

# CL-6A Voltage Regulator Control Technical Specifications

## Introduction

This specification describes the features of the CL-6A communication-ready voltage regulator control.

The control shall operate on 50 and 60 Hz systems.

The control shall have a functional temperature range of -40°C to +85°C.

The regulator control shall be mounted in a weather-resistant enclosure, which is capable of being padlocked, absent other appropriate security options. The control enclosure shall have an external 1/2" – 13 UNC stainless steel welded ground boss.

The control shall be hinge-mounted and designed for easy replacement. The control shall be constructed to provide direct interchangeability without removal of the control enclosure. Visible means shall be provided to de-energize the control and short the regulator's internal current transformer prior to control testing or removal.

All leads in the control enclosure shall be color coded and labeled for easy identification.

The terminal strips of the control back panel shall consist of clamp-style quick connectors for ease of access.

All printed circuit boards shall be conformal coated for fungi and moisture protection.

A ratio-correction transformer shall be provided inside the enclosure for easy access for fine voltage adjustment. Ratio-correction taps and the corresponding system voltage shall be clearly identified on the nameplates.

## Front Panel

The control front panel shall include the following features:

- A numeric keypad for quick, easy modification of existing control parameters.
- A flash card port for programming and data retrieval capabilities via compact flash card.
- A backlit LCD display, 4 lines by 20 characters each, for displaying relevant information. The display shall have an adjustment for contrast.
- Four user-selectable languages (English, Spanish, French, Portuguese), 3 user-selectable date formats (MM/DD/YYYY, DD/MM/YYYY, YYYY/MM/DD), and two user-selectable time formats (12 hour AM/PM, 24 hour).
- A six-digit electronic operations counter, which counts every tap change.
- An EIA-232 DB-9 port for temporary communications connection for upload or download of data.

- A motor fuse, which is replaceable. Fuse size shall be clearly marked near the fuse holder. A spare fuse shall be included within the control enclosure.

The control front panel shall also include the following features:

## Switches

- A three-position voltage source switch, labeled INTERNAL-OFF-EXTERNAL, which allows the control to be energized from the regulator's internal voltage supply or from an external source. The OFF position is provided to de-energize the control.
- A three-position, AUTO/REMOTE-OFF-MANUAL control switch, which allows for automatic/remote or manual/local operation of the voltage regulator. Monitoring of the control is available at all positions.
- A momentary three-position RAISE-OFF-LOWER control switch, which shall be active only when the adjacent control switch is in the MANUAL position.
- A position-indicator drag-hand reset switch.
- A two-position supervisory ON-OFF switch which, in the OFF position, inhibits tap-changer motor control and parameter changing via digital SCADA but allows for monitoring of the control data base via SCADA.

## Terminals

- High-impedance voltmeter test terminals which monitor the load side voltage (L bushing) of the regulator. An automatic resetting fuse shall be provided to inhibit an accidental backfeed loop in the voltage regulator by way of the voltmeter test terminals.
- External voltage source terminals to allow tap-changer and control operation from an external 120 Vac source. Ground terminal shall be clearly identified. An interlocking means shall be provided to inhibit energizing of the high-voltage bushings from the external source.
- Additional ground terminal for the front panel, prominently and clearly identified.

## LED Indicators

- Dual neutral position LEDs that are actuated via the tap-changer to provide neutral position indication. These LEDs must be of the high-intensity type and easily readable in direct sunlight.
- LED indicators to indicate whether the voltage is inside or outside of the set voltage band and whether the voltage is high or low.

- LED indicators for Alarms, configurable via the interface software provided by the manufacturer.
- LED indicators for Warnings, configurable via the interface software provided by the manufacturer.
- LED indicator for a diagnostics test failure.
- Transmit and Receive LEDs for all communication ports located on the front panel of the control for user visibility.
- LED indicators to indicate whether the voltage is inside or outside the voltage limiter settings, when active, and whether the voltage is high or low.
- LED indicator to indicate activation of a tap-changer-blocked condition.
- LED indicator to indicate activation of a reverse power flow mode.
- LED indicator to indicate activation of the voltage reduction feature.
- LED indicator for user-defined output of programmable I/O, configurable via the interface software.

### Front-Panel Programming

The control shall be microprocessor based, shall be accessible from the front panel via a combination structure using function codes and a scrollable nested menu, and shall have provisions for programming of the following parameters:

- Set voltage adjustable from 100.0 to 135.0 V in increments of 0.1 V.
- Set voltage bandwidth adjustable from 1.0 to 6.0 V in increments of 0.1 V.
- Time delay adjustable from 5 seconds to 180 seconds in 1-second increments.
- Line-Drop Compensation, resistance and reactance settings, adjustable from -96.0 to +96.0 V in increments of 0.1 V.

### Alarms

The control shall allow for over 15 user-configurable Status (binary) alarms and over 30 Data (analog) alarms. Alarms shall be able to turn on an LED viewed on the front panel, generate time-tagged Events or Profile snapshots, and be used as a programmable I/O input.

