

Multilin F60



Advanced Protection, Control & Automation for Distribution Feeders

The Multilin™ F60 Feeder Protection System provides feeder protection, control, monitoring and metering in an integrated, economical, and compact package.

The F60 incorporates a unique and matured algorithm to detect high-impedance faults, such as downed conductor detection. It also provides fast and deterministic execution of programmable logic, which is necessary for substation automation applications. Graphical programming tools (Viewpoint Engineer), supported by a library of logic components, make the F60 simple to use and configure.

Key Benefits

- Advanced and flexible protection and control for distribution feeder applications with unique and secure downed conductor detection backed by many years of field experience
- Flexible load encroachment allows secure operation during heavy load conditions
- Voltage and frequency elements provide load shedding & transfer schemes for increased system uptime and stability
- 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
- An integrated large, full color display, provides real-time visualization and control of the protected bay, via a bay mimic as well as annunciator functionality and graphical visualization of phasors
- Advanced IEC 61850 Ed. 1 and Ed. 2 certified implementation, complete settings via SCL files and IEC 61850-9-2 process bus solution ensures interoperability, device managing optimization and reduced cost of ownership
- Routable GOOSE (R-GOOSE) enables GOOSE messages going beyond the substation, which enables wide area protection and control applications
- Increased network availability via failover time reduced to zero through IEC® 62439-3 "PRP" support
- Supports IEEE C37.111-1999/2013, IEC 60255-24 Ed 2.0 COMTRADE standard

Applications

- Primary protection and control for feeders on solidly, impedance or resonant (Petersen coil) grounded systems
- Busblocking / interlocking schemes
- Distribution load shedding schemes based on voltage and frequency elements
- High-speed fault detection for arc flash mitigation
- Throw over schemes (bus transfer scheme applications)
- Backup protection for transmission lines, feeders and transformers
- Distributed Generation (DG) interconnect protection , including active and passive anti-islanding

Protection & Control

- High-impedance fault detection (downed conductor detection)
- Thermal overload, incipient cable fault and broken conductor detection
- Four-shot autorecloser, VT fuse failure detection, and synchronism check
- Protection and control functionality in one box, reducing the number of devices
- High density inputs/outputs to support the control of many switchyard assets – all from one powerful device
- Integrated large, full color display, for real-time visualization and control of the protected bay

Advanced Communications

- 3 independent Ethernet ports for simultaneous & dedicated network connections with IEEE 1588 support
- IEC 61850-9-2 process bus support
- Direct I/O for secure, high-speed exchange of data between URs for DTT & pilot-aided schemes

Cyber Security

- CyberSentry™ provides high-end cyber security aligned to industry standards and services (NERC® CIP, AAA, Radius, RBAC, Syslog)

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

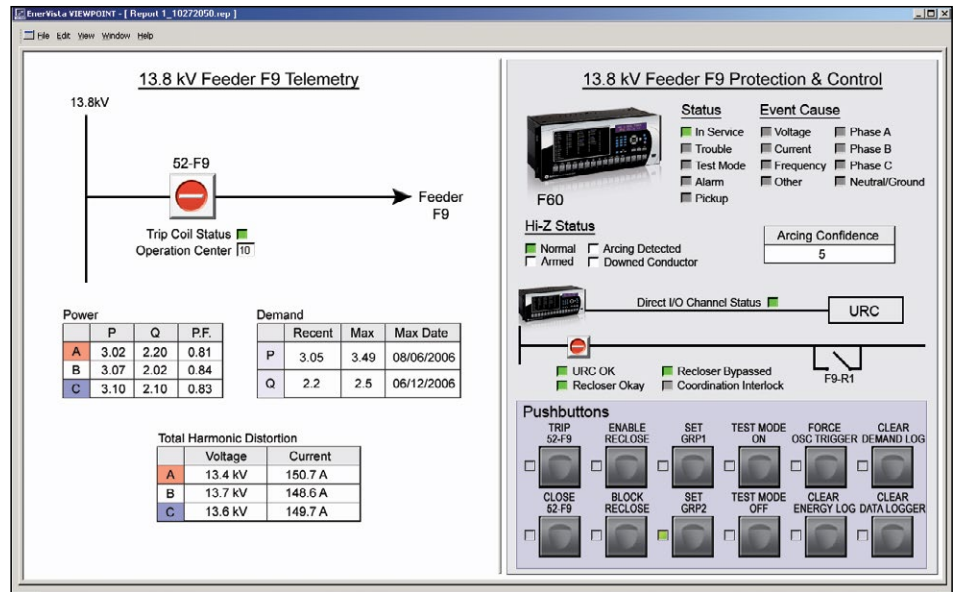
As part of the Universal Relay (UR) family, the F60 features high-performance protection, expandable I/O options, integrated monitoring and metering, high-speed communications, and extensive programming and configuration capabilities including:

Downed Conductor (Hi-Z) Detection

Fires, injuries, and even fatalities may be caused by a live downed conductor. Unfortunately, these high risk incidences often go undetected by conventional protective relays.

