

Multilin™ G60

GENERATOR PROTECTION SYSTEM

Comprehensive protection for generators



KEY BENEFITS

- Secure, high-speed protection elements for complete generator protection, compliant with IEEE C37.102
- Complete IEC 61850 Process Bus solution providing resource optimization and minimizing total P&C lifecycle costs
- Advanced fault and disturbance recording, including internal relay operating signals thus eliminating the need for external recording devices
- Robust network security enabling Critical Infrastructure Protection through user command logging, and dual permission access control
- Advanced automation capabilities for providing customized protection and control solutions
- Phasor Measurement Unit - Synchronised phasor information according to IEEE C37.118 standard
- Available Ethernet Global Data (EGD) eases integration with new and existing GE Energy control systems
- Reduced relay to relay wiring and associated installation costs through high-speed inter-relay communications
- Ambient temperature monitoring with alarming when outside temperature exceeds upper thresholds

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 system
- Standard protection product offering on new General Electric generator installations.

FEATURES

Protection and Control

- Generator stator differential
- 100% stator ground protection 3rd harmonic
- Field ground protection
- 100% stator ground fault protection using sub-harmonic injection
- Loss of excitation
- Power swing blocking and out-of-step tripping
- Backup distance
- Reverse / low forward power
- Restricted Ground Fault and Thermal overload protection
- Overexcitation
- Generator unbalance

Communications

- Networking interfaces - 100Mbit Fiber Optic Ethernet, RS485, RS232, RS422, G.703, C37.94
- Multiple Protocols - IEC 61850, DNP 3.0 Level 2, Modbus RTU, Modbus TCP/IP, IEC 60870-5-104, Ethernet Global Data (EGD)
- Direct I/O - secure, high-speed exchange of data between URs for Direct Transfer Trip and I/O Extension applications
- Embedded Managed Ethernet Switch with 4 - 100 Mbit Fiber optic ports and 2 copper ports

IEC 61850 Process Bus Interface

- Robust communications with up to 8 HardFiber Bricks
- Seamless integration with existing G60 functions
- Redundant architecture for dependability and security

Monitoring and Metering

- Metering - current, voltage, power, energy, frequency
- Oscillography - analog and digital parameters at 64 samples/cycle
- Event Recorder - 1024 time tagged events with 0.5ms scan of digital inputs
- Data Logger - 16 channels with sampling rate up to 1 sample / cycle
- Advanced relay health diagnostics
- P & M Class synchrophasors of voltage, current and sequence components - 1 to 120 frames/sec

EnerVista™ Software

- Graphical Logic Designer and Logic Monitor to simplify designing and testing procedures
- Document and software archiving toolset to ensure reference material and device utilities are up-to-date
- EnerVista™ Integrator providing easy integration of data in the G60 into new or existing monitoring and control systems



Protection and Control

The 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. As part of the UR Family, the G60 provides superior protection and control that includes:

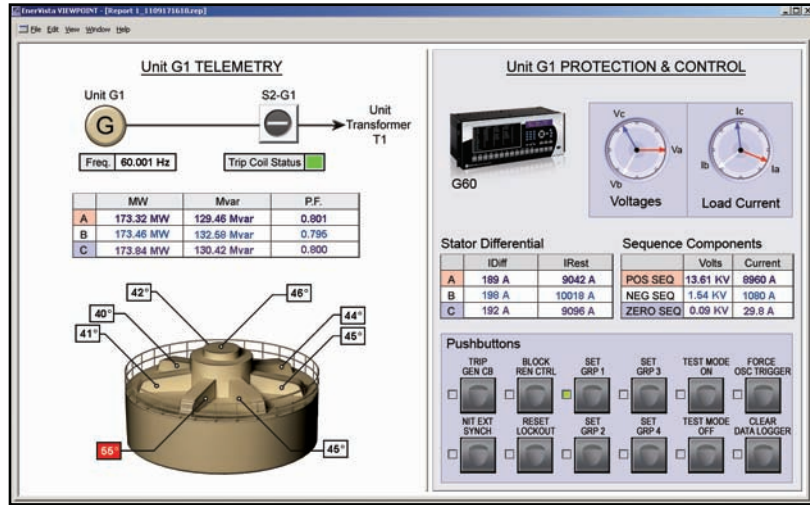
Generator Stator Differential

High-speed stator differential protection provides sub-cycle detection and high speed clearing of stator phase faults. Advanced CT saturation 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

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.

