

# Multilin R650

## Advanced Recloser Controller

The Multilin™ R650 Recloser Controller a member of GE's Multilin 650 family of field proven protection and control devices, allowing customers to use the same platform both inside and outside the substation. This recloser controller delivers comprehensive performance in protection, monitoring, control, automatic network configuration and communications. With high speed, reliable performance this solution works to reduce customer outages and ensure fast recovery of medium voltage network sections for increased reliability of secondary distribution systems.

The R650 recloser controller is the result of a collaboration between GE and G&W. At the heart of the R650 is the intelligent driving electronics which ensure seamless integration between the controller and the recloser device. These driving electronics are in the form of an internal module option, and deliver high speed operation, whilst consuming minimal power - thereby ensuring true multiple-shot capability.

The R650 extends beyond pure performance, by providing power system engineers with the data, measurement accuracy, and visibility needed for comprehensive asset management. The device ensures seamless integration with distribution automation tools and systems, and provides Network Operators with the visibility to turn reactive actions into proactive actions for efficient and reliable network restoration.

With a focus on connectivity and security, the R650 supports the latest in communications technologies and protocols including IEC 61850 and IEC 62439/PRP/HSR, and provides standard security tools, ensuring that device integration into new or existing SCADA, OMS or DMS is as simple and secure as possible.

### Key Benefits

- Fast reliable 4 shots auto reclosing with a single charge
- Comprehensive protection and control functions
- Advanced logic engine for creating customized control schemes
- Built on IEC 61850 platform, choice of serial and Ethernet protocols for seamless system integration
- Minimize outage times using single-phase tripping
- Improved performance and reliability by integrating remote feeders into DMS/OMS/SCADA
- Real time asset monitoring for increased reliability and optimized asset life
- Enhanced troubleshooting tools (Oscillography and Fault recording) simplifying post-fault analysis

### Applications

- Recloser Protection and Control
- Fault Location, Isolation and Service Restoration (FLISR)
- Dynamic network restoration
- Communicating and non-communicating loop automation schemes
- Open and closed loop schemes
- Post-fault selective tripping
- Loss of Voltage (LOV) automation schemes



## Innovative Technology & Design

- Unique driving electronics module enabling true 4 shot auto reclosing
- Continuous monitoring and event reporting
- 6 Low Energy Analog (LEA) inputs for monitoring voltage on both sides of recloser
- Advanced, flexible, embedded communications: Modbus RTU, TCP/IP, DNP 3.0, IEC 60870-5-101, IEC 60870-5-103, IEC 60870-5-104, IEC 61850 Ed2, IEC 62439/PRP/HSR
- Simple set-up and configuration
- Integrated with GE's Automation Products and Software for advanced fault location resolution
- Compact design, small panel footprint

## Exceptional Quality & Reliability

- Based on GE's 650 relay & control platform, with an installed base of over 100,000 devices
- IPC A-610-E Class 2 manufacturing standards
- Highest reliability standards for electronics testing
- 100% Environmental Stress Screening and full functional testing
- Harsh Environment Conformal Coating