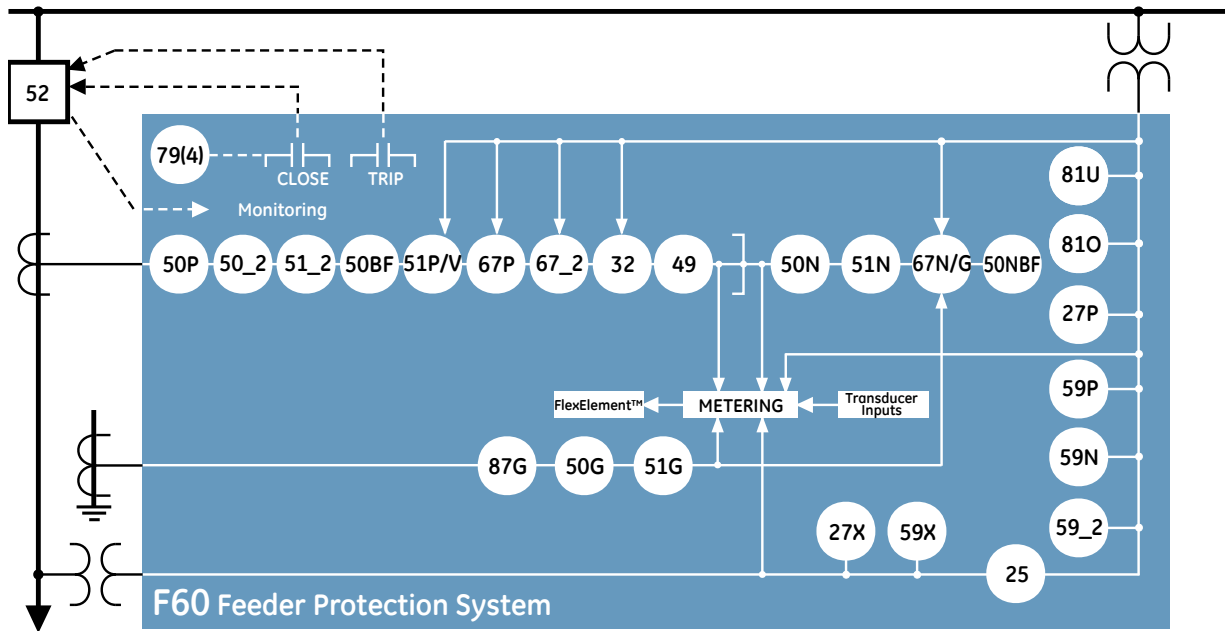
The Hi-Z element in the F60, unique to Multilin, provides reliable detection of faults caused by downed conductors. Sophisticated algorithms developed over the past 20 years, detect downed conductors, tree branch contacts, and insulation fault in underground cables. This unique, field-proven algorithm incorporates artificial intelligence to maximize dependability. Key benefits of Hi-Z detection in the F60:

F60 - Protection, Metering, Monitoring and Control



The F60 offers an integrated protection, control, metering and monitoring package that can directly connect into DCS or SCADA monitoring control systems, such as Viewpoint Monitoring.