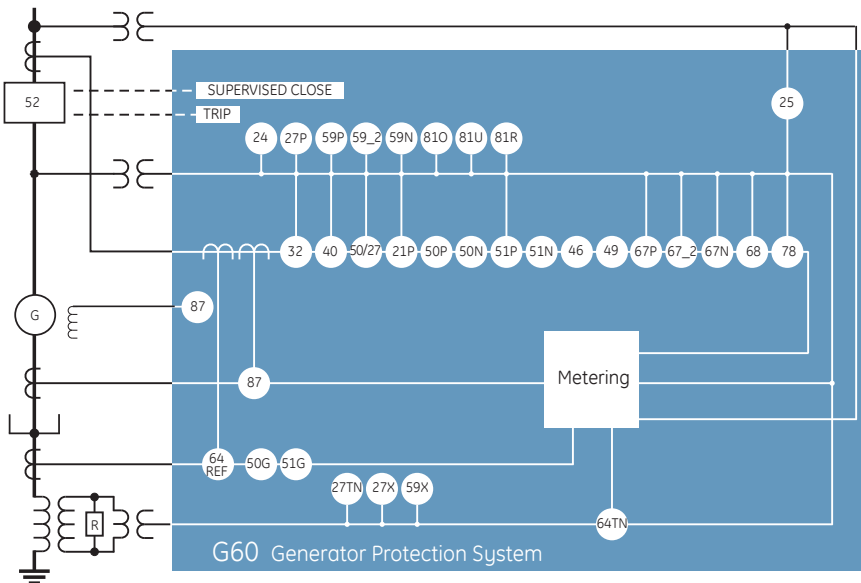
insensitive to the absolute value of the third harmonic and is easily set without the need for on-line measurements. For generator with delta connected PTs, a third harmonic undervoltage element is also offered for detecting a loss of the third harmonic voltage at the generator neutral.

Field Ground Protection*

Field ground protection identifies occurrence of ground fault in a generator field winding and helps to prevent serious

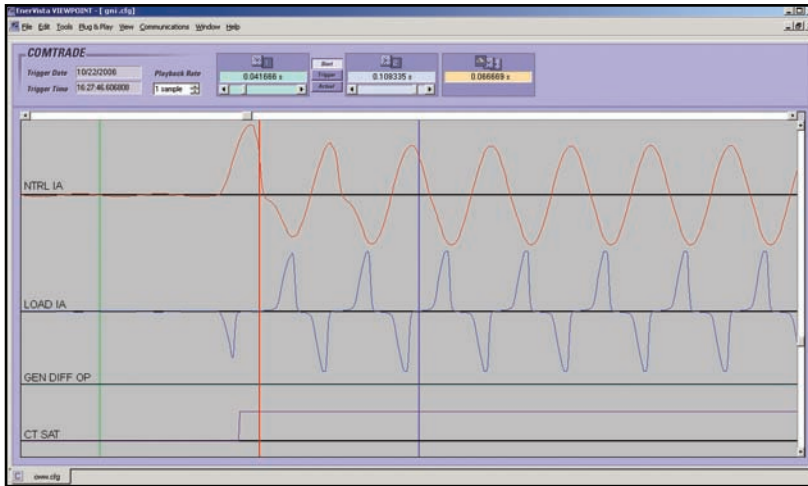
damage to the generator, maximizing operational lifespan. The field ground protection module works in combination with UR G60 to detect ground faults in the field winding of the generator. The solution includes: two stage field ground detection, injected voltage and current supervision, brush lift-off detection, field over and under current elements and field ground fault location.

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
50P	Phase Instantaneous Overcurrent
50SP	Split Phase Instantaneous Overcurrent
50/27	Accidental Energization
51G	Ground Time Overcurrent
51P	Phase Time Overcurrent
59N	Neutral Overvoltage
59P	Phase Overvoltage
59X	Auxiliary Overvoltage
59_2	Negative Sequence Overvoltage
64RGF	Restricted Ground Fault
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
87	Generator Stator Differential



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.