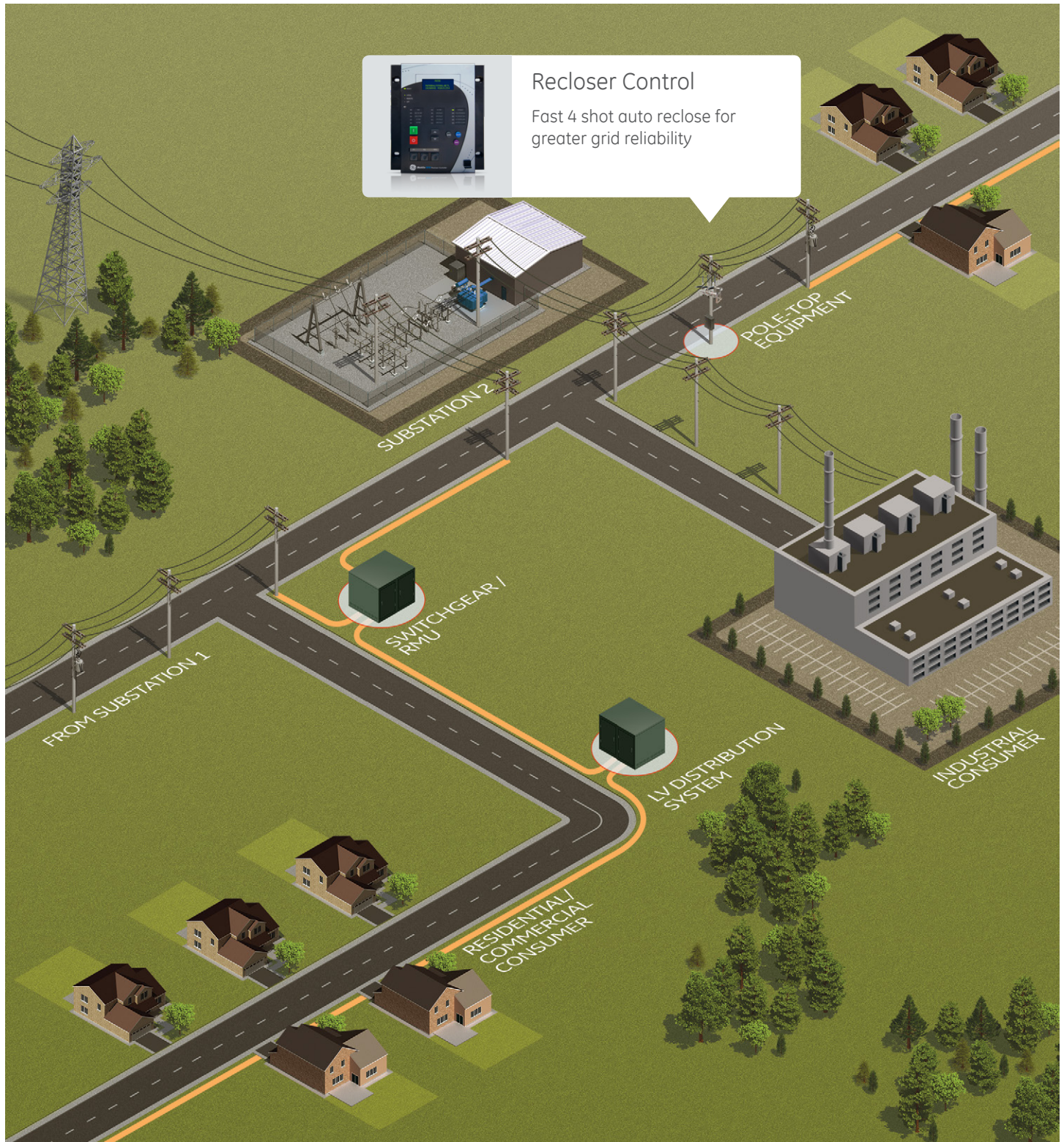
## Uncompromising Service & Support

- Covered by GE's 10-year warranty
- Designed, tested and assembled by GE

## An integrated Solution

The need to equip distribution networks with devices and software to meet the challenges of distributed generation and increased demand is global. GE has accepted this challenge on behalf of its customers, and is leading the way with products that are more intelligent, simpler to deploy and more effective in addressing the demands of the new network.

The R650 provides high speed distribution automation integrating easily into new or existing networks, enabling more reliable and efficient distribution systems.



## Overview

The role of a recloser in a distribution network has developed in line with the increasing demand for operators to minimize outage duration and the numbers of customers affected by faults (maximizing performance according to reliability indices like CAIDI/SAIDI). As a result, it has two main functions. Its primary function is to clear the fault when it occurs as quickly as possible. Secondly, if the fault proves to be permanent, the recloser takes on a sectionalizing role driven by logic, or commands from centralized or decentralized control. These control systems are themselves dependent on the data delivered by the recloser on three levels: general monitoring from a historic perspective, fault data at the time of fault and pre/post fault data.