Functional Block Diagram



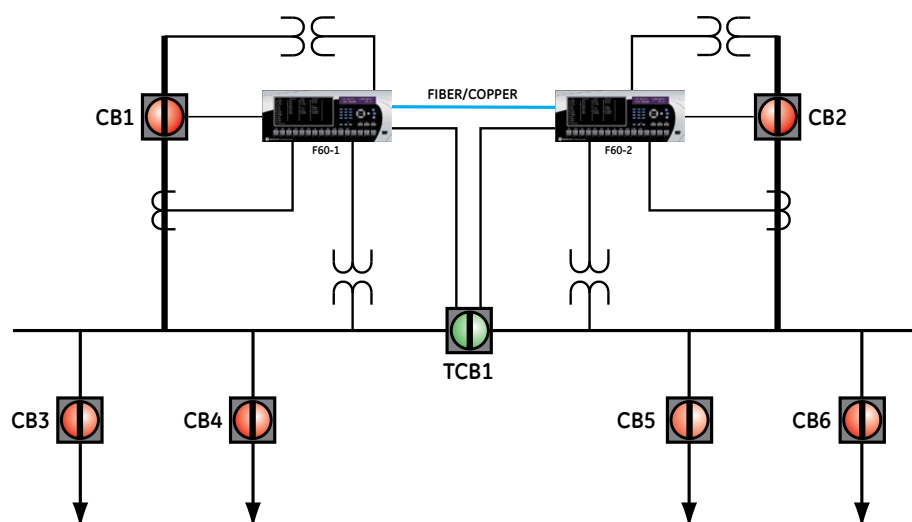
ANSI® Device Numbers & Functions

DEVICE NUMBER	FUNCTION
25	Synchrocheck
27P	Phase Undervoltage
27X	Auxiliary Undervoltage
32	Sensitive Directional Power
50BF/50BNF(2)	Breaker Failure
50DD	Disturbance Detector
50G	Ground Instantaneous Overcurrent
50N	Neutral Instantaneous Overcurrent
50P	Phase Instantaneous Overcurrent

DEVICE NUMBER	FUNCTION
50_2	Negative Sequence Instantaneous Overcurrent
51G	Ground Time Overcurrent
51N	Neutral Time Overcurrent
51P	Phase Time Overcurrent
51_2	Negative Sequence Time Overcurrent
52	AC Circuit Breaker
59N	Neutral Overvoltage
59P	Phase Overvoltage

DEVICE NUMBER	FUNCTION
59X	Auxiliary Overvoltage
59_2	Negative Sequence Overvoltage
67N	Neutral Directional Overcurrent
67P	Phase Directional
67_2	Negative Sequence Directional Overcurrent
79	Automatic Recloser
81O	Overfrequency
81U	Underfrequency
87G(RFG)	Restricted Ground Fault

Auto-Transfer Scheme Implementation Example



Auto-transfer schemes can be implemented using programmable FlexLogic. Wiring between relays can be eliminated using peer-to-peer communication.

- Reliable detection of faults caused by downed conductors
- Fast response to hazardous situations
- Dependable and secure operation using artificial intelligence
- Detection of arcing faults
- Easy integration by the addition of a Hi-Z module to a new or existing F60 relay

Directional Overcurrent Protection

The F60 also has built-in standard IEEE, IEC, IAC and FlexCurves™ overcurrent characteristics (TOC), most commonly used for primary and backup protection in various protective zones. It has phase IOC elements with separate outputs for each phase. Each TOC element has the following programmable characteristics:

- Pickup current level for trip, alarm, or control
- Choice of 17 curve shapes (including FlexCurves) and curve multipliers
- Instantaneous or linear reset time characteristic to coordinate with upstream transformer damage curves and downstream reclosers and fuses
- Voltage restraint to increase sensitivity

The majority of distribution systems are either solidly grounded or grounded through a low impedance. Fast fault clearance is required due to the ground fault impact. The following functions are incorporated in the F60 to provide secure ground protection:

- Neutral IOC and TOC
- Ground IOC and TOC

The F60 allows the use of directional elements for supervision of ground overcurrent protection elements and provide sensitive tripping for faults in one direction. Typical application for directional overcurrent includes:

- Isolation of faulted feeders in ring bus or parallel feeder arrangements
- Prevention of back-feeding utility source fault from industrial plant generators
- Sensitive high-speed ground fault protection for transformers

For neutral directional sensing, the residual current of the phase CTs is used as the operating current. For current polarization, a residual CT is used to measure zero-sequence current. For voltage polarization, the calculated or measured zero-sequence voltage can be used. The maximum torque angle is programmable. Two enhanced dual polarization modes use both current and voltage signals to determine polarity. “Dual-V” polarization gives priority to polarity determined based on voltage while “Dual-I” polarization gives priority to polarity determined based on current.

Load Encroachment

The load encroachment function in the F60 provides the capability to manage load growth in feeders. The load encroachment element can be set for the feeder’s expected maximum load, reducing the likelihood of false tripping for load conditions while maintaining dependability to trip for legitimate faults.

It allows the phase overcurrent elements to be set to see end-of-line phase faults in heavily loaded feeder applications.

Over/Under Voltage Protection

The F60 includes the following voltage elements:

- Up to 2 phase undervoltage and 3 phase overvoltage elements
- 1 auxiliary under/over voltage element
- 1 neutral overvoltage element

The following are some of the key applications where voltage elements can be used:

- Source transfer schemes
- Load shedding schemes
- Backup capacitor bank protection and control
- Backup motor protection to prevent automatic restart

Abnormal Frequency Protection

The F60 offers over and underfrequency elements to improve network (grid) stability using voltage or frequency-based load shedding techniques. The F60 can be integrated into a communications network containing N60 network stability relays to implement wide area, intelligent load shedding schemes. It also provides backup protection when protecting feeders and other frequency-sensitive power equipment.

