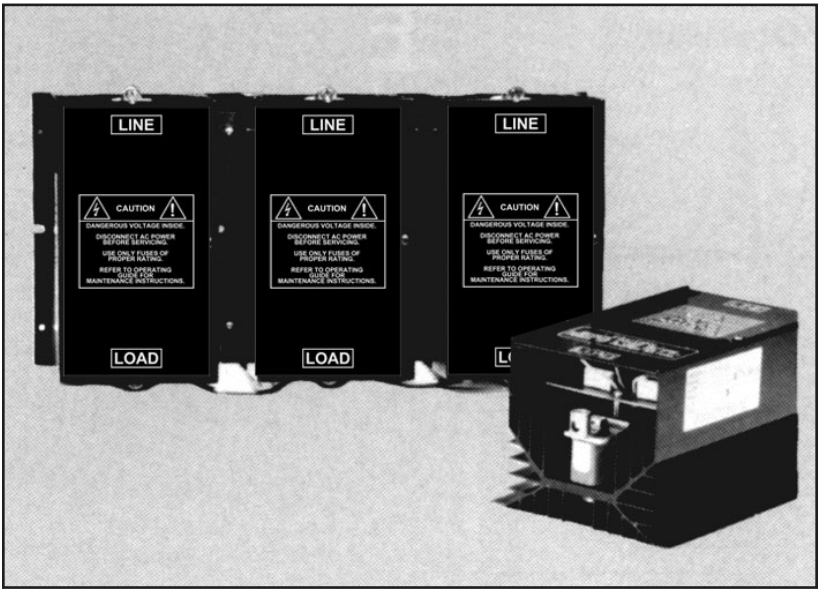
SCR Power Controllers



Instruction Manual

SCR POWER CONTROLLERS
TABLE OF CONTENTS

OPERATING INSTRUCTIONS

Series 19 and 39 SCR Power Controllers
Series 91 and 93 SCR Power Controllers

Section 1. General Description

Introduction

SCR Power Controllers are designed to regulate ac power to electrical heating processes, such as ovens, furnaces, heat sealers, etc. (Note: They are not designed to drive transformers, coils or other inductive-type loads.)

The controller accepts an input signal, such as 4-20 mAdc from some signal conditioning device, e.g., a temperature controller. For most processes, the combination of a temperature controller and SCR power controller will provide very accurate, automatic temperature control. For manual operation, a manual control option with a remote potentiometer is available.

General Specifications

Inputs:	4-20 mAdc standard, or as ordered (see serial number) minimum voltage requirements 10 Vdc; all inputs electrically isolated via optical coupling
Supply Voltage:	110/120; 208/240; 440/480, 575/600 Vac, or as ordered (Phase connection not critical on 3-phase units)
Frequency:	50/60 Hz
Ambient Temperature:	30° to 122° F for listed power ratings
Cooling:	Convection
Protection:	Sub-cycle, current-limiting fuse; transient voltage suppresion
Load	Resistive, 1- or 3-phase - 3-wire Wye or Delta

All specifications subject to change.

Section 1. Firing Modes

Zero-Crossing Control

A zero-crossing switched (zer-switched or burst fired) SCR power controller works by triggering at the moment when the value of the ac sine wave is at the baseline or “zero” voltage point (Figure 1.) This results in a “burst” of full line voltage with no RFI. SCR power controllers utilize a patented trigger circuit that turns on the SCRs as close as possible to the ac zero voltage point. Proportioning action is obtained by varying the number of cycles on to the number of cycles off. The output will vary from a few cycles on and a large number of cycles off at low input, through halh the cycles on and half off at half input, to all cycles on at maximum input. This output is integrated by the heaters which produce a smoothly proportioning heat output that varies directly with the input signal.

