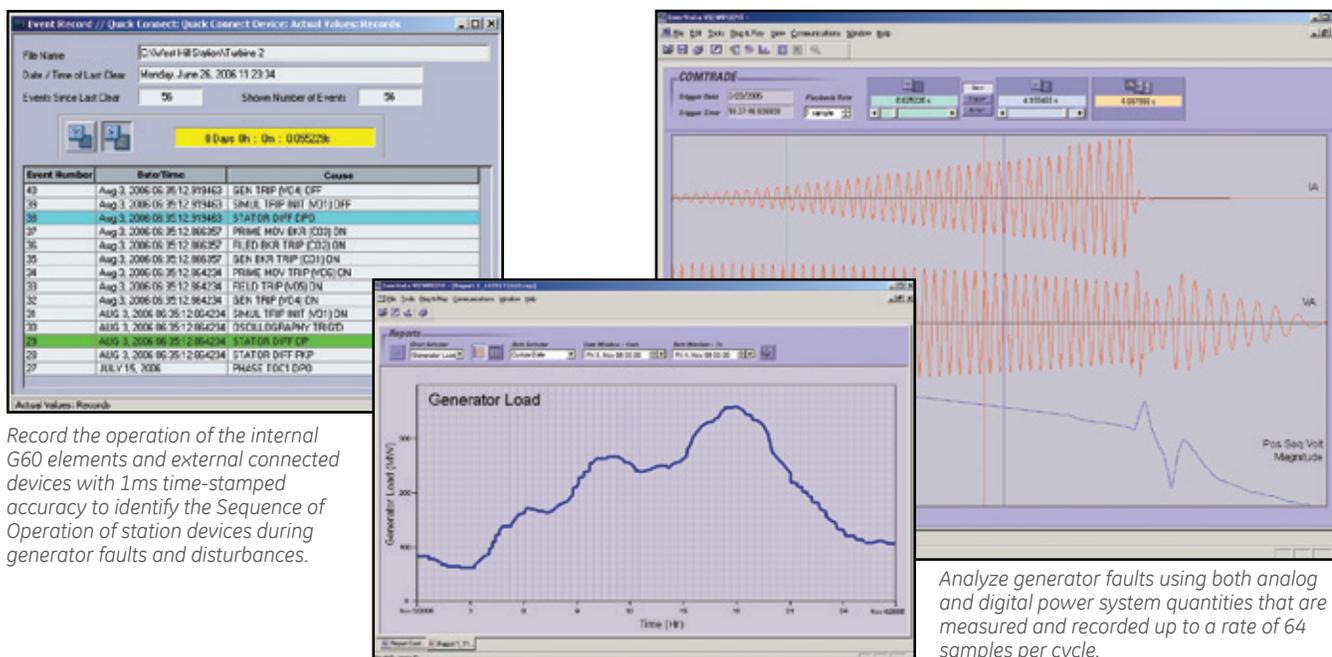
Substation LAN redundancy has been traditionally accomplished by reconfiguring the active network topology in case of failure. Regardless of the type of LAN architecture (tree, mesh, etc), reconfiguring the active LAN requires time to switchover, during which the LAN is unavailable. UR devices deliver redundancy as specified by PRP-IEC 62439-3, which eliminates the dependency on LAN reconfiguration and the associated switchover time. The UR becomes a dual attached node that transmits data packets over both main and redundant networks simultaneously, so in case of failure, one of the data packets will reach the receiving device with no time delay.

Multi-Language

UR devices support multiple languages: English, French, Russian, Chinese, Turkish and German. These language options are available on the front panel, in the EnerVista setup software, and in the product manuals. Easily switch between English and an additional language on the local displays without uploading new firmware.

Power System Troubleshooting

The G60 contains many tools and reports that simplify and reduce the amount of time required for troubleshooting power system events.



Record the operation of the internal G60 elements and external connected devices with 1ms time-stamped accuracy to identify the Sequence of Operation of station devices during generator faults and disturbances.

Log generator operating parameters to allow for analyzing generator loading and performance over weeks and months.

Analyze generator faults using both analog and digital power system quantities that are measured and recorded up to a rate of 64 samples per cycle.