### Primary Function

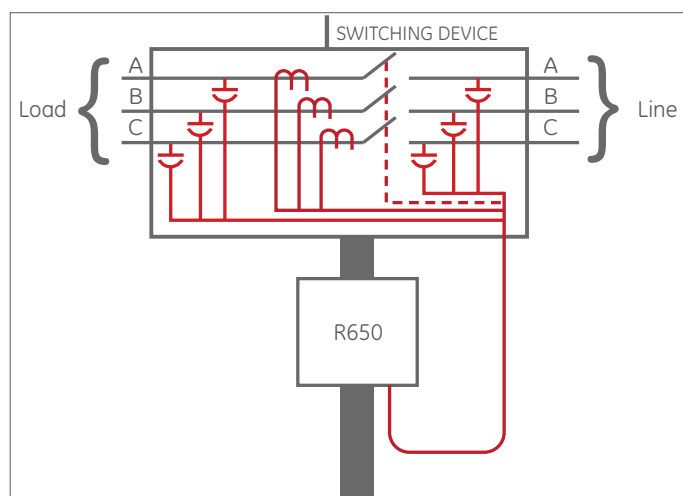
As its primary function, the recloser must have an accurate and efficient tripping mechanism in order to clear as many faults as possible. The recloser must have the most accurate and efficient tripping mechanism possible, in order to clear as many faults as possible and fulfil its primary function. The R650 contains a unique driving electronics module that has been specifically matched to the G&W Viper-ST recloser device. This design provides reliable 4 shot auto reclosing.

Supported modes of operation include:

- 3 phase trip, 3 phase lockout
- 1 phase trip, 3 phase lockout
- 1 phase trip, 1 phase lockout

### Secondary Function

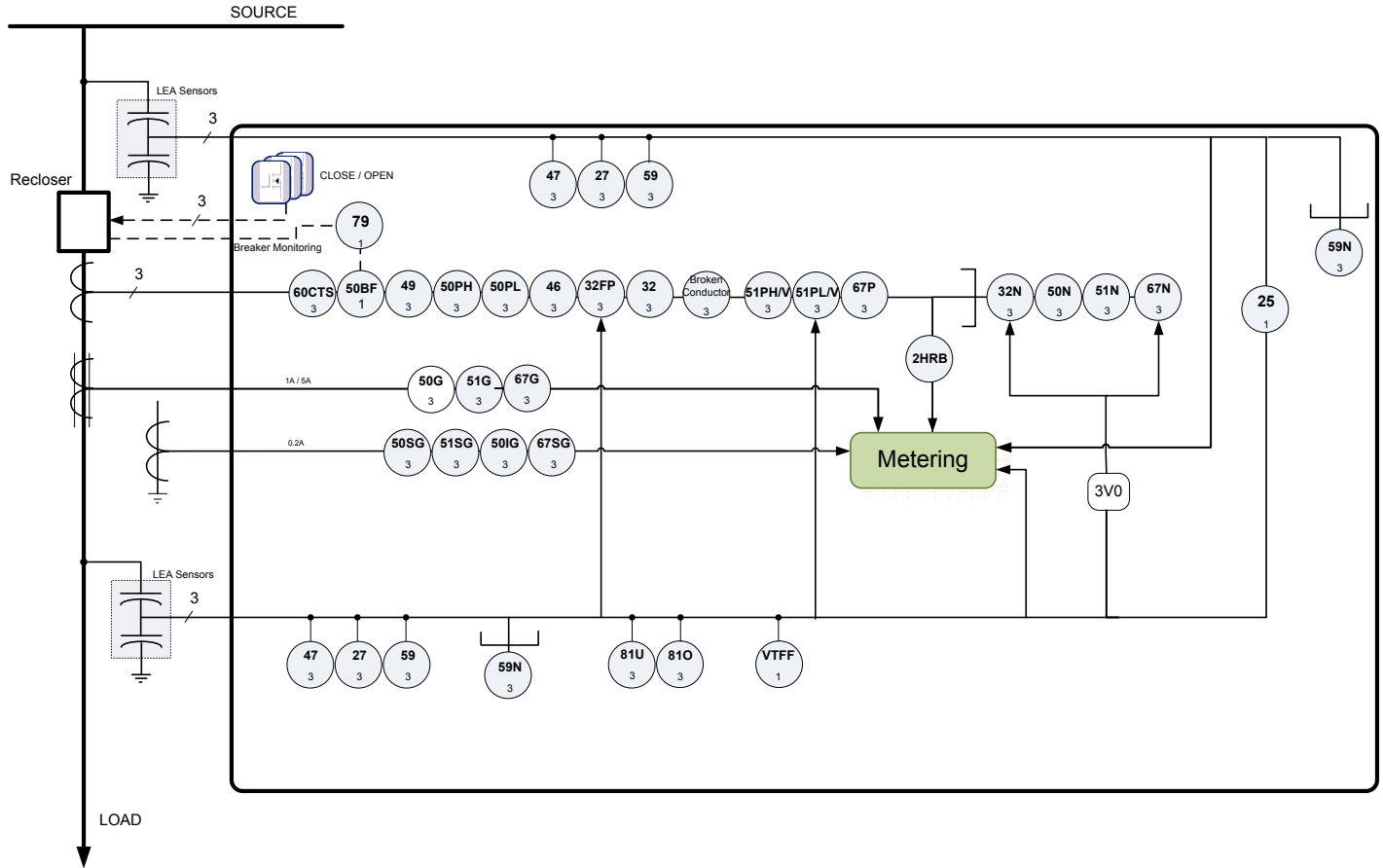
When lockout occurs the recloser becomes a pivotal fault make and fault break switch. The optimization of the network is now in the hands of the operator, either manually or automatically through automation and/or FDIR/FLISR schemes. Whichever scheme is employed, reliable communications and rapid response are required. The R650 supports redundant Ethernet and fiber port physical interface options and a wide range of industry standard protocols for communication, namely Modbus TCP/IP, DNP 3.0, IEC 60870-5-101, IEC 60870-5-103, IEC 60870-5-104, IEC 61850 Ed2, IEC 62439 / PRP/HSR.



