SERIES 900A

ELECTRONIC LINE VOLTAGE REGULATOR
OWNERS & SERVICE MANUAL

IMPORTANT SAVE THESE INSTRUCTIONS
PLEASE READ THIS MANUAL BEFORE USING EQUIPMENT.

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REVISION: 4
Part #107861
# SERIES 900A
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INTRODUCTION

The Series 900A Line Voltage Regulator is one of the leading members of the family of power protection products manufactured by Controlled Power Company. The Series 900A provides a narrow band of output regulation for a wide range of input power variation.

The Series 900A is available in a wide range of input/output voltage and KVA sizes. The Series 900A can be matched with other Controlled Power products to enhance its power protection capabilities.

FEATURES AND BENEFITS:

Adjustable Output: The output voltage is adjustable over a range of ±10% of nominal with an internal potentiometer.

Remote Sensing: The voltage to be regulated can be sensed at the load to automatically compensate for line and wire loss to the load.

Excellent Load Regulation: Output voltage is regulated to within ±0.5%.

Wide Input Voltage Range: The output is regulated to within ±1% with input voltage fluctuations of +10% to −25% from nominal.

Enclosures: Available in industrial or commercial (computer type) enclosures.

Wide Range of Types Available: The Series 900A Electronic Line Voltage Regulator is available in single phase and three phase configurations and in 50 Hertz or 60 Hertz models. In addition, a wide range of KVA sizes are available.

**Enhanced Power Protection: The Series 900A can be matched with Controlled Power Company Series 200 (Double Shielded Isolation Transformer) or Series 600 (Triple Shielded Isolation Transformer).**
The Series 900A Electronic Line Voltage Regulator is especially designed to deliver constant output voltage to the load. The Series 900A is electronically and magnetically regulated and conforms to the following specifications:

1. **INPUT VOLTAGE RANGE** - +10% to -25% of nominal
2. **OUTPUT VOLTAGE** - Adjustable from +10% to -10% of the Nominal Input Voltage by means of internally located potentiometer. *Affects input regulation band.
3. **AUDIBLE NOISE LEVEL** - 45 dB
4. **AMBIENT TEMPERATURE** - 0 to 40° C
5. **TEMPERATURE RISE** - 150° C
6. **FULL LOAD EFFICIENCY** - 95% Typical
7. **REGULATION** - ±1% for any combination of line variation, load variation, thermal drift and warm-up.
8. **REMOTE SENSING** - Remote sensing to compensate for series voltage drop to the load is furnished when specified.
9. **HARMONIC DISTORTION** - 5% THD Maximum
10. **RESPONSE TIME** - Starts immediately and complete within 5 cycles under worst case conditions.
11. **FREQUENCY RANGE**
    A. 57 to 63 Hertz on 60 Hertz Models.
    B. 48 to 52 Hertz on 50 Hertz Models.
SERIES 200, SERIES 600

TRANSFORMER SPECIFICATIONS (OPTIONAL)

The Series 200 Transformer is a Double Shielded Isolation Transformer. The overall function of the Series 200 is to receive electrical building power, remove transients and noise from that power, and step up or down that voltage to match the voltage of the Regulator. The Series 600 provides the same functions as the Series 200, but is triple shielded for better common mode noise attenuation.

1. ELECTRICAL CHARACTERISTICS
A. Percent Impedance
   2% to 5%, depending on size
B. Percent Reactance
   1.5% to 4%, depending on size.
C. Harmonic Distortion
   Less than 1% THD added.
D. Audible Noise
   45 dB at full rated load.
E. Common Mode Noise Attenuation
   120 dB or greater. *140 dB or greater for Series 600.
F. Transverse Noise Attenuation
   80 dB.
G. Operating Frequency
   57 to 63 Hertz (60 Hertz Models).
   48 to 52 Hertz (50 Hertz Models).
THEORY OF OPERATION

The Series 900A Electronic Line Voltage Regulator is designed to deliver a very narrow output voltage band for a wide input voltage range. The Series 900A automatically compensates for abrupt input power variations by electrically altering the magnetic properties of the regulator core to compensate changes in output voltage.