Ordering

	G60	-	*	00	-	H	*	*	-	F	**	-	H	**	-	M	**	-	P	**	-	U	**	-	W/X	**
Base Unit	G60																									For full sized horizontal mount
CPU																										Base Unit RS485 + RS485 (IEC 61850 option not available) RS485 + multimode ST 100BaseFX RS485 + multimode ST Redundant 100BaseFX RS485 + 10/100 BaseT RS485 + three multimode SFP LC 100BaseFX. Req FW v7xx or higher RS485 + two multimode SFP LC 100BaseFX + one SFP RJ45 100BaseT. Req FW v7xx or higher RS485 + three SFP RJ45 100BaseT. Req FW v7xx or higher
Software Options (see note 1 below)																										No Software Options Ethernet Global Data (EGD) IEC 61850 Ethernet Global Data (EGD) + IEC 61850 Phasor Measurement Unit (PMU) IEC 61850 + Phasor Measurement Unit (PMU) CyberSentry UR Lvl 1. Req UR FW 7.xx or higher IEEE 1588. Req UR FW 7.xx or higher PRP IEEE 1588 + CyberSentry UR. Req UR FW 7.xx or higher IEC 61850 + PMU + 61850-90-5
Mount / Coating																										Horizontal (19" rack) - Standard Horizontal (19" rack) - Harsh Environment Coating Vertical (3/4 size) - Standard Vertical (3/4 size) - Harsh Environment Coating
User Interface																										Vertical Front Panel with English Display Enhanced German Front Panel Enhanced German Front Panel with User-Programmable Pushbuttons Enhanced English Front Panel Enhanced English Front Panel with User-Programmable Pushbuttons Enhanced French Front Panel Enhanced French Front Panel with User-Programmable Pushbuttons Enhanced Russian Front Panel Enhanced Russian Front Panel with User-Programmable Pushbuttons Enhanced Chinese Front Panel Enhanced Chinese Front Panel with User-Programmable Pushbuttons Enhanced Turkish Front Panel Enhanced Turkish Front Panel with User-Programmable Pushbuttons
Power Supply (see note 2 below)																										125 / 250 V AC/DC 125/250 V AC/DC with redundant 125/250 V AC/DC 24 - 48 V (DC only)
CT/VT DSP																										Standard 4CT/4VT w/ enhanced diagnostics Sensitive Ground 4CT/4VT w/ enhanced diagnostics Standard 8CT w/ enhanced diagnostics Sensitive Ground 8CT w/ enhanced diagnostics
IEC 61850 Process Bus																										8 Port IEC 61850 Process Bus Module
Digital I/O																										No module 4A 4 Solid State (No Monitoring) MOSFET Outputs 4C 4 Solid State (Current w/opt Voltage) MOSFET Outputs 4D 16 Digital Inputs with Auto-Burnish 4L 14 Form-A (No Monitoring) Latchable Outputs 67 8 Form-A (No Monitoring) Outputs 6C 8 Form-C Outputs 6D 16 Digital Inputs 6E 4 Form-C Outputs, 8 Digital Inputs 6F 8 Fast Form-C Outputs 6K 4 Form-C & 4 Fast Form-C Outputs 6L 2 Form-A (Current w/ opt Voltage) & 2 Form-C Outputs, 8 Digital Inputs 6M 2 Form-A (Current w/ opt Voltage) & 4 Form-C Outputs, 4 Digital Inputs 6N 4 Form-A (Current w/ opt Voltage) Outputs, 8 Digital Inputs 6P 6 Form-A (Current w/ opt Voltage) Outputs, 4 Digital Inputs 6R 2 Form-A (No Monitoring) & 2 Form-C Outputs, 8 Digital Inputs 6S 2 Form-A (No Monitoring) & 4 Form-C Outputs, 4 Digital Inputs 6T 4 Form-A (No Monitoring) Outputs, 8 Digital Inputs 6U 6 Form-A (No Monitoring) Outputs, 4 Digital Inputs 6V 2 Form-A (Cur w/ opt Volt) 1 Form-C Output, 2 Latching Outputs, 8 Digital Inputs
Transducer I/O																										5A 4 dcmA Inputs, 4 dcmA Outputs 5C 8 RTD Inputs 5D 4 RTD Inputs, 4 dcmA Outputs 5E 4 dcmA Inputs, 4 RTD Inputs 5F 8 dcmA Inputs
Inter-Relay Communications																										7A 820 nm, multimode, LED, 1 Channel 7B 1300 nm, multimode, LED, 1 Channel 7C 1300 nm, singlemode, ELED, 1 Channel 7H 820 nm, multimode, LED, 2 Channels 7I 1300 nm, multimode, LED, 2 Channels 7J 1300 nm, singlemode, ELED, 2 Channels 7S G.703, 2 Channels 7W RS422, 2 Channels 76 IEEE C37.94, 820 nm, multimode, LED, 1 Channel 77 IEEE C37.94, 820 nm, multimode, LED, 2 Channel

Ordering Notes:

1. To view all available model order codes, options for G60 or to order the UR Classic Front Panel, please visit GE's On-Line Store at <http://store.gedigitalenergy.com/viewprod.asp?model=G60>
2. Redundant power supply only available in horizontal unit. If redundant is chosen, must be same type. Maximum 2 per chassis

GEDigitalEnergy.com

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English
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imagination at work