

Multilin™ Voltage Regulator Controller

DGCV



KEY BENEFITS

- Increases grid efficiency by optimizing voltage regulation
- Through deployment of the Volt/VAR system, the Multilin DGCV:
 - Enables up to a 6% reduction in energy demand
 - Improves load management and power quality
- Enhances and optimizes voltage regulator utilization
- Common hardware, firmware, software platform with other Multilin Distribution Automation (DA) controllers
- Performs real-time control from remote or local locations
- Lowers operational costs through improved system & operational efficiency
- Integrates with industry leading voltage regulator manufacturers
- Rugged construction designed for outdoor use in harsh environments (-40°C to +60°C)
- Reduces time associated with setup and commissioning with easy-to-use, industry leading, software tools and quick setup keys on front panel
- Local Raise/Lower control through large pushbuttons on front panel
- Advanced logic engine using FlexLogic™ for creating customized control schemes

APPLICATIONS

- Regulator control for pole-top or pad mounted voltage regulators for Distribution and Industrial feeders
- Integrated into centralized or decentralized Volt/VAR systems
- Ideal for medium and small size Distribution transformers with On-Load Tap Changer (OLTC)

FEATURES

Voltage Regulation

- Auto/Manual or Local/Remote control
- Adjustable Voltage Bandwidth
- Configurable Voltage ratio correction
- Tap change time delay
- Voltage runback limits
- 3 stage Voltage reduction
- Line Drop Compensation (forward & reverse)
- Reverse Power Operation & Override
- Tap change inhibits
- Tap position limits
- Sequential and non-sequential type
- Bi-directional mode of operation
- Drag hands operation
- 3 setting groups

Automation & Control

- Customized automation schemes using FlexLogic™
- Expandable inputs and outputs for advanced applications

Metering & Monitoring

- Metering - current, voltage, power, frequency, PF, Harmonics
- Event Recorder - Up to 256 time tagged events
- Enhanced system diagnostics & reporting

Communications

- Networking Interface - Two Wire RS485
 - Multiple Protocols (Modbus®, DNP3.0)
 - Optional wireless communications (radio or cellular)
- User Interface
 - Front panel USB port
 - 4 line HMI Display
 - 18 System status LED's
 - 6 quick setting keys

Security & EnerVista™ Software

- 4-Level device security to maintain authorized access only
- Simplified device configuration software tool and industry leading suite of software tools to manage and maintain Multilin devices.

Volt/VAR Control

Utilities face a difficult challenge having to dynamically balance the load scenario between customer demands and available generation capacity. Adding to the challenge is the ever changing consumption patterns due to factors such as day of the week, time of day, season, temperature and Power Factor from connected loads.

Maintaining an efficient and reliable distribution network is critical to a utility's operation. Meeting this challenge requires voltage regulator controller and capacitor bank controllers working in unison. These devices can operate as part of an integrated Volt/VAR Control (IVVC) scheme or as a Centralized Volt/VAR control (CVVC) system.

The IVVC or CVVC system works to achieve two key objectives:

- 1) Optimize Voltage - through 'Conservation of Voltage' that leads to reduced demand, that may result in decreased generation up to 6%.
- 2) Increased efficiency - through improved power factor and reduced VAR which helps to reduce power line losses.

Overview

The Multilin DGCV Voltage Regulator Controller enables a utility to optimize operational planning, enables short- / long-term load for forecasting, and asset tracking through Power Quality monitoring. This is accomplished through the monitoring of feeder voltages and the issuing Raise/Lower commands to a connected Voltage Regulator to increase or decrease the downstream voltage, when required. This action ensures voltages across a distribution feeder remains within, utility specified, voltage limits, under varying load conditions.

The Multilin DGCV is compatible with many voltage regulators and can be used for the control of new regulators or can be easily interfaced with existing regulators in retrofit applications.

The Multilin DGCV Voltage Regulator Controller is part of a platform of distribution automation controllers that integrate into GE's advanced Distribution Automation solution. The other controllers in the platform include a Capacitor Bank controller, Switch controller and a Field RTU/Monitor controller.