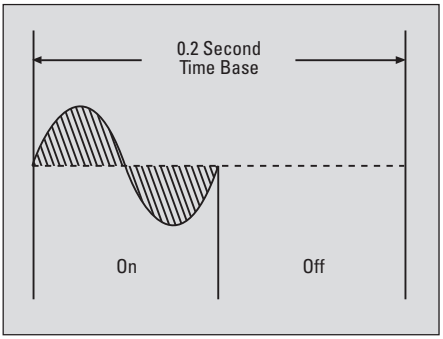


Figure 1. Time-proportioned, zero-cross burst.

Phase-Angle Control

A phase-angle type SCR power controller works by delaying the trigger pulse to some point in the half cycle of the ac wave. This trigger point, from 0 to 180 degrees, is referred to as the phase angle (Figure 2). The SCR will turn on when triggerred, and remain on for the rest of the half cycle. Increasing the control signal will cause the trigger pulse to occur earlier in the half cycle, thus delivering a greater portion of the wave to the load.

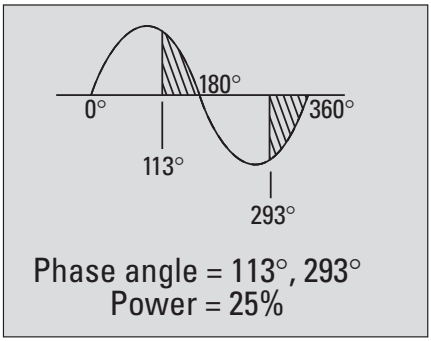


Figure 2. Phase-angle changes and their effect on output power.

Because it provides an extremely fast response, phase-angle control should be used in low-mass element applications that require high switching speeds, such as tungsten elements, quartz lamps, hot wires and other loads subject to high inrush currents. (Note: Some RFI can be generated from the phase-angle controller) SCR phase-angle power controllers are available with a soft-start timing option that provides a ramp to peak voltage, and are available with a voltage limit option that "clamps" output voltage to a level lower than the supply voltage.

Section 3. Installation

3.1 Mounting

Mount the controller, with the heat sinks in a vertical position, in a reasonably cool location -- 50°C (122°F) maximum. Some space should be left above and below the unit to allow for air circulation. If the controller must be placed in an environment where the ambient temperature exceeds 50°C (122°F), it will be necessary to derate the unit. If derating is not possible, venting or an exhaust fan must be used to keep ambient temperatures at an acceptable level. (See Figure 3 for cooling calculations).

Formula for minimum metal enclosure size for convection cooling

$$\frac{.72 \times \text{AMPS} \times \#\text{ of Controlled Legs}}{122^{\circ}\text{F} - \text{Ambient } ^{\circ}\text{F}} = \text{Min. Exposed Sq. Ft.}$$

$$\frac{.40 \times \text{AMPS} \times \#\text{ of Controlled Legs}}{50^{\circ}\text{C} - \text{Ambient } ^{\circ}\text{C}} = \text{Min. Exposed Sq. Ft.}$$

Formula for forced air cooling

$$\frac{2.2 \times \text{AMPS} \times \#\text{ of Controlled Legs}}{50^{\circ}\text{C} - \text{Ambient } ^{\circ}\text{C}} = \text{Min. CFM}$$

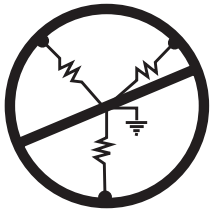
$$\frac{3.8 \times \text{AMPS} \times \#\text{ of Controlled Legs}}{122^{\circ}\text{F} - \text{Ambient } ^{\circ}\text{F}} = \text{Min. CFM}$$

Figure 3. Calculations for determining cooling requirements

3.2 Wiring

The wiring components of SCR power controllers consists of line voltage, heater, load, and signal input. Follow the wiring diagrams on the following pages (Figures 4 and 5) and the terminal labels on the unit. On three-phase controllers (Series 39), it is not necessary to connect the phases to any particular terminal. Because the controllers are phase-to-phase controllers, either Wye or Delta connected loads may be used.

CAUTION

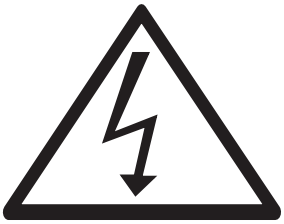


On Wye connected loads, do not connect the center terminal to the line or to the ground.