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 works in combination with UR G60 to provide a 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 over current 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. 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 protections. 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 (RGF)

Restricted Ground Fault 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 RGF protection provided 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 elements to monitor differences in voltage magnitudes, phase angles, and frequencies to perform synchronism check across up to two breakers. 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 to standard RTD wiring.

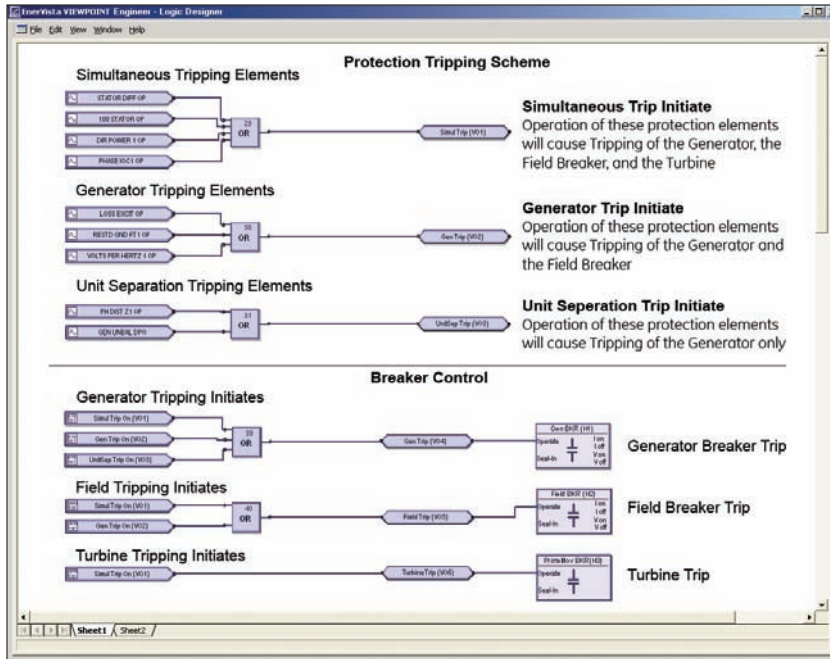
IEC 61850 Process Bus

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 the existing Universal Relay 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 IEC 61850 Process Bus module

FlexLogic™ Designer



FlexLogic™ allows for customizing the G60 outputs for most generator protection schemes and applications.

- 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 the unit and auxiliary transformers, and Balance of Plant protection.

FlexLogic™

FlexLogic™ is the powerful UR-platform programming logic engine that provides the ability of creating customized protection and control schemes thereby minimizing the need, and the associated costs, of auxiliary components and wiring. Using FlexLogic™, the G60 can be programmed to provide 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 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 & 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 creation of regulatory reports. Recording functions include:

- Sequence of Event (SOE)
 - 1024 time stamped events
- Oscillography
 - 64 digital & up to 40 Analog channels
- Data Logger, 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 standalone recording equipment.

Advanced Device Health Diagnostics

The G60 performs comprehensive device health diagnostic tests during startup and continuously at runtime 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 helps improve system uptime.

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

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 redundant Ethernet option and the embedded managed Ethernet switch provide the means of creating 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
- DNP 3.0
- Ethernet Global Data (EGD)
- IEC 60870-5-104
- Modbus RTU, Modbus TCP/IP

Interoperability with Embedded IEC 61850

Use the G60 with integrated IEC 61850 to lower costs associated with generator protection, control and automation. GE Energy's leadership in IEC 61850 comes from thousands of installed devices and follows on seven years of development experience with UCA 2.0.

- Replace expensive copper wiring between devices with direct transfer of data using GOOSE messaging
- Configure systems based on IEC 61850 and also monitor and troubleshoot them in real-time with EnerVista™ Viewpoint Engineer
- Integrate Multilin IEDs and generic IEC 61850-compliant devices seamlessly in EnerVista™ Viewpoint Monitoring

Direct I/O Messaging

Direct I/O allows for 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.