Frequency Rate of Change Protection

Frequency rate of change (df/dt) elements are included in the F60 to provide protection against system disturbances through load shedding and to provide anti-islanding protection for distributed generator interconnections.

Cold Load Pickup

A cold load condition can be caused by a prolonged outage of the load, by opening the circuit breaker, or by a loss of supply even if the breaker remains closed (cyclic loads like HVAC, refrigeration systems). F60 can automatically detect conditions that would lead to cold load pickup and selectively block protection elements for security during feeder energization.

Wattmetric Ground Fault Protection

A sensitive wattmetric zero-sequence directional function can be used on isolated or resonant (Petersen coil) grounded, low-resistance grounded and solidly grounded systems to detect ground faults.

This function determines the presence and direction of ground faults by measuring the value and direction of zero-sequence power. This flexible element responds to power derived from zero-sequence voltage and current in a direction specified by the element characteristic angle. Power can be selected as active, reactive, or apparent. Therefore, the element may be used to sense either forward or reverse ground faults.

Autorecloser

Two autoreclose elements are provided for use with distribution lines in three-pole tripping schemes with up to two breakers. Up to four selectable recloser "shots" are possible prior to locking out. Any of the autoreclose elements can be dynamically blocked or unblocked by other elements or user logic. This way they can coordinate with the F60 protection setting groups.

Synchronism Check

The F60 provides six synchrocheck elements that monitor voltage difference, phase angle difference and slip frequency taking the CB closing time into account to ensure proper breaker closure as per user requirement. Any of the six synchrocheck elements can be dynamically blocked or unblocked by other elements or user logic. This way they can coordinate with the F60 protection setting groups.

Breaker Failure and Control

The F60 provides the required elements to perform two independent breaker failure functions. The F60 can provide independent breaker failure protection for both breakers on a feeder with a breaker-and-a-half or ring bus terminal. The relay also provides for the control of one or two breakers from faceplate pushbuttons, remote communications or contact inputs. A breaker position can be indicated by LEDs on the faceplate.

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 F60'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 F60 incorporates advanced automation features including powerful FlexLogic programmable logic, communication, and SCADA capabilities that far surpass what is found in the average feeder relay. The F60 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 to create customized protection and control schemes, minimizing the need and associated costs of auxiliary components and wiring. With 1024 lines of FlexLogic, the F60 can be programmed to provide the required tripping logic along with custom scheme logic for auto transfer schemes (main-tie-main), load shedding based on frequency, voltage and communication, loop restoration schemes, other remedial action schemes and dynamic setting group changes.

Scalable Hardware

The F60 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.

- Flexible, modular high density 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
- RTDs and DCmA inputs are available to monitor equipment parameters such as temperature and pressure

Monitoring and Metering

The F60 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. The F60 also measures up to the 25th harmonic on voltage and current, suitable for power quality applications.

Fault and Disturbance Recording

The advanced disturbance and event recording features within the F60 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
 - Supports IEEE C37.111-1999/2013, IEC 60255-24 Ed 2.0 COMTRADE standard
 - 64 digital & up to 40 analog channels
 - Events with up to 45s 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
- Extensive breaker info (continuous coil monitor, arcing current, operating time, operation counter for asset management)

The very high sampling rates and large amount of storage space available for data recording in the F60 can eliminate the need for installing costly stand-alone recording equipment.

Advanced Device Health Diagnostics

The F60 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 F60 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 F60 supports the most popular industry standard protocols enabling easy, direct integration into DCS and SCADA systems.

- IEC 61850 Ed. 1 and 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
- IEEE1588 and redundant SNTP for time synchronization
- PRP as per IEC 62439-3
- Supports Routable GOOSE (R-GOOSE)

Interoperability with Embedded IEC 61850 Ed. 1 and Ed. 2

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

- Implements, user selectable, Ed. 1 and Ed. 2 of the standard across the entire UR Family
- 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 from up to 64 remote devices, 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
- R-GOOSE enable customer to send GOOSE messages beyond the substation, which enables WAPC and more cost effective communication architectures for wide area applications

