W650

WIND GENERATOR PROTECTION SYSTEM

Advanced wind turbine protection and control system

KEY BENEFITS

- Complete wind generator protection, control, metering and monitoring in a single device
- High accuracy metering for enhanced power control (real and reactive) even at low loads and harmonics presence
- Direct connection to generators up to 690 VAC eliminating the need of VTs.
- Maximum EMC and environmental performance per IEC/ANSI standards enabling the use wind turbines environment including off-shore wind farms
- Reduced system event analyzing time and cost through integrated Sequence of Event reports, Oscillography recording, and Trending files.
- Flexible and cost effective control for complex systems through the use of IEC 61131 compatible programmable logic to customize the relay's operation
- Reduced communications downtime through the use of reliable redundant fiber optic Ethernet communications ports

APPLICATIONS

- Protection of single wind turbine generators
- Transfer trip application for wind farm controls

FEATURES

Protection and Control

- Phase, neutral, ground and sensitive ground overcurrent
- Negative sequence overcurrent
- Directional overcurrent
- Phase overvoltage
- Phase undervoltage
- Neutral overvoltage
- Voltage unbalance
- Breaker failure
- VT Fuse failure
- Generator Overload
- Underpower and reverse power
- Overfrequency and Underfrequency

Communications

- 100Mbit Fiber Optic Ethernet
- RS485, USB or RS232, and Canbus serial interfaces
- Multiple Protocols - IEC61850, DNP 3.0 Level 2, Modbus RTU, Modbus TCP/IP, IEC60870-5-104, CANopen

Monitoring and Metering

- Metering - current, voltage, power, power factor, frequency, energy, demand
- Oscillography – analog and digital parameters at 64 samples/cycle
- Event Recorder - 128 time tagged events
- Data Logger - 16 channels with sampling rate up to 1 sample / second
- Fault Locator – 10 configurable Fault Reports

EnerVista™ Software

- State of the art software for configuration and commissioning GE Multilin products
- Document and software archiving toolset to ensure reference material and device utilities are up-to-date
- Ease to use real time monitoring, control, and data archiving software available
- EnerVista™ Integrator providing easy integration of data in the W650 into new or existing monitoring and control systems

Protection and Control

The W650 Wind Generator Protection System has been designed as a comprehensive generator protection and control device specially developed for wind turbine generators. Based on the state of the art 650 family of protection relays, the W650 provides a complete solution not only for the needs of present systems but also for the expanding needs of future infrastructure. The W650 simplifies the design of management of wind turbine generation systems through the complete set of protection, control, monitoring, metering, and recording functions available. The user-configurable modular design of the W650 provides a scalable, cost effective solution for protection and control of medium to large sized wind generators.

The W650 provides a unique solution that includes the most advanced communications technology available allowing for remote monitoring and control of both the relay and the wind turbine. Through the use of the embedded IEC61850 protocol, advance automated schemes such as transfer trip and upstream blocking applications can be developed without the need of hard wire connections between devices and thereby drastically reducing the overall costs of installation and maintenance.

Overcurrent Protection

Instantaneous and Time Overcurrent functions are available for phase, neutral, ground, and negative sequence currents. A variety of time curves are provided including IEC, IEEE/ANSI, IAC, I2t , definite time and rectifier curves along with the ability of using FlexCurves for creating user-definable overcurrent characteristics. The phase time overcurrent elements have a voltage-restrained feature that when enabled, can be used for providing more sensitivity under conditions that cause the measured voltage to drop to below nominal levels.

Directional Elements

Directional elements are provided to detect the direction of current flow and supervise or block the operation of overcurrent elements thereby allowing for proper coordination between internal and external faults. Directional Overcurrent elements are available for phase, neutral, and ground currents.

