**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.
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 remain within utility specified, voltage limits, under varying load conditions.

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

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.

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

- Centralized Control & Operations
- Increase Reliability: Fault Detection, Isolation & Restoration (FDIR)
- Optimization & Efficiency: Volt/VAR Control (IVVC / CVVC)
- Network Monitoring

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

- 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 Volgate 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 a 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.
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 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.

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 from 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 reconstructions. 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 (IMDS 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

- Display: 4x20 character LCD display
- USB 2.0 Port
- Tap Changer Neutral tap LED
- Status LEDs
- Multi-functional menu navigation keypad
- Target Reset and Drag Hands Reset key

Quick setpoints access pushbuttons

External Voltage Source Terminals

Voltmeter Terminals

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:** 35 ms

### POWER SUPPLY (LOW)
- **Nominal:** 24 to 48 V DC
- **Range:** 20 to 60 V DC
- **Ride-Through:** 35 ms

### ALL RANGES
- **Voltage Withstand:** 2 x highest nominal voltage for 10 ms
- **Power Consumption:** 16 W typical, 25 W maximum

### Input range:
- **Range:** 0.05 to 0.5 × CT
- **Input type:** AC, DC
- **Frequency:** 50 or 60 Hz
- **Voltage:** Nominal, 24 to 48 V DC
- **Current draw at 2 cycles:** 60 mA @ 120 V; 75 mA @ 240 V

### External inputs:
- **Type:** opto-isolated inputs
- **Frequency:** 1.7 kΩ
- **Accuracy:** ±0.5% of Nominal
- **Input impedance:** Momentarily sampled every cycle

### Commutation
- **Operating time:** 10 ms
- **Minimum contact load:** 10 mA at 5 V DC
- **Maximum switching rate:** 300 operations per minute (load)
- **Mechanical life:** 10 000 000 operations
- **Continuous current:** 10 A
- **Make and carry for 0.2s:** 2 A per ANSI C37.90
- **External switch:** (FORM-A RELAY)
- **Input relay break capacity:**
  - 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:**
  - AC resistive: 120 V AC 10 A normally-open, 5 A normally-closed
  - AC inductive: PF = 0.4 pilot duty 2.5 A
  - DC resistive: 30 V DC 10 A

### COMMUNICATION
- **RS485 port:** Opto-coupled
- **Baud rates:** up to 115 kbps
- **Response time:** 1 ms typical
- **Parity:** None, Odd, Even
- **Isolation:** 2 kV
- **Frequency:** 9600 baud
- **Protocol:** Modbus RTU, DNP 3.0
- **USB:** Compliant with USB 2.0

### Digital inputs:
- **Type:** AC, DC
- **Frequency:** 50 or 60 Hz
- **Voltage:** 60529 for pole top installation.
- **Current draw at rated voltage:** Input impedance: 1.7 kΩ

### Analog inputs:
- **Type:** AC, DC
- **Frequency:** 50 or 60 Hz
- **Voltage:** Nominal, 24 to 48 V DC
- **Current draw at 2 cycles:** 60 mA @ 120 V; 75 mA @ 240 V

### Digital I/O:
- **Type:** AC, DC
- **Frequency:** 50 or 60 Hz
- **Voltage:** Nominal, 24 to 48 V DC
- **Current draw at 2 cycles:** 60 mA @ 120 V; 75 mA @ 240 V

### Analog I/O:
- **Type:** AC, DC
- **Frequency:** 50 or 60 Hz
- **Voltage:** Nominal, 24 to 48 V DC
- **Current draw at 2 cycles:** 60 mA @ 120 V; 75 mA @ 240 V

### Testing and Certification
- **ISO:** Manufactured under an ISO9001 registered program

### Physical Specifications
- **Enclosure Size:** 225 mm (W) x 400 mm (H) x 165 mm (D) [±10mm]
- **Weight (Base):** 16 kg
- **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)
- **NEMA equivalent IP rating:** NEMA 4 and equivalent IP rating – IP65 as defined by NEMA IEC 60529 for pole top installation.

### Ordering

#### Language
- **English (Standard)**

#### Power Supply
- **High (H):** 60-300 V AC (50 and 60 Hz)
- **Low (L):** 20-60 V DC

#### Communication Options
- **Standard (S):** RS485 Modbus RTU, DNP 3.0
- **RS485 Modbus RTU (S):** Standard
- **RS485 Modbus RTU / DNP3.0 (Standard):** Standard
- **1A/5A Current Input Card (B):** 0.2A Current Input Card
- **Opto-isolated outputs:** 115 kbps
- **Compliant with USB 2.0:** 115 kbps

#### Controller packaging
- **Only Controller (X):** Only Controller
- **Controller + Front Display Panel (D):** Controller + Front Display Panel
- **Controller + Front Display Panel in Enclosure (B):** Controller + Front Display Panel

#### Wireless Radio Option
- **Contact GE for any wireless option, including prewiring for Radio (X):** Contact GE for any wireless option, including prewiring for Radio

---

Visit [www.GEMultilin.com/DGCV](http://www.GEMultilin.com/DGCV) to:

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