## Protection

The R650 provides secure and reliable protection by offering a comprehensive range of standard and advanced elements with multiple-stages and wide setting ranges for each. The controller provides directional and non-directional overcurrent protection along with the option of single-phase tripping and reclosing, to limit system impact and improve reliability. A synchronism check function is available and ensures that the voltages are within safe limits before allowing manual closing and auto-reclose operations. Additionally, voltage and frequency protection elements may be used to disconnect generation connected to the feeder. The R650 includes six voltage inputs to monitor voltages on both sides of the recloser thereby delivering a safer level of performance.

## Functional Block Diagram



## ANSI Device Numbers and Functions

DEVICE NUMBER	PROTECTION & CONTROL FUNCTIONS
25	Synchronism Check
27	Source/Load Undervoltage
32	Sensitive Directional Power
32FP	Forward Power
32N	Wattmetric Zero-Sequence Directional
46	Negative Sequence Time Overcurrent
47	Negative Sequence Voltage
49P	Thermal Model
50BF	Breaker Failure
50PH/PL	Phase Instantaneous Overcurrent (High/Low)
50N	Neutral Instantaneous Overcurrent
50G	Ground Instantaneous Overcurrent
50SG	Ground Instantaneous Overcurrent for sensitive ground systems (measured from 5th current transformer input)
50IG	Isolated Ground Instantaneous Overcurrent (measured from 5th current transformer input)
51N	Neutral Time Overcurrent

DEVICE NUMBER	PROTECTION & CONTROL FUNCTIONS
51G	Ground Time Overcurrent
51SG	Sensitive Ground Time Overcurrent
51PH/V	Voltage Restraint Phase Time Overcurrent (high)
51PL/V	Voltage Restraint Phase Time Overcurrent (low)
59	Source/Load Overvoltage
59N	Source/Load Neutral Overvoltage
67P	Phase Directional Overcurrent
67N	Neutral Directional Overcurrent
67SG	Sensitive Ground Directional Overcurrent
79	Autoreclose (Four shot recloser)
81 U/O	Under/Over Frequency
-	Broken Conductor
VTFF	VT Fuse Failure Detection
60CTS Failure	Current Transformer Failure
2nd Harmonic Inhibit	Second Harmonic Inhibit