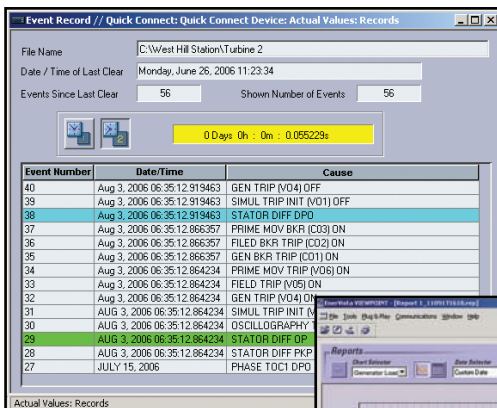
- Communication with up to 16 UR relays in single or redundant rings rather than strictly limited to simplistic point-to-point configurations between two devices
- Connect to standard DS0 channel banks through standard RS422, G.703 or IEEE C37.94 interfaces or via direct fiber optic connections
- No external or handheld tester required to provide channel diagnostic information

Multi-Language

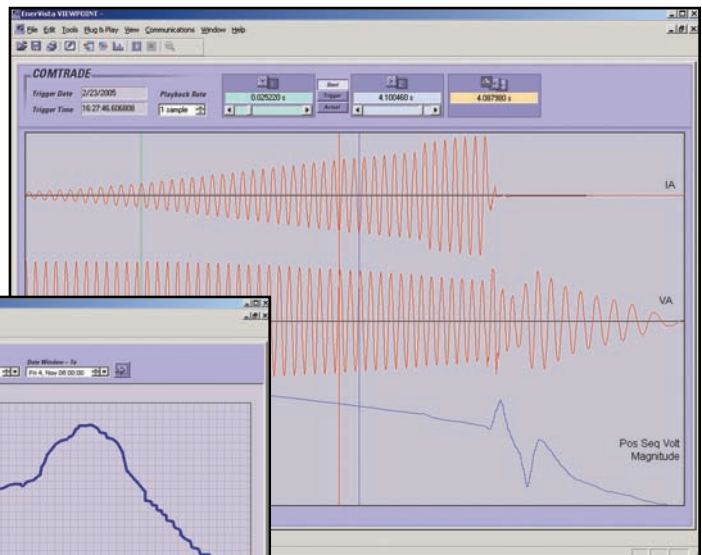
The G60 supports English, French, Russian, Chinese and Turkish Languages on the front panel, EnerVista™ setup software, and product manual. Easily switch between English and an additional language on the local displays without uploading new firmware.

Power System Troubleshooting

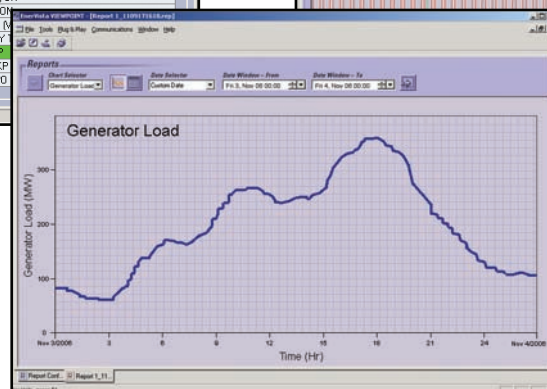
The G60 contains many tools and reports that simplify and reduce the amount of time required for troubleshooting power system events.



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.



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.



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

EnerVista™ Software

The EnerVista™ Suite is an industry-leading set of software programs that simplifies every aspect of using the G60 relay. The EnerVista™ suite provides all the tools to monitor the status of the protected asset, maintain the relay, and integrate information measured by the G60 into DCS or SCADA monitoring systems. Convenient COMTRADE and Sequence of Events viewers are an integral part of the UR Setup software included with every UR relay, to carry out postmortem event analysis to ensure proper protection system operation.

EnerVista™ Launchpad

EnerVista™ Launchpad is a powerful software package that provides users with all of the setup and support tools needed for configuring and maintaining Multilin products. The setup software within Launchpad allows configuring devices in real-time by communicating using serial, Ethernet, or modem connections, or offline by creating setting files to be sent to devices at a later time.