Wire gauge for power and load connections will vary depending on the size of the load. Standard electrical code procedures should be followed. Do not exceed the voltage and ampere ratings indicated on the controller's label. Before connecting the controller to a heater, we recommend that the heater be connected directly to the power line to ensure that the current rating is correct and that no shorts exist.

CAUTION:

Possible Shock Hazard --



Exposed high voltage exists on heat sinks and other parts of these units. To prevent possible electrocution, the controller must be locked in a secure enclosure during operation. Solid state devices do not completely remove power from the load, even in the OFF state. This leakage current presents a potential shock hazard at all unit and load terminals. All power must be completely off before servicing. Only qualified personnel should be allowed access.

Possible Fire Hazard --

Because SCR power controls and associated equipment are not fail-safe devices, an approved temperature and/or pressure safety control should be used to ensure safe operation.

3.21 Zero-Cross

Zero-cross mode power controllers may only be used with constant resistance heating elements, such as Nichrome. They are NOT intended for high-inrush loads. Depending on the type of element used, you can oversize the load controller.

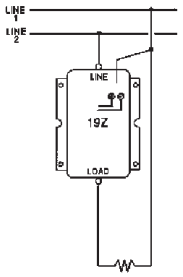


Figure 4a. Wiring scheme for Series 19Z.

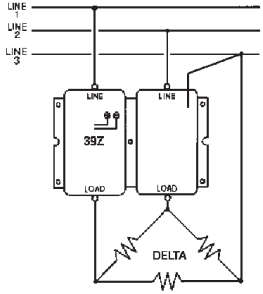


Figure 4b. Wiring scheme for Series 39Z.

3.22 Phase-Angle

Phase-Angle fired power controllers may be used with high-inrush loads if the "soft-start" option is installed.

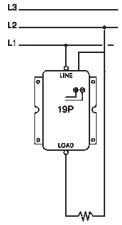


Figure 5a. Wiring scheme for Series 19P.

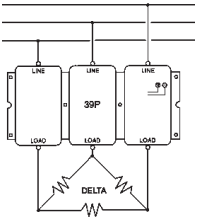
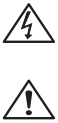


Figure 5b. Wiring scheme for Series 39P.

3.23 Fuses and Safety Warnings

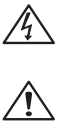
Only I^2 fuses should be used for protecting the power controller's SCRs. These fuses are especially designed to protect the solid state devices under short-circuit conditions; other fuses may not act quickly enough. If it becomes necessary to replace a fuse, use only a Chase-Shawmut Form 101 or semiconductor fuse, or equivalent.

IMPORTANT SAFETY WARNINGS - READ BEFORE OPERATING CONTROLLER.



Standard fuses or a circuit breaker should be used on all power lines for safety and to meet electrical code requirements. The supplied fuses are for protecting the SCRs only and are not acceptable as power line fuses.

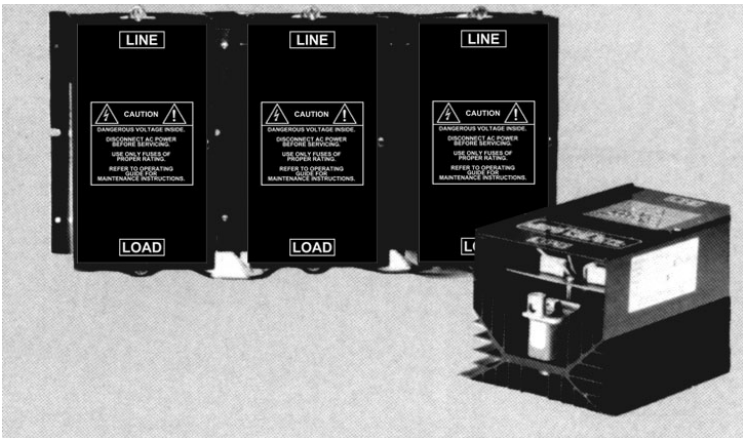
SCR power controllers do not satisfy electrical code disconnect requirements in the non-conducting or OFF state. Because they are semiconductor devices, the have a leakage current in the OFF state on the order of 10mA at rated line voltage. Therefore, the controller should be connected to a circuit breaker or disconnect switch.