Voltage Regulator Control

Robust design

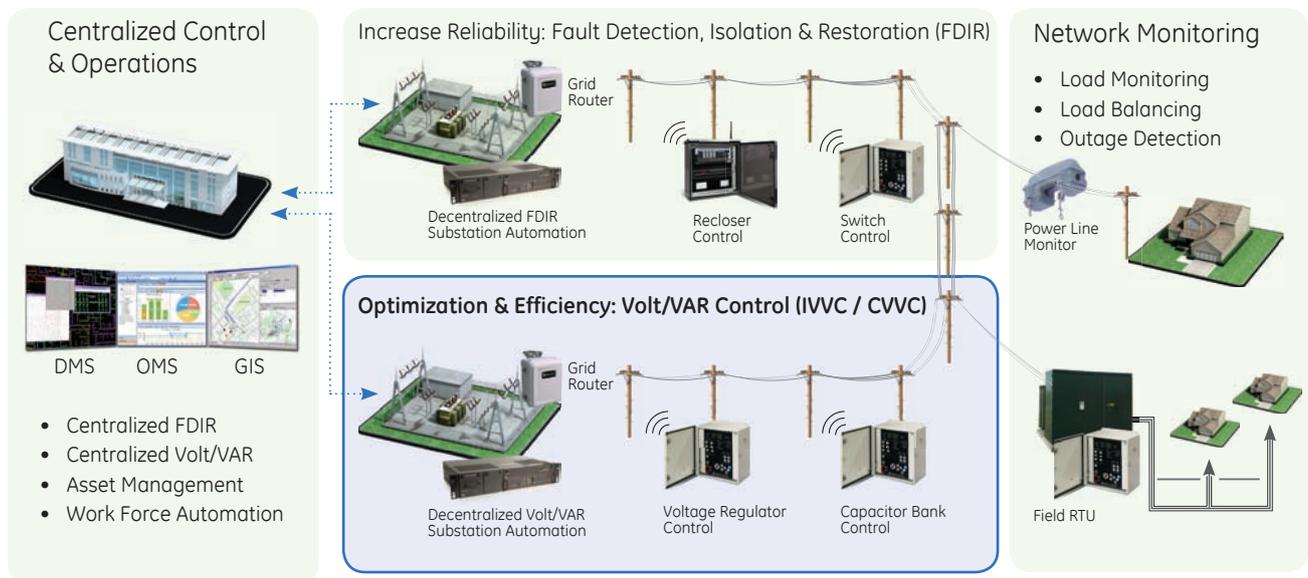
Based on GE's proven controller platform with tens of thousands of units installed globally, the Multilin DGCV underwent extensive Accelerated Life Testing (ALT) and Highly Accelerated Life Testing (HALT) to validate accurate functionality under specified conditions and to ensure accurate performance in extreme operating conditions and harsh environments.

Mode of Operation

To provide optimal application flexibility, the Multilin DGCV offers two modes or methods of operation in which the device can be implemented to control the voltage regulator:

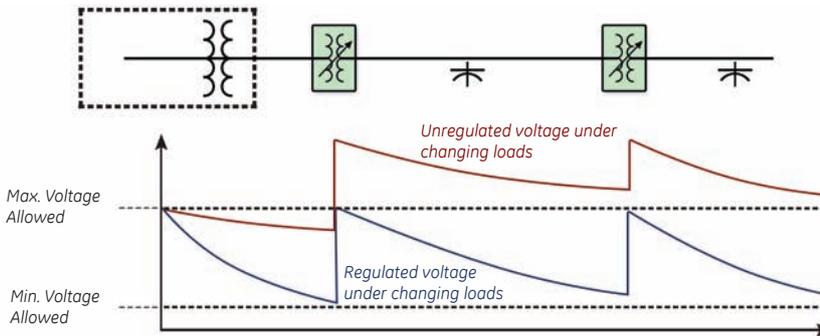
- a) Manual Mode (Local Control or Remote Control)
- b) Automatic Mode

Typical Application of Distribution Automation solutions (Volt/VAR control (VVC) & Fault Detection, Isolation & Restoration (FDIR))