Included in Launchpad is a document archiving and management system that ensures critical documentation is up-to-date and available when needed. Documents made available include:

- Manuals
- Application Notes
- Guideform Specifications
- Brochures
- Wiring Diagrams
- FAQs
- Service Bulletins

Viewpoint Monitoring

Viewpoint Monitoring is a simple-to-use and full-featured monitoring and data recording software package for small systems. Viewpoint Monitoring provides a complete HMI package with the following functionality:

- Plug & Play Device Monitoring
- System Single-Line Monitoring & Control
- Annunciator Alarm Screens
- Trending Reports
- Automatic Event Retrieval
- Automatic Waveform Retrieval

Viewpoint Engineer

Viewpoint Engineer is a set of powerful tools that will allow the configuration and testing of UR relays at a system level in an easy-to-use graphical drag-and-drop environment. Viewpoint Engineer

provides the following configuration and commissioning utilities:

- Graphical Logic Designer
- Graphical System Designer
- Graphical Logic Monitor
- Graphical System Monitor

Viewpoint Maintenance

Viewpoint Maintenance provides tools that will create reports on the operating status of the relay, simplify the steps to download fault and event data, and reduce the work required for cyber-security compliance audits. Tools available in Viewpoint Maintenance include:

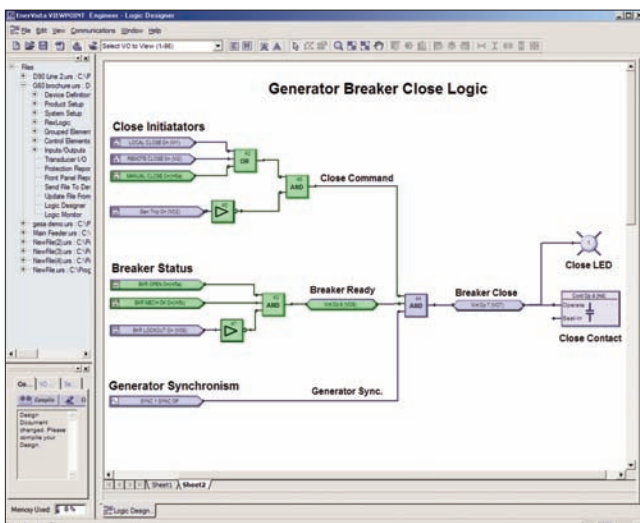
- Settings Security Audit Report
- Device Health Report
- Single Click Fault Data Retrieval

EnerVista™ Integrator

EnerVista™ Integrator is a toolkit that allows seamless integration of Multilin devices into new or existing automation systems. Included in EnerVista™ Integrator is:

- OPC/DDE Server
- Multilin Drivers
- Automatic Event Retrieval
- Automatic Waveform Retrieval

Simplifying Commissioning and Testing



The internal operation of the G60 elements, logic, and outputs can be monitored in real time to simplify commissioning and troubleshooting procedures

Simplifying G60 Configuration

SETTING	PARAMETER
Function	Enabled
Line End Source	SRC 1 (SRC 1)
Neutral End Source	SRC 2 (SRC 2)
Pickup	0.100 pu
Break 1	15 %
Break 2	1.15 pu
Block	80 %
Targets	8.00 pu
Events	Enabled