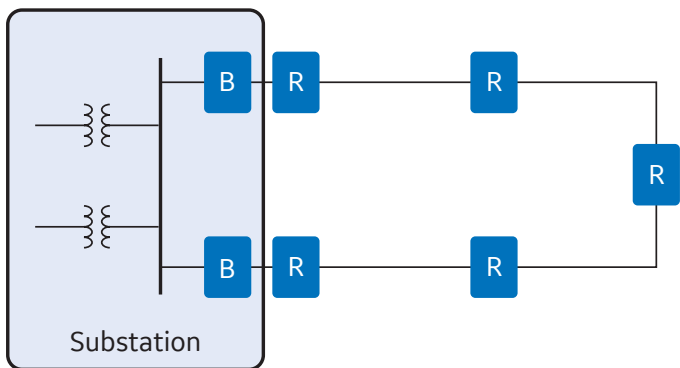
## Automation

From simple automation to advanced analytics, the R650 provides the flexibility and scalability required to meet unique application requirements.

### Simple loop recloser automation schemes

This is a logic-based automation scheme for self-healing networks. This type of scheme is generally used for providing faster fault isolation and restoration.

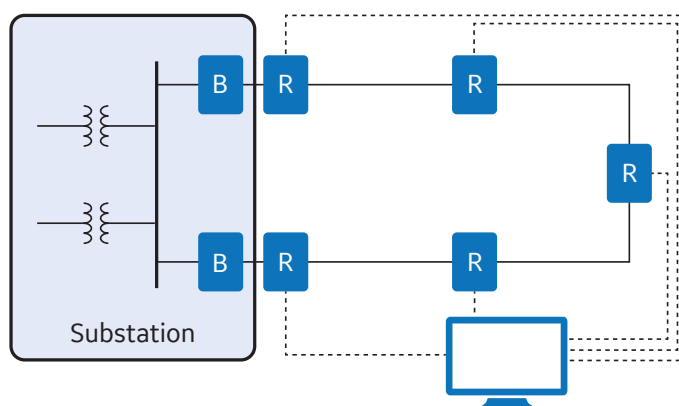
Individual recloser controllers make decisions for restoration based on the restoration logic that is programmed into the controllers. This results in quick isolation of the faulty section and automatic restoration thereby minimizing impact on other neighboring customers.



