



# Specifications

## HI/ICMI UVR-1 Universal Voltage Regulator Control



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## UVR-1 Universal Voltage Regulator Control Specification

The UVR-1 Universal Voltage Regulator Control is a microprocessor-based single phase step voltage regulator control with an integrated remote monitoring and control capability supporting multiple communications protocols. The control uses waveform sampling and digital signal processing to accurately measure and compute system parameters. The UVR-1 is compatible with most single phase step voltage regulators from various manufacturers. The differences in regulator types (i.e. operation counters, neutral switch/polarity, holding switch) are handled through UVR-1 configuration selections. The UVR-1 can be ordered in panel and harness configurations that fit existing regulator control cabinets. The UVR-1 provides the maintenance/retrofit/upgrade marketplace with a flexible, functional step voltage regulator control including the widely used DNP3 communications protocol.

### Regulation Features:

- **Bandcenter** - load center set voltage, adjustable from 100.0 to 135.0 V with 0.1 V resolution.
- **Bandwidth** - load center voltage bandwidth, adjustable from 1.0 to 6.0 V with 0.1 V resolution.
- **Time Delay** - time delay before tap change, adjustable from 5 to 180 sec. with 1 sec. resolution.
- **Line Drop Compensation** - allows for correction of load center voltage due to voltage drop (or rise) caused by transmission lines or other devices.
  - Resistive Compensation - resistive voltage change, at rated load current, between the voltage regulator and the load center, adjustable from -24.0 to +24.0 V with 0.1 V resolution.
  - Reactive Compensation - reactive voltage change, at rated load current, between the voltage regulator and the load center, adjustable from -24.0 to +24.0 V with 0.1 V resolution.
- **Reverse Power Flow Detection/Operation** - reverse power flow is detected by phase angle and real current monitoring.
  - Separate setpoints and metering data are maintained for reverse power flow (mode dependent).
  - Current threshold for reverse power flow mode determination, adjustable from 1% to 10% with 1% resolution.
  - Source-side sensing transformer not required.
- **Multiple Modes of Operation:**
  - Locked Forward - regulation and metering based on forward power flow.
  - Locked Reverse - regulation and metering based on reverse power flow.
  - Idle Reverse - regulation and metering based on power flow direction, but tap changes do not occur during reverse operation.
  - Bi-directional - regulation and metering based on power flow direction.
  - Neutral Reverse - regulation and metering based on power flow direction, but regulator returns to neutral position during reverse operation.
  - Co-generation - regulation and metering based on forward power flow, except that reverse line drop compensation values are used during reverse power flow.
- **Multiple Regulation Algorithms/Timer Modes**
  - Sequential - When the load center voltage exceeds either band edge, the time delay is initiated. After the time delay has expired, the appropriate raise or lower operations are performed with 2 second intervals between, until the load center voltage is in-band. If the load center voltage returns to within the band edges during the time delay period, the timer is reset.
  - Time-Integrating Sequential - When the load center voltage exceeds either band edge, the timer (initially 0) is incremented each second. If the timer meets or exceeds the time delay, the appropriate raise or lower operations are performed with 2 second intervals between, until the load center voltage is in-band. If the load center voltage returns to within the band edges during the time delay period, the timer is decremented each second until it reaches 0.
  - Voltage-Averaging - When the load center voltage exceeds either band edge, the time delay is initiated. The load center voltage is monitored and averaged over the delay. After the time delay has expired, the computed number of raise or lower operations is performed (up to 5, with no inter-tap delay) to bring the load center voltage to the bandcenter. If the load center voltage returns to within the band edges for 10 continuous seconds during the time delay period, the timer is reset.