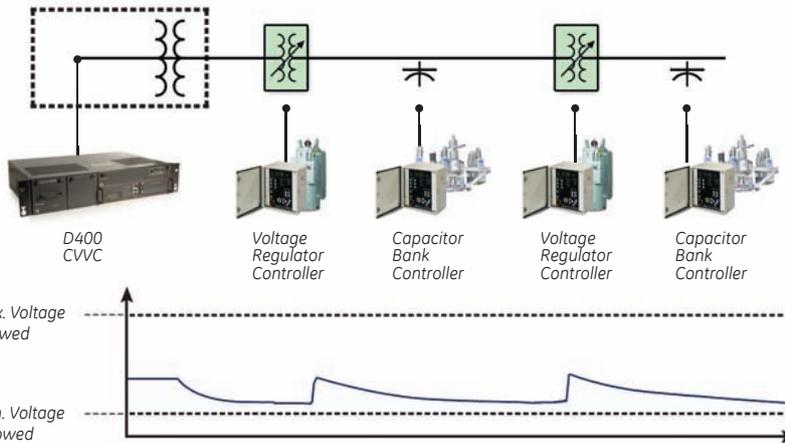


Above depicts a simplified distribution network and two key distribution automation solutions driving grid optimization, efficiency, and reliability

Unregulated voltage supply vs. Regulated supply using Multilin DA Controllers



- Unregulated end-of-line voltage will fluctuate with changes in load demand and often may drift outside allowable limits, potentially causing damage to connected loads.
- Regulated end-of-line voltage through the use of voltage regulators and capacitor bank controllers ensure voltage supply is kept within allowable limits. Equating to a safe and healthy end-of-line voltage to consumers.



When integrated with an IVVC or CVVC system, Vol/VAR controllers provide regulated voltage levels with minimal fluctuations along the feeder segment, they ensure voltage is maintained within allowable limits, and they improve power factor which reduces line losses (VAR reduced).

- Voltage Level (bandcenter)
- Voltage Bandwidth (Min / Max Voltage limits)
- Tap Changer Time Delay
- Tap Changer Position
- Voltage Reduction
- Input Voltage & Current
- Computation Time Delay
- Line Drop Compensation (LDC) & Reverse Power LDC
- Reverse Power
- Voltage Runback Limits
- Reverse Power Override
- Inhibit Operations (Overcurrent / Overvoltage / Undervoltage)

Voltage Level (Bandcenter)

Voltage Level is the desired level of voltage to be held at the load side of the transformer. In many cases this voltage level is set to 120 V on the secondary, which corresponds to the desired primary voltage.

Voltage Bandwidth

The Voltage Bandwidth defines the allowable tolerance for change in the set voltage level that will not lead to a change of Tap position. If the load voltage falls outside the set bandwidth, the Multilin DGCV Voltage Regulator Controller will issue a Raise or Lower command.

Voltage Reduction

The Voltage Reduction function can be used in cases where system-wide voltage reduction is imposed in order to reduce demand (required generation) at critical periods. This voltage reduction technique allows for three separate levels of voltage dropping up to maximum of 10% of the nominal voltage. Commands to drop the voltage can be received by the Multilin DGCV through communications and integration with SCADA or Volt/VAR control systems.

Computation Time Delay

The Computation Time delay is used to delay operation of the tap changer. This function operates in situations where the deviation in voltage is temporary in nature & the voltage returns back to normal or within the set bandwidth limits.

Manual mode – Local Control

In this mode, it is possible to Raise or Lower the tap locally from the Push buttons that are available on the front panel of the Multilin DGCV. For added operational reliability and operator safety, inhibit functions configured in the unit continue to operate as defined.

Manual mode – Remote Control

In this mode, the commands for Tap Raise and Lower are received from SCADA or a Volt/VAR control systems via communications. This communications channel can be provided via optional radio or cellular communications.

The regulator can be forced to its normal or neutral position through either mode of manual operation (i.e.: remotely through SCADA or locally through front HMI).

Automatic mode

In automatic mode, the Multilin DGCV compares the measured voltage to the set voltage level, and if the difference exceeds the set bandwidth (voltage limits), the Multilin DGCV issues a Raise or Lower tap commands to maintain the desired voltage levels. In automatic mode, the voltage regulator controls the load voltage using the following parameters:

Line Drop Compensation (LDC)

The Line Drop Compensation function ensures that the voltage drop along the line away from the measurement point, is taken into consideration when determining the final tap position. The LDC function uses the resistive and inductive components of the line to determine the respective voltage drop between the voltage regulator and the next regulator controller or the connected consumers.

Reverse Power LDC

When power flows in the reverse direction due to large amounts of Distributed Generation or a network reconfiguration (FDIR action), most regulator controllers assume the line length in each direction are the same resulting in incorrect voltage regulation.

The Multilin DGCV provides separate line parameters for forward and reverse directions to take into account the change in distance to the next end of line segment. This proper voltage regulation ensures reliable service to all consumers.