Create G60 Setting File Templates to ensure critical settings are not altered

Ordering

Generator Protection

	G60	-	* 00	-	H	*	-	F **	-	H **	-	M **	-	P **	-	U **	-	W/X	**	For full size
Base Unit	G60																			Base Unit
CPU	E																			RS485 + RS485 (IEC 61850 option not available)
	G																			RS485 + multi-mode ST 10BaseF
	H																			RS485 + multi-mode ST Redundant 10BaseF
	J																			RS485 + multi-mode ST 100BaseFX
	K																			RS485 + multi-mode ST Redundant 100BaseFX
	N																			RS485 + 10/100 BaseT
	S																			RS485 + 6 port, 100 Mbps, Managed Ethernet Switch
Software Options			00																	No Software Options
			01																	Ethernet Global Data (EGD)
			03																	IEC 61850
			04																	Ethernet Global Data (EGD) + IEC 61850
			05																	Phasor Measurement Unit (PMU)
			06																	IEC 61850 + Phasor Measurement Unit (PMU)
Mount / Coating					H															Horizontal (19" rack) - Standard
					A															Horizontal (19" rack) - Harsh Environment Coating
					V															Vertical (3/4 size) - Standard
					B															Vertical (3/4 size) - Harsh Environment Coating
User Interface																				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
																				Vertical Front Panel with English display
																				Enhanced Turkish Front Panel
																				Enhanced Turkish Front Panel with User-Programmable Pushbuttons
Power Supply																				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								8L				8L								Standard 4CT/4VT w/ enhanced diagnostics
								8M				8M								Sensitive Ground 4CT/4VT w/ enhanced diagnostics
								8N				8N								Standard 8CT w/ enhanced diagnostics
								8R				8R								Sensitive Ground 8CT w/ enhanced diagnostics
IEC 61850 Process Bus										81										8 Port IEC 61850 Process Bus Module
Digital I/O																				No module
										XX		XX		XX		XX				4 Solid State (No Monitoring) MOSFET Outputs
										4A		4A		4A		4A				4 Solid State (Current w/opt Voltage) MOSFET Outputs
										4C		4C		4C		4C				16 Digital Inputs with Auto-Burnish
										4D		4D		4D		4D				14 Form-A (No Monitoring) Latchable Outputs
										4L		4L		4L		4L				8 Form-A (No Monitoring) Outputs
										67		67		67		67				8 Form-C Outputs
										6C		6C		6C		6C				16 Digital Inputs
										6D		6D		6D		6D				4 Form-C Outputs, 8 Digital Inputs
										6E		6E		6E		6E				8 Fast Form-C Outputs
										6F		6F		6F		6F				4 Form-C & 4 Fast Form-C Outputs
										6K		6K		6K		6K				2 Form-A (Current w/ opt Voltage) & 2 Form-C Outputs, 8 Digital Inputs
										6L		6L		6L		6L				4 Form-A (Current w/ opt Voltage) & 4 Form-C Outputs, 4 Digital Inputs
										6M		6M		6M		6M				4 Form-A (Current w/ opt Voltage) Outputs, 8 Digital Inputs
										6N		6N		6N		6N				2 Form-A (Current w/ opt Voltage) Outputs, 4 Digital Inputs
										6P		6P		6P		6P				4 Form-A (No Monitoring) & 2 Form-C Outputs, 8 Digital Inputs
										6R		6R		6R		6R				2 Form-A (No Monitoring) & 4 Form-C Outputs, 4 Digital Inputs
										6S		6S		6S		6S				4 Form-A (No Monitoring) Outputs, 8 Digital Inputs
										6T		6T		6T		6T				6 Form-A (No Monitoring) Outputs, 4 Digital Inputs
										6U		6U		6U		6U				2 Form-A (Cur w/ opt Volt) 1 Form-C Output, 2 Latching Outputs, 8 Digital Inputs
										6V		6V		6V		6V				4 dcmA Inputs, 4 dcmA Outputs
Transducer I/O										5A		5A		5A		5A				8 RTD Inputs
										5C		5C		5C		5C				4 RTD Inputs, 4 dcmA Outputs
										5D		5D		5D		5D				4 dcmA Inputs, 4 RTD Inputs
										5E		5E		5E		5E				8 dcmA Inputs
										5F		5F		5F		5F				
Inter-Relay Communications																				7A 820 nm, multi-mode, LED, 1 Channel
																				7B 1300 nm, multi-mode, LED, 1 Channel
																				7C 1300 nm, single-mode, ELED, 1 Channel
																				7H 820 nm, multi-mode, LED, 2 Channels
																				7I 1300 nm, multi-mode, LED, 2 Channels
																				7J 1300 nm, single-mode, ELED, 2 Channels
																				7S G.703, 2 Channels
																				7W RS422, 2 Channels
																				76 IEEE C37.94, 820 nm, multi-mode, LED, 1 Channel
																				77 IEEE C37.94, 820 nm, multi-mode, LED, 2 Channel
																				2S 6 port, 100 Mbps, Managed Ethernet Switch, HI (125/250V AC/DC)
																				2T 6 port, 100 Mbps, Managed Ethernet Switch, LO (24-48 Vdc)

Ordering Notes:

- 1 - For vertical mounting order codes, please visit our online store
- 2 - To view the latest options available for the G60 please visit our online store for more details.

Accessories for the G60

- UR Applications I Learning CD TRCD-URA1-C-S-1
- Multilink Ethernet Switch ML2400-F-HI-HI-A2-A2-A6-G1
- Viewpoint Engineer VPE-1
- Viewpoint Maintenance VPM-1
- Viewpoint Monitoring IEC 61850 VP-1-61850

Visit www.GEMultilin.com/G60 to:



- View Guideform Specifications
- Download the instruction manual
- Review applications notes and support documents
- Buy a G60 online
- View the UR Family brochure