SCRs can fail in a "shorted-closed" mode, resulting in full application of power. Use of a seperate, thermally protected safety contactor is strongly recommended.

Section 4. Operation

Series
19/39



4.1 Series 19Z/39Z

The Series 19Z and 39Z power controllers are designed to control ac power to electrical heating processes, such as ovens, furnaces, heat sealers, etc. (Note: They are NOT intended to drive transformer coupled or inductive loads.) The controllers consist of power semiconductors (SCRs), properly sized heat sinks, and trigger circuitry. These controllers accept a control signal (e.g., 4-20 mAdc) from a signal conditioning device, such as a temperature controller.

The “Z” suffix designates the controller as operating in the Zero Cross, Zero Voltage Switched, or Zero Burst firing mode. A patented trigger circuit turns on the SCRs as close as possible to the point at which the ac sine wave crosses through zero. In effect, this turns the line voltage on and off in full cycles. With an input of 4-20 mA , the output will be FULL OFF below 4 mA and FULL ON at 20 mA. Proportioning action is obtained by varying the number of cycles ON to the number of cycles OFF. The resulting output power is integrated by the heaters to produce smoothly proportional heating that varies directly with the input signal.

4.2 Series 19P/39P

The Series 19P and 39P power controllers are designed to control ac power to electrical heating processes, such as ovens, furnaces, heat sealers, etc. (Note: They are NOT designed to drive transformer-coupled loads.) The controllers consist of power semiconductors (SCRs), properly sized heat sinks, and trigger circuitry.

These controllers accept a control signal (e.g., 4-20 mAdc) from a signal conditioning device, such as a temperature controller.

The “P” Suffix designates the controller as operating in the Phase-Angle firing mode. Providing full proportional control, SCRs are turned ON during each 1/2 cycle at apoint (phase angle) of the ac sine wave, remaining ON for the rest of the 1/2 cycle. By varying the phase angle setting, the amount of voltage reaching the load may be adjusted. The output voltage is proportional to the input signal. At 4 mA input, no voltage will be applied to the load; at 20 mA input, the output voltage will almost equal the line voltage.

4.3 Voltage Limit Option (Phase-Angle Fired Units Only)

The output voltage of the controller can be limited by adjusting the trimmer on the printed circuit board. Turning the adjustment clockwise will increase the out put voltage limit. This control will operate over a range of about 20% to full output. Ordinarily, this adjustment is used to protect heaters that cannot operate on full line voltage, or to limit the maximum heating of a process.

4.4 Soft Start Option (Phase-Angle Fired Units Only)

The soft start circuitry is used to slowly turn on the voltage from the controller to the load. It is used to protect the controller when it is operating into loads having high-current, turn-on characteristics, e.g., quartz or tungsten heaters. The output voltage will rise from zero to full output over various times, depending on the time option selected.

The soft start circuit presents an initial high impedance which is inserted between the signal source and the controller. This impedance decreases in value with time. Soft start action can be seen as the input signal slowly changes from 4-20 mA when full output is required.

4.5 Manual Option

A module board is added to the standard controller which converts a variable resistance potentiometer to a 0-20 mA signal. This signal is then applied to the input of the standard trigger board and operates the controller in the standard manner (Figure 6). The input potentiometer can be any three-lead pot from 100 to 1000 ohms. The pot supplied with the manual option is 500 ohms. This pot has a 0-10 scale and knob. There will be no output at the "0" setting and full output at the "10" setting.