Regulator Type

The Direct (type A) and reverse (type B) operation function ensure that the Multilin DGCV can be used with regulators that have taps on either the primary side or on the secondary side.

Reverse Power Override

The Reverse Power function enables the regulator to perform its operation on detection of reverse power. This function has four setpoint options: IGNORE, BLOCK, Return to Neutral, and REGULATE

If the Reverse Power Override function is set to IGNORE, the Multilin DGCV will continue to regulate the voltage using the normal LDC parameters. When set to BLOCK, the Multilin DGCV will be blocked from issuing raise or lower tap changer commands until power again flows in the forward direction. If set to Return to Neutral, the Multilin DGCV issues Raise or Lower commands to bring the voltage regulator to the Neutral position. Finally, if this function is set to REGULATE, on detection of Reverse power, the Multilin DGCV will continue to issue Raise and Lower operations in order to regulate voltage using the defined Reverse Power LDC parameters.

Voltage Runback Limits

The voltage runback limit function is used to quickly raise or lower the taps of the voltage regulator if system conditions cause the voltage at any point on the line to exceed upper or lower allowable limits. Such instances of voltage exceeding these limits can occur when a large amount of load is removed from heavily loaded lines or a large load is added to lightly loaded lines.

Inhibit Operations

The Multilin DGCV include many Inhibit Operation functions to ensure optimized power system reliability and operator safety during maintenance or functional operations. The following provides an outline of the key inhibit operation functions included within the Multilin DGCV

Overcurrent Inhibit

The Overcurrent Inhibit function prevents the Multilin DGCV from issuing any further raise or lower commands due to detection of line current exceeding the pre-defined overcurrent limit. This inhibit function prevents tap contact wear that can occur in periods of severe overloading or low level faults.

Overvoltage Inhibit

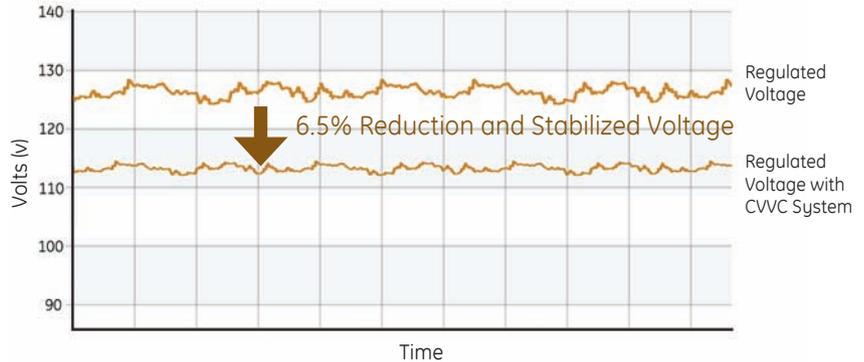
The maximum voltage level that the Multilin DGCV can force the regulator to continue raising the tap position is limited by the Overvoltage Inhibit function.

Under-Voltage Inhibit

The minimum voltage level that the Multilin DGCV can force the regulator to continue lowering the tap position is limited by the Under-Voltage Inhibit function.

Benefits of implementing a CVVC System with GE's Multilin DA Controllers

Typical End-of-Line Voltage Profile



Typical End-of-Line Power Profile



A 6.5% voltage reduction translates to an approximate 13% reduction in Power consumption, under certain load conditions

Automation

The Multilin DGCV offers powerful I/O and programmable logic (FlexLogic™) options for advanced automation control, reducing the need and costs associated with additional programmable controllers or discrete control devices.

Set point group control

The Multilin DGCV has three identical set point groups. The activation of the group can be done either from the HMI or via a Digital Input.

Virtual Inputs and Outputs

The Multilin DGCV provides 32 virtual inputs and 32 virtual outputs that provide users the ability to send commands to the device. The Multilin DGCV can accept commands from SCADA, through the front HMI, or front USB port to issue commands such as Raise or Lower tap position.

Command Setting

The Multilin DGCV has the ability to force commands from the menu structure. This can also be achieved via the Enervista software that runs on a PC. This simulation ensures that the Raise and Lower commands can be safely issued from a distance without using the HMI.

Drag-Hands Reset

The Drag – Hand Reset provides the ability to reset the Drag hands to the current tap position. Commands can be sent to the Multilin DGCV to reset the Drag Hand position from the front HMI, from SCADA or through the front panel USB communications.