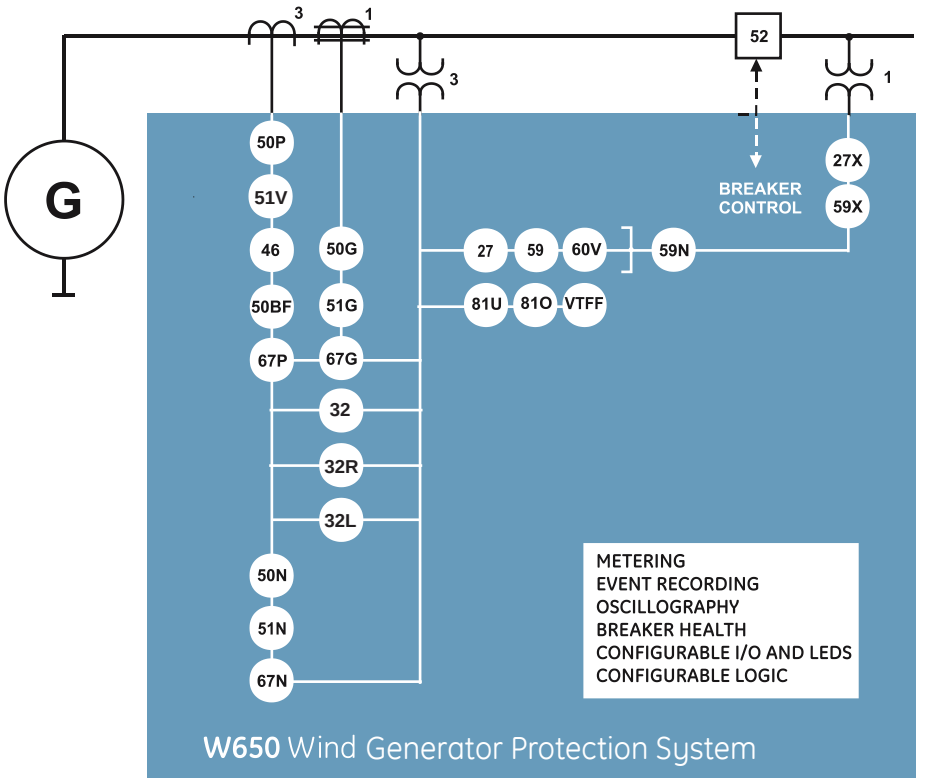
Negative Sequence Overcurrent

Rotor thermal protection of directly connected wind turbines is provided through monitoring of negative sequence current, which is a significant contributor to rotor heating, to ensure it does not increase above the generator's capability limits. The W650 provides a negative sequence overcurrent element that can be configured to trip instantaneous upon reaching predefined levels of negative sequence current, or have delayed tripping through the use of the many available IEEE, IEC and ANSI curves.

Abnormal Voltage Protection

Overvoltage and undervoltage elements are provided to ensure that the generator is providing power at nominal voltage levels as well as to isolate the generator when system instabilities are causing the abnormal voltages to be induced upon the generator.

Functional Block Diagram



ANSI Device Numbers & Functions

Device Number	Function
27P	Phase Undervoltage
27X	Auxiliary Undervoltage
32	Directional Power
32R	Reverse Power
32L	Low Forward Power
46	Stator Current Unbalance
47	Phase reversal
50BF	Breaker Failure
50P	Phase Instantaneous Overcurrent
50N	Neutral Instantaneous Overcurrent
50G	Ground Instantaneous Overcurrent
51P	Phase Time Overcurrent
51N	Neutral Time Overcurrent
51G	Ground Time Overcurrent
51V	Voltage Restrained Time Overcurrent
55	Power Factor
59P	Phase Overvoltage
59X	Auxiliary Overvoltage
59N	Neutral Overvoltage
67P	Phase Directional Overcurrent
67N	Neutral Directional Overcurrent
67G	Ground Directional Overcurrent
60V	Voltage Unbalance
81U/O	Under/Over Frequency
VTFF	VT Fuse Failure Detection

Voltage Unbalance

W650 units incorporate a definite time voltage unbalance function, operating on the ratio between negative and positive sequence voltage. The voltage unbalance element can be used to protect directly connected turbines from excessive unbalanced voltages and associated unbalanced currents that lead to damaging rotor heating. For electronically regulated wind turbines, the voltage unbalance element can act as backup protection for malfunctioning voltage regulators in the turbine.

Directional Power

The directional power element detects reverse power conditions on directly connected wind turbines thereby preventing cases of generator motoring and associated turbine damage. Two levels of settings are available providing differentiation between low forward power and reverse power conditions.