The Series 900A Regulator consists of 6 individual windings, which perform different functions in the regulator (See Figure 1A and 1B). These are listed below.

Figure 1A

Figure 1B

- PRIMARY WINDING
- AIDING WINDING
- OPPOSING WINDING
- BIAS WINDING
- BRIDGE SUPPLY WINDING
- CARD SUPPLY WINDING
THEORY OF OPERATION (CONTINUED)

The primary (1) and aiding (2) windings are placed on the upper section of the core and are connected in a series-aiding configuration. The voltage applied to the primary winding from the source induces voltage into the aiding winding. The aiding winding being connected to the primary in a series aiding configuration increases the total voltage measured across both these windings.

The opposing winding (3) is placed in the lower section of the core and is wound over the bias windings (4). The opposing winding is connected in a series opposing configuration with the aiding winding. As a result, the total voltage measured between the start of the primary winding (Lead #1, common to both input and output circuits) and the start of the opposing winding (Lead #6 of the output circuit) is approximately 10% less than the voltage applied from the source to the primary winding.

The voltage of the opposing winding is controlled by the amount of DC current that flows through the bias windings. By increasing the DC bias current in the bias winding, the magnetic properties in the section of the regulator core that both the bias winding and the opposing winding are placed is altered. As a result, the voltage induced into the opposing winding is reduced. By reducing the voltage across the opposing winding, the total sum of the voltages between the start of the primary winding and the start of the opposing winding (output circuit) is increased.

If the DC bias current is increased, thereby decreasing the opposing voltage, the total output of the regulator can be adjusted to a nominal level. By regulating the DC bias current, thus controlling the voltage across the opposing winding, the output voltage can be regulated throughout the input voltage band of +10% to -25%.

Regulation control is performed by the electronic control card and the SCR bridge assembly which derive their power sources from the card supply winding (6) and the bridge supply winding (5) respectively.

The sensing and regulation circuitry detects any deviation in output voltage and immediately corrects for that change by adjusting the DC bias current in the bias winding via the conduction angle of the SCR bridge assembly.

In this way, narrow band output regulation is maintained.

Further, a filter circuit (Figure 2), which consists of two high reactance transformers and filter capacitors which are connected across the opposing and aiding windings. This provides a low impedance path of the dominant third and fifth harmonics while appearing as a relatively high impedance for the fundamental frequency (60 Hertz or 50 Hertz). This will limit the harmonic distortion present on the output to a minimum level.

The power protection capabilities of the Series 900A can be enhanced by the use of Controlled Power Company Series 200 or Series 600 Isolation Transformers to increase the noise attenuation capability of the total system.
System Block Diagram

Figure 2

INPUT
SERIES 900A REGULATOR & FILTER ASSEMBLY

BIAS CONTROL
BRIDGE SUPPLY

CARD SUPPLY
SCR BRIDGE ASSEMBLY

LIMIT ADJUST
GATE PULSE WIDTH CONTROL CIRCUIT
DIFFERENTIAL AMPLIFIER
REFERENCE AMPLIFIER

SERIES 200 OR 600 SHIELDED ISOLATION TRANSFORMER (OPTIONAL)

OUTPUT
VOLTAGE FEEDBACK
OUTPUT ADJUST

Page 6.0
INSPECTION AND INSTALLATION

WARNING: THERE ARE DANGEROUS HIGH VOLTAGES PRESENT WITHIN THE ENCLOSURE OF THE POWER SUPPLY SYSTEM. UNDER NO CIRCUMSTANCES SHOULD ANY PERSON REACH WITHIN THE ENCLOSURE OF THIS EQUIPMENT WITHOUT THE IMMEDIATE PRESENCE OF ANOTHER PERSON CAPABLE OF RENDERING FIRST AID. ALL SERVICE TO THIS PIECE OF EQUIPMENT SHOULD BE PERFORMED BY QUALIFIED PERSONNEL ONLY.