- **Voltage Limiting** - monitors the regulator load voltage to protect customers near the regulator.
  - High Limit - the regulator load voltage is not allowed above this setting. Tapchanger raise operations are inhibited 1 volt below this setting. Adjustable from 95.0 to 135.0 V in 0.1 V increments, or can be disabled.
  - Low Limit - the regulator load voltage is not allowed below this setting. Tapchanger lower operations are inhibited 1 volt above this setting. Adjustable from 95.0 to 135.0 V in 0.1 V increments, or can be disabled.
  - Auto-Runback - If the line characteristics change and either of the voltage limits are exceeded for a minimum time period, the control will automatically return the regulator load voltage to within the voltage limits.
- **Voltage Reduction** - lowers the effective set voltage by one of three percentages selectable by external inputs†, or by an explicit percentage set locally or remotely. All percentages adjustable from 1.0% to 10.0% with 0.1% resolution.
- **Tap Position Limits for Increased Load Capability** - raise and lower tap position limits, adjustable from positions 16 lower to 16 raise.
- **Load Current Limit** - load current exceeding this limit inhibits the automatic control algorithm and can cause an alert. Adjustable from 0 to 440 mA CT secondary current (higher with less measurement accuracy).
- **Automatic Control Algorithm Inhibit** - the automatic control algorithm can be inhibited for manual, auxiliary (external)†, or direct remote control of the regulator.
- **Tap Position Indication** - current tap position is tracked based on the neutral position indicator and acknowledgement from the operation counter or holding switch. The tap position is maintained in non-volatile memory, and can be set to match existing physical tap position.
- **Electronic Draghands** - resettable electronic tap position draghands, along with the time and date of each min/max, are kept in non-volatile memory.
- **Operation Counter** - two digital operation counters, one resettable, are kept in non-volatile memory. The non-resettable counter may be set to match an existing operation counter for replacement applications.
- **External Raise and Lower Inputs and Outputs†** - external motor control signals that can be used to gang multiple regulator controls.
- **External Alert Input and Output†** - external alert source, and an indication that one of several selectable alert conditions has occurred.

### Additional Control Features:

- **Auxiliary Programmable I/O†** - eight individually programmable signals may be assigned to dedicated control functions or general purpose use.
- **Heater Control Output†** - used to control a heater based on a selectable ambient temperature.
- **Cooling Device Control Output†** - used to control a cooling device based on a selectable ambient temperature.
- **Data Logging** - up to 7 user-selectable data items may be logged on a periodic basis, and displayed or read out via the front panel PC port. A portion of the most recent data log records are stored in non-volatile memory.
- **Internal Clock/Calendar with Powerfail Backup** - used for timestamping min/max, log, and communications protocol data. Powerfail backup maintains clock/calendar for up to 3 days without AC power.
- **Ambient Temperature Monitor** - present and min/max ambient temperature monitoring.
- **Non-volatile Parameter Storage** - all configuration parameters are stored in non-volatile memory.
- **3 User Parameter Profiles with Selectable Date Activation** - 3 user-customizable profiles for storage of UVR-1 parameters. These can be loaded directly, and/or the date activation feature allows any of these to be automatically loaded on any of 4 user-selectable dates each year.
- **Factory Defaults for All Parameters** - UVR-1 can be reset to factory defaults from front panel.
- **Self Test and Equipment Protection** - comprehensive control self test, and safeguards against equipment damage due to conditions such as voltage transients, low tapchanger motor voltage, and stuck switches.
- **Tapchanger Contact Wear Log and Alert** - data related to tapchanger contact wear may be logged, and accessed via the protocol, displayed, or read out via the front panel PC port. The data is stored in non-volatile memory. In addition, thresholds can be set to cause an alert.

### Compatibility:

- The UVR-1 is designed to be directly compatible with the following single phase step voltage regulators:
  - **General Electric** - ML 32 Step Voltage Regulator.
  - **Siemens** - JFR Regulators.
  - **Howard** - SVR-1 Regulator.
  - **CPS/McGraw Edison** - VR-32 Regulator, spring drive models 170 and 928 and direct drive models 660 and 770.
- The UVR-1 can be used to control most other regulators, including those without a neutral switch.
- Source-side sensing transformer not required.
- Ratio-correcting transformers are not required for control operation. Adjustable base voltage.
- Configurable parameters allow setup with all commonly available regulator transformers.
- Configurable phasing correction for use with 1-phase and 3-phase wye and delta power systems.
- Special DNP3 points for drop-in compatibility with Georgia Power regulator controls.