FlexLogic™

FlexLogic in the Multilin DGCV, provides the ability to create customized control schemes. This minimizes the need and costs associated with auxiliary components and wiring. Schemes can be configured with FlexLogic™ specifying what actions need be taken based on the status of fault detections or control elements, as well as inputs driven by connected sensors and equipment.

Metering & Monitoring

The Multilin DGCV provides high accuracy metering and recording of all AC signals, measuring the following key parameters:

- Phase-Ground Voltages (kV)
- Phase to phase Voltages (kV)
- Line Voltage (kV)
- Phase A, B, and C currents (A)
- Line Current (A)
- Ground Current (A)
- 3-Phase Active power (KW)
- 3-Phase Reactive power (KVar)
- 3-Phase Apparent Power
- Power Factor (Lag or Lead)
- 2nd to 8th harmonic upto 20% – for current
- 2nd to 8th harmonic upto 20% – for voltage
- THD in 20% – for current
- THD in 20% – for voltage

These data points can be easily integrated into a customer's database for seamless viewing through a SCADA or DMS system.

Event recorder

To significantly reduce time and enable more effective disturbance, post fault analysis and troubleshooting, the Multilin DGCV provides an integrated event recorder and detailed diagnostic features. The Sequence of events recorder offers the following features:

- Up to 256 consecutive events stored
- Enable or disable, operate and dropout events by set points
- Phase voltage/current and power metering shot is also included and stored at each Event

Data Management and Diagnostics

The Multilin DGCV provides advanced disturbance diagnostic features that significantly reduce the time and costs associated with troubleshooting power system events and reconstruction. Recording functions include enhanced diagnostics with a 10 channel RMS recorder Data Logger. In addition, Statistics & Counters are utilized to keep a record on the number of operations as well as the various dependable parameters.

Statistics & Counters

The Multilin DGCV includes two tap changer counters which records the following information:

- DAILY TAP OPERATIONS,
- TOTAL TAP OPERATIONS.

The MIN/MAX TAP in the Multilin DGCV provides information on the lowest (minimum), and the highest (maximum) tap position the tap changer reached during one 24 hour day period.

Advanced Device Health Diagnostics

Comprehensive device health diagnostic tests are performed by the Multilin DGCV during startup and continuously at runtime to test its own major functions and critical hardware. These diagnostic tests monitor for conditions that could impact the Multilin DGCV Controller's performance, evaluates the potential impact and criticality of this condition and presents the device status to operators, via SCADA and/or through the front panel display. Providing continuous monitoring and early detection of possible issues enables preventative and predictive maintenance programs, thus improving system availability and reliability.

Communications

The Multilin DGCV utilizes industry standard, communications technologies making it one of easiest and most flexible controllers to use and integrate into new and existing SCADA or DMS infrastructures. Supported communication protocols include:

- DNP 3.0
- Modbus RTU (RS485)

Multiple communication ports and protocols allow for remote control and easy access to device and system information. All communication ports are capable of simultaneous communications. The Multilin DGCV can also communicate to Volt/VAR or SCADA systems via wireless communications media. The supported wireless media includes:

- Wireless Radio (MDS or customer specific)
- GSM/GPRS
- Pre-wired for future radio

Security

The Multilin DGCV Controller and associated software tools provide a suite of security features that ensure only approved personnel can make changes to the configuration of the system or execute commands. These functions enable a utility to meet NERC/CIP requirements.

Password Security

The Multilin DGCV offers multiple levels of password security to limit access control based on settings or command levels. There are four levels of password security provided:

- Local Settings Access
- Local Control Access
- Remote Settings Access
- Remote Control Access

Local Access refers to users making changes using the front USB serial port and the HMI. Remote Access refers to users making changes using the rear RS485 port.

Software & Configuration

Quick Keys

Quick settings buttons available on the front plate of the Multilin DGCV enables user to set required application settings, bypassing the standard HMI menu.