Simple Loop Automation

### Advanced loop recloser automation schemes

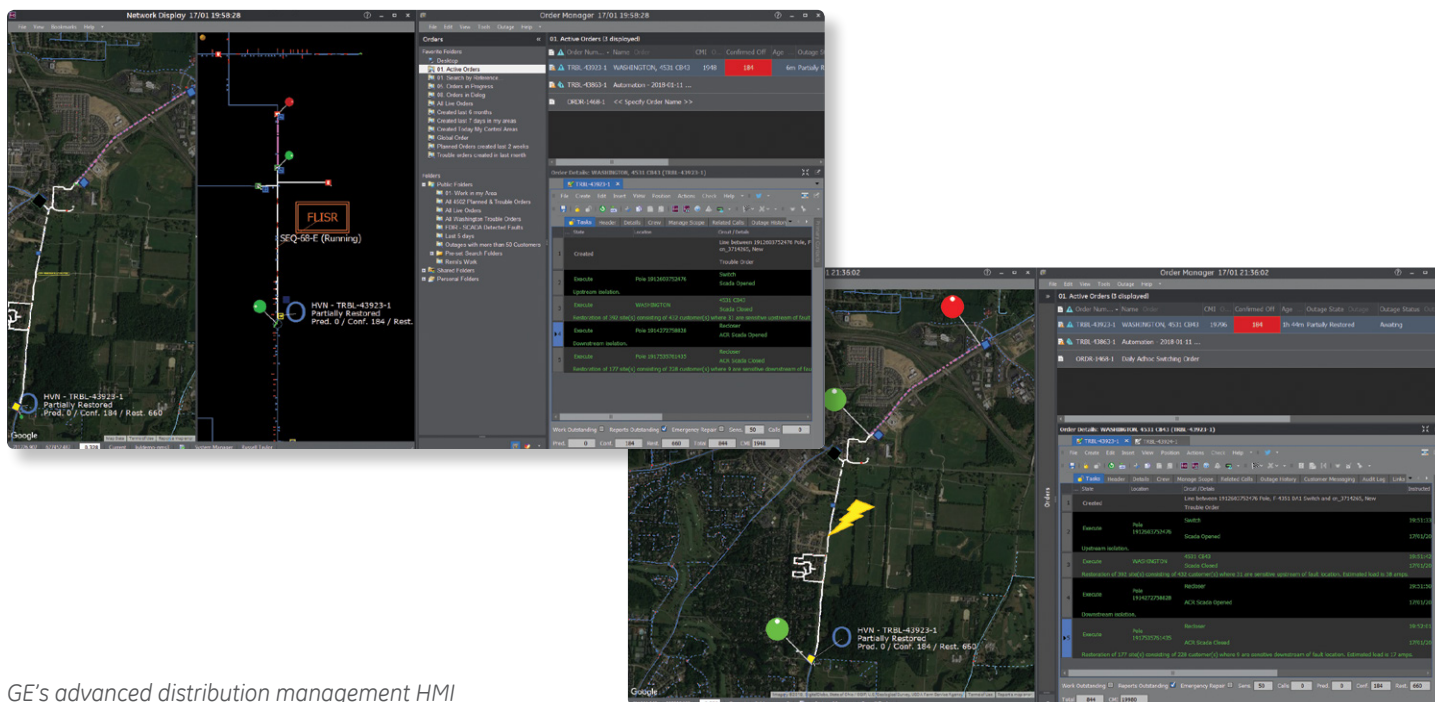
The recloser controllers can provide data to remote SCADA, Outage Management Systems (OMS) and Distribution Management Systems (DMS). These systems manage the network automation process by utilizing the recloser controller data for running FDIR/FLISR and taking restoration decisions dynamically.



Advanced Loop Automation

## Monitoring and Data Input

The R650 delivers accurate data to centralized and decentralized applications enabling advanced analytics. This distributed fault data analysis enables FDIR/FLISR schemes to deliver optimal network reconfiguration in varying neutral treatments, such as direct or high impedance grounding.



GE's advanced distribution management HMI

## Low Energy Analog Inputs

The R650 supports six Low Energy Analog (LEA) voltage inputs which overcomes the challenges in mounting conventional MV transformers. With six LEA voltage inputs, voltage on both sides of the recloser can be measured thereby assisting in developing automation and restoration schemes.

## Control

### Unique Driving Electronics Module

The R650 delivers precise and efficient recloser functionality. At the heart of the design is the driving electronics module that accurately matches the requirements of the recloser device with the controller outputs. This module has been designed to ensure minimum delay between the R650 output signals and the breaker operation. Through intelligent design, this 'best in class' operation is achieved with optimal energy management, ensuring completion of multiple shots.

The driving electronics module design has been extensively tested and validated to ensure optimum performance and facilitate high-speed, multi-shot capability. Test results demonstrate that the module delivers rapid, accurate and efficient reclosing cycles by enabling the trip and close capacitors of the Viper-ST to provide sufficient charge to perform a 4 shot sequence.

## Quality & Reliability

Industry-leading quality, reliability and design processes are at the core of the R650. Significant investments in state-of-the-art type test facilities simulate a complete and onerous range of operating environments. The R650 is manufactured and designed to the IPC A-610 Class 2 standard, adhering to the highest reliability standards and ensuring rugged performance. Each device completes one hundred percent Electrical Stress screening prior to shipping from GE's facility.