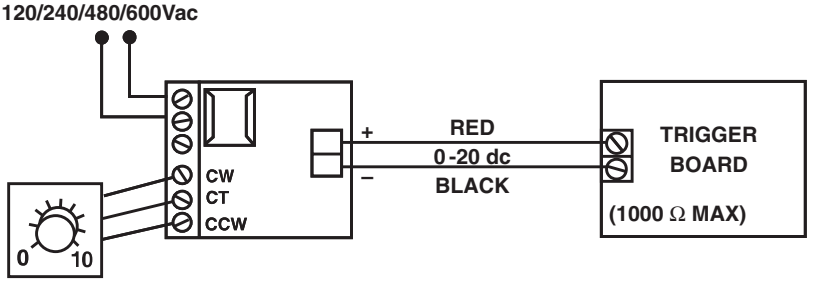


Figure 6. Wiring diagram for manual control (Option module M required).

4.6 Thermostat Option

The module will also operate from a standard 135-ohm thermostat. Connect the three output wires to the controller as shown on the drawing (Figure 7) and on the terminal strip. If the output terminals on the thermostat are not marked in the same fashion, connect the center wire to the CT point on the terminal strip, connect the other two wires to the CW and CCW points. The controller should then provide an output as the thermostat setpoint is increased. If the reverse action occurs, interchange the CW and the CCW wires.

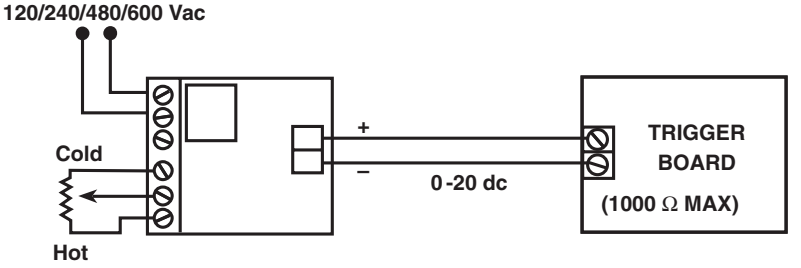
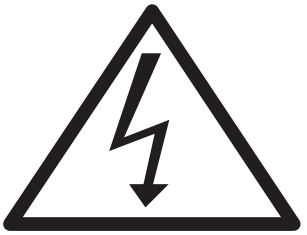


Figure 7. Wiring diagram for thermostatic control (Option H required).

4.7 Maintenance

SCR power controllers require little, if any, maintenance. However, as with all products exposed to industrial environments, they should be cleaned periodically to prevent corrosion and to remove any surface dust, dirt, and oil. We also recommend inspecting, and re-tightening if necessary, all electrical and mechanical connections (lugs, terminals, fuses, buss bars, etc.)



WARNING: Before Touching Controller Parts, Make Sure Power Is Disconnected.

4.8 Troubleshooting

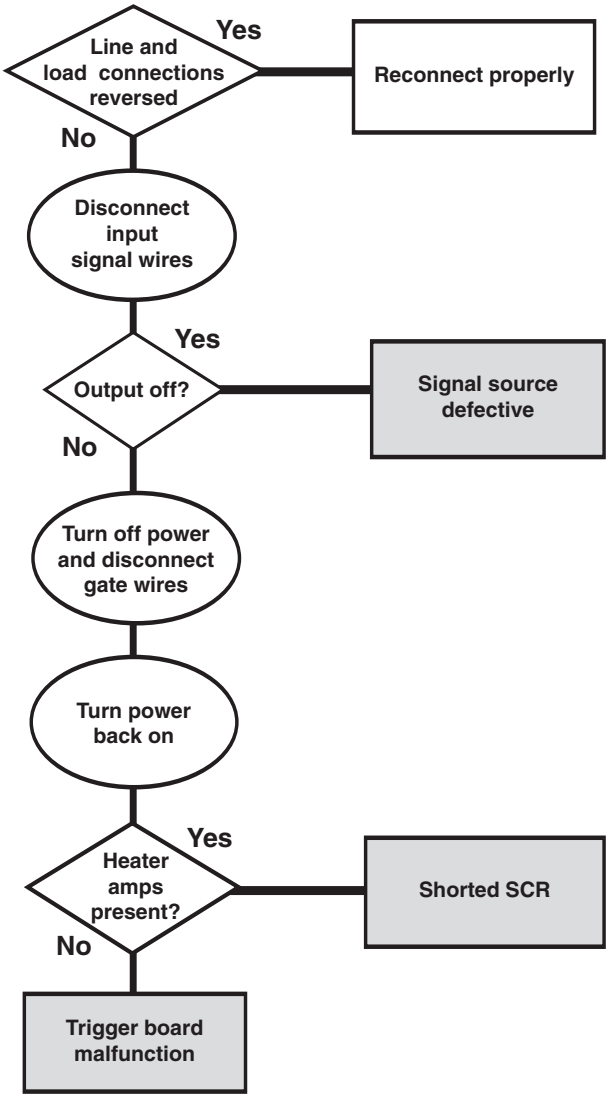
If the power controller is not functioning properly, refer to these troubleshooting procedures.