Quick settings links are : Voltage Level (bandcenter), Voltage Bandwidth , Line Drop Compensation (LDC), Voltage Runback Limits , Voltage Reduction, Reverse Power

EnerVista™ Software

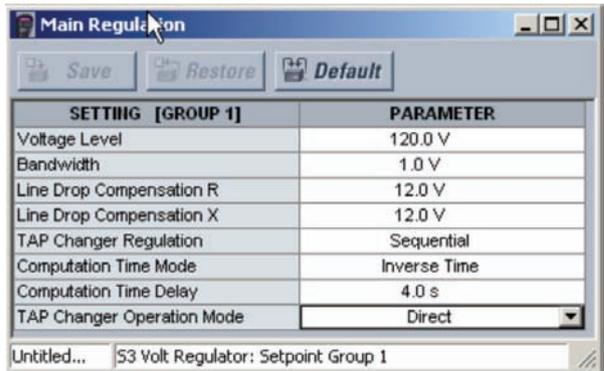
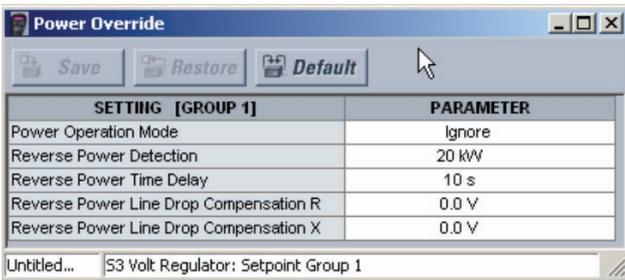
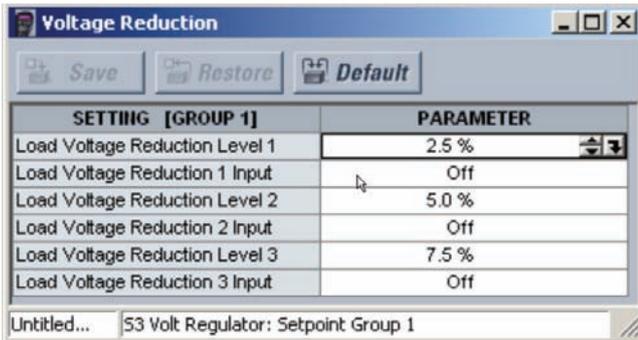
The EnerVista™ Suite is an industry-leading set of software programs that simplifies every aspect of using the Multilin DGCV. The EnerVista™ suite provides all the tools to monitor the status of the protected asset, maintain the controller, and integrate information measured by the Multilin DGCV into SCADA or the DMS monitoring systems. The ability to easily view sequence of events is an integral part of the setup software, as postmortem event analysis is critical to proper system operation.

EnerVista™ Launchpad

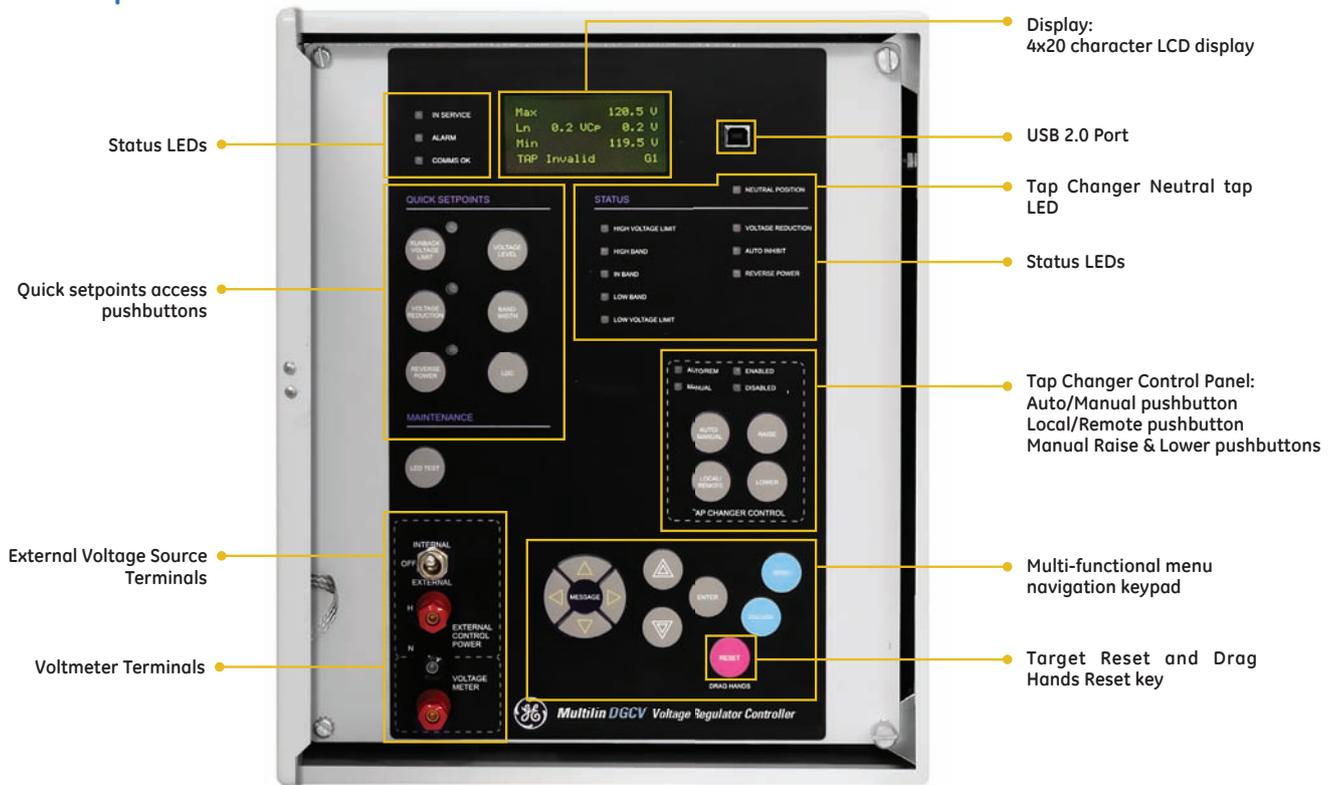
EnerVista™ Launchpad is a powerful software package that provides users with all of the setup and support tools needed for configuring and maintaining GE's Multilin products. The setup software within Launchpad allows configuring devices in real-time by communicating using serial, Ethernet, or modem 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
- Guide form Specifications
- Brochures
- Wiring Diagrams
- FAQs
- Service Bulletins