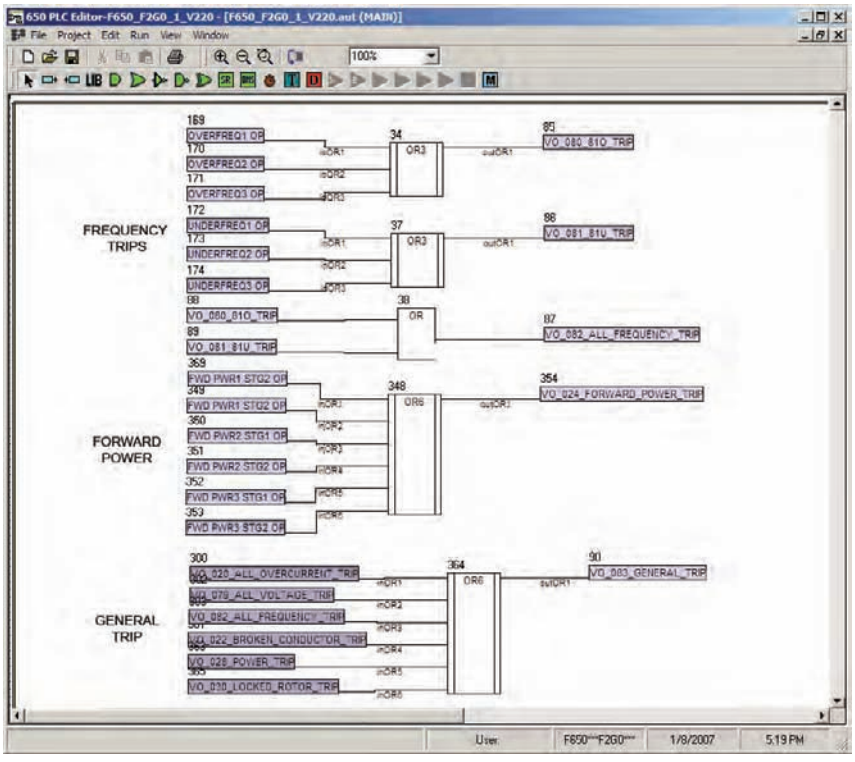
Automation

The W650 incorporates advanced automation features including programmable logic, peer-to-peer communications, and manual control capability through the graphical front panel that far surpass what is found in the average wind generator relay. The combination of these tools allow the user to create customized control schemes such as transfer tripping or blocking applications that utilize communications for inter-relay signaling at a fraction of the cost of the standard method of hardwiring these signals.

Programmable Logic

The programmable logic engine in the W650 allows for creating customized control schemes for automatically control of the connections between the wind turbines and the collector bus. The programmable logic interface meets the IEC 61131-3 Functional Block Diagram industry standard method of programming logical controllers and contains all of the Boolean logic operators required to carry out most distributed generation automation applications.

Programmable Control Logic



The W650 programmable control logic allows for the creation of customized wind generator protection schemes and applications.

Scalable Hardware

The W650 is available with up to 64 programmable digital inputs, up to 16 analog inputs and up to 16 digital outputs. Using the additional CIO module that is available, the digital inputs, analog inputs and digital outputs available are increased to 128, 32, and 32 respectively. All digital inputs may be filtered with a separate debounce time to tailor individual requirements. More over, programmable threshold allows the use of different voltage levels (20 to 230 VDC) for each input.

Multiple Setting Groups

Three separate setting groups for protection functions may be stored in the W650. The W650 includes three units for each protection function, all of which can be active simultaneously in a single group, or be grouped in three different tables. An easy to use programmable mechanism is provided to instantly switch the active settings. This switching may be done internally and/or externally via contact inputs or communications or combinations of the above.

Monitoring and Metering

The W650 includes high accuracy metering and recording for all AC signals. Voltage, current, and power metering are built into the relay as a standard feature. Diagnostics features such as Oscillography, and event recording, combined with EnerVista software tools, significantly reduce troubleshooting time and simplify report generation in the event of a system fault.