Symptom: No heat or reduced heat output.

Possible Cause(s)	Action
1. Loss of line voltage.	Check power supply.
2. Line fuse or controller fuse blown.	Check heater for short circuit and correct problem.
3. No input signal.	Check signal conditioner.
4. Malfunction on trigger board.	Consult factory.
5. Open SCR	Consult factory.

Troubleshooting Flowchart

Symptom: Heaters will not turn off.

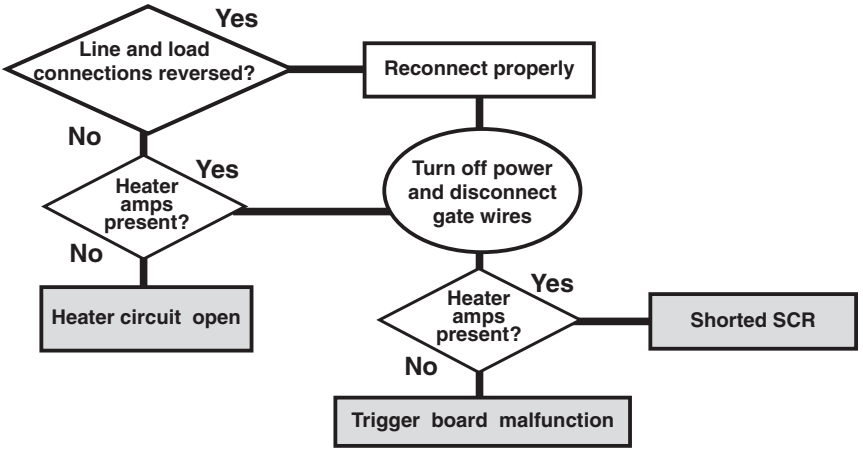


Input Signal Problems: In normal operation, the green LED will illuminate if an input signal of proper polarity is present. Its brightness indicates signal level.

Symptom: Red or amber input LED is lit
Red: Polarity of input signal is reversed (Change polarity).
Amber: AC on input signal (Check signal source).

Output Signal Problems: In normal operation, the amber LED will illuminate if an output voltage is present. Its brightness indicates output level.

Symptom: Output LED lit with no input.



Symptom: Output LED is red or green with input.

Check and correct the following conditions:

1. Gate wire unplugged or broken
2. Open SCR
3. Trigger board malfunction
4. Balance pot misadjusted (Phase-angle controllers only)