UNPACKING AND STORING

As all units are shipped F.O.B. Troy, Michigan, it is suggested that the shipping container be removed and the unit be inspected for possible damage during shipment. If any damage is found, the purchaser must file a claim and the carrier contacted immediately.

Controlled Power Company should be notified if the nature of damage is such that operation of the equipment has been impaired.

If it is necessary to store the unit for a period of time before it is installed, be sure to place the unit in a clean and dry area. To prevent excessive dust from accumulating on the unit, it is advisable to protect it by placing it in the original container. The unit must be handled at all times with the same care you would give to any piece of precision industrial equipment.

CHOICE OF LOCATION

The unit has been completely inspected and extensively tested under various load conditions prior to shipment. Care to install it at a proper location will assure long trouble-free operation.

The unit is air cooled with the air intake at the bottom or front and exhausts at the top, rear, or at the sides. Therefore, it should be installed in a clean and dry place with enough clearance to allow a free flow of air. Allow at least 4 inches of space between the unit and the wall or other equipment for portable units. Allow enough space for maintenance on all four sides of larger units.

INSPECTION

A. Check all electrical connections to be sure none have loosened during shipment. Tighten if necessary.

B. Check the Spec. plate on the front or rear of the unit to be sure that the voltage and frequency matches the available power supply. (Under no circumstances should the unit be connected to a power source, which does not conform to the spec plate rating).
INSTALLATION PROCEDURE

A. Locate and remove access panels to the input and output connections.

B. If your regulator does not have a Series 200 Isolation Transformer, you **must** supply an input neutral wire rated for the unit’s full current capacity.

C. Verify that the input voltage to the unit matches the unit’s specification plate. Refer to the circuit diagram supplied with your unit.

D. Verify that all output breakers and receptacles are properly sized for the loads to be connected.

E. On units with hardwired input and output installations assure the wire and protection devices are sized correctly in accordance with NEC and any local electrical codes.

F. Check your circuit diagram that was supplied with the unit for remote sensing. If you have this option, make sure to connect the remote sensing wires in the proper phase sequence. The sensing wires must connect as close to your load as possible to offset only voltage drops on your main output wires.

G. Re-install all panels that may have been removed.

START-UP SEQUENCE

**WARNING:** THERE ARE DANGEROUS HIGH VOLTAGES PRESENT WITHIN THE ENCLOSURE OF THE SYSTEM. CAUTION MUST BE TAKEN WHEN WORKING WITHIN THE ENCLOSURE. IT IS RECOMMENDED THAT ALL WORK BE PERFORMED BY QUALIFIED AND TRAINED PERSONNEL ONLY.

**NOTE:** INITIAL START-UP SHOULD BE PERFORMED WITH NO LOAD ON SYSTEM.

A. Make sure all circuit breakers are in the off position.

B. Energize the primary building power.

C. Turn on the A.C. input breaker (if applicable).

D. Turn on the A.C. output breakers and wait 30 seconds and then verify that the output voltage is within the specified range.

**NOTE:** ALL ELECTRICAL ADJUSTMENTS ARE MADE AT THE FACTORY. NORMALLY NO FURTHER ADJUSTMENTS ARE NECESSARY.

E. If output voltages are not within specified range, see Page 11.0 for instructions.

F. System is ready for use.
MAINTENANCE

The Series 900A Power Line Regulator is designed and manufactured to assure maximum reliability, flexibility, serviceability and performance.

WARNING: ONLY QUALIFIED ELECTRICAL PERSONNEL SHOULD PERFORM MAINTENANCE ON THIS EQUIPMENT!!

PREVENTIVE MAINTENANCE

To ensure longer component life and trouble-free operation, minor preventive maintenance procedures should be performed annually. More frequent inspection intervals are recommended for severe operating conditions.

A. Turn off all power to the unit. Remove the top panel for access into the unit.

B. At each service inspection, any accumulated dust, dirt or foreign particles should be carefully removed. Special care should be exercised in cleaning the thyristors, heat sinks and the control assembly.