Basic Metering Functions

The W650 provides the following metering values:

- Current: Ia, Ib, Ic, In, Ig, Isg
- Phase-to-phase and phase to ground voltage values for bus and line: Van, Vbn, Vcn, Vab, Vbc, Vca, Vx.

- Active power (per phase and total): Wa, Wb, Wc, W.
- Reactive power (per phase and total): VARa, VARb, VARc, VAR.
- Power factor (per phase and total)
- Frequency

These signals are available for local display, and accessible remotely using communications.

Oscillography

Up to 20 simultaneous Oscillography records can be recorded to monitor up to 9 fixed analog variables (IA, IB, IC, IG, IS,VI, VII, VIII and VX) and any physical I/O point or internal digital operand (up to 16 configurable channels). The waveform traces and digital states provide a visual display of power system and relay operational data captured during specified triggered events. Sampling rates of up to 3600 Hz can be recorded and the capacity of each record will depend on the configuration of Oscillography function.

Event Recorder

Capture the last 479 events, with 1 ms resolution time, to provide SOE recorder functionality. Consolidate the event records from multiple devices using EnerVista software tools and use the IRIG-B time synchronization feature to synchronize all events across a system of relays for even more accurate analysis and troubleshooting.

Trip Circuit Monitoring

The W650 offers two complete supervision circuits for monitoring breaker trip and closing coils circuits. These supervision inputs monitor both the battery voltage level and the continuity of the trip and closing circuits by applying current through those circuits and checking that it flows properly.

Communications

The W650 supports a wide range of communication mediums and protocols compatible with new and existing communication infrastructures. The W650 includes a maximum of three independent communication ports: COM1, COM2 and COM3, with many physical choices through the use of two removable plug and play boards.

COM1 and COM2 support Modbus® RTU, and serial DNP 3.0. They are located in the first plug and play board, with three different media choices: RS-485, and plastic or glass fiber optic. In addition, COM2 is accessible from the faceplate of the relay through opto-isolated USB port or RS232. COM3 supports ModBus TCP/IP and DNP 3.0 over Ethernet cable (10/100 Base TX) and fiber optic (100 Base FX).

EnerVista™ Software

The EnerVista™ Suite is an industry-leading set of software programs that simplifies every aspect of using the W650 relay. The EnerVista™ suite provides all the tools to monitor the status of your the protected asset, maintain the relay, and integrate information measured by the W650 into DCS or SCADA monitoring systems. Convenient COMTRADE and Sequence of Events viewers are an integral part of the W650 Setup software included with every 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 GE 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.

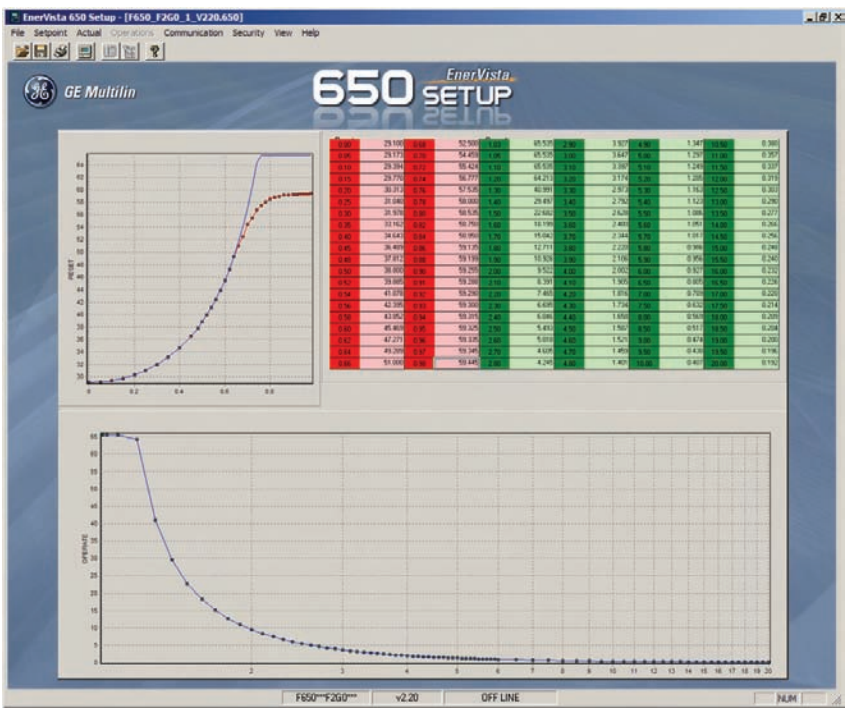
Included in Launchpad is a document archiving and management system that ensures critical documentation is up-to-date and available when needed. Documents made available include:

- 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

W650 Setup Software



Create overcurrent curves customized to the characteristics of a wind generator using the W650 setup software

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

EnerVista™ Integrator

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

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

User Interfaces

Keypad & Display

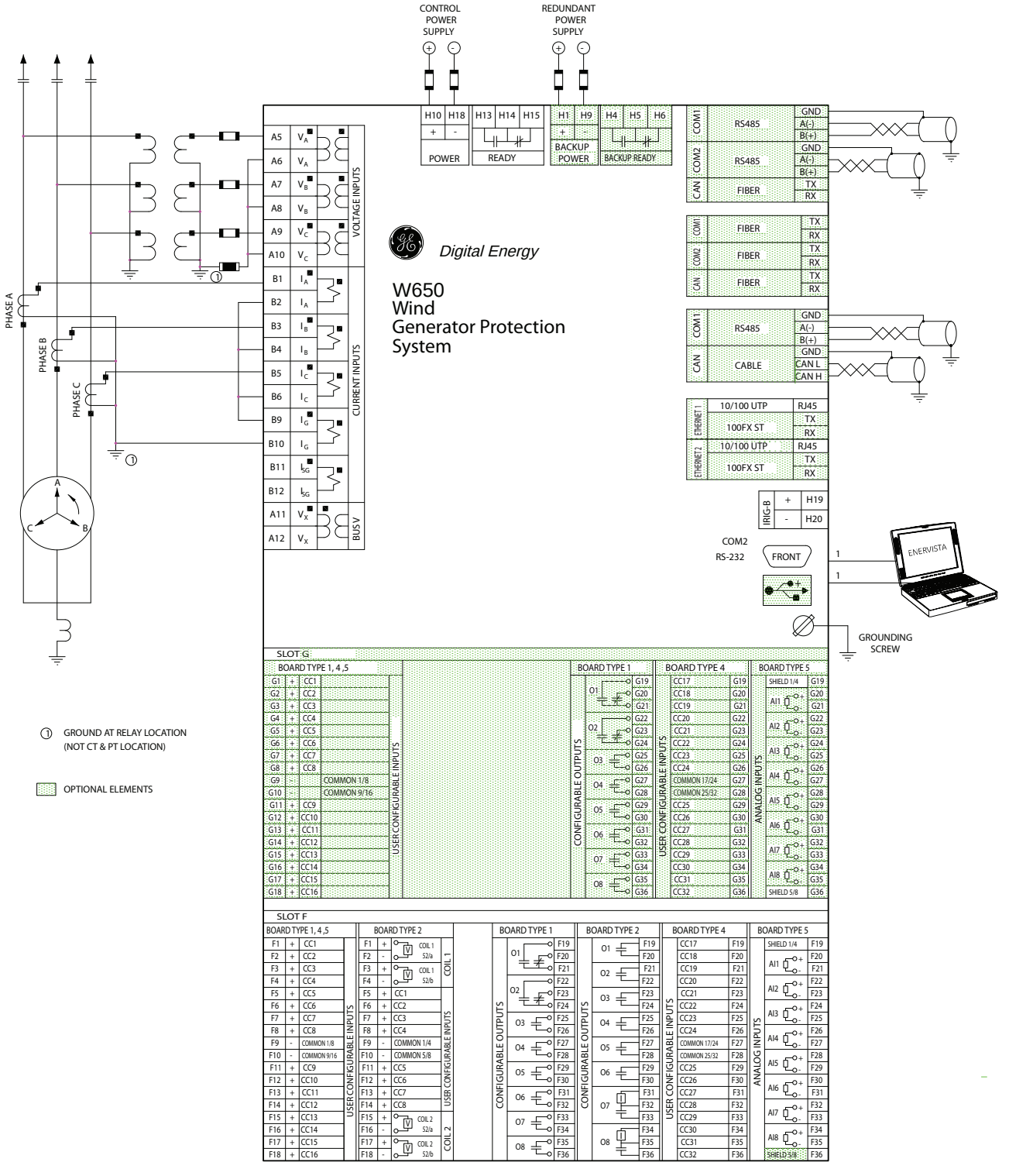
There are versions with text display (4x20 characters) as well as an optional large graphic display (16x40 characters) with fluorescent backlit for a better visibility under all conditions.