### Communications:

- **Remote Monitoring and Control** - All configuration parameters, setpoints, status, and measurements can be read and/or written remotely if enabled. The unit serial number is remotely readable. The UVR-1 is designed to support multiple protocols.
- **DNP3 Protocol** - Subset Definition Level 2 Slave Device with report by exception.
- **Protocol Port** - serial EIA-232, EIA-485, or daughter board interface selectable. Configurable baud rate (300, 600, 1200, 2400, 4800, 9600, 19200, or 38400), parity (even, odd, or none), stop bits (1 or 2), protocol mode, and transmission delay (0 to 5000 ms).
- **Daughter Board Interface** - allows optional daughter board to be used to support additional communications interfaces such as fiber-optic or modem. Optional daughter boards are available from ICMI.
- **Communications Gateway** - The UVR-1 can serve as a communications gateway, permitting a different host-side (SCADA master) interface for multi-dropped and loop configurations.
- **Front Panel PC Port** - for UVR-1 maintenance and configuration, as well as for data readout (min/max metering values, data log, and contact wear log).

### Metering:

- **Load Voltage** (direct sensing)
- **Load Current** (direct sensing)
- **Control Input Voltage**
- **Source Voltage**
- **Load Center Voltage**
- **Power Factor and Phase Angle**
- **Load VA, W, and VAR Power Values**
- **Line Frequency**
- **Harmonics for Load Voltage and Load Current** - % THD, and % of fundamental for 3rd through 13th odd harmonics.
- **Demand Metering** - thermal demand values for load current, VA, W, and VAR, for both forward and reverse power flow. Demand interval adjustable from 1 to 120 min. with 1 min. resolution.
- **Min/Max Metering** - min and max values for average load, source, and load center voltage, max values for all demand quantities, and power factor at max VA, along with the time and date of each min/max, are stored in non-volatile memory. Separate min/max values are maintained for forward and reverse power flow. These values are independently resettable.
- Primary power values may be displayed as 1-phase or 3-phase quantities.

### Accuracy:

- 0.3% basic accuracy (tested per IEEE C57.15-1999), excluding VT and CT errors.

### Operational Requirements:

- **Temperature** - -40 to +85 °C (-20 to +60 °C useful display range for LCD).
- **Humidity** - maximum relative humidity of 95% non-condensing.
- **Input Voltage** - 80 to 145 Vrms (line-to-ground).
- **Input Current** - 2 A max.
- **CT Secondary Current** - 0 to 1000 mA rms (0 to 400 mA for stated accuracy).
- **Frequency** - 45 to 65 Hz (50 and 60 Hz nominal operation).

### Standards Compliance:

- ANSI Class 1 metering.
- ANSI/IEEE C57.15-1999, Standard Requirements, Terminology, and Test Code for Step-Voltage Regulators.
- ANSI/IEEE C37.90.2 (1987-1995), Radio Frequency Interference (RFI) Immunity.
- IEC 61000-4-2 (1995-2001), Electrostatic Discharge (ESD) Immunity.
- ANSI/IEEE C37.90.1-2002, Oscillatory SWC Immunity.
- ANSI/IEEE C37.90.1-2002, Fast Transient SWC Immunity.
- Certified as a DNP3-2001 Subset Level 2 compliant IED by Advanced Control Systems, Inc.
- Navy Military Specification I-46058 conformal coating protection for global weather climates.

### User Interface:

- Menu driven with intuitive, easy to use panel controls.
- 2 line x 20 character alphanumeric display.
- Multiple display types - LCD with backlight (standard), or optional vacuum fluorescent for extreme climates.
- User-specified circuit ID string.
- Single level security code, with log of last 16 times that security Read/Write/Execute was enabled.