## Technology & Design

As part of the of the Multilin 650 platform that provides comprehensive, high performance protection and control for critical assets in utility and industrial environments. There are over 100,000 of these devices installed globally, delivering protection reliably across a range of applications for feeders and other critical power system assets.

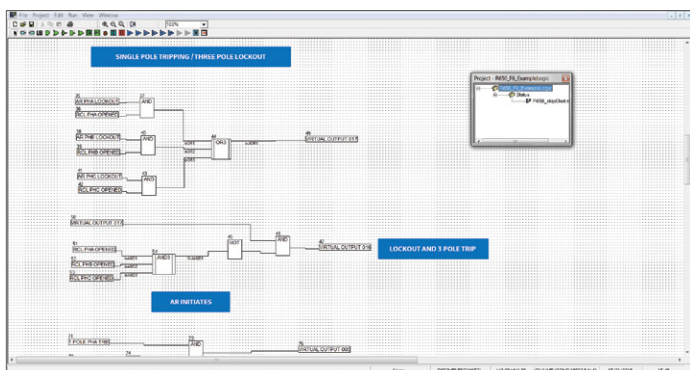


## Setup & Configuration

### EnerVista Setup & Configuration Software

The EnerVista™ Suite is an industry-leading set of software programs that simplifies every aspect of using the R650. The EnerVista suite provides all the tools to monitor the status of the recloser, maintain the controller, and integrate information measured by the R650 into DCS or SCADA monitoring systems.





Examples of Graphical Logic Capability and Asset Monitoring Dashboard

## Technical Specifications

COMPLIANCE	SPECIFICATION
Design & Manufacture	ISO9001 QMS
EMC	EN-60255-26
Safety	EN-60255-27
GENERAL	SPECIFICATION
AC Current Inputs	5 CT Current Inputs (3 Ph., 1 Ground, 1 Sensitive)
AC Voltage Inputs	6 LEA Type Inputs
Number of Reclosures	Up to 4 per charge
Operation	Single phase and/or three phase tripping
Driving Electronics Compatibility	G&W Viper-ST
Remote Inputs	IEC 61850 (GSSE/GOOSE)
Operating Temperature	-40°C to 60°C
Weight	6 Kg
Physical Dimensions (DxWxH)	30 x 40 x 40 cm
Power Supply Option 1 (LO)	24V to 48V DC
Power Supply Option 2 (HI)	110V to 250V DC 120V to 230V AC
COMMUNICATIONS	SPECIFICATION
Ethernet, Serial, USB Protocols Supported	RS232/RS485/Optical Modbus RTU, Modbus TCP/IP IEC 60870-5 101/103/104 IEC 61850 PRP/HSR/RSTP DNP 3.0 / IEEE 1588 Synch
USER PROGRAMMING	SPECIFICATION
Programming supported	PLC Logic, Flexcurves, User programmable LEDs, User definable displays, User programmable front keys.
ADDITIONAL FEATURES	SPECIFICATION
Integrated Web Server	✓
Hot Line Tagging	✓

PROTECTION	SPECIFICATION
Protection Elements Supported	27P, 32, 32FP, 32N, 46,47,49, 50PH/PL, 50N, 50G, 50SG, 50IG,51N, 51G, 51SG, 51PH/V, 51PL/V, 59P, 59NH/NL 67P, 67G, 67N, 67SG, 81U, 81O, Broken Conductor
CONTROL	SPECIFICATION
Control Elements Supported	Autoreclose (79) Synchrocheck (25) Fuse Failure Breaker Failure (50BF) CT Supervision Failure (60CTs) Second Harmonic Inhibit Pulse Counters (up to 8) Analog Comparators Digital Counters Cold Load Pickup
RECLOSER	SPECIFICATION
Settings	Type, breaker wear, interrupt kA, number of openings, single pole/3 pole trip logic switchgear settings
MONITORING	SPECIFICATION
Oscillography	20 Records, Data Logger, Demand, Programmable Sampling Rate up to 64 Samples per cycle
Events	Fault Locator, Snapshot Events, Control Events,
Device Monitoring	Internal Monitoring, Coil Circuit Supervision
METERING	SPECIFICATION
Parameters	Current, Voltage, Real Power (Watts), Reactive Power (VARs), Apparent Power (VA), Watt Hrs, (Positive and Negative), Frequency, Angle