LED Indicators

Up to 15 programmable LEDs are provided in green, yellow and red colors with labels that can be tailored to specific applications. Five additional large configurable keys can be used for automating frequently performed control functions such as breaker opening, breaker closing, and recloser lockouts.

User Interface

Typical Wiring



Technical Specifications

PROTECTION

TIME OVERCURRENT UNITS

Pickup level: 0.05 - 160 A in steps of 0.01 A
Curve Shapes: IEC, IEEE/ANSI, IAC, I2t, definite time, rectifier curve, FlexCurve user curve.
Time Multiplier: 0-900 in steps of 0.01
Definite Time: Up to 900 sec (10 msec steps)
Accuracy:
Level: ±0.5% of the reading ±10 mA up to 10A ±1.5% of the reading for values over 10A
Time: From 1.05 times the pickup, ±3% or ±30 ms

INSTANTANEOUS OVERCURRENT UNITS

Pickup level: 0.05 - 160 A in steps of 0.01 A
Definite Time: 0.00-900.00 seconds in steps 10ms
Accuracy
Level: ±0.5% of the reading ±10 mA up to 10A ±1.5% of the reading for values over 10A
Time: From 1.05 times the pickup, ±3% or ±30 ms

SENSITIVE GROUND TIME OVERCURRENT UNITS

Pickup level: 0.005 - 16 A in steps of 0.001 A
Curve Shapes: IEC, IEEE/ANSI, IAC, I2t, definite time, rectifier curve, FlexCurve user curve.
Accuracy
Level: ±0.5% of the reading ±10 mA up to 10A ±1.5% of the reading for values over 10A
Time: From 1.05 times the pickup, ±3% or ±30 ms

SENSITIVE GROUND INSTANTANEOUS OVERCURRENT UNITS

Pickup level: 0.005 - 16 A in steps of 0.001 A
Accuracy
Level: ±0.5% of the reading ±10 mA up to 10A ±1.5% of the reading for values over 10A
Time: From 1.05 times the pickup, ±3% or ±30 ms

PHASE DIRECTIONAL UNITS

Polarization: Crossed voltage
Polarization voltage: 0 to 850 Vac
Characteristic angle: -90° to +90° in steps of 1°

NEUTRAL AND GROUND DIRECTIONAL UNITS

Polarization: Zero sequence voltage, current, dual
Polarization voltage: 0 to 500 Vac
Characteristic angle: -90° to +90° in steps of 1°

NEGATIVE SEQUENCE UNITS

Pickup level: 0.05 to 160.00 A in steps of 0.01 A
Curve Shapes: IEC, IEEE/ANSI, IAC, I2t, definite time, rectifier curve, FlexCurve user curve.
Accuracy:
Level: ±0.5% of the reading ±10 mA up to 10A ±1.5% of the reading for values over 10A
Time: From 1.05 times the pickup, ±3.5% or ±30 ms

OVERVOLTAGE UNITS

Voltage: Fundamental phasor of phase-to-phase voltage
Pickup Level: 3 to 500 V (3 to 850 w) in steps of 1 V
Dropout Level Reset: 97% of pickup
Type of dropout: Instantaneous or timed
Level Accuracy: ±1% of the reading
Timing Accuracy: From 1.05 times the pickup, ±3.5% or ±30 ms

UNDERVOLTAGE UNITS

Voltage: Fundamental phasor of phase-to-phase or phase-to-ground voltage (sel. by setting)
Pickup Level: 3 to 500 V (3 to 850 w) in steps of 1 V
Dropout Level: 103% of pickup
Type of Reset: Instantaneous
Level Accuracy: ±1% of the reading
Timing Accuracy: From 1.05 times the pickup, ±3.5% or ±30 ms

VOLTAGE UNBALANCE

Pickup Level: 0-500% of V2/V1 ratio in steps of 0.01
Time Delay: 0.0 to 900s in steps of 0.01s.