C. Assure all cooling fans (if applicable) are operational, clean and free of dust and debris.

D. Inspect all wiring for loose connections, burnt, frayed or broken wires. Check for burned semi-conductor components and circuit boards.

E. Re-torque all high current connections and correct any loose connections. Replace any physically burned or broken components.

F. Remove all output loads and turn on the input power.

G. Verify output voltage and be sure it is within specifications. If it is not, refer to the adjustment procedure.

H. Turn off all power to the unit. Replace panels.

I. Turn on the power and verify output voltage with the loads on the unit.

J. Maintenance is complete.

PRODUCT SUPPORT SERVICES

Controlled Power Company offers a variety of Support Services. Services available are full coverage maintenance contracts, spare parts kits, training seminars (If your staff maintenance personnel), and a 24 hour emergency service hotline. Contact the Customer Support Department at 1-248-528-3700.
WARRANTY

This Warranty applies only to the original purchaser who must properly register the product within thirty (30) days of receipt.

Register online at http://www.controlledpwr.com/csupport-warranty.php

Controlled Power Company warrants that our products and their components will remain free from defects in material and workmanship for the period of one (1) year from the date of shipment and agrees to replace, F.O.B. its factory, any parts which fault through defect in material or workmanship during such period.

1. This Warranty shall be effective only if and so long as the system is installed and operated in the manner specified in the manual which accompanied the product, and is operated within the ratings on the nameplate of the system.

2. This Warranty shall be effective provided the purchaser pays the cost of transporting the faulty component(s) to and from Controlled Power Company’s factory at the purchaser’s own expense. There is no cost for installation of the replacement component(s) when done at the factory. Otherwise installation of the replacement component(s) are the responsibility of the purchaser. If after inspection the faulty component has been caused by misuse or abnormal conditions in the judgment of Controlled Power Company, the purchaser will be charged for repairs based on parts and labor required. This Warranty does not cover fuses, light bulbs, and other normally expendable items. Controlled Power Company service personnel are not included in this warranty.

3. This Warranty shall be void if any alteration is made to the system, or any of its components are altered by anyone other than an authorized Controlled Power Company service person, without the written permission of Controlled Power Company.

4. This Warranty is in lieu of all other warranties, expressed or implied. Controlled Power Company neither assumes, nor authorizes any person to assume for it, any liability other than that specifically set forth in this Warranty. Except for its obligations, Controlled Power Company assumes no liability or responsibility for personal injury, loss of life, consequential or other damages resulting from defects in, or failure of, the system or any of its components.

http://www.controlledpwr.com/csupport-warranty.php
## TROUBLE SHOOTING FLOW CHART

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>PROBABLE CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Output voltage too high.</td>
<td>A. Input voltage out of range.</td>
</tr>
<tr>
<td></td>
<td>B. Control card out of adjustment (Refer to Adjustment Procedure).</td>
</tr>
<tr>
<td></td>
<td>C. Defective SCR or power mod. (Refer to Advanced Trouble Shooting).</td>
</tr>
<tr>
<td></td>
<td>D. Defective control card. (Refer to Advanced Trouble Shooting).</td>
</tr>
<tr>
<td>2. Output voltage too low.</td>
<td>A. Input voltage out of range.</td>
</tr>
<tr>
<td></td>
<td>B. Control card out of adjustment. (Refer to Adjustment Procedure).</td>
</tr>
<tr>
<td></td>
<td>C. Blown bridge supply fuses.</td>
</tr>
<tr>
<td></td>
<td>D. Defective SCR or power mod. (Refer to Advanced Trouble Shooting).</td>
</tr>
<tr>
<td>3. Incorrect line to line voltage on three phase unit.</td>
<td>A. No input neutral to regulator.</td>
</tr>
<tr>
<td></td>
<td>B. Extreme unbalanced loading.</td>
</tr>
<tr>
<td></td>
<td>C. Defective harmonic output filter component.</td>
</tr>
<tr>
<td>4. Excessive output distortion.</td>
<td>A. Defective filter capacitor.</td>
</tr>
<tr>
<td></td>
<td>B. Extreme non-linear loading.</td>
</tr>
</tbody>
</table>