### Digital Metering

A digital metering package of Class 1 accuracy which shall provide the following information:

- Instantaneous values of load voltage, compensated voltage, current, power factor, kVA load, kW load, kvar load, voltage harmonics, and current harmonics. Voltage and current harmonics shall include, at a minimum, total harmonic distortion.
- Demand values of load voltage, compensated voltage, current, kVA load, kW load, and kvar load. For each of these values, the present value, highest value since last reset, and lowest value since last reset shall be provided. Highest and lowest values shall be time and date tagged. Power factor at maximum and minimum kVA load shall be provided. Metering values must be available for both forward and reverse power flow conditions.

The metering data must be easily accessible at the control.

### Data Acquisition

#### Profiler

The control shall have a profiler that consists of over 60 user-selectable metering values with configurable sample time intervals.

#### Event Recorder

The control shall allow for time-tagged recording of user-definable Events. The last 50 Events shall be viewable through the LED display.

#### Histograms

The control shall store user-configurable data for Histograms (graphs that show voltage regulator performance at a glance).

### Control Communications

The voltage regulator control shall include the following features:

- Flash card, programming and data retrieval, capabilities. The control shall be capable of uploading or downloading parameters and data via a flash card port without requiring the use of external computers or hand-held devices.
- A front-panel EIA-232 DB-9 port for temporary communications connection for upload or download of data.
- Two permanent communications ports for use with communication accessories.
- DNP 3 and DATA 2179 protocols resident in the control and user-configurable for all communication ports.
- DNP 3 protocol certified level 2 compliant.

## SCADA

The control shall have provisions to allow remote override of regulator operation via discrete (analog) supervisory control. Terminals shall be provided on the back panel of the control enclosure as follows:

- For motor raise: Two terminals for normally-open, momentary-close contacts.
- For motor lower: Two terminals for normally-open, momentary-close contacts.
- For auto inhibit: Two terminals for normally-closed, latch-open contacts (120 Vac must be supplied to activate auto inhibit).

## Programmable I/O

The control shall have programmable I/O capabilities, which will allow the user to write logical equations to perform user-defined control and communication operations.

The control shall have four discrete 120 Vac inputs and four FORM-C discrete output contacts for discrete I/O interfacing.

## Standard Control Features

### Tap Position Indication

A tap position indication capability, which tracks the movement of the tap-changer motor, shall provide the present tap position and the highest and lowest positions since last reset. The highest and lowest values shall be date and time tagged.

### Voltage Limiting

A voltage-limiting capability that prevents the regulator from making additional tap changes once the regulator output voltage meets a programmed upper- or lower-limit setting. If the source voltage should change, causing the regulator output voltage to exceed either limit, the control, after an initial fixed shorten-time delay, dependent on the voltage swing outside the voltage limit, shall have the tap-changer step the voltage to within the voltage-limiter setting.

### Voltage Reduction

A configurable voltage reduction capability which consists of at least three distinct modes as follows:

Up to three voltage reduction values shall be able to be set locally at the control or remotely via a digital SCADA/communications system from 0.0 to 10.0 percent in 0.1% steps.

Remote voltage reduction shall allow any one of the three voltage reduction values to be activated remotely by applying 120 Vac to the appropriate discrete input points on the control. A 120 Vac wetting voltage shall be available at the discrete I/O terminal for this purpose. Each of the three reduction values shall be independent of each other and shall be programmable from 0.0 to 10.0 percent.

Pulse-activated voltage reduction shall provide a programmable number of steps of reduction, from 0 to 10.0 percent in increments of 0.1 percent. Total allowable reduction shall be limited to 10.0 percent. Stepping shall be accomplished by momentarily applying 120 Vac to a contact provided on the back panel of the control enclosure. Immediate reset to 0 percent shall be accomplished by applying 120 Vac to a second terminal on the back panel.

### Reverse Power Flow

A Reverse Power Flow Detector that automatically senses a power reversal and can provide indication that a power reversal is taking place. The regulator control shall incorporate separate forward and reverse control settings for voltage level, bandwidth, time delay, and line-drop compensation R and X. At a minimum, the following modes of reverse power operation shall be provided:

- Locked forward mode
- Locked reverse mode
- Reverse idle mode
- Bidirectional mode
- Neutral idle mode
- Cogeneration mode
- Reactive bidirectional mode

### Source Voltage Calculation

A configuration point which, when turned on, will calculate the source voltage, based on tap position, regulator type, and internal impedance. The regulator types are either Type A or Type B per IEEE standard C57.15. The calculated source voltage will enable reverse power flow operation without the use of a source-side potential transformer.

## Tap-Changer Diagnostics and Maintenance

### Duty Cycle Monitor

The control shall have a "Duty Cycle Monitor" that will calculate the life used for all contacts of the tap-changer based upon actual service conditions and the individual regulator design.

### PMT™ Preventive Maintenance Tapping

The control shall be able to perform PMT™ preventive maintenance tapping, which is the ability for the control to exercise the tap-changer based upon user-defined conditions on a routine basis to prevent the build-up of carbon deposits on the contacts (contact coking). Two modes shall be available allowing for various degrees of configurability and the ability to exercise all stationary and moveable contacts.

### TIME-ON-TAP™ feature

The control shall have a TIME-ON-TAP™ feature that provides specific information about the amount of time that the regulator has spent on each tap position.

### Deviation from Specification

It is expected that any controls supplied by the vendor will be in strict accordance with this specification unless appropriately noted with the original bid and agreed to by vendor in writing.