## Ordering Code

R650	*	*	*	F	*	G	*	*	*	*	*	*	Description
Display	B												Basic Display
	M												Enhanced Display
Rear serial communications board 1	F												None
	A												Redundant RS485
	P												Redundant plastic fiber optic
	G												Redundant glass fiber optic
	X												Redundant RS485 + fiber remote CAN bus I/O
	Y												Redundant plastic fiber optic + fiber remote CAN bus I/O
	Z												Redundant glass fiber optic + fiber remote CAN bus I/O
	C												Cable remote CAN bus I/O
Rear ethernet communications board 2	M												RS485 + cable remote CAN bus I/O
	L												PRP, 1588, 10/100 Base TX + Redundant 100 Base TX <sup>1</sup>
	M												PRP, HSR, RSTP, 1588, 10/100 Base TX + Redundant 100 Base TX <sup>1</sup>
	J												PRP, 1588, 10/100 Base TX* + Redundant 100 Base FX <sup>1</sup>
I/O board in slot F	K												PRP, HSR, RSTP, 1588, 10/100 Base TX* + Redundant 100 Base FX <sup>1</sup>
	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	6												Driving electronics for Viper-ST + 8 Digital Inputs
	0												None
	1												16 Inputs + 8 Outputs <sup>2</sup>
	4												32 Digital Inputs <sup>2</sup>
Auxiliary voltage	5												16 Digital Inputs + 8 Analog Inputs <sup>2</sup>
	LO												24-48 Vdc (range 19.2 – 57.6)
	HI												110-250 Vdc (range 88 – 300), 120-230 Vac (range 96 – 250)
	LR												Redundant 24-48 Vdc (range 19.2 – 57.6)
Language	HR												Redundant 110-250 Vdc (range 88 – 300), 120-230 Vac (range 96 – 250)
	E												English
Protocol													
	2												Modbus <sup>®</sup> RTU, TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104, IEC 60870-5-103, IEC 60870-5-101
Voltage and current analog measurements	7												IEC 61850 Edition 2, Modbus <sup>®</sup> RTU & TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104, IEC 60870-5-103, IEC 60870-5-101
	L												LEA/ Standard CT- 6x LEA phase voltage inputs + 3 phase current inputs VT/CT + 1 ground current input +1 Sensitive ground current
Environmental protection													
	N												Without Harsh Environment Conformal Coating
	H												Harsh Environment Conformal Coating <sup>3</sup>

### Notes:

\* ETH E port is intended for maintenance purposes.

<sup>1</sup> Advanced functionalities Level II:

J, L: Parallel Redundancy Port (PRP), IEEE1588 Precision Time Protocol (PTP), IEC61850 Edition 2.0. Digital counters, DFT, 16 Switchgear mapped in IEC61850, 16 nodes CIO, and mapping of BlkOpn and BlkClsleafs of XSWI nodes.

K, M: High-Availability Seamless Redundancy (HSR), Rapid Spanning Tree Protocol (RSTP), Parallel Redundancy Port (PRP), IEEE1588 Precision Time Protocol (PTC), IEC61850 Edition 2.0. Digital counters, DFT, 16 Switchgear mapped in IEC61850, 16 nodes CIO, mapping of BlkOpn and BlkClsleafs of XSWI nodes, Max numbers of starts and Cold Load Pick-up functionalities.

<sup>2</sup> The digit selected for option G must be equal or higher than the digit selected for option F4 and F5 only. (This does not apply for order codes with option F6. In this cases, the digit selected for option G can be less than digit selected for option F.

<sup>3</sup> It is recommended to select Harsh Environment Conformal coating option for outdoor application.

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