### Indicator Lamps:

- **High Band** - On indicates load center voltage above high band edge.  
Flashing indicates same, but corrective tap changes inhibited due to operating mode.
- **In Band** - indicates load center voltage within band edges.
- **Low Band** - On indicates load center voltage below low band edge.  
Flashing indicates same, but corrective tap changes inhibited due to operating mode.
- **High Limit** - On indicates regulator load voltage above high limit setpoint (auto-runback pending).  
Flashing indicates raise operations inhibited near high limit setpoint.
- **Low Limit** - On indicates regulator load voltage below low limit setpoint (auto-runback pending).  
Flashing indicates lower operations inhibited near low limit setpoint.
- **Voltage Reduction** - indicates that the selected voltage reduction setting is non-zero.
- **Reverse Power** - indicates reverse power flow detected.
- **Alert** - indicates that one of several selectable alert conditions has occurred.
- **Neutral Position Indicator** - indicates regulator is at the neutral tap position.

### Panel Features:

- **Voltmeter Terminals** - the actual load voltage input to the regulator.
- **External Source Terminals** - used to apply an external 120 VAC source to the UVR-1.
- **Fuses** - separate replaceable fuses for Control (2A) and Motor Power (6A max.).
- **Main Power Switch** - controls power and inputs to the UVR-1.
  - Internal Source - Control power/load voltage input is from PS terminal, motor power is from MS terminal.
  - Off - Control power/load voltage input and motor power are disconnected.
  - External Source - Control power/load voltage input and motor power are from external source terminals.

- **Motor Control Switches:**
  - Auto/Off/Manual Switch:
    - Auto - routes the motor power selected with the Main Power switch to the UVR-1 and allows the UVR-1 to control tapchanger operation based on programmed settings.
    - Off - disconnects power from the tapchanger motor, disabling automatic and manual control.
    - Manual - routes the motor power selected with the Main Power switch to the Raise/Lower switch, disabling automatic control.
  - Raise/Lower Switch:
    - Raise - allows a local operator to manually run the tapchanger in the raise direction.
    - Lower - allows a local operator to manually run the tapchanger in the lower direction.
- **Draghand Reset Switch** - used to reset the draghands on the mechanical position indicator to the current tap position.
- **Local/Remote Switch:**
  - Local - Enables the following UVR-1 parameter access and control:
    - User Interface and PC port: Read/Write access
    - Remote: Read-only access
    - Auxiliary (external†) control: disabled
  - Remote - Enables the following UVR-1 parameter access and control:
    - User Interface and PC port: Read-only access
    - Remote: Read/Write access
    - Auxiliary (external†) control: enabled when Auto/Off/Manual switch is in Auto position

### Configuration and Utility Software:

- **Protocol Configuration Utility** - Microsoft Windows®-compatible program used to customize the point map and its attributes.
- **Device Configuration Utility** - Microsoft Windows®-compatible program used to configure all UVR-1 parameters and setpoints. Can also be used to read min/max metering values, data log, and contact wear log from control.
- **Data Log Analysis Package** - Microsoft Windows®-compatible program used to display UVR-1 data log files in both graphical (strip-chart) and tabular formats.
- **Contact Wear Log Analysis Package** - Microsoft Windows®-compatible program used to display UVR-1 tapchanger contact wear log files in both graphical and tabular formats.

### Maintenance and Upgrade Path:

The front panel PC Port allows for firmware revisions as features are added or enhanced. The UVR-1 control is designed to accommodate additional data acquisition and control functions in the future. These functions may include event recording and protocols other than DNP3. As additional features are released, firmware and/or hardware revisions will be announced. The main processing circuit board inside the UVR-1 is designed to be replaceable with more powerful processors and larger program and data spaces. This provides a cost-effective upgrade path, insuring the flexibility of the UVR-1 and protecting the original investment.

*I.C.M.I. reserves the right to modify this design specification in any way it sees fit to meet corporate goals.*

†Requires optional XIO Port Interface Board (or XIO Port Input-only Interface Board if only input functions are needed), available from ICMI.