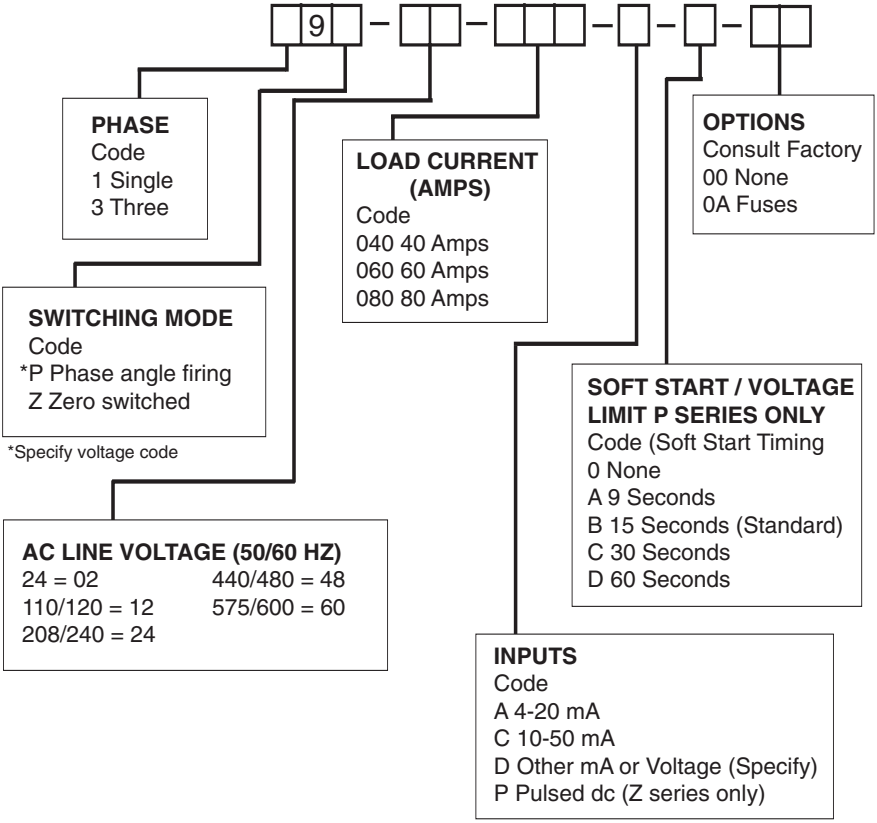
Section 5. Parts Lists

Series 19/39

MODEL # (Voltage / Load)	FUSES	SCR MODULE (19P, 19Z, 39Z)	SCR MODULE (39P)
24040/12040	A050F040	IRKT 57-10	IRKH 72-10
24060/12060	A050F060	IRKT 57-10	IRKH 72-10
24080/12080	A050URG080XAA	IRKT 92-10	IRKH 92-10
48040	A050F040	IRKT 57-10	IRKH 72-10
48060	A070F060	IRKT 57-10	IRKH 72-10
48080	A070URGC080WA	IRKT 92-10	IRKH 92-10

Section 6. Model Identification

Ordering Codes: Series 19/39



Ordering Example:
Model 39Z-24-040-P-0-00
Three phase, zero switched,
208/240 Vac line voltage, 40 amps,
pulsed dc input, no options, no timing.
(Use "0" for all spaces not used.)

ACCESSORIES
Manual Station with Remote Potentiometer
(Requires Input "A" on SCR unit)
90M001-120 (120 Vac supply voltage)
90M001-240 (240 Vac supply voltage)
90M001-480 (480 Vac supply voltage)
90M001-600 (600 Vac supply voltage)

Section 7. Dimensions

Series 19/39

19Z	19P	39Z	39P
Dimensions H x W x D (in)	**Dimensions H x W x D (in)**	**Dimensions H x W x D (in)**	**Dimensions H x W x D (in)**
7 x 4.75 x 4	7 x 4.75 x 4	7 x 9.62 x 4	7 x 14.37 x 4

Notes: If fuses are added to unit, add 3 1/4". Overall depth is 4".

Warranty

This equipment is warranteed to be free from defects of material and workmanship. It is sold subject to our mutual agreement that the liability of the manufacturer is limited to replacement and/or repair at its factory, provided the equipment is returned, transportation prepaid, within one (1) year of purchase.

The purchaser agrees that the manufacturer shall assume no liability for consequential damages resulting from its use or from packaging of shipments returned to the factory.

Components that wear or are damaged by misuse are not warranted. These include contact points, fuses and triacs. Units that have been customer modified are not warranted.

Specifications are subject to change without notice.