OVERFREQUENCY UNITS

Pickup Level: 20.00 to 65.00 in steps of 0.01 Hz
Dropout Level: Pickup - 0.03 Hz
Reset Type: Instantaneous or Timed
Level Accuracy: ±0.01 Hz
Timing Accuracy: From 1.05 times the pickup, ±3.5% or ±100 ms

UNDERFREQUENCY UNITS

Pickup Level: 20.00 to 65.00 in steps of 0.01 Hz
Dropout Level: Pickup + 0.03 Hz
Reset Type: Instantaneous or timed
Level Accuracy: ±0.01 Hz
Timing Accuracy: From 1.05 times the pickup, ±3.5% or ±100 ms

PROTECTION

DIRECTIONAL POWER

Current, Voltage: Fundamental Phasor.
Pickup level (two steps): -10000.00 to 10000.00 Mw (primary values) in steps of 0.01
Characteristic angle (two steps): 0.00° to 359.99° in steps of 0.01°
Reset level: 97% of the pickup level.

Accuracy for primary magnitudes: ±3% in complete range.
Reset type: Instantaneous.
Timing (two steps): 0.00 to 900.00 s in steps of 0.01s
Timer accuracy: ±3% of operation time or 30 ms

CONTROL

Graphical Display: 128x240 pixels 16 x 40 characters
Text Display: 4 Lines x 20 characters
Virtual PLC logic according to IEC61131-3 Functional block diagrams

MONITORING

VT FAILURE

Programmable to inhibit features

TRIP / CLOSE COIL MONITORS

Detect open trip and close circuits

WAVEFORM CAPTURE

Data Channels: 4 currents, 4 voltages, 16 digital states
Sample Rate: 4, 8, 16, 32 or 64 samples per cycle
Trigger Source: Pickup/trip/dropout, control/alarm event, logic input or manual command
Trigger Position: 5% to 95%
Storage Capacity: Up to 20 oscillography records. Oscillography records can be con catenated by setting

METERING VALUES

Voltage: 10 to 500 Vac (line to ground) universal range
Current: 0.05 Aac to 150 Aac universal range valid for /1A and /5A
Frequency: 20 to 65 Hz

POWER SUPPLY

Options:
LO Range: DC: 24 to 48 V ±20%
HI Range: DC: 110 to 250 V ±20%
AC: 120 to 230 V±20%
Power consumption: Typical 25 W. Maximum 45 W
Voltage Loss hold-up time: 100 ms with single power supply

COMMUNICATIONS

USB/RS232: Front port (Up to 115 kbps)
CAN open port RS485: 125 or 500 Kbits/second Optional rear ports (up to 115 kpbs) kbauds See ordering code
Ethernet Port: 100 BaseFX or redundant 100 BaseFX 10/100 BaseTX or redundant 10/100 BaseTX

MECHANICAL CHARACTERISTICS

- Metallic package in 1/2 19" rack and 6 units high
- Protection class IP52 (according to IEC 529)

INPUTS

CURRENT

Sensing: Current transformers
Current-carrying capacity: 20 A continuously 500 A during 1 s
Burden: < 0.15 VA at 5 Aac

VOLTAGE

Sensing: Voltage transformers
Maximum continuous: 700 Vac
Linear measuring range: Up to 500 Vac line to ground
Burden: < 0.15 VA at 400 Vac

DIGITAL INPUTS

Isolation: Opto-isolated in groups of 8 inputs with a common
Range: 20 to 230 Vdc threshold programmable in steps of 1 Vdc
Resistance: > 100 kOhms

OUTPUTS

TRIPPING CONTACTS/OUTPUT RELAYS

Permanent current: 16 A
Closing current: 60 A during 1 second
Opening current: 0.3 A with L/R = 40 ms at 125 Vdc
0.25 A with L/R = 40 ms at 250 Vdc