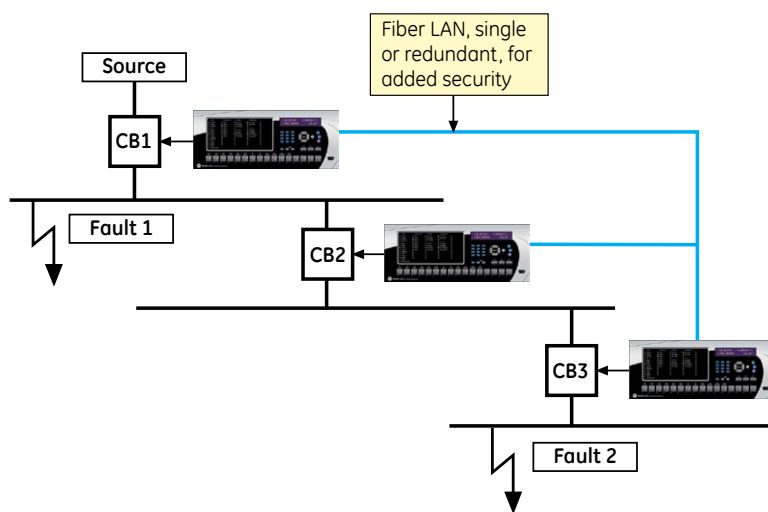
Direct I/O Messaging

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 DSO 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 DSO 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



Reverse zone interlocking protection. By using the IEC 61850/GOOSE or hi-speed direct I/O capability blocking signals can be transferred upstream, allowing for minimal coordination delays. Fast clearance can be provided for Fault 1 while still maintaining coordination for Fault 2.

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, German, Polish and Japanese. 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.

EnerVista Software

The EnerVista suite is an industry-leading set of software programs that simplifies every aspect of using the F60 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 F60 into DCS or SCADA monitoring systems. Convenient COMTRADE and SOE viewers are an integral part of the UR setup software included with every UR relay, to carry out postmortem event analysis and ensure proper protection of 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

for the configuration of 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
- FAQ's
- 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 UR Engineer

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

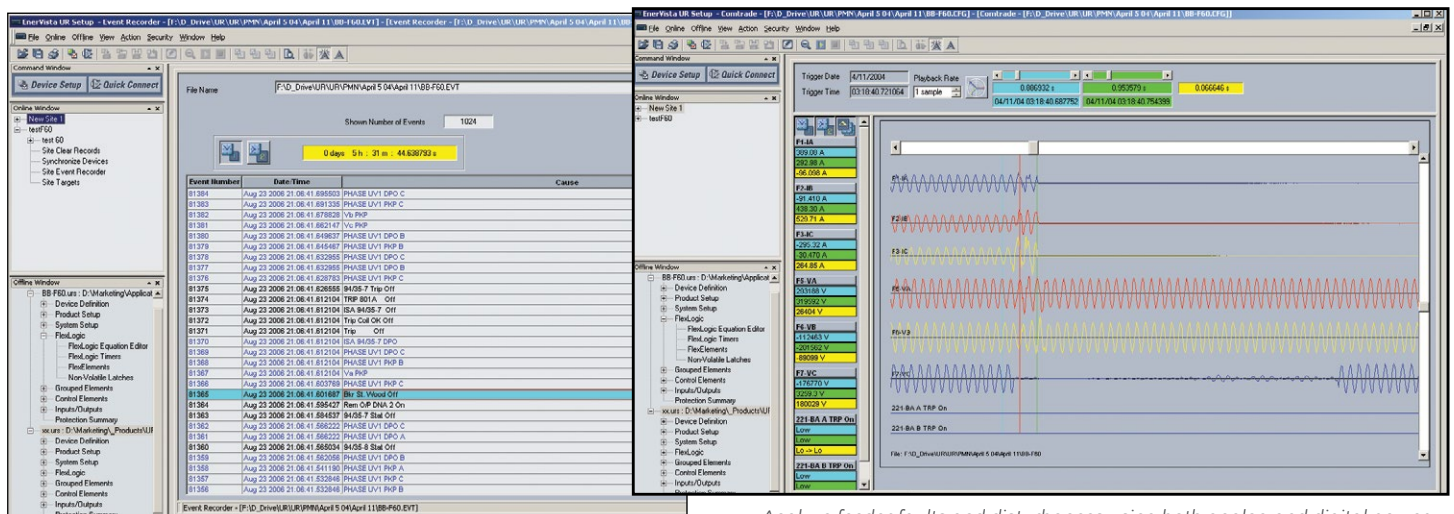
EnerVista Integrator

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

Power System Troubleshooting

The F60 contains many tools and reports that simplify and reduce the amount of time required for troubleshooting power system events, increase uptime and reduce loss of production.



Record the operation of the internal F60 elements and external connected devices with 1ms time-stamped accuracy to identify the Sequence of Operation of station devices during faults and disturbances.

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

