



# Product Specifications

## Guide Specification for Automatic Voltage Regulation and Power Conditioning

7-30-2010

# 1.0 GENERAL

## 1.1 Summary

These specifications describe requirements for an Automatic Voltage Regulator (AVR)/ Power Conditioner supplying conditioned power to sensitive loads through a series regulation transformer with no active electronics in the primary power path. The specified system shall provide regulation and control of AC Power with optional isolation, noise and transient suppression. It shall include all equipment to properly interface the AC power source to the intended load.

## 1.2 Standards

The specified system shall be designed, manufactured, and installed in compliance with:

- American National Standards Institute (ANSI)
- Institute of Electrical and Electronics Engineers (IEEE)
- International Standards Organization Quality Standard ISO 9001
- National Electrical Code (NEC - NFPA 70)
- National Electrical Manufacturers Association (NEMA)
- National Fire Protection Association (NFPA 75)

## 1.3 Documentation

### 1.3.1 Equipment Manual

The manufacturer shall furnish an installation manual with installation, start-up, wiring diagrams and product one-line drawings for the specified system.

## 1.4 Warranty

The manufacturer shall provide a warranty against defects in material and workmanship for three years after initial start-up, not more than 42 months after ship date, whichever occurs first (refer to the Warranty Statement for details).

## 1.5 Quality Assurance

The specified system shall be factory-tested before shipment. Testing shall include, but shall not be limited to: Quality Control Checks, "Hi-Pot" Test (two times rated voltage plus 1000 volts, per UL requirements), Load Tests, and Metering Calibration Tests. The system shall be designed and manufactured according to world-class quality standards. The manufacturer shall be ISO 9001 certified.

# 2.0 SYSTEM DESCRIPTION (BASE AVR CONFIGURATION)

## 2.1 Performance Characteristics

**2.1.1 KVA Rating:** The Voltage Regulator shall be available in standard and custom ratings from 2.5 to 2,000 KVA,

**2.1.2 Input Voltage:** The Voltage Regulator shall be available in any nominal domestic, international or optional, custom rating, 100Vac - 600Vac.

**2.1.3 Output Voltage:** The Voltage Regulator shall be available in any domestic, international or optional, custom rating, 100Vac - 600Vac.

**2.1.4 Input Voltage Range/Regulation:** +10% to -20% / +/-1% of nominal  
(+10% to -25% / +1% to -5% of nominal)  
Contact factory for other range/regulations

**2.1.5 Regulation Response Rate:** <2 cycle

**2.1.6 Correction Time:** 29V/sec. at 480Vac 3-phase, 48V/sec at 240Vac single-phase typical.  
Contact factory for other.

**2.1.7 Frequency Range:** 60Hz nominal (57-63Hz) [47-53Hz option available]

**2.1.8 Output Impedance:** Less than 1%

**2.1.9 Unbalanced Load:** At nominal input voltage, and with 100% load imbalance, output voltage shall be within +1% and -1%.

**2.1.10 Overload Regulation:** At nominal input voltage, while increasing the load from no load to 100% of full load, the output voltage shall be -1% of nominal or better.

**2.1.11 Overload Capacity:** 33% for 2 hours  
50% for 1 hour  
100% for 15 minutes  
1000% for 30 cycles

**2.1.12 Harmonic Distortion (No load to full load):** The Regulator shall add no voltage total harmonic distortion (THD) to the output.

**2.1.13 Efficiency:** The efficiency of the system shall typically be 99% (AVR units) and 97% (PLC Units) at any load condition. [additional magnetics may affect efficiency]

**2.1.14 Power Factor:** Any power factor shall be supported from 0 lagging to 0 leading.

**2.1.15 Reliability:** The Voltage Regulator shall have a mean-time-between-failure (MTBF) of not less than 200,000 hours. At no time shall there be semiconductor switching devices in the primary power path.

**2.1.16 Cooling:** The Voltage Regulator shall be convection cooled.

**2.1.17 Manual (Redundant) Regulation Control:** The Voltage Regulator shall be equipped with a manual regulation switch for troubleshooting and for operation in the event the automatic controller is not available.

**2.1.18 Single-Point Ground:** A computer-grade, single-point ground shall be provided in accordance with IEEE Std. 1100, and the requirements of the NEC. The output neutral shall be solidly grounded in accordance with NEC article 250-26.

**2.1.19 Output Power Connections:** The specified unit shall contain power terminals for connection of the output AC power. All output power terminals shall be designed to accept wire sizes commensurate with the system rating.

## 2.2 Environmental Requirements

Audible Noise	<45 db @ 5'
Ambient Operating Temperature	0°C to +40°C
Ambient Storage Temperature	-55°C to +85°C
Relative Operating Humidity	95% without condensation
Operating Altitude	Up to 10,000 feet

## 2.3 Transformer Construction

**2.3.1 Variable Transformers:** All variable transformers shall be constructed using a grain-oriented, laminated steel core surrounded by a solid copper wire conductor. All conductive surfaces will be gold electroplated.

**2.3.2 Series Regulation Transformers:** The series regulation shall be constructed using grain-oriented, laminated steel. All windings shall be copper. The transformer shall be dry-type, common-core, convection air-cooled. The transformer shall conform to UL1561, with 125°C maximum temperature rise.

## 2.4 Enclosure

Units shall be provided in a standard NEMA 1 enclosure.