Set up with EnerVista™ Software



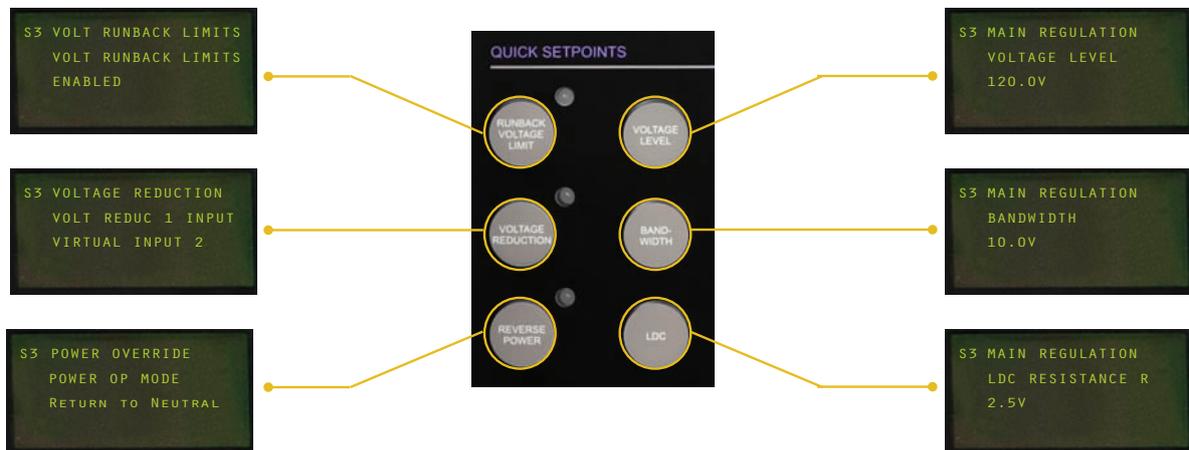
Front panel



Distribution Automation Controller

HMI Quick Setting Displays

Front panel quick keys provides direct access to key individual setting parameters



Technical Specifications

POWER SUPPLY (HIGH)

Nominal: 120 to 240 V AC , 125 to 250 V DC
Range: 60 to 300 V AC (50 and 60 Hz) , 84 to 250 V DC

Ride-Through

POWER SUPPLY (LOW)

Nominal: 24 to 48 V DC
Range: 20 to 60 V DC
Ride-Through: 35ms

ALL RANGES

Voltage Withstand: 2 x highest nominal voltage for 10 ms

Power Consumption: 16 W typical, 25 W maximum

AC CURRENT (OPTION A)