TYPE TESTS

CATEGORY	STANDARD	CLASS	TEST
EMC	IEC 61000-4-1 IEC 60255-22-1	III	Oscillatory waves immunity
	IEC 61000-4-2 IEC 60255-22-2	IV	Electrostatic dis charge immunity test
	IEC 61000-4-3 IEC 60255-22-3	III	Radiated electro magnetic field disturbance test
	IEC 61000-4-4 IEC 60255-22-4	A	Electrical fast transient
	IEC 61000-4-5 IEC 60255-22-5	IV	Surge immunity test
	IEC 61000-4-6 IEC 60255-22-6	III	Conducted electromagnetic field disturbance test
	IEC 61000-4-8 EN 61000-4-8	IV	Power frequency magnetic field immunity
	ENV50204	III	Radiated electromagnetic field disturbance test -1890 MHz.
	IEC 60255-25 EN 61000-6-4	A	Conducted and radiated emissions
Product	IEC 60255-5	2 kV	Insulation resistance - dielectric test
	IEC 60255-5	6kV .5J	Impulse test
	IEC 60255-11	100ms	Power supply Voltagedips/ interruptions/ variations
Mechanical	IEC 60255-21-1	I	Vibration test (sinusoidal)
	IEC 60255-21-2	I	Shock and bump
	IEC 60255-21-2	II	Seismic

APPROVALS

CE: Conforms to EN/IEC 60255, 61010
ISO: Manufactured to an ISO9001 registered program
UL: Conforms UL 508

PACKAGING

Approximate Weight:
Net: 11 lbs (5 kgs)
Ship: 13.2 lbs (6 kgs)
Shipping dimensions: 30x40x40 cm (WxHxD)
Connection: Screw plug terminals in connectors fixed to the case

ENVIRONMENTAL

Temperature:
Storage: -40 to +80° C
Operation: -20 to +60° C
Humidity: Up to 95% without condensing

** Specifications subject to change without notice.*

Ordering

To order select the basic model and the desired features from the Selection Guide below:

W650	*	*	*	F	*	G	*	***	*	*	
Display	B										Basic display (4 x 20 characters)
	M										Graphic display (240 x 128 pixels)
Rear serial communications board 1		F									None
		A									Redundant RS485
		P									Redundant plastic fiber optic
		G									Redundant glass fiber optic
		X									Redundant RS485 + fiber CAN port (CANopen)
		Y									Redundant plastic fiber optic + fiber CAN port (CANopen)
		Z									Redundant glass fiber optic + fiber CAN port (CANopen)
		C									Cable CAN port (CANopen)
		M									RS485 + cable CAN port (CANopen)
Rear ethernet communications board 2			B								10/100 Base TX
			C								10/100 Base TX + 100 Base FX
			D								10/100 Base TX + Redundant 100 Base FX
			E								Redundant 10/100 Base TX
I/O Board 1 in Slot F					1						16 Digital Inputs + 8 Outputs
					2						8 Digital Inputs + 8 Outputs + 2 Trip / Close circuit supervision circuits
					4						32 Digital Inputs
					5						16 Digital Inputs + 8 Analog Inputs
I/O Board In Slot G							0				None
							1				16 Inputs + 8 Outputs
							4				32 Digital Inputs (See Note 1)
							5				16 Digital Inputs + 8 Analog Inputs (See Note 1)
Auxiliary Voltage								LO			24-48 Vdc (range 19.2 - 57.6)
								HI			110-250 Vdc (range 88 - 300)
											120-230 Vac (range 96 - 250)
								LOR			Redundant LO
								HIR			Redundant HI
Protocol									-		without IEC 61850
									6		IEC61850
Environmental Protection										-	Without Harsh (Chemical) Environment Conformal Coating
										H	Harsh (Chemical) Environment Conformal Coating

Note 1: The number selected for option G must be equal or higher than the number selected for option F.

Accessories for the W650

• Multilink Ethernet Switch	ML1600-HI-A2-A2
• Multinet	Multinet-FE
• Viewpoint Monitoring	VP-1

Visit www.GEMultilin.com/W650 to:

- View Guideform specifications
- Download the instruction manual
- Review applications notes and support documents
- Buy a W650 online
- View the W650 brochure