The enclosure shall be designed so that the unit can be moved by forklift equipment. A tool shall be required to remove the panels that access the hazardous voltage area of the unit.

All service shall be accessible from the front of the unit with the additional ability for all front, side, rear and top panel to be removed.

Unit shall be designed to accept either side or rear input and output wiring access.

# 3.0 OPTIONAL COMPONENTS

## 3.1 [Optional] Advanced Communications & Control (MP Controller)

The specified system shall be equipped with a microprocessor-based controller and power monitor Panel. The control and monitor panel shall gather and process information from electrical sensors. The monitored parameters shall be displayed on the unit monitor panel, and shall also be available for communication using low-voltage signal circuit using RS-232 or RS-422 format.

### 3.1.1 Control and Display

All monitored parameters shall be displayed on a 1 X 16 character, high visibility liquid crystal display (LCD) located on the front of the unit along with all control functions. A 10-digit control panel will be provided for accessing monitoring and control function.

**3.2 [Optional] Remote Monitoring and Control (MP Controller):** The controller shall be capable of separate and remote installation from the regulator. This feature shall allow for the

remote installation of the regulator while maintaining a local installation of all monitoring and control circuits and functions.

### **3.3 [Optional] Full Function Metering**

All voltage and current parameters shall be monitored using true RMS measurements for accurate representation of non-sinusoidal waveforms typical of computers and other sensitive loads.

The monitoring system shall monitor and display all of the following parameters:

- Input Voltages, Line-to-Line for all three-phases
- Output Voltages, Line-to-Line and line-to-neutral for all three-phases
- Output Current for all three phases, neutral and ground
- Output Frequency
- Output kVA and kW
- Output Power Factor

### **3.4 [Optional] Transient Voltage Surge Suppression**

No power disturbances shall be evident on the output when high-energy ringing transients are impressed on the input lines. The specified system shall protect against surges as defined by ANSI/IEEE Standards C62.41 and C62.45.

### **3.5 [Optional] Output Isolation Transformer**

The output isolation transformer shall be a wye/wye type to provide 120dB Common Mode, 60dB Transverse Mode isolation and voltage step-down (if required). The transformer capacity shall be the same as the system capacity. The transformer shall be a dry-type, common-core, double-shielded, convection air-cooled transformer. The transformer shall conform to UL1561, with 125°C maximum temperature rise. All transformer windings shall be copper. The transformer shall have less than 2.0% impedance and a full load efficiency of 97% typical. The transformer shall be enclosed in the same cabinet as the voltage regulator (NEMA 1).

### **3.6 [Optional] Individual Phase Control**

Individual phase control shall regulate each phase independently and maintain the phase to neutral output voltage to +/-1% or better for each phase. Individual phase control will not affect phase angle separation.

### **3.7 [Optional] Extended Voltage/Frequency Range**

Input regulation window shall be (+\_\_\_\_\_% / -\_\_\_\_\_% ) with 1% regulation output. The frequency range shall be 47-63 Hz.

### **3.8 [Optional] External Bypass Switch**

The unit shall be equipped with an external bypass circuit for manually removing Voltage Regulator from the power path. The bypass circuit shall include all connections required for a manually operated break-before-make switch.

The switch shall be rated for 600 VAC and sized for 100% or greater of the bypass circuit full load. The bypass switch shall be a UL recognized double-throw, break-before-make switch rated for industrial use. The bypass switch shall switch the output phases and neutral simultaneously.

### **3.9 [Optional] Main Input Circuit Breaker**

The specified unit shall be equipped with a main input circuit breaker to provide overcurrent protection and a means for disconnecting power to the unit. The main input circuit breaker shall

be of molded case design sized for at least 125% of the specified full load input current and rated for 600 VAC. The minimum UL-listed interrupting rating for the main input circuit breaker shall be 25kAIC or better.

### **3.10 [Optional] Main Output Breaker**

The specified unit shall have a main output circuit breaker for overcurrent protection and a means for disconnecting power to the load. The main output circuit breaker shall be of molded case design sized for at least 125% of the specified full load output current and rated for 600 VAC. The minimum UL-listed interrupting rating for the main output circuit breaker shall be 25kAIC or better.

### **3.11 [Optional] Main Output Contactor (requires MP Controller)**

The specified unit shall have a main output contactor as a means for disconnecting power to the load. The contactor shall be capable of disconnecting the load upon a user-selectable, voltage out-of-band condition. The load shall be automatically reconnected when the input voltage is within the specified tolerance.

### **3.12 [Optional] Remote Emergency Power Off (REPO)**

Pressing the customer supplied REPO switch shall immediately shut down the system by activating the shunt trip of the main input circuit breaker (input circuit breaker required).

### **3.13 [Optional] NEMA 3R Enclosure**

The Voltage Regulator shall be provided with a NEMA 3R enclosure upon request.

## **4.0 EXECUTION**

Factory start-up, preventive maintenance, and full service for the specified system shall be available and included upon request.

## **5.0 QUALIFYING EXPERIENCE**

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The manufacturer shall have a minimum of twenty years experience in the design, manufacture, and testing voltage regulation and power conditioning systems. This specification outlines the minimum requirements for a voltage regulation and power condition system. Every supplier shall provide a specification compliance statement with its proposal referencing each section of this specification.

### **5.2 APPROVED MANUFACTURER**

**STACO ENERGY PRODUCTS COMPANY**

**301 GADDIS BLVD**

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