Range: 0.2 to 2.5 x CT
Input type: combined 1 A / 5 A
Frequency: 50 or 60 Hz
CT Connection: IA,IB,IC

AC CURRENT (OPTION H)

Range: 0.05 to 0.5 x CT
Input type: 0.2 A
Frequency: 50 or 60 Hz

Accuracy: ±0.5% of Nominal

AC VOLTAGE:

Input range: 60 to 300 V AC
Nominal frequency: 50 or 60 Hz
VT Connection: VA,VB,VC,VAB,VBC,VCA
Accuracy: ±0.5% of reading

DIGITAL INPUTS:

Type: opto-isolated inputs
External switch: wet contact
Maximum input voltage: 300 V AC
Fixed pickup: 65 V AC
Recognition time: 2 cycles
Current draw at rated voltage: 60 mA @ 120 V; 75 mA @ 240 V
Momentarily sampled every cycle
Input impedance: 1.7 kΩ

OUTPUTS

Operate time: 10 ms
Minimum contact load: 10 mA at 5 V DC
Maximum switching rate 300 operations per minute (no load): 30 operations per minute (load)
Mechanical life: 10 000 000 operations
Continuous current: 10 A
Make and carry for 0.2s: 30 A per ANSI C37.90
Output relay break capacity: (FORM-A RELAY)
AC resistive: 120/240 V AC 10 A
AC inductive: PF = 0.4 pilot duty 2 A
DC resistive: 30 V DC 10 A
Output relay break capacity: (FORM-C RELAY)
AC resistive: 120 V AC 10 A normally-open, 5 A normally-closed
AC inductive: 240 V AC 10 A normally-open, 8 A normally-closed
DC resistive: PF = 0.4 pilot duty 2.5 A
30 V DC 10 A
EXECUTION RATE
4 times/cycle: Main task for detection elements
1/sec – display update rate: 115 kbps

COMMUNICATION

SERIAL
RS485 port: Opto-coupled
Baud rates: up to 115 kbps
Response time: 1 ms typical
Parity: None, Odd, Even
Maximum distance: 1200 m (4000 ft)
Isolation: 2 kV
Protocol: Modbus RTU, DNP 3.0
USB
Standard specification: Compliant with USB 2.0
Connector: 115 kbps

TESTING AND CERTIFICATION

ISO: Manufactured under an ISO9001 registered program

PHYSICAL SPECIFICATIONS

Enclosure Size: 325 mm (W) x 400 mm (H) x 215 mm (D) [+ terminals 10mm]
Weight (Base): 16 kg

ENVIRONMENT

Ambient operating temperature: -40°C to +60°C [-40°F to +140°F]
Ambient storage / shipping Temperature: -40°C to +85°C [-40°F to +185°F]
Humidity: up to 90% non-condensing
Pollution degree: 2
Installation category: Class I
Overvoltage category: Class III
IP rating: IP20 (base unit), IP65 (control panel)

Provides ingress protection rating of NEMA 4 (and equivalent IP rating – IP65) as defined by NEMA IEC 60529 for pole top installation.

Ordering

	DGCV	E	*	S	S	*	B	*	*	*	*	*	X	X	X	X	Description
Language		E															English (Standard)
Power Supply			H														High (60-300 VAC/80-250VDC) Low (20 to 60VDC)
Communication			L	S													RS485 Modbus RTU / DNP3.0 (Standard)
Options					S												Standard
Analogue I/O						A											1A/5A Current Input Card 0.2A Current Input Card Voltage Input Card
Digital I/O						H	B										Two (2) 10 A Form-A relays and six (6) 60 to 300V AC digital Inputs (Standard either IO-C or IO-E) Two (2) 10 A Form-A relays and six (6) 20 to 60V DC digital Inputs (Standard either IO-C or IO-E) Four (4) 10A form-C relays (optional) Not Required
Controller packaging								C	C								1 Only Controller 2 Controller + Front Display Panel 3 Controller + Front Display Panel in Enclosure
Wireless Radio Option										D	D	D					X Contact GE for any wireless option, including prewiring for Radio

Visit www.GEMultilin.com/DGCV to:



- Download the instruction manual
- Review applications Notes and support documents
- Buy the Multilin DGCV Voltage Regulator Controller online
- View/download the Multilin DGCV brochure