## ADVANCED TROUBLE SHOOTING GUIDE

**WARNING:** THERE ARE DANGEROUS HIGH VOLTAGES PRESENT WITHIN THE ENCLOSURE OF THE POWER SUPPLY SYSTEM. ALL SERVICE TO THIS EQUIPMENT SHOULD BE PERFORMED BY QUALIFIED SERVICE PERSONNEL ONLY.

Equipment required: 2 channel 20 Mhz oscilloscope, fluke true RMS Model 87 digital multimeter or equivalent, safety glasses, common hand tools associated with electronics industry and a spare parts kit (contact factory).

Note: Refer to typical single phase and three phase circuit diagrams at the end of this manual to aid in locating components and test points.

1. **ELECTRICAL CONNECTIONS AND FUSES**
   
   A. Turn off the input power source to the unit.
   
   B. Turn off the input and output breakers on the unit.
   
   C. Inspect the unit for proper tightness of all electronic components and electrical connections. Carefully check for any visible damage to any components.
   
   D. Check bridge supply fuses F1 and F2.

   Note: Remove fuse from circuit before metering.

**WARNING:** TO REDUCE THE RISK OF FIRE, REPLACE ONLY WITH THE SAME TYPE AND RATING FUSE.
2. SCR BRIDGE ASSEMBLY: (Refer to Figure 3).

NOTE: There are 3 SCR bridge assemblies on 3 phase units and 1 on single phase units.

A. Remove bridge supply fuses F1 and F2.
B. Remove all TP2 wires from bridge assembly.
C. Place multimeter on diode bias scale.
D. The SCR bridge assembly should meter as follows:

Note: Measurements are done with components connected in the circuit. If readings are incorrect, isolate components and meter in accordance with Figures 4 and 5.

Note: Also verify diodes D1 and D2 are ok.

<table>
<thead>
<tr>
<th>RED METER LEAD</th>
<th>BLACK METER LEAD</th>
<th>MEASUREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP1</td>
<td>TP6</td>
<td>Infinite</td>
</tr>
<tr>
<td>TP5</td>
<td>TP1</td>
<td>Infinite</td>
</tr>
<tr>
<td>TP6</td>
<td>TP2</td>
<td>Infinite</td>
</tr>
<tr>
<td>TP2</td>
<td>TP6</td>
<td>About .500</td>
</tr>
<tr>
<td>TP5</td>
<td>TP2</td>
<td>Infinite</td>
</tr>
<tr>
<td>TP2</td>
<td>TP5</td>
<td>About .500</td>
</tr>
<tr>
<td>TP1</td>
<td>TP3</td>
<td>About .010-.090</td>
</tr>
<tr>
<td>TP1</td>
<td>TP4</td>
<td>About .010-.090</td>
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<tr>
<td>TP2</td>
<td>TP1</td>
<td>About .450-.550</td>
</tr>
<tr>
<td>TP1</td>
<td>TP2</td>
<td>Infinite</td>
</tr>
<tr>
<td>TP5</td>
<td>TP7</td>
<td>About .010-.090</td>
</tr>
<tr>
<td>TP6</td>
<td>TP8</td>
<td>About .010-.090</td>
</tr>
</tbody>
</table>

E. Replace any defective components.

F. Replace bridge supply fuses F1 and F2, refasten TP2 wires to SCR bridge assembly.
ADVANCED TROUBLE SHOOTING GUIDE (CONTINUED)

**Figure 3:** TP1 through TP8 are for illustration purposes only and do not match actual unit wire numbers, but the physical locations will match.

![Diagram](image)

**Figure 3A:** TP1 through TP8 are for illustration purposes only and do not match actual unit wire numbers, but the physical locations will match.

![Diagram](image)

75 KVA AND LARGER
ADVANCED TROUBLE SHOOTING GUIDE (CONTINUED)

**Figure 4:** PM3 resistance checks with device isolated.

Physical Appearance

Schematic

<table>
<thead>
<tr>
<th>Measurement on Diode Bias Scale (2K Ohm)</th>
</tr>
</thead>
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<tr>
<td><strong>RED LEAD</strong> (POS.)</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>AK</td>
</tr>
<tr>
<td>AK</td>
</tr>
<tr>
<td>K</td>
</tr>
</tbody>
</table>

**Figure 5:** PM1 and PM2 resistance checks with device isolated.

Physical Appearance

Schematic

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<thead>
<tr>
<th>Measurement on Diode Bias Scale (2K Ohm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RED LEAD</strong> (POS.)</td>
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<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
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<td>2</td>
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<td>1</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
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</table>
Figure 6: PM3 resistance checks with device isolated.

Physical Appearance  Schematic

<table>
<thead>
<tr>
<th>MEASUREMENT ON DIODE BIAS SCALE (2K OHM)</th>
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<tbody>
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<td>RED LEAD (POS.)</td>
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<td>-----------------</td>
</tr>
<tr>
<td>A</td>
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<tr>
<td>AK</td>
</tr>
<tr>
<td>AK</td>
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<tr>
<td>K</td>
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</tbody>
</table>

Figure 7: PM3 resistance checks with device isolated.

Physical Appearance  Schematic

<table>
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<th>MEASUREMENT ON DIODE BIAS SCALE (2K OHM)</th>
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<tbody>
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<td>RED LEAD (POS.)</td>
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<td>-----------------</td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>1</td>
</tr>
<tr>
<td>5</td>
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<tr>
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<tr>
<td>7</td>
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<tr>
<td>3</td>
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<td>4</td>
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<tr>
<td>5</td>
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<td>6</td>
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ADVANCED TROUBLE SHOOTING GUIDE (CONTINUED)

3. ADJUSTMENT PROCEDURE (Refer to Figure 6).

Note: Repeat this procedure for each phase on 3 phase units.

A. Make sure that the main input power, input and output circuit breakers are all off. Remove all loads from the output of unit.

B. Rotate P2 on control card all the way counter clockwise.

C. Energize the main input power, and input circuit breaker to the unit and verify the following voltages at the control card terminal strip.

Control Card Supply:
- Terminal 3 to Terminal 4 = 18-26 VAC.
- Terminal 4 to Terminal 5 = 18-26 VAC.
- Terminal 3 to Terminal 5 = 36-52 VAC.
- Terminal 1 to Terminal 2 = 120, 208, 220, 240, 277 VAC (Should match units rated output voltage).

Bridge Supply: Measure across fuse 1 to fuse 2 = about 18-26 VAC.

Output Voltage: -10% of rated output voltage.

Turn off main circuit breaker.

D. Connect scope probe across output of SCR bridge assembly (TP1 and TP2) TP2=GND.

WARNING: Oscilloscope must have its line cord ground isolated or severe damage will occur.

Turn on main input breaker.

E. Adjust P1 on control card so SCR bridge output is at \( V_{pk} \) level as shown below.

F. While monitoring output voltage with an AC voltmeter, adjust P2 SLOWLY clockwise until the output voltage begins to increase. As soon as an increase is noticed, continue turning P2 clockwise until the output voltage is at nominal level ±1%.

Note: Monitor the phase you are adjusting from each line to neutral on 3 phase units.

G. Limit adjustment (P3) is a factory set adjustment and is not field adjustable. Limit adjust is used to limit bias current under extreme low line conditions.
ADVANCED TROUBLE SHOOTING GUIDE (CONTINUED)

Figure 6:

- **P2 OUTPUT ADJUST**
- **SW1 RESPONSE TIME SELECTOR SWITCH**
  - 1: FASTEST
  - 2: MEDIUM-FAST
  - 3: MEDIUM-SLOW
  - 4: SLOW

**NOTE:** THESE SWITCHES CAN BE SELECTED IN COMBINATIONS (MORE THAN ONE AT A TIME) TO FINE TUNE RESPONSE.

- **P1 GATE OFFSET ADJUST**
- **P3 LIMIT ADJUST**

### RSscale

<table>
<thead>
<tr>
<th>Output V</th>
<th>R44</th>
<th>R45</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>SHORT</td>
<td>56.2K Ω</td>
</tr>
<tr>
<td>208</td>
<td>41.5K Ω</td>
<td>56.2K Ω</td>
</tr>
<tr>
<td>220</td>
<td>47.5K Ω</td>
<td>56.2K Ω</td>
</tr>
<tr>
<td>240</td>
<td>56.2K Ω</td>
<td>56.2K Ω</td>
</tr>
<tr>
<td>277</td>
<td>73.5K Ω</td>
<td>56.2K Ω</td>
</tr>
</tbody>
</table>

H. Check SCR bridge output on scope (TP1 and TP2). The bridge output pulses should have advanced as shown below. Assure there is a pulse every 8.33 milliseconds. (10 milliseconds on 50 Hertz units).

I. Turn unit off and reconnect the load to the unit, turn on the unit and re-verify the output voltage.
INPUT OVERCURRENT PROTECTION

Primary Overcurrent Protection –

Every unit incorporates a custom tuned inductor/capacitor filter combination, which makes each Series 900 somewhat unique. The typical input power factor is .8, with a typical efficiency of 95%. It is important to note that the load power factor will reflect back to the primary of the transformer.

Example:

<table>
<thead>
<tr>
<th>Series 900</th>
<th>.8 Power Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load</td>
<td>.8 Power Factor</td>
</tr>
<tr>
<td>Input</td>
<td>.64 Power Factor</td>
</tr>
</tbody>
</table>

The following calculations are simplified for ease of use.

**Nominal Input Current –**

**Single Phase**

\[
\frac{\text{VA} \times 1.3}{\text{Input Voltage}} = \text{Input Current}
\]

**Three Phase**

\[
\frac{\text{VA} \times 1.3}{\text{Input voltage} \times 1.73} = \text{Input Current}
\]

**Maximum Input Current –**

(Allows for a 20% low line voltage)

**Single Phase**

\[
\frac{\text{VA} \times 1.64}{\text{line to line voltage}} = \text{Max Input Current}
\]

**Three Phase**

\[
\frac{\text{VA} \times 1.64}{\text{line to line voltage} \times 1.73} = \text{Max Input Current}
\]

If the Circuit Breaker is installed at the factory, the maximum input current is used. To size the input overcurrent protection, multiply the maximum input current by 1.25 to select the breaker or fuse.

**Actual calculation**

\[
\begin{align*}
\text{VI} &= \text{Input Voltage} \\
\text{EFF} &= 95\% \ (0.95) \\
\text{Power factor (P.F.)} &= 0.8 \ (\text{If load P.F.} = 0.8, \text{use } 0.8 \times 0.8 = 0.64)
\end{align*}
\]

**Nominal**

\[
\begin{align*}
\text{Single Phase} & \quad \frac{\text{VA}}{(\text{VI} \times \text{EFF} \times \text{P.F.})} \\
\text{Three Phase} & \quad \frac{\text{VA}}{(\text{VI} \times 1.73) \times (\text{EFF} \times \text{P.F.})}
\end{align*}
\]

**Maximum**

\[
\begin{align*}
\text{Single Phase} & \quad \frac{\text{VA}}{(\text{VI} \times 0.8) \times (\text{EFF} \times \text{P.F.})} \\
\text{Three Phase} & \quad \frac{\text{VA}}{(\text{VI} \times 1.73) \times 0.8 \times (\text{EFF} \times \text{P.F.})}
\end{align*}
\]

If the load power factor causes the primary current to rise above the maximum values as listed above, the